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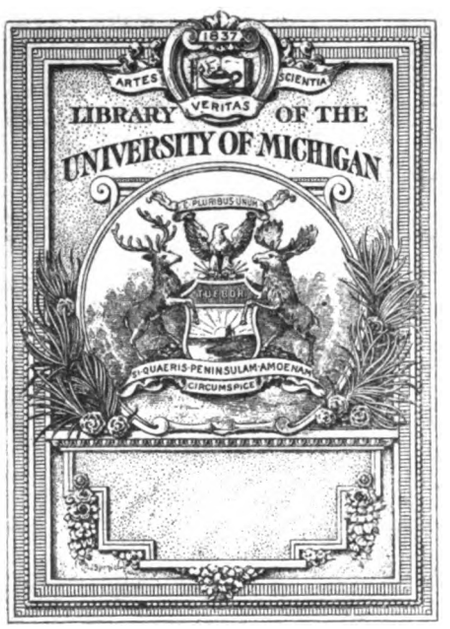

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OURSELVES.

In this our first issue of the New Year we have altered the general arrangement of our paper, with the hope of making it more convenient to all classes. Our intention is to improve, and we shall welcome the co-operation of our readers to this end. Any news of business likely to be forthcoming will be welcomed if sent direct to us.

1908.

Gentlemen, the usual toast: To all our readers and their friends a year of health and prosperity. Drunk with enthusiasm in bumpers, and no heel-taps.

There is a double difficulty in addressing any audience at the beginning of a new year, in that the books are written up and the balances declared. Throughout the electrical trading community there has been, and is, some wailing and gnashing of teeth. Prosperity, according to the pessimists, hath fled, and in the future there is nothing but woe. We have heard that tale before. Indeed, it seems to be the fashion to decry the possibility of good trade, and yet there is nothing more certain than that the demand for electrical goods and apparatus of all kinds does appreciably increase with each succeeding year. Why, then, all this fuss? For two reasons. In the first place, it is another case of too many cooks spoil the broth. Firms and companies of various kinds spring up, and in the rush to get business are quietly cutting each other's throats. In many cases the taking of orders at too low a price has been followed by the installation of apparatus that only by the wildest stretch of the imagination can be regarded as passably good. In the second place, there has been far too much promotion. Schemes that of themselves are excellent have been damaged by the incubus of the plunder of promoters. Case after case could be cited where the prey is the investing public, rushing to the lure of the promoter's prospectus and in the end finding, like the fox did the grapes, modest results to be out of reach. Yet, as we say, the fact remains that the demand is, and must be, constantly increasing. Years ago, yea, from its commencement, this journal insisted upon the view that the future of electrical undertakings existed in the distribution of power, and that ultimately lighting would take a secondary position. No one would be found to dispute that view now, but originally it called down curses upon our heads because promoters thought wrongly that this idea would deter investment. As things are known at present there is every indication that electrical motors must be as common throughout the civilised world as the sands are on the seashore. If that is so, then electrical manufacturers and contractors must increase and multiply. There is one unfortunate outlook. Several of the large pioneering firms seem to be coming to a premature end. They went up like the proverbial rocket, and are rapidly falling down like the proverbial stick. You never see mention of their work, or, indeed, never see the name in the real technical journals, and yet the organisers seem to imagine their names and makes of apparatus will remain known to all the nations of the world till the end of the electrical era comes along. Probably the various (we are speaking of the best, and of what we know and can demonstrate) journal offices, each are asked to privately report upon the value of apparatus on the market more than any of the greatest manufacturing concerns in the kingdom, and these requests for information come from all parts of the world. To the insider it is easily understood why some

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firms are prosperous and others always grumbling. The former take good care that their productions are thoroughly known and understood, the latter are too stand-offish for this world; hence are taking the best means of leaving it. Thus, if we could inculcate a moral, it would be something to this effect—business is and must be increasing; purchasers do not mind a fair price for a good article; manufacturers are supposed to be business men, and as such should not think it below their dignity to give detailed information about their work. Good work in the centre of Ireland does not speak for itself in Australia or Argentina, and it is often from the further away places that the request for information comes. The conclusion is that publicity must be sought if a steady business is to be maintained. This world-wide publicity we provide.

1907 DEATH ROLL.

The year just ended has entailed a heavy loss from the ranks of those who have distinguished themselves in electrical science. Amongst the pioneers in the commercial development of electrical engineering death has been also responsible for many gaps. The death of Lord Kelvin naturally takes the first place in any review of those eminent men who have been removed from the rank of workers during the past year. He stood so high above his fellows, both as a pure scientist and as an electrical engineer, that there can never be his equal in the electrical world. Approaching electrical science in its infancy, he did more original work than can be properly summarised in a full obituary notice. Amongst the other eminent engineers who have passed away during 1907, Sir Benjamin Baker claims, perhaps, first place on account of his success in all branches of civil engineering. His work in connection with electrical matters was in itself sufficient to warrant the many honours showered upon him. Mr. W. F. L. Gaine, the energetic manager for many years of the National Telephone Company, may be considered by some to have been more of a business man than an electrical engineer. His organising capabilities, however, like those of Mr. George Herring, the late chairman of the Electric and General Investment Company, were devoted to the development of electrical enterprises in the early days when money was hard to obtain for such purposes. In Mr. J. N. Shoolbred we lost one of the engineers who led municipal authorities to undertake electrical work. The list of other workers who have passed away is, unfortunately, a long one, and amongst the pure scientists we have to deplore the loss of such distinguished leaders as Henri Moissan, Prof. Mendelejeff, M. Berthelot, and L. F. Vernon-Harcourt. Amongst the engineers more directly connected with the practical side of the electrical industry we miss Mr. J. Kincaid (who did more for tramways than any other engineer), Mr. John R. Brittle (eminent in submarine cable laying), Sir James Ferguson, H. Brehmlaender, Dr. C. Liebenow, David Lumsden, G. Winter, M. Serpollet, J. A. Timmis, and Friedrich Uppenhorn. Amongst the ranks of editors we have lost Mr. E. Hospitalier, who was also a leader of electrical progress in France, and Mr. J. W. Johnson, who for years owned and edited the *Electrical Engineer* of New York, and Mr. P. F. Nursey.

THE PROPOSED HOME OFFICE REGULATIONS.

Mr. Frank Broadbent has collected the objections raised by various bodies to the proposed Home Office regulations, and in a paper which he recently read before the Electrical Contractors' Association he dealt seriatim with the proposed regulations. A common objection raised has been as to the general nature of the rules, and also as to the restrictive tendency of some of them. Mr. Broadbent, however, defended the regulations, and contended that the Home Office mining regulations were more restrictive than the factory rules. Touching upon the regulation relating to switches and fuses, to which so much exception has been taken, Mr Broadbent pointed out that what appeared to be aimed at by the rule was not necessarily the provision of a separate switch to every fuse, but that there should be power of making a fuseway dead in order to replace the fuse wire. This condition is met by the provision of a double-pole switch to each distribution box. An alternative is, however, provided—namely, to make the switch of such a type that no shock or burn can be obtained in handling it. He further pointed out that fuses of the well-known porcelain tubular handle pattern, with exposed live ends, were not altogether in conformity with the Home Office requirements. Such a pattern certainly did not meet the conditions of the Home Office proposed regulations, according to which either wide porcelain flanges must be provided at the ends of the tube or the live ends must be entirely covered. In Mr. Broadbent's opinion the type of fuse which is really called for is that known as the switch-handle pattern, in which the fuse and its contacts are all fixed below a screened insulating handle. Mr. Broadbent considered that the regulation which would be most strenuously objected to was that relating to motor-starting switches, which calls for the provision for each motor above ½ h.p. in size of a starting switch provided with a no-voltage release, unless the arrangements are such that the motor could not start on the supply being restored after a failure of supply. The chief objections to this rule are, *inter alia*, that it would tend to restrict the use of small motors, and, further, that the regulation should not apply to polyphase work. But Mr. Broadbent pointed out that even were such objections sound ones, they applied equally to the institution rules which were drawn up by the very men who were now objecting to the enforcement of the rule by the Home Office. Mr. Broadbent was of opinion that it would be to the general advantage of the industry if a code of rules were adopted which could be made compulsory under penalty for non-compliance, though we doubt whether the interests of electrical contractors will be promoted by the issue of regulations alone.

CAPITAL FOR ELECTRICAL ENTERPRISE.

To those connected—in one way or another—with an industry in which so much capital has been invested (such as the electrical industry), the compilation of figures relating to the flotation of companies and the raising of new capital generally must have a peculiar interest. If only for this reason, then, the exhaustive data relating to capital application in 1907 given by our contemporary, the *Economist*, are to be welcomed. On looking into the figures we find that in the closing quarter of 1907 the total amount of applications is £18,265,000, as compared with £24,013,000 in the December quarter of 1906; the total for the year being £123,630,000 against £120,173,000 in 1906, and £167,187,000 in 1905. As will be seen from figures which we will show in a moment, applications for substantial sums by various descriptions of electric power and lighting enterprises were made. It would be of exceptional interest to us if we could have figures showing the sums applied for for the manufacturing side of electrical engineering, but these, we suppose, have been grouped by our contemporary under the heading of "Iron, Coal, Steel, and Engineering," to which was applied in all—about

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2¼ millions—a sum almost wholly in the form of new capital issued by existing companies. Subjoined is a statement for the quarter and the whole year, with a comparison of the amounts raised for similar purposes in the previous year:

Description.	1906.	1907	
		Fourth quarter.	Whole year.
Electric lighting, power, telegraphs, etc.	£ 5,316,400	£ 1,324,200	£ 10,471,200
Tramways and omnibus	2,669,100	464,000	1,085,500

It is thus seen that electrical enterprise was responsible for a sum of over 10 millions. The *Economist* explains, however, that quite three-quarters of that sum—consisting of bonds offered by the American Telephone and Telegraph Company — which, though offered here simultaneously with the issue in New York, were not probably taken up by British investors to any large extent. Fairly substantial amounts were offered by electrical enterprises operating in Canada, Mexico, and the River Plate, as well as by home lighting and power undertakings. On the whole the figures are not unsatisfactory, bearing in mind the circumstances prevailing throughout the year. Our only hope is that the manufacturing side of the British electrical industry will derive some advantage from electric lighting and power enterprise.

THE G.B. SURFACE-CONTACT SYSTEM.

This system is being used for the line that the London County Council are now laying along the Mile End-road, and therefore the lecture delivered by Prof. J. T. Morris, M.I.E.E., at East London College on Dec. 19 was decidedly appropriate. Mr. Morris is professor in electrical engineering at this college, and has made several experiments upon the apparatus of the system. The chair was taken by Prof. C. A. Smith, B.Sc., of the same college. Mr. Bedell, the inventor of the system (its full name is Griffiths-Bedell) was present.

In opening, Prof. Morris made a few remarks about tramway traction in general and then passed to the G.B. system. The London County Council are using this system in the Mile End-road because of the special condition of the road. There is not sufficient depth for the conduit system, as the underground railway runs beneath, and the borough authorities strongly opposed the overhead system. The only other example of the system is found at Lincoln, where a line about three miles long has been working satisfactorily for a considerable time. The method of working is as follows: A magnetised skate, attached to the car by insulating bolts, slides over a series of iron studs in the roadway along the centre of the track.

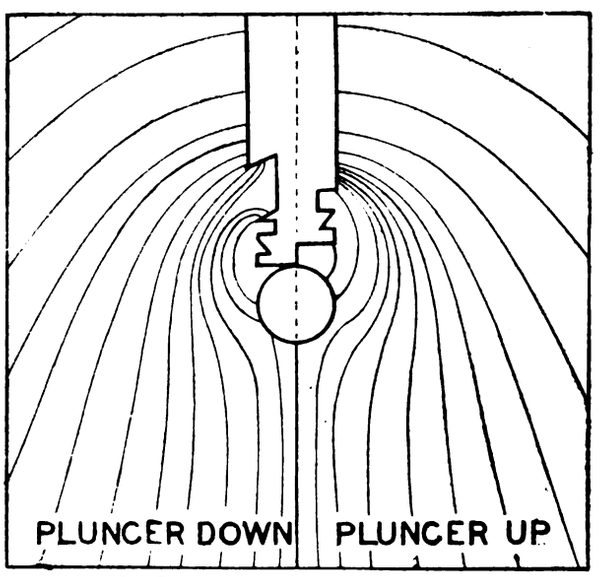

FIG. 1.—Flux Distribution round the G.B. Surface-Contact Stud.

The skate magnetises the stud and actuates a switch connecting the stud to a live conductor beneath it, and thus supplying current to the car. Immediately the skate leaves the stud the switch automatically opens The skate employed in the G.B. system is flexible, and in consequence allows the studs to be level with the road surface. It is made up of iron links strung on a flexible cable and supported by vertical springs in a slot running along one pole of an electromagnet. Normally the skate is 2in. above the road surface, but any part that is over a stud is attracted down and makes contact with it. The magnet consists of two long poles, one above the other, connected by three yokes on which the coils are wound. The skate is attached to the lower pole. The coils are supplied with current from the underground conductor, and a battery is provided for use when the car is standing still. The construction of the stud is as follows: From the cast-iron plate in the road surface two soft-iron prongs, or cheeks, project downwards. Between these the plunger,

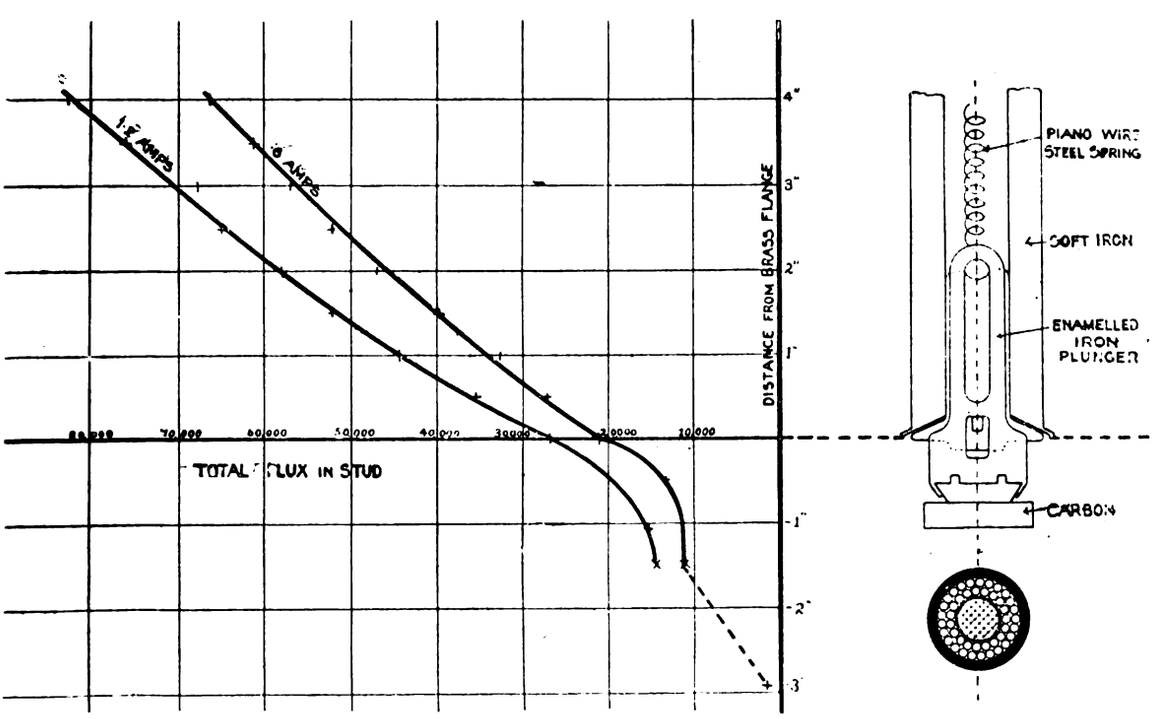

FIG. .—Distribution of Flux in G.B. Stud.

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or switch-piece, is supported by a vertical spring. When the stud is magnetised, the plunger is forced out from between the cheeks and a carbon block at the lower end makes contact with the underground conductor. Current then flows from the conductor up through the plunger by flexible leads to the stud, and thus to the car. The spring is insulated and does not carry current. It is also heavily plated to protect it against rust.

The underground conductor is bare, and is made up of a centre of jute surrounded by a ring of copper wires. These are, in turn, surrounded by two rings of galvanised iron wire, and galvanised iron tubing in 6in. lengths is fitted over all. This cable is drawn into earthenware pipes, and is supported near the top of the pipes on reel-shaped insulators, one at each stud. The lengths of pipe are connected by waterproof joints of tape and pitch inside an iron sheath. Alternate lengths have a stalk projecting upwards in which the stud fits. A cavity is left in the granite blocks, below the road surface, and filled in with pitch, thus sealing the stud into the pipe. The cable being bare is subject to electric osmosis. Provision is made to protect the cable. The iron pins on which the insulators fit project on one side outside the pipe. These ends are then all connected by hoop iron. The action then takes place on this iron instead of on the cable. The theory of the action of the plunger is this: The stud is magnetised in

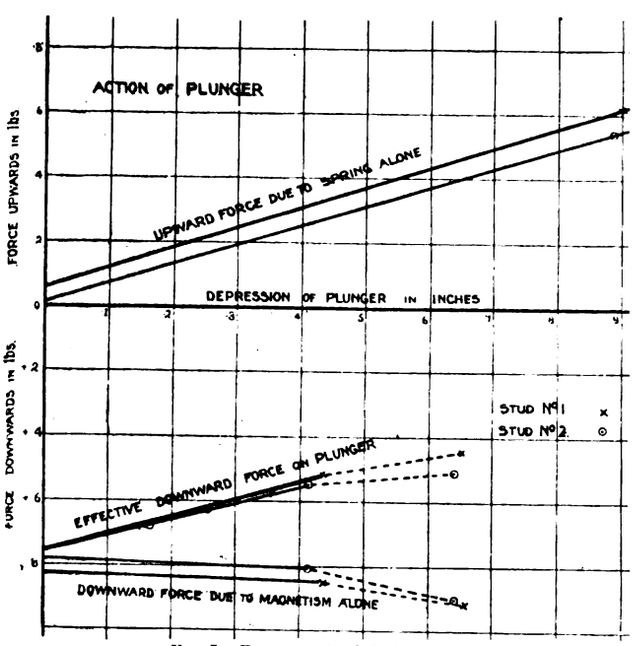
ACTION OF PLUNGER
FORCE UPWARDS IN lbs.
UPWARD FORCE DUE TO SPRING ALONE
DEPRESSION OF PLUNGER IN INCHES
FORCE DOWNWARDS IN lbs.
STUD No 1
STUD No 2
EFFECTIVE DOWNWARD FORCE ON PLUNGER
DOWNWARD FORCE DUE TO MAGNETISM ALONE

FIG. 3.—Forces on the G.P. Plunger.

such a way that two N poles (the skate being a N pole) are formed at the ends of the cheeks. The plunger is magnetised with a S pole at the upper end and a N pole at the lower end. The S pole is attracted by the two N poles and the N pole repulsed by them, and the result is that the plunger is forced out against the pull of the spring. Fig. 1 shows the magnetic field of the stud with the plunger up and down, and Fig. 2 the total magnetic flux through the different parts of the stud. The ·6 ampere curve gives working condition. The value of the induction density, B, near the bottom of the cheeks is about 4,000.

It is obvious that if ordinary iron rails were used at points and crossings, the skate would be attracted to the rail as well as to the studs, and would short-circuit the 500-volt supply. To prevent this, manganese steel is used at such positions. This steel, which consists of 88 parts of iron to 12 parts of manganese, is practically non-magnetic. Further protection is provided in a special type of stud. In this stud the upper and lower parts are insulated and connected by cable through a resistance of eight ohms. This resistance limits the short-circuit current to 60 amperes. The resistances are placed three or more together in a pit under the road. It is, of course, quite possible for the spring to break and leave the stud permanently alive. We do not, however, consider this a weak point in the system. At Lincoln, from August to December, not a single live stud was found. Every car is fitted with apparatus for detecting live studs. A steel brush is carried that slides over the stud after the skate has left it. If the stud is still alive, current from the brush either rings a bell or opens the canopy switch. In the London line the studs are 6ft. apart instead of 9ft., as at Lincoln. The shorter distance is necessary, as it is required to use the cars on the conduit system as well as on the surface-contact, with the result that only a short skate can be employed. Fig 3 shows the actual forces acting on the plunger It will be observed that the resultant force has its maximum value at the commencement of the motion, thus giving sharp action. Some figures as to the comparative cost of overhead, surface-contact, and conduit systems are interesting. The surface-contact costs about 20 per cent. more than overhead. The conduit system costs close upon double. A question as to the braking effect of the skate sliding over the studs elicited from Mr. Bedell the information that the actual pull between the skate and the stud has been adjusted to 3lb.

Prof. Morris is to be complimented on an interesting and instructive paper, and Mr. Bedell deserves thanks for the complete information about his system that he has supplied. Increased confidence in it should repay him for his trouble.

SIBERIA AS A MARKET FOR ELECTRIC MINING MACHINERY.

The manufacturers of electrical machinery in this country are not so engrossed in developments at home as to afford total neglect of the rest of the world, and in this connection Siberia opens up an important sphere in the export mining machinery trade. We are indebted to an article by Mr. L. Lodian in our American contemporary, the *Selling Magazine*, for a very succinct and informative article on this country as a market for mining machinery. It is, of course, written primarily in the interests of American manufacturers, but there is no doubt that the points which he enumerates are of considerable value to the manufacturers in the old country who wish to develop their sales in this part of the world.

The first difficulty which is encountered in the sale of machinery in Siberia is the fact that the executive staff of the mines in this region, which is situated at the works, is dominated by an overwhelming financial interest in a board of directors situated thousands of miles away, probably in St. Petersburg. It is a most difficult matter for the mines manager to convey to his directors an adequate sense of the urgent need for new machinery, and this state of affairs can be readily realised by English manufacturers if they first of all remember the difficulty which they now experience in selling machinery for the development of African mines to a board situated in London, and then recollect that, instead of dealing with gentlemen within easy reach of a few moments' telephonic communication from their own head offices, they would have either to trust to the resources of letter writing in a foreign language, or to send a specially-qualified representative to treat, either in St. Petersburg or Siberia, with the men responsible for expenditure of capital on plant. The advice given by Mr. Lodian, therefore, appears very sound, which is to put a considerable amount of expenditure and time on the preparation of efficient catalogues, which shall be so complete, both in description and pricing, as to answer every requirement of the possible buyer. Mr. Lodian writes, "I am a certain believer in catalogues, especially after noting how the Continental European ones were prized and guarded in the remote works of Siberia—more than family Bible ever was." It will be gathered from this that the Siberian mines are already being exploited by Continental machinery makers, and an instructive paragraph tells how the astute French or German firm will add to their quotation the full cost of a year's, or even two or three years', advertising contract in the journal through whose advertisement the order has come. This arises from the fact that Siberian mining managers mainly derive their engineering information from French or German mining journals. It is from

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this source that they obtain the names of suitable firms from whom to obtain mining appliances, and they usually mention the name of the journal when applying for catalogues; as a result there is a considerable amount of French, German, and Belgian machinery in Siberia, and not very much English or American. As illustrating the length to which some Continental firms are prepared to go, this writer, who from his former residence in Siberia is well qualified to make strong assertions, states that there are numbers of a certain make of rock drills to be observed all over Siberia purporting to be of American manufacture, but being in the majority of cases counterfeits cast (with the makers' name, patent, wording, and numbering complete) in their entirety in that land *par excellence* of the counterfeiter—Germania! It should, therefore, seem that it would be worth the while of English manufacturers to pay special attention to the preparation of ample catalogues in the Russian language for distribution in Siberia.

There are certain points with regard to the construction of such catalogues which, Mr. Lodian points out, need to be carefully watched. The first is that the Russian mining engineer has been educated in the metric system as well as the Russian national measurements, and compared with either the Russian or the metric systems the English measure of inch, foot, and yard is preposterously complicated. This not only holds good in the ordering of the original machinery, but in the provision of renewals. It would be by no means a simple job for a Russian engineer to send a wire to an English firm for a duplicate part expressed in measurement of feet and inches, whereas it is a comparatively simple thing for him to detail metric measurements. For this reason the dimensions stated in the catalogue intended for the Siberian market should be expressed in metric measure. The question of expense of printing in a foreign language may be partly met by lavishly illustrating the catalogue; indeed, the writer of the article suggests that if the illustrations are only frequent enough the language of the catalogue does not materially matter. This may be true generally, but we fear that cases of grave misunderstanding might arise if photographic representations, or even dimensioned drawings, were solely relied upon to give information. It must, however, be insisted upon that a catalogue unadorned by a considerable amount of illustrations is one entirely useless for this market, and hence follows the proposition that any catalogue intended to compete with Continental trade must be a well got-up and expensive matter.

Having regard to this necessity of expense, the problem is to dispatch each individual catalogue in such a way that it is not wasted either by the process of non-delivery or by arrival in a damaged and unpresentable condition. To start with, the utmost care should be taken in enclosing the catalogue in a suitable covering to withstand the amount of wear and tear it is certain to receive in transmission. Every precaution should be taken at the home end to ensure that the catalogues are posted carefully—that is to say, they should be delivered by a responsible agent direct to the General Post Office, and not bundled and crushed into any odd letter-box. A considerable amount of effect depends on receipt in a good condition of a catalogue by a manager to whom it is sent. Once it reaches its destination in such a place as Siberia, it is by no means as likely to reach the waste-paper basket as a similar catalogue addressed to a home firm which daily receives so much of this kind of thing. It is, therefore, a paying proposition to send good catalogue matter to out-of-the-way areas, and Siberia is pre eminently an area to be developed in this connection.

One of the heaviest ways in which Continental electrical machinery manufacturing firms are hitting English firms is in their terms of payment. The *Board of Trade Review* for November contains an instructive report from the British consul at Madrid, in which he states that Continental makers in dealing with Spanish markets are prepared to usually accept one-third cash with order, one-third on delivery from works, and the remaining third three months afterwards, while they very frequently take deferred payments extending over a year or even two years. The same thing holds good in Siberia. Mr. Lodian states that Continental firms usually credit for six, nine, and twelve months; this he denounces as an evil, and strongly recommends American manufacturers to insist on a cash basis, pointing out that the cost of collection of such long term payments frequently converts a profit into a substantial loss. At the same time, there is no doubt that in this way Continental makers have pushed their sales in this region, and even if British firms are adverse to doing business on this basis, it is well for them to know what tactics are being pursued by competitors.

The value of such an article as the one to which we have referred, written by a man who has had actual working experience of the area concerning which he writes, is immense, and it is to be hoped that English electrical manufacturers will seek to make good the deficiency in English goods in this nearest point of Asia by means of a judiciously lavish expenditure in well-constructed catalogue matter.

THE COMMERCIAL ASPECT OF ELECTRIC POWER SUPPLY.*

BY W. B. WOODHOUSE, ASSOCIATE MEMBER.

Although it is now becoming more generally recognised that the development of a general supply of electric power in the industrial areas of England is a matter of vital importance to the country at large on account of its commercial value, there are yet many obstacles in the way of the full realisation of such a development As these obstacles are largely due to an imperfect conception of the advantages and possibilities of centralisation, it is hoped that a general discussion of the commercial aspect of the question, together with a consideration of the future trend of developments, may be of interest.

Progress of Legislation.—A glance at the history of electricity supply in this country shows that in the beginning the business was built up entirely on the basis of supply in isolated areas, the boundaries of which, for the sake of convenience, were made coincident with those of parishes or other administrative districts. For various reasons it was enacted that a company wishing to undertake the supply of electricity in any area must obtain the consent of the local authority concerned, to whom also was conceded a right of veto without necessity of adducing a reason for their action. This privilege, which has acted so harmfully in retarding the development of the industry, was probably granted in order to prevent the creation of a monopoly similar to those enjoyed by previous concessionaires, such as gas, water, and railway undertakers, which have in certain cases proved somewhat burdensome. Recent events would appear to show that this fear of establishing an injurious monopoly still haunts the minds of our legislators, despite the fact that the supply of electricity for light or power is subject to as severe competition as any commodity which can be mentioned. To quote Mr. Ferranti, the monopoly conferred on authorised undertakers is, if it exists at all, "a monopoly of cheapness." The electric lighting business developed along the definite lines laid down by the framers of the early Acts, but the growth of the use of electric power for urban tramways and for general purposes considerably altered the working conditions of the existing supply stations. The overflow of the population of large towns beyond their boundaries, the development of inter-urban tramways, and the foreshadowing of a general electrification of the railways, led to the passing of Power Acts as a solution. The provisions of these Acts are based on the recommendations of Lord Cross's committee of 1898, in which the benefits of supply over a large area and the damaging effect of the veto and powers of purchase possessed by local authorities were recognised. The first batch of Power Bills was considered in 1900 by a committee presided over by Lord Airedale (then Sir James Kitson), and the declaration of that committee as to the lines on which clauses were to be settled marks an important step in the progress of electric supply. Prejudices die hard, however, and the local authorities devoted their energies to the crippling of power supply by the insertion in Power Acts of restrictive clauses; not only was the veto of the local authority maintained in the case of towns having

* Paper read before the Institution of Electrical Engineers.

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their own electricity works, but also in many cases where no supply of any kind was available. A comparison of the Acts of 1900 with those of later years shows the disastrous effect of such opposition. The South Wales Act of 1900 may well be compared with the Lancashire Act of 1901 in this respect. In 1902 our Institution marked its sense of disappointment with the state of affairs in the resolutions of March 25, which are worthy of quotation in full (see appendix), but it is lamentable to state that legislation on this matter is yet unaltered.

The Technical Problem.—While the legislative changes mentioned above were being made, the technical problems of electricity supply had also changed in a remarkable degree. The growth of the demand for electricity for power purposes has led to the adoption of larger generating units, which has facilitated distribution over a larger area at high pressure, and the economy of the large generating station—and inferentially the uneconomy of small stations—is now an accepted fact. The commercial limitations to the size of a generating station which underlie the whole financial problem of power supply may be briefly summarised as follows: The argument for centralisation is (1) reduced capital expenditure per kilowatt of generating plant due to increased size of units; (2) increased efficiency of plant; (3) improved load factor due to diversity of requirements and demand; (4) reduced wages and management charges; (5) small proportion of stand-by plant. Against which must be set the disadvantages of: (1) extra capital expenditure on transmission; (2) losses in transmission and conversion. Practice has shown that the small generating station cannot produce electricity at a price sufficiently low to enable it to be supplied to power users at a competitive price. A station of 1,000 kw., for example, cannot hope to supply a power user requiring 300 kw. as cheaply as the power user can generate for himself; this for several reasons. First, the capital cost of the generating plant in both cases will be practically the same per kilowatt, while the public supply is burdened with an additional cost for mains; secondly, the owner of an isolated power plant will usually install a smaller proportion of stand-by machinery, setting the increased risk of shut-down against the reduced capital charges; thirdly, the public supply station must run continuously, often at very inefficient loads, whereas the isolated plant—a mill engine, for instance—is only run during certain definite hours, so that the "working load factor" is greater and the works costs less in case of the latter. Apart from this, one finds that the owners of isolated power plants very frequently do not include any allowance for rent, management charges, etc., in estimating their power costs, so that the difficulty of the supply authority obtaining such a load is increased by the power user's want of appreciation of all the items making up power costs. Assuming the power user's load factor to be equal to that of the supply station, the author's experience is that the limiting size of a consumer's installation which can profitably be supplied from the central station is from one-tenth to one-fifth the capacity of the station plant. As, however, the size of the generating station is increased, the advantages of centralisation come into fuller play, although to some extent counterbalanced by the increased capital expenditure on distribution and by the increased losses. These disadvantages of centralisation depend on local conditions, such as the density of the power load per mile of main and on the nature of the load supplied. In any particular case a balance will occur at some point—that is to say, there is a limit to the economical radius of distribution, and, therefore, to the size of the generating station required. It does not appear that there is any limit to the size of the generating station on the score of efficiency and cost per kilowatt.

Capital Cost.—To take round figures, the capital cost of generating stations of various sizes is as given in Table I.

TABLE I.

Capacity of station. Kilowatts.	Cost per kilowatt. £	Relative cost per cent.
60,000	10	100
6,000	15	150
600	20	200

That is to say, if 100 consumers each requiring 600 kw. combine together in a joint station, the total capital expenditure on generating plant would be one-half of that required for isolated plants.

Efficiency.—The improvement in efficiency due to the use of large units may be seen by considering some typical figures of turbine steam consumption (Table II.). To the full-load test figures the author has added an estimate of the average working figures in stations with a load factor of 25 per cent.

TABLE II.

Size of generating set.	Test figures. Full-load consumption in pounds per kilowatt-hour. Water.	Coal.	Working figures. Estimated coal consumption.	Relative cost per cent.
3,000	15	1·875	3·125	100
600	20	2·500	4·160	133
300	24	3·000	5 000	160

It will be seen that the coal consumption of the smallest unit is 60 per cent. in excess of that of the largest.

Load Factor and Diversity.—Supply over a large area brings with it the supply to power users with diverse requirements—lighting, traction, general power users, and collieries, for example, each have different hours of use, and in each case the peak load occurs at a different hour in the day. Experience shows that the station demand will not exceed one-third of the total lighting connected to the system, nor one-half of the power installed by power users, and that if the individual maximum demands of a number of power users be added together that figure will be from 50 to 100 per cent. in excess of the demand at the generating station, with a consequent improvement of the load factor.

Works Costs.—As to the saving in wages and management charges in the larger station, this depends on so many variables that general figures are not of great value. Since, however, one man can attend to a 3,000-kw. set as well as he can to a 300-kw. set, the saving is obviously considerable. The effect of load factor on works costs is still more important. Table III. is a statement drawn from the author's experience of the effect of load factor on works costs.

TABLE III.

Item of cost.	Load factor. 15 per cent.	30 per cent.	60 per cent.
Coal	100	70	55·0
Wages	45	25	12·5
Stores	10	8	6·0
Repairs	50	40	30·0
Total	205	143	103·5
Relative cost per cent.	198	138	100

Summary of Advantages.—Summarising the advantages of centralisation and the consequent diversity of demand, it will be seen that diversity of demand has effect both on capital and running cost. The capital cost of generating plant per kilowatt installed in the large power scheme may be taken at one-half that of a small power station. The diversity factor will approach 2—*i.e.*, the large scheme has the further advantage of requiring only one-half of the plant required by the individual consumers if isolated stations were erected, or, taking the two advantages together, a capital expenditure per kilowatt of demand of one-quarter. The works costs are reduced both on account of increased size of generating sets and improved load factor, the latter advantage representing a saving of 50 per cent. over the works costs of the average power user. We may express the total saving due to centralisation by a curve (Fig. 1). It will be seen that before equality of expenditure on isolated and public supply plants is obtained, the expenditure on transmission and distribution may be three times as great as that on the station, and the losses and costs of distribution may be increased by 100 per cent. Naturally these extreme figures are never reached in practice, and, therefore, the margin in favour of the power company is a very considerable one.

Sources of Fuel.—The prospect of the generation of electricity on a large scale has led engineers to seek for new sources of fuel, and the generation of power by the utilisation of waste heat from blast furnaces, coke ovens, and similar thermo-chemical processes now forms a separate study. It may be safely predicted that future developments will consist in the co-operation of electric supply

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undertakings with processes of manufacture in which fuel or heat is merely one of several products to be dealt with. The conditions of the electricity supply will no longer be the sole factor in determining the situation or magnitude of a generating station, but the economical handling of the other products of manufacture will also have a determining effect upon the decision. The sources of power such as those above mentioned either are or should be placed outside large residential towns, and the utilisation of such sources to their full effect would appear to involve the joint working of a number of stations. Such joint working can only be economically carried on by running certain of the stations at their full capacity continuously, fluctuations of demand on the system being dealt with by stations specially designed for the purpose. For example, there are a number of collieries in the West Riding where waste heat from coke ovens is available to an amount equivalent to from 1,000 kw. to 2,000 kw. To erect at each battery of ovens a generating station with spare plant sufficient to ensure a continuous supply in the event of breakdown, and to supply from such a station a fluctuating load such as a general power supply demands, is not an efficient arrangement. The high cost of the small generating units per kilowatt, the cost of management, and the partial use made of the plant all tend to increase the cost of supply. When, however, a number of such stations are worked in conjunction by a power company, the amount of spare plant may be reduced to a minimum, and each station would consist of a single generating unit, with no spare plant, running continuously at full load or else shut down completely. The resultant economy of capital expenditure and operating costs of such an arrangement is considerable. This is rather a reversal

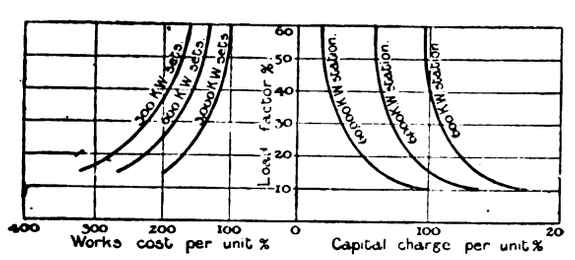

FIG. 1.

of the present idea of the peak load station, the author's view being that the station dealing with fluctuations would contain the biggest and most economical units, and would be the largest station of the system.

Electro-Chemical Development.—The development of electro-thermal and chemical processes introduces a class of load of high load factor, which, added to a general supply, increases the load factor on the system. But where, as is usual, the demand is a large one, the price at which it could be generated in a station designed specially for that purpose is so low that only a large undertaking could offer a supply at a corresponding price. There is, however, a possibility of development in the use of a restricted supply of current varied according to the power station's requirements and designed to equalise the demand on the station. The curves Figs. 2 and 3 may make this clearer. Fig. 2 represents a typical variation of maximum demand on a station throughout a year, the growth of load being accompanied by the seasonal variation due to lighting, etc. Fig. 3 is a typical load curve for a winter's day on a station supplying light and power. It will be seen from the two curves that there is necessarily a considerable amount of generating plant which is lying idle for the greater part of the year, its use being, in fact, only required for a few hours a day in the winter months. If a load can be found which may be varied inversely as the normal demand, then a profit may be earned by such machinery throughout the year. The author has recently arranged an agreement on these lines for the Yorkshire Electric Power Company with a company manufacturing calcium carbide by electric furnaces. The improved conditions under which the station will operate should show a considerable decrease in the average costs of production.

Co-operation. — The arrangements mentioned above involve co-operation between those who produce waste heat, the general power user and the power company, and, in fact, the power company may be regarded as a joint committee of such manufacturers. The co-operation of collieries alone through such an agency would effect an enormous annual saving. The output of coal for Yorkshire in 1906 was 33 million tons, and assuming, as we fairly may, that 5 per cent. of this was used for power purposes by various collieries, we have an amount of fuel which, if

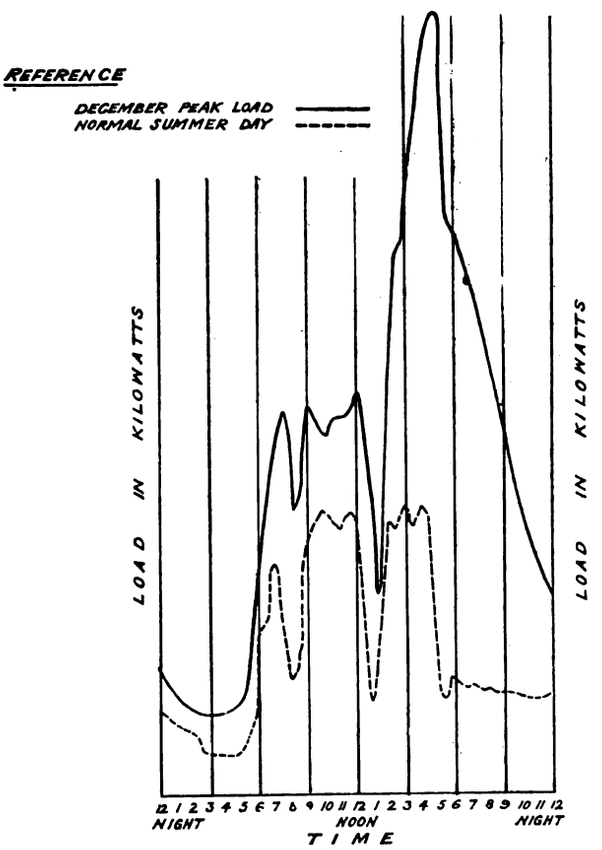
REFERENCE
DECEMBER PEAK LOAD
NORMAL SUMMER DAY
LOAD IN KILOWATTS
LOAD IN KILOWATTS
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
NIGHT
NOON
NIGHT
TIME

FIG. 2.—Typical Load Curves, Lighting and Power.

consumed by the power company under their economical conditions of working, would supply not only the collieries but practically all the textile mills in Yorkshire. The blast furnaces of the kingdom also produce a large amount of waste heat, and a very large portion can be utilised by co-operation with the power companies. The considera tions dealt with above as the advantages of a public supply to a power user apply with even greater force to small and

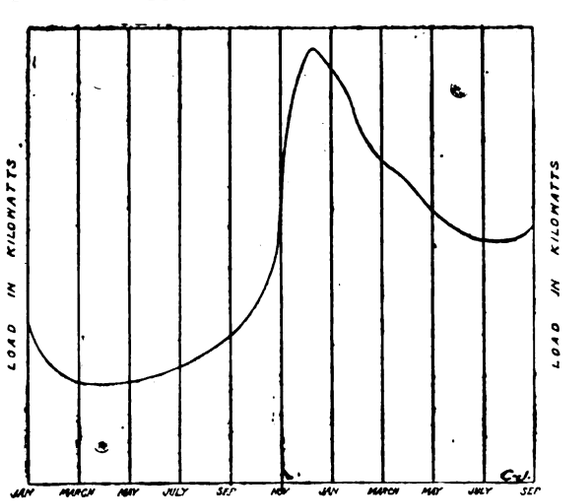

FIG. 3.—Typical Curve of Peak Loads, showing Monthly Variations, accompanied by Growth of Connections.

medium-sized public supply generating stations, say, of less than 10,000 kw. Co-operation between authorised undertakers seems to the author a vital necessity if progress is to be made. The older generating stations are situated in the centre of the towns they supply, and the developments in the economical generation outlined above cannot in such circumstances be taken full advantage of. Further-

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more, the large number of undertakings which are under municipal control are for this reason not in a position to deal with the problem as freely as a company can, even were it advisable for them to do so with money borrowed on the security of the rates. Where distribution of electricity is considered, however, the local authority controlling an electrical undertaking have more justification for dealing with the matter themselves—their local knowledge and the fact of being the road authority are good reasons for undertaking the distribution of electric power provided that they are prepared to offer as cheap a power supply as can be obtained in other districts. There is no doubt that local authorities have in many cases hesitated to allow a power company to supply in their area from a fear that the matter might grow in the course of years to be beyond their control. The joint control of a supply by a company and a corporation is an arrangement which the Board of Trade do not favour, and possibly it is one which would present many difficulties in working. It has occurred to the author that a way out of the difficulty might be found if the local authorities were empowered to become debenture holders in the company. They would thus exercise some control over the business if improperly managed, and the provision of further capital would depend on the satisfaction given by the company to the local authority. This is, however, to look into the future, and in the meantime economical conditions are bringing home to the local authorities the advantages of the general power supply in the face of many prejudices.

Smoke Nuisance and Decentralisation.—Of causes other than the direct advantages of power supply which are assisting the development, two may be mentioned. The abolition of the smoke nuisance in towns is receiving increased attention on all sides, and there are undoubtedly signs of decrease of the nuisance in towns due to the use of electric motors and gas stoves, as well as to the more stringent action taken by some local authorities. Doubtless the improvement in the atmosphere of districts where the electric supply is generally adopted will become so noticeable in a few years that other districts will be forced to take action. It is obvious, however, that strong action cannot be taken fairly by the local authority unless a cheap power supply is available in their district, and they must first see that such a supply is provided. But a more important reason for the action of local authorities in the matter of a cheap power supply is the steady industrial exodus that is going on from all the large towns. High rates, crowded sites, and dear power all act as an incitement to a manufacturer to remove to a cleaner and better place. The facilities for transit of men and material have so increased of late years that with the aid of electric power we do seem to be approaching the ideal of industrial decentralisation if not a return to cottage industries. The ultimate effect of this decentralisation on the finances of large towns is a matter worthy of the most serious consideration.

Sales.—The sale of electricity can be developed by a well organised system such as one applies to the sale of any other commodity, but it can only be carried out successfully by a careful study of the requirements of the various power users, and, therefore, by a staff of commercial engineers. To anyone familiar with the state of power supply six years ago the development which has taken place in the business on the initiative of power companies is, perhaps, marvellous, but to the one who has knowledge of the possibilities of development yet to come the results are somewhat meagre. The fact has been impressed on the industry lately by the technical Press, and with considerable justice, that the selling organisation of most supply undertakings has been somewhat neglected. Here, again, is room and a necessity for co-operation amongst the various supply authorities. Anyone who, like the author, has had to do pioneer work in the electrification for the first time of an industry such as the textile, realises how valuable may be an accumulation of data relating to the power taken by various machines, the unit consumption, the load factor, etc If every undertaking were working together, such information could be collected by a central bureau and would be available to all. This refers not merely to technical data, but also to such points as legislative restriction and Government regulations. For example, we cannot hope to obtain a general improvement of the law with regard to easements for overhead lines until a strong case is made out by the collection of data from all parts of the country as to the present disadvantages suffered. Of much greater value would be a central advertising association. One is only too apt to assume that the general public are familiar with all the advantages and developments of the use of electric power. It may be safely said that the general public, except, perhaps, as regards electric tramways, is more ignorant of the extent of electrical development (in which, in this country alone, over £340.000,000 of capital is employed) than of any other industry of similar importance. This can only be removed by systematic advertising and circulation of information, and this, again, can only be properly carried out by a combination of supply authorities each contributing to a common fund for such work. A contribution of 1 per cent. of the revenue per annum would allow advertising to be carried out on a scale sufficient to give a big impetus to the business. On a small scale the various power companies are co-operating in this way through the medium of *Electrics*, and the London supply companies also have a joint publication. An advertising combination of every supply undertaking, municipal or company, would, however, be of enormously greater value. The question of tariffs is one which cannot be dealt with within the limits of this paper. One thing may be said—namely, that electrical engineers have generally followed the principle laid down by Dr. Hopkinson in attempting to treat each consumer quite fairly and asking payment on a scale which varies the charges in proportion to the individual cost of supply. The old and pernicious principle of railway charge, which has been summed up as charging "what the traffic can stand," is open to damaging criticism. We are gradually establishing in the minds of the public the opinion that although our tariffs are somewhat difficult of comprehension, yet their basis is a just one. This must in the end be to the good of the industry as strengthening the confidence which is so necessary to the success of a public supply.

Appendix.

Resolutions passed by the Committee of the Institution of Electrical Engineers on Electrical Legislation, March 25, 1902. Adopted by the Council, April 10, 1902.

1. That notwithstanding that our countrymen have been among the first in inventive genius in electrical science, its development in the United Kingdom is in a backward condition, as compared with other countries, in respect of practical application to the industrial and social requirements of the nation.

2. That the cause of such backwardness is largely due to the conditions under which the electrical industry has been carried on in this country, and especially to the restrictive character of the legislation governing the initiation and development of electric power and traction undertakings, and the powers of obstruction granted to local authorities.

3. That local boundaries have usually no reference whatever to the needs of the community in regard to electric supply and traction; that the selection of suitable areas should be dealt with on the basis of economic principles and industrial demands; and that this has been found to apply to gas, water, and sanitary engineering.

4. That the development of electric power and traction undertakings offers the most favourable means of relieving congested centres, and of thus contributing towards the settlement of the housing question.

5. That it is expedient in the national interests that the Electric Lighting Acts, 1882-8, the Tramways Act, 1870, and the Standing Orders relating to special Acts for tramways should be amended in so far as they enable local authorities to veto or delay the carrying out of electric supply and traction projects of which the utility can be shown, and that effect should be given to the recommendations of the Joint Select Committee of Parliament, 1898, on "Electrical Energy—Generating Stations and Supply."

6. That excessive time is occupied and expense incurred in obtaining authority to carry out electrical undertakings,

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and that important and growing industries are thereby checked.

7. That while this committee fully recognises the ability of the technical officials of the Government departments concerned, it is of opinion that the staffs of those departments, as at present existing, are wholly inadequate having regard to the great industrial interests involved; that it is essential that these departments should be put into a position enabling them to keep in touch with all developments in engineering matters, both in this country and abroad, and that a sufficient sum should be provided annually by Government to enable them to employ and pay a proper staff for such purposes.

8. That the adjustment of departmental regulations to engineering development should not be delayed until the industrial interests concerned are seriously hampered, and that, with a view to preventing any such delay, the Institution of Electrical Engineers should be willing to take part in revising such regulations from time to time.

9. That this committee recommends that the Institution should memorialise the Prime Minister to receive a deputation for the purpose of urging the removal of the present disabilities and restrictions which prevent electrical engineering from making the progress that the national interests demand, and attaining at least the same level as in America, Germany, and other industrial countries.

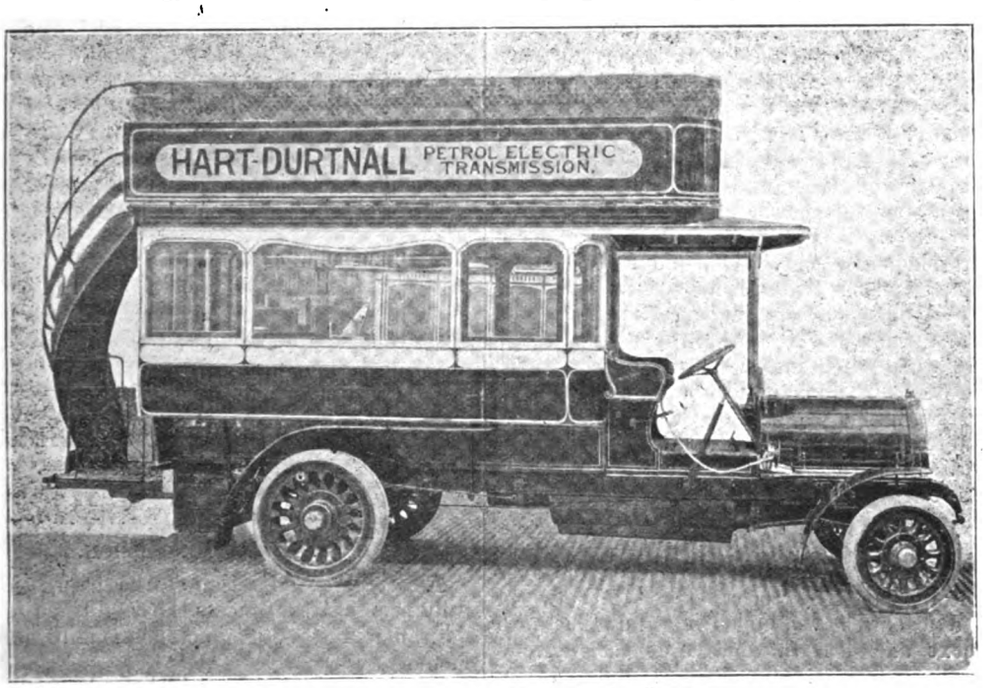
PETROL-ELECTRIC MOTOR OMNIBUSES.

The Hart-Durtnall Polyphase Alternating-Current System.

There is no phase in automobilism so fascinating as that in which electrical energy is used to transmit the power of a petrol-engine to the road wheels. The combination is known as the petrol-electric or mixed system, and advocates of electrical transmission for road vehicles have been enthusiasts, as becomes pioneers in any revolutionary change from accepted practice, and till recently their claims were not treated seriously, as petrol-electric combinations were generally regarded as "freaks," until the scheme attracted the attention of engineers of undoubted experience, who investigated the matter and have brought it to a successful issue, and have lately forced their claims before the engineering world with no uncertain voice. These gentlemen, who looked beyond the first crude productions in mixed vehicles, saw in those heavy, complicated, and inefficient machines the nucleus of a vast and radical improvement in motor vehicle design. And the above system which we are about to describe is the outcome of a large number of practical experiments with both continuous current and polyphase alternating current, after having experienced considerable trouble with the first-mentioned system owing to the presence of accumulators, commutators, brush gear, ponderous controllers, numerous switches, and a marked absence of accessibility, simplicity, and utility. And although great improvements are being effected in the construction of roads, it is hardly probable that they will ever be in such an ideal condition as not to aggravate sparking at the brushes owing to vibration in the continuous current systems, which causes the jumping of high-voltage current from brush to brush on both generators and motors, etc.

In the Hart-Durtnall system advantage has been taken of the simplicity and reliability of the polyphase alternating-current generator and induction motor, and there is no doubt that the three-phase system embodies a great many good points as regards simplicity and low cost of upkeep, combined with machines of great mechanical strength; and there is also promise of it becoming very popular among those operating companies and municipalities who welcome apparatus that require very little attention and low working costs with not a heavy initial outlay.

The composition of the system as applied to the motor omnibus shown is made up as follows: Mounted in front and under the bonnet shown is a 40-b.h.p. petrol-engine which is coupled direct to a specially-constructed polyphase alternating-current generator and small continuous-current series-wound exciter combined, which is arranged with an extended shaft (at the rear end), on which is mounted the live half of a magnetic clutch. Next comes a polyphase-current induction motor (with squirrel-cage rotor). On the forward end of the motor shaft is mounted the armature side of the previously-mentioned magnetic clutch; the near end of the shaft is coupled through a flexible joint coupling to the propeller shaft, which in turn is coupled to the worm of the (worm-driven) back axle. This worm reduction is arranged for 8 to 1 reduction, and with 40in. diameter wheels gives, at an engine speed of 800 r.p.m., a speed to the vehicle of 12 miles per hour (the legal limit), and, so composed, it is by far the most robust and by far the cheapest electro-mechanical combination on the market to-day. The above exciter magnetic field is so wound that it is brought out in sections, which are connected to a short-circuiting switch (attached to the top of the steering wheel, so as to be of easy operation by the driver). This switch is not (as is usual) to open the exciter circuit, but it is so arranged that the sections of the exciter field winding is short-circuited on itself, and most of the driving is controlled in this manner (without opening any circuit, with its attendant burning of contacts and wear and tear). It will become quite obvious that



Hart-Durtnall Petrol-Electric Motor Omnibus.

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if the switch is put into such a position that it short-circuits the field winding of the exciter (being series wound), it immediately is put in a no-voltage condition; and such being the case the alternator is also in likewise condition, and the clutch action of the induction motor is also immediately conspicuous by its absence. The above also takes place when the exciter is working on the magnetic clutch, as immediately the exciter is in a no-voltage condition the clutch disengages, and the back axle is free to stop or go at lower speed. The generator of the above-shown 'bus is a four-pole one, and the motor is wound with two separate windings on the stator—namely, for six and sixteen poles respectively. The rotor is fitted with solid copper bars short-circuited at their ends with solid rings, making a good sound "mechanical" job.

As regards operation, this is practically the acme of simplicity. First the engine is started up in the usual way, and runs governed at 800 r.p.m., the driver then taking his seat. He then moves his short-circuiting switch handle, which thus frees the exciter field winding, and which immediately begins to build up in voltage, and with it the alternator, and at the same time the motor gradually increases its torque, until it starts against the standing friction of the vehicle; the exciter still continues to build up until the motor accelerates the vehicle to a motor speed (if coupled in the six-pole condition) of about 533 r.p.m., equalling a vehicle speed of eight miles per hour; the efficiency of transmitting the power of the engine to the worm shaft is then about 70 per cent. at full load.

Now, it is well known that electrical transmission of power for long distances has been proved by extensive experience to have no successful competitor "commercially," but when it comes to the transmission of the power about a self-contained and propelled road vehicle it is another matter, and this is no doubt the crux of the question "why" the Hart-Durtnall system is so economical as regards petrol consumption per ton-mile when compared with other petrol-electric systems. We refer to a magnetic clutch above, and now we shall see the important part which it plays. A 30 per cent. absolute loss on a 40-b.h.p. road vehicle it is very evident could not be allowed to exist "commercially," owing to the fact that we should only get (for our 40 b.h.p as developed by our engine), say, 28 b.h.p. at our worm shaft, and, in order to raise the commercial efficiency of this power transmission combination, the above clutch is provided, and we will now describe its operation and action. On, and forming part of, the above short-circuiting switch is a set of two contacts, which until now have been short-circuiting the winding of the above magnetic clutch. Now, the road being clear, the driver moves the switch into its next to last notch. This movement opens the magnetic clutch winding and drops it in series with the winding of the alternator and the series-wound exciter. This operation does two natural things—it increases the external resistance of the exciter circuit, and thus lowers its voltage, and at the same time prevents the magnetic clutch pulling over and gripping solid, but causes it to gently partly to engage, so that in that condition some of the power of the engine goes direct "mechanically" and part "electrically" to the worm shaft, the magnetic clutch winding being now let into series. The next and last movement of the driver's switch short-circuits the alternator field winding, and by thus lowering the external resistance of the exciter the consequence is that the exciter gradually builds up to its normal condition, the current increases and the magnetic clutch engages (gently), and the vehicle is thus accelerated to a speed of 12 miles per hour, or the worm shaft is clutched solid with the engine shaft, at a speed of 800 r p m It will now be observed that the full 40 b.h p. of the engine (minus about 2 to 3 per cent for exciting current) is being transmitted at full load to the worm shaft, thus raising the commercial efficiency of the power transmission combination to about 98 per cent., and this direct drive can be obtained at any intermediate speed by regulating the admission of the fuel (on the steering by another small handle) to the engine down to about three miles per hour. It will now be seen why a series-wound is to be preferred to a shunt or compound wound, as the before-mentioned type will hold its field at a lower speed than the latter.

Now we are proceeding at, say, 12 miles per hour speed, and it is, say, necessary to pull up the vehicles suddenly, for some traffic condition. Without touching anything else the driver applies his foot brake, and before the brake blocks go on a short-circuiting contact bridges the exciter field, and it immediately goes into a no-voltage condition, the magnetic clutch disengages and the power goes off, the brakes go on, and the governor on the engine looks to its speed, and the vehicle stops. The driver then puts the short-circuiting switch in the first notch again, so that when he releases the foot brake the bands of same come away from the drums, and then, and not before, the short-circuiting contact opens up the exciter field and the same cycle of operation takes place. It is interesting to note that, although we start on electrical drive and change to mechanical drive, we do not open or close any live circuit, which is a very good feature, and must tend toward economy. Now it may be necessary to reverse the direction of speed. The driver pulls over the reversing switch lever provided at the side of the vehicle, and which is fixed in its two positions—"forward and back"—by two notches, to disengage from which he must, before being able to move the lever, pull a small trigger. This operation short-circuits the exciter field, and the reversing of two out of the three phases of the 16-pole winding is done under no-voltage conditions, and consequently without sparking or flashing, etc. Should it be necessary to go dead slow or to climb a very steep hill, the 16-pole winding is coupled in with the generator circuit, also under no-voltage conditions, and then the exciter field is let out and the motor runs at a speed of about 200 r.p.m., or a vehicle speed of three miles per hour, this speed being same as the reverse, the six-pole winding being only used for the normal forward electrical speed. At this lower speed there is an increase of starting torque available should it be required in position as starting with full load on a hill.

A fleet of omnibuses fitted with the above system of power transmission would, no doubt, secure low operating costs, so much desired by the directors of motor-omnibus companies, who would be well advised to get into further touch with it, as there is much to be said for this system on the ground of simplicity and low cost of upkeep, and the polyphase induction motor with squirrel-cage rotor gives an absence of moving contacts, which is a considerable advantage.

The gentleman responsible for the technical portion of this system is Mr. William P. Durtnall, of Luton, who was until recently engineer and manager of the Walsall Electrical Company (London and South of England branch).

AUTOMATIC CAB-SIGNALLING ON LOCOMOTIVES.*

BY J. PIGG, MEMBER.

(Concluded from page 910, Vol. XL.)

CONCLUSION.

A careful consideration of the description will show how fully the apparatus meets the conditions found necessary or desirable in the introductory examination of the requirements.

I. (*a*) The natural action of the bar, A, through the brushes, and that of the yielding bars upon the rotary switches upon the engine circuits constitute a signal, warning the driver of his approach to a signalling point at which further indications must be looked for *at once*. (*b*) Neither the engine driver nor the signalman are required to do anything to produce this signal. (*c*) The indications being given from three independent points for double lines, and from two for single lines, provide ample margins for failures of apparatus from any cause outside ordinary maintenance of the battery. (*d*) The alternative methods for producing this indication, and the difference in their positions on the engine and track, are guarantees that anything likely to affect one means prejudicially is not likely to affect the other.

II. The continuance of the "warning" signal constitutes

* Paper read before the Institution of Electrical Engineers,

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an effective "danger" "condition of line" signal, relating to the "stop" signals which are being approached. The bar A is situated at a distance of about 100 yards from B. The "warning" signal proper is, therefore, of short continuance only if the "stop" signals are "off." No time is lost in conveying the further indication "on" when the "stop" signals are in that position. The subsidiary indications, given by the momentary stoppages of the bell, are valuable for indicating the progress of the train towards the "stop" signal, when conditions of weather prevent the ordinary landmarks from being seen.

III. The stopping of the "warning" signal by the return of the semaphore arm to the "off" position, the stopping of the bell, and the receipt of the "route" indication constitute a complete "off" or "line clear" signal, which, since it cannot be given unless both the "stop" signals controlling entrance to the next section are "off," gives also the exact information now given by the lowering of the line distant signal. The convention under which the "route" indications are numbered is in strict accordance with the convention under which the line signals are erected. As will be seen from diagrams 1-5, the left-hand signals refer to the left-hand road, and so on, for any number of diverging roads. The numbering of the "route" indicators is from left to right, as will be seen by reference to Fig. 9. A straight through point is always signalled as 1.

IV. Either "condition of line" indication received at bar B can be reversed before the engine reaches the "stop" signal. That is to say, an emergency "danger" signal can be given at any one of several intermediate points if the "off" signal has been obtained; or an "off" signal can be received at the same intermediate points if the "on" signal was originally obtained at B. The number of intermediate points at which these reversals can be obtained is limited only by the number of intermediate bars provided. Additional bars are not costly, as will be obvious from the illustrations.

V. The "off" signal can be given when the train is standing at the "home" signal equally as well as when it is travelling, and attention is called to its being given by the audible signal. The signal given when the train is standing at the "home" signal can be modified by the signalman to indicate a "calling on" signal, or the equivalent of a flag signal, and this is totally distinct to the "off" or "line clear" signal referred to already in this section.

VI. Indications are provided in the cabin by which the signalman knows whether his apparatus is in order, and by which he can, if he desires, trace the progress of a train towards the "home" signal from the bar B, and note whether the signals appear to be given correctly.

VII. The system, being electrical, admits of the signalling point—the bar B—being put at any distance from the cabin without affecting the efficiency. There is, therefore, no reason why it should be put at the point at which the line distant is now erected. Such signals are usually visible at some distance, and there is no reason why the bar B should not be set at this "sighting" distance. The increasing speed of trains make it desirable that the signals given at B should be obtained as early as possible, to admit of easy braking when necessary.

VIII. The line distant signal plays no part in the working of the system, and may be dispensed with if desired.

IX. A further examination of the system will show that failure of the apparatus on the line will not cause a false "off" signal to be given. Any failure of the battery in the cabin, or breakage of the line wire, puts the bars B, C, D, and E into exactly the same condition as A, which can only produce the "danger" indications. Contact of the line wire with telegraph wires on the same poles is not likely to give a false signal, as the apparatus on the engine requires stronger currents than are to be met with in telegraphy. Failure of the apparatus on the engine provides its own indications. These have already been mentioned.

X. Probably the most important requirement from such a system is that of reliability. No matter what other advantages a system may possess, a want of reliability will be fatal. The most important point in any system is the means by which the signals are collected. Theoretically, the maintenance of such means of collection should be a matter of difficulty during bad weather, as snow or ice is liable to form an insulating layer upon the top of the line bars, and thus prevent the collection of the currents. As has been said, this is a theoretical consideration, and necessarily, owing to the absence of bars for such purposes in this country to such an extent as to allow of the forming of a definite judgment, there is little or no local evidence for or against. The experimental work in connection with this system, however, has extended over the two last winters, and no difficulty has been experienced in collecting the currents from the presence of snow or ice. The surface of the bars is slightly rounded to allow water to run off, and only a thin film of ice can form. The contact between the brushes and the bars is of a particularly scarching character, due to the construction of the former. They seem to clean the bars effectually at every operation, and if more engines were equipped this question would hardly appear at all. In any case, occasional rubbing of the surfaces of the bars with an oiled rag, which can easily be done by the platelayers when making their daily inspection, seems to prevent the formation of continuous films of ice throughout the lengths of the bars. This matter is largely a question of adequate maintenance, obtained by co-operation with other departments. Like all engineering work, cab-signalling apparatus requires attention. Such attention is always better directed towards the prevention of failures than to repairs after failures have taken place. Intelligent maintenance is all that is required. During the two years' experimental work it has been found that the maintenance of the insulation of the energised bars, B, C, D, and E, is of much greater importance than the contact between the bars and the brushes. The first energised bars were insulated in the same maner as the bar A and worked perfectly well in good weather. Long continued rain was, however, found to soak the sleepers and wood blocks supporting the bar to such an extent as practically to short-circuit the battery. Since the double-shed insulator has been adopted, nearly 18 months ago, no trouble in this respect has been experienced, and the insulators have given no trouble from breakage, except when they have been used as targets by mischievous boys. The question of the reliability of the system is bound up in the maintenance of good insulation and perfect contact, since, although failure to collect the currents results in the maintenance of the "danger" indications, and is, therefore, on the side of safety, the "off" signal is of almost as much importance as the "on" signal, from the point of view of dispatch of traffic, and railway companies could not countenance any apparatus the working of which unduly delayed their traffic. On the reliability of the systems depends the important question of whether railway companies will obtain any of the financial relief which, as already stated, is most desirable. The design of the apparatus is such as to render unnecessary the whole of the complex and dangerous arrangement of fog signalling by explosive detonators now universally used by railways at great expense.

XI. Further consideration will show that this system is capable of being adapted to use of parts, instead of the complete system as herein described, on less fully doveloped railways where the conditions of service are not so onerous. It is capable of being adapted to show signals for "distant' and "home" signals, or, as already stated, it can be adapted to operate with the present "distant" signal only. As described, however, the arrangements are such as to give the maximum information with a minimum of apparatus, and, moreover, it provides further inducement in that, as the line distant signal is superfluous, it may be dispensed with. It is essentially a contact system in which shocks due to impact have been practically eliminated without impairing its reliability. As already stated, however, it is capable of being operated as a "contactless" system, with all operations for giving signals on the engine, carried out under magnetic influence.

XII. The system has now been in use experimentally on the North-Eastern Railway for nearly two years, on what is the fastest short-distance train in the world, and on other express passenger trains. No attempt has been made to develop it by trials on slow trains. Under the con-

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ditions of use the apparatus is working perfectly. The directors of the North-Eastern Railway Company have arranged for the equipment of 20 more of their express engines and of about 14 miles of their main line between Newcastle and Durham. Dry cells have been found to give the best results on the engine, and have given perfectly good results in connection with the track circuits. Six cells are required on the engine, and 12 cells are used in the cabin for the track circuits. The wire for connecting the energised bars with the battery in the cabin is carried on the telegraph poles, as seen in Fig. 16.

DISCUSSION AT LONDON MEETING, DEC. 5.

Mr. J. W. JACOMB-HOOD (London and South-Western Railway) expressed his indebtedness to Mr. Pigg for the able and lucid way in which he had put his scheme before the Institution. There were points in the paper upon which railway men could hardly agree with the author, and it was not difficult to criticise many details; but rather than do so, he (the speaker) was prepared to emphasise that in the future railways must depend upon some system of signalling such as that described. It was disappointing to him that Mr. Raven's system was nothing more than a supplementary system of signalling to the outdoor visual system of signalling, and it was doubtful whether the expense justified the addition of such a method to the existing system. Further, it did not entirely remove the weak spot in the chain between the signalman and the driver. In future, with this system, the driver would still be able to disregard the signal. Any future advance would be in the direction of preventing the driver disregarding the signals.

Mr. A. C. BROWN claimed to be the first to introduce the particular method of connection on which this system depended—*i.e.*, the steel-wire brush which makes the connection between the engine and the track. He believed a flexible and almost weightless connection to be the best means that could be used to make sure of contact between train and the track. He was surprised that an auxiliary apparatus should be introduced—viz., the disc—which did not appear to have anything like the efficiency of a wire brush. The disc would cause trouble at high speeds, especially if snow, for instance, drifted under the flexible rail. [Mr. Pigg here explained that the disc did not make contact; it simply put into action a circuit-closing device within the cover.] With regard to the general question of electric railway signalling, he regretted that the limitations of the old visual system of signalling should be adopted on systems of electric railway signalling. It was possible with an electrical system to arrange for the driver to see the signals throughout the whole of the block section, which could be done by means of the inductive system. He suggested that the connecting wires could be placed on telegraph poles, and mentioned some successful experiments which he carried out in 1880 in conjunction with the National Telephone Company.

Mr. A. T. BLACKALL (Great Western Railway) said the ideal system of signalling was one in which the driver received the danger signal upon the failure of any part of the apparatus. On the Great Western Railway they had displaced distance signals, and now relied entirely upon the cab-signalling. The signals for this system were a bell for "all right," and a steam whistle for "danger."

Mr. A. H. JOHNSON (London and South-Western Railway) said that the idea of giving a preliminary signal to show a driver that he is approaching a distant signal was an old but very vital one. In signalling, for safety it was necessary to have the apparatus so designed that, should any part fail, it must give the danger signal. The ideal system seemed to be a continuous rail running along the track, but this was at present out of the question, owing to financial considerations. Mr. Raven's system was most ingeniously safeguarded, but it did not seem to take notice of the fact that the engine-driver was apt to forget that the battery could fail and would not look at the indicator. Mr. Pigg talked about doing away with contacts and getting indication by magnetic induction on the engine. That practically meant going back to Mr. Boult's system, which, however, depended on making a contact to give a danger signal.

Mr. R. BURN thought that the system described by Mr. Pigg was a most complicated one (therefore, a most costly one), and hat there would be great difficulty in getting it adopted. He ventured to think that the most economical method was to get the signal off the engine, for the reason that the first cost of fitting up the engine for cab-signalling was prohibitive, and also because of the number of foreign engines which ran over our lines, and which were not fitted with the apparatus on the locomotive. The latter, he said, would form an insuperable difficulty. He advised having a pole fixed at the roadside which would duplicate the signal by a loud-sounding hooter like that employed on the tube railways. The vital point which Mr. Burn brought out was the necessity of keeping down expense, to do which the signal must be given to the driver off the cab.

Mr. ALEXANDER SIEMENS said that cost was a governing factor in railway management as in all engineering concerns, but in the case of railway signalling it was somewhat modified by the requirements of public safety. The system described by Mr. Pigg seemed extremely complicated. Four or five bars were proposed for a set of signals, and, in addition, two extra ones were thrown in outside. The Great Western Railway had done away with the distant signals altogether, and had thereby effected a great saving in maintenance cost. Mr. Pigg treated the matter from the engineer's point of view, and had described a system which, in his (the speaker's) opinion, was too expensive. The fatal defect was that the danger signal depended on the making of a contact. While the failure of the battery might give an indication, the driver might not be looking at the indicator at the time, and, even if he were, the indicator told him nothing. Mechanical indication, however, gave the danger signal at a certain point on the line. Mr. Siemens proposed to patent a system which would do away with the usual signals, and which would only deal with indications on the engine.

Mr. ANDERSON (Great Western Railway) said that when the Great Western first thought of introducing their system they drew up a list of requirements, and, comparing them with the system described in the paper, they found that they agreed in all but two. One of these was that the danger signal, in order to be perfectly reliable, must be by mechanical means, and the other was that the audible signals must be different for danger and safety. Speaking from the traffic man's point of view, he said that in the system described in the paper the normal position of the visual signal given on the engine was "all right," whereas the normal position of the signal given on the running track was "danger." This struck him as an anomaly. With regard to single-line working, the reversal of the switch from double to single line seemed to him a weakness, as it imposed upon the driver another duty to remember at a junction.

Mr. H. G. JEFCOATE said he was struck by the great complication of the system described, which affected the question of cost. He then proceeded to describe in detail his own system of mechanical signalling, which he termed the safe signalling system, until he was reminded by the chairman that he was not speaking to the paper, but was putting forward a comparative system.

Mr. RAYNAR WILSON referred to the objection to the great number of bars, which, he said, was one of the bright features of the scheme, as it enabled the signalman and the driver to get into touch directly the driver came within the zone of the signal box.

Mr. PIGG replied briefly to a few of the points raised, but he preferred to reserve his full reply.

THE STAFF OF SMALL CENTRAL STATIONS.

BY CENTRAL-STATION MAN.

One of the most important items of the standing charges attached to central-station work is the amount spent on staff salaries and wages, and it is of the utmost importance that there should be some rule whereby the staffing of such undertakings could be ascertained. On studying the information available on this subject, however, one is struck by the large variations noticeable in the number of men employed by different stations of the same kilowatt capacity, and, as far as one can tell, of the same output under the same conditions.

For the purpose of examining this subject, it is worth while considering in particular the case of direct-current three-wire supplies up to, say, 500 kw. of plant installed. This is a very common size of station for small country towns and large villages, and one would anticipate a certain amount of uniformity in the staffing. One may assume that in a station of such a size that only one shift is run, this being in the evening, with the addition during the four darkest winter months of an early morning shift. It should be possible to run such a station all the year round with a total regular staff from manager to office boy of ten. This should consist of engineer and manager, a chief clerk, a junior clerk, a fitter-driver, two stokers, two apprentices, a meter and mains man, and a storekeeper.

To make the duties of these different officials more clear, we may take a station of, say, 450 kw. of plant installed with about 500 consumers to supply; the capacity of the plant and the number of consumers being, of course, the controlling factors in making up the staff. The engineer and manager, who must combine the qualities of both commercial and engineering ability, should be a gentleman with a good mechanical engineering training, and he must, in

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addition to his usual duties, be capable of personally directing all mechanical and electrical repairs incidental to the running of such supply, including breakdown work, and should be able to supervise meter and mains testing In addition, he should have a fairly close acquaintance with modern business methods, and, above all, should be able to maintain touch with all classes of his consumers, from the manager of the staple industry of the district down to the smallest householder. The chief clerk must, besides his usual clerical work, be capable of dealing with prospective consumers in a commonsense way, and of attending to consumers' complaints. He should be a man who can settle right away any minor points relating to the requirements of consumers without having to consult the manager. There is nothing more irritating to the consumer, or bewildering to the manager, as to be constantly faced with delay due to pettifogging difficulties. The junior clerk, who is best worked up from a glorified office boy, acts also as typist. With a proper lad of this sort about the place it is quite unnecessary to keep an office boy, as the junior clerk can be easily persuaded to lower his dignity down to the level of lighting the office fire, or switching on the radiator, and to do the necessary performance of stamp licking and letter addressing, which, after all, is practically the sole job of the average office boy.

The fitter-driver is a most important man in the combination, and should be an absolutely reliable person, free from bibulous tendencies, and with a sound mechanical experience. He should be solely responsible to the manager for the safe running of the plant, and in a station with modern machinery, much of it being enclosed and automatically lubricated, he should easily be in a position to keep all repairs up to date, and be available, if necessary, to take on outside work during the daytime. This sounds rather paradoxical, but in a small station one cannot afford to stand on ceremony with regard to the division between inside and outside work. The fitter-driver should have standing orders to be about the works during the evening run, and it is quite consistent with due watchfulness on the running that any of the small repairs can be done on that shift. Of the two stokers, one of them is on the evening shift, and the other can act as cleaner and fitter's mate during the daytime, stoking on the early morning shift in the winter. Of the two apprentices, one of these should always be on the switchboard for the evening run, while the other should assist the fitter or the outside man during the day, and he should overlap the evening apprentice on the switchboard until the peak is over. These lads are quite easy to get hold of, as many of the brightest and best lads of the community are anxious to get into electrical engineering work, and a fresh one should be taken on about every six months to keep the supply up, as it is a moral certainty that the apprentices will take the first opportunity of bettering their experiences as soon as they have got their feet on the first rung of the ladder The meter and mains man would find that his duties are divided over many jobs – chiefly fixing meters and testing installations, meter reading, repairs to meters, and look after the feeder pillars and street boxes. He should conveniently be an artisan drawn from an outside staff of a contracting firm, this type of man usually having a wide practical experience in dealing with network. The storekeeper should be a smart youth who can issue stores to the mains and generating departments, check goods in and out, and in his spare time he should be able to assist the meterman, and at the end of quarters, when the rush is on, should be available to go out meter reading.

With a staff such as is outlined above it is quite possible to run a small station successfully, and to keep the wages costs down to a very low figure. At times, of course, extra unskilled labour must be taken on, at such times when boiler cleaning is necessary. The practice of utilising one man for two or three different functions, although not desirable in many ways, is necessary in such small stations, and in practice works out quite well. For example, the fitter-driver can easily manage to put in service during the daytime, using his day stoker as mate, and at the same time keep the plant repairs well in hand. The practice of keeping the outside staff, such as mains and meter men, entirely separate from the generating staff is, of course, a necessity in a station of any considerable size, but in small works it is quite unnecessary, and at times there is not sufficient work to keep the men fully employed if a sharp distinction of this sort is made. An assistant engineer is a luxury in this size of station, although it is better in many cases to have one, if he can be afforded, as he relieves the chief engineer of many small duties which he should not be called upon to perform, but except in the case of breakdowns, or at the end of quarters, when the office work is heavy, the assistant engineer has absolutely nothing to do in a station of this size that is not doing any capital work in the way of extensions.

It occasionally happens, of course, that the chief engineer has to be away, and in his absence it is advisable to make the fitter-driver take charge of all plant and mains and to make the meterman responsible for meters and consumers. The practice of making the men capable of doing different jobs is strongly to be recommended in such stations, on the ground that it gives a virtual stand by in cases of illness, and always give the men more interest in their work It is the writer's contention that many of the smaller stations, especially corporation jobs, of the present day are greatly overstaffed, and it is quite possible to work with such a staff as has been described without risking the safety of supply, and without imposing any undue overwork on individuals.

The importance of the subject in view of the increasing keenness of competition between gas and electricity interests in small towns, and the frequent reference one sees to the insecure financial footing of such concerns, is apparent, and the writer trusts that the notes will be productive of some discussion on the ways and means of reducing in a safe and efficient manner the staff expenses of small electricity supply undertakings.

LIQUID FUEL FOR GENERATING STATIONS.

BY F. PURSER FLETCHER, A.M I MECH.E., ETC.

Little attention appears to have been given to the use of oil in generating stations for any purpose other than lubrication. There are many instances where without doubt its application as an additional fuel would give most satisfactory results. Every station engineer, especially those within the London area, knows the necessity of being able to provide a large quantity of steam with very little notice, and when many of the boilers are banked it is a difficult matter to meet the sudden demands of a fog or darkness without a considerable drop in steam. This could be got over by the addition of, say, a Körting oil-jet fitted over the fire-door of each furnace, so that the oil spray which is delivered under pressure is directed down on to the fire, where it is ignited and the gases of combustion passing on through the boiler with those from the coal. It may be said that the furnace which is suitable for the combustion of coal is not equally suitable for oil, which requires rather different conditions. This is true, but the results obtained are such as to fully justify its use for such purposes. In the event of a sudden demand it is only necessary for the stoker, after opening his dampers and "shaking" up his fire, to turn on the oil to the required amount, the coal feed going on as usual. When good fires are obtained the oil supply may be discontinued. The first cost of such an arrangement would not be excessive, and with boilers of the water type gives very satisfactory results. Until recently considerable trouble was met with in the way of smoke when burning oil, but the arrangement suggested, with a good combustion chamber, gives practically no trouble in that direction. Further, a good type of water-tube boiler will allow of considerable forcing without either priming or damage to the tubes, so that the addition of such jets to a station with a poor load factor would be a considerable help.

It is not suggested that oil should be used as the main fuel for a station, as the quantity produced annually is only approximately 20,000,000 tons, of which only 6,000,000 tons is suitable for fuel. In addition to this, any very large demand, such as the quantity that would be required by generating stations, would undoubtedly force the price up very considerably, and which is already high

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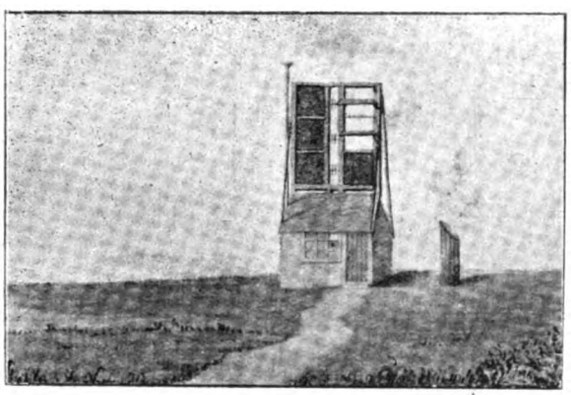
owing chiefly to its supply being wholly in the hands of foreign countries.

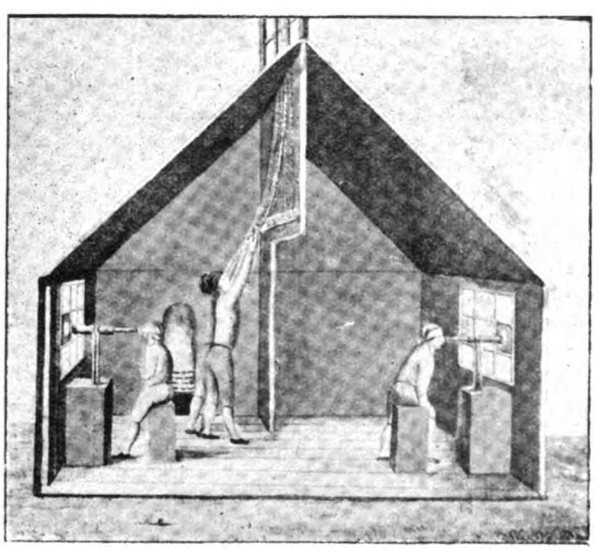
THE OLD METHOD OF TELEGRAPHING.

The accompanying photographs represent one of the stations on the line of semaphores which were used by



View of the Semaphore Station at Telegraph Hill in 1795.

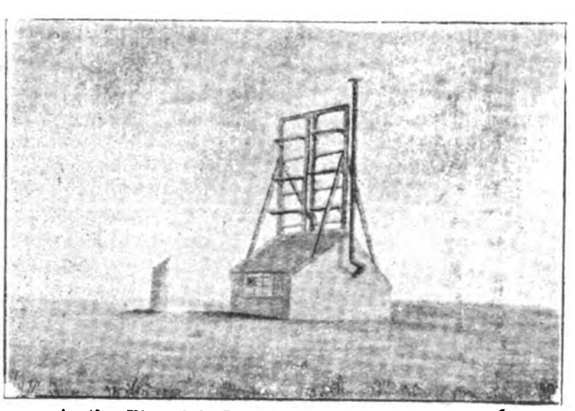
the Admiralty before the introduction of the electric telegraph. This was one of the first lines of semaphores introduced in England, and formed the line between London, Deal, and Dover. It was established by Lord



Interior of the Station.

George Murray in 1795, and continued in use until the invention of the present electric system.

The apparatus shown on the top of the building consisted of six shutters arranged in two frames, and by means



Another View of the Plow Garlic Hill Semaphore Station.

of opening and shutting these in various ways 63 distinct signals could be formed. These stations were in charge of four officials, consisting of a naval officer (usually a lieutenant) with three men to assist him in receiving the messages and transmitting them on to the other stations, which were at the Admiralty, St. George's-in-the-Fields, Plow Garlic Hill, New Cross, Shooter's Hill, and so on to their destination. Plow Garlic Hill is now called Telegraph Hill, due to this station being placed there. It will be noticed in the interior photograph that the men in the centre are working the shutters, while those with the telescopes, one is receiving the message while the other sees that it has been properly received at the next station. It may be interesting to know that this was the actual station (the last before reaching London) that transmitted to the Metropolis the news of Wellington's great victory at Waterloo.

By this system a message could be sent from London and a reply from Dover in 6½ minutes. The relative positions of the six shutters gave the signals. Each shutter could be opened or shut independently, and they revolved round an horizontal axis

THE CROMPTON-BLONDEL FLAME ARC LIGHTING SYSTEM.

A flame arc lamp possessing some novel and interesting features has recently been placed on the market by Messrs. Crompton and Co., Limited, who have secured a licence for the manufacture and sale of flame lamps and carbons made under patents held by M. André Blondel. Some particulars regarding these lamps appeared towards the end of the past year, but we are now able to present a good deal of

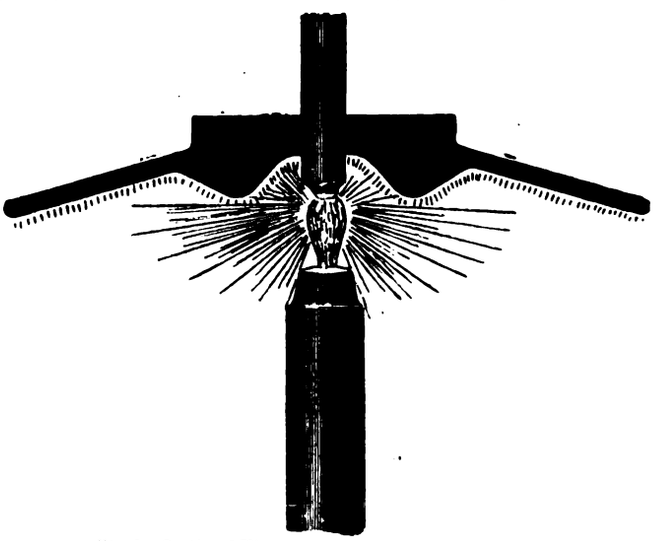


FIG. 1.—Sectional Vie Arc nd Economiser.

additional information, and, in particular, would draw attention to the illumination curve shown in Fig. 2, which has been formed from tests taken since the earlier information was published.

The lamps are sold under the title of "Crompton-Blondel." The patents by which they are covered include a considerable number of claims, but it is only necessary here to refer to two of them, one being for the composition of the carbons, and the other for the use of mineralised carbons in a vertical position with the larger and heavily mineralised carbon (always connected to the positive pole in continuous-current work) at the bottom. With this system a particularly well-shaped flame is formed, having a very high candle-power. The carbons give a long and curious shaped flame of great intensity, emitting light of a pale yellow or primrose colour, which is most pleasant to the eye. The colour is a mean between the orange-coloured light given by most of the inclined carbon lamps and the white light of the ordinary arc. The carbons are surrounded by a specially-shaped economiser, which not only directs the air currents, but also acts as a reflector. A sectional view of the flame arc and the economiser is shown in Fig. 1.

It will be noticed that most of the light is given out by the flame itself, which is of some considerable length. Other light comes from the incandescent end of the

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carbons, and a certain amount is reflected from the surfaces of the economiser, which rapidly becomes covered with a very fine white deposit well suited to this purpose.

The lamp itself is a modification of Messrs. Crompton's well-known "S" type arc lamp. It is, however, modified slightly, the mechanism being arranged for a somewhat longer stroke and more delicate feed. It is also provided with the special economiser referred to above, and a special ventilating corona and ashpan. By this means a proper supply of air is admitted to the globe and the burnt gases and fumes are carried away, so that they cannot have any injurious effect upon the mechanism.

The results of some recent tests on candle-power and illumination are given in the form of two curves shown in Fig. 2. These curves both refer to a 10-ampere lamp. The polar curve shows the candle-power in each direction and the illumination curve the illumination in candle-feet at various distances from the lamp-post, the lamp-post in this case being suspended with the arc 25ft. above the ground level, and the test readings being taken at a height of 3ft. above the ground level. The illumination readings are taken with the photometer screen perpendicular to the ray of light which strikes it. Both these curves are taken from lamps under actual working conditions, the lamps being fitted with slightly obscured spherical globes. Further tests show that for the lower currents the candle-power in each direction is practically proportional to the value of the current. Thus the illuminating value for the smaller power lamps can readily be estimated. From these curves we obtain the following figures for mean hemispherical candle-power: 5 amperes, 1,000; 7 amperes, 1,500; 10 amperes, 2,200.

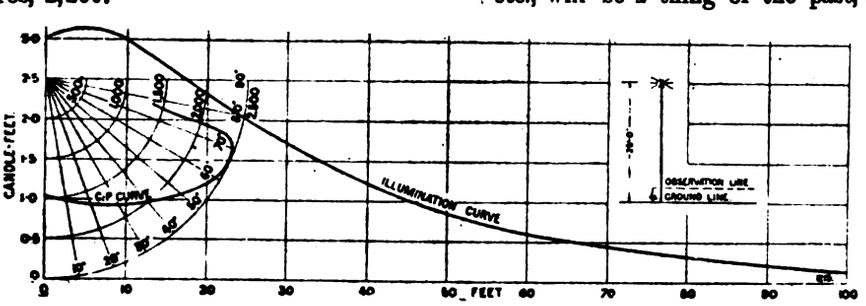

FIG. 2.—Candle Power and Illumination Curves.

These lamps can be run under the same conditions of grouping as ordinary open-type lamps. The line resistances should be adjusted so as to give 40 volts across the lamp terminals, the feed mechanism being adjusted for a length of arc corresponding to this figure. In arranging the groups of lamps a minimum allowance of seven volts per lamp for steadying resistances (including line wire resistance) must be made, making a total of 47 volts per lamp. Thus it is possible to run two lamps in series on 100 or 110 volts, four lamps on 200 or 220 volts, five lamps on 230 or 250 volts, eight lamps on 400 volts, nine lamps on 440 or 450 volts, 10 lamps on 460 or 500 volts, 12 lamps on 550 volts and 13 lamps on 600 volts. Messrs. Crompton and Co. are now substituting these lamps for the older open-type lamps in their shops at Chelmsford, where the lighting is entirely by arc lamps, no incandescent lamps being used. The new lamps take 250 watts against 400 and 600 watts in the old type, which effects a very large saving in the running cost of the shops, while the new light is acknowledged to be greatly superior to the old both from the point of view of intensity and of absence of shadows.

We are indebted for the information contained in this article, and for the valuable results of recent tests, to Messrs. Crompton and Co., who have informed us that the "Crompton-Blondel" lamps have been used most successfully in several parts of the country both for the lighting of factories and for streets and open spaces.

ELECTRICITY AND ARCHITECTURAL DESIGN.

At first sight there would seem to be very little connection between electricity and architectural design, but a little consideration will show that there *is* a connection, and that the steadily increasing use of electricity for such domestic uses as heating and cooking, and also for lifts, is gradually exercising a powerful influence which must soon show itself in radical alterations in the design of our dwelling-houses.

In the first place, stairs, in such buildings as the New York skyscrapers, have to all intents and purposes ceased to exist, and already in England electric lifts are becoming increasingly numerous (a fact due to the remarkable economy of this type of elevator), and where they are installed the stairs are practically never used, so that we may expect that the physical law of nature which gets rid of neglected or unused members will begin to apply in this inorganic instance, and then the space formerly given up to stairs and staircases will be taken into the rooms of the house. An additional advantage will here accrue, from a fire risk point of view, as the lift well may be entirely encased in iron, so that when the doors are closed there would be no "chimney" effect such as is afforded by the open staircase.

The next greatest radical change to be foreshadowed is in the kitchen premises, where electricity will make great alterations. There will be no more "ranges" as we have always known them for use with coal or gas, as it is more than probable that the electrical apparatus will develop along new lines of its own, though at present there is a somewhat slavish copying of the older models, which we have not yet freed ourselves from entirely, even in our lighting arrangements. In any case "range setting," with its attendant expense in the building of flues, chimneys, etc., will be a thing of the past, as the cooking apparatus will be entirely portable, and will be placed where required, a great deal of small cookery, indeed, being done at the meal table itself, so that in the smaller houses, at any rate it is very doubtful whether we shall find a "kitchen" or room set apart for cooking solely and only. The stifling atmosphere caused by the waste of heat from the coal range, or the poisonous "choke damp" of the gas range, will be horrors of the barbaric age, as the only "external evidence" of electric cooking is the smell of the food itself.

The abolition of the "range" brings us at once to the question, "What about the hot water?" It seems a little difficult at present to forecast how the bulk of the water heating for baths, etc., will be done electrically. By that we not mean that there is any doubt about whether it *can* be done electrically, but merely on what method; whether the water system will be single pipe throughout, with local "geysers" where the hot water may be required, or whether the hot-water "system" may not survive, combined with the heating system in some form of electrically-heated hot-water radiator, of which there are even now some excellent economical examples obtainable. Whichever system is finally adopted, the kitchen boiler may be marked "scrap," as neither requires its assistance, so that the water service will be very much simplified.

The next change is due to the use of electricity for heating the house and dwelling-rooms. At present we still cling to a "stove" of some sort, its shape very much altered from the original fireplace of which it is the modern descendant, *viâ* "bombshell" gas stoves, and now arrived at a very apotheosis, as far as the type admits, in the numerous portable and efficient types of electric radiator and convector which are being so largely used nowadays. It is quite debatable, however, whether stoves, portable or fixed, will be used at all in the house of the

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future, as it is more than probable that the heating will either be combined with the hot-water system as outlined above, or, more likely still, with the ventilating arrangements.

Ventilation at present is usually more or less unprovided for except by accident or bad design in modern houses, but we are gradually waking up to its importance, and it is likely that in future houses will be provided throughout with some such system as Tobin tubes, in which, when necessary, the air will be electrically heated as it flows through by some form of what we call now tramcar heaters, as these are extremely cheap and efficient, and as they would be out of sight their construction can be of the simplest. Whatever method of heating is adopted, there will be no more fireplaces, chimneys, and flues, so that we come to the conclusion that the house of the future will, in all probability, be of radically different construction, due to the use of electricity, in that it will have no stairs, fires, fireplaces, chimneys, flues, or kitchens. It will be much less expensive to build and much safer to live in, besides being much more convenient, as most of the housework will by that time be done by electricity.

SEASONABLE MEMENTOES.

The Brush Electrical Engineering Company are among the first in the field this year with diaries and other seasonable souvenirs, their self-opening waistcoat pocket diary and notebook for 1908 being a welcome and convenient little gift. It is in no way burdened with advertisement pages, and the information it contains is useful and presented in a handy form. There is a £1,000 accident coupon. We venture to think that the diary will be highly appreciated by all those electrical engineers who are fortunate enough to receive it.

Messrs. Marples, Leach, and Co., of 6, Victoria-avenue, Bishopsgate-street Without, London, E.C., electrical engineers and suppliers, have forwarded us a neat little memento in the form of a 6in. slide rule. They inform us that they would be pleased to send one of these on to any reader who will drop a postcard to them. This is an attractive little novelty, and cannot fail to be appreciated by our readers.

Electromotors, Limited, of Openshaw, Manchester, have sent us a useful wall calender with monthly tear-off sheets. The calendar is for 1908 and for the first four months of 1909.

The British Electric Transformer Company, Limited, Hayes, Middlesex, have sent us a copy of Whittaker's Almanack for 1908 beautifully bound in padded leather. About half a dozen pages have been inset, in which are given the names of the members of the executive and council of the Institution of Civil Engineers, Institution of Electrical Engineers, Incorporated Municipal Electrical Association, and the Institution of Mechanical Engineers. The remainder of these few pages illustrate the Berry patent standard naturally air-cooled transformer, which is used in over 90 per cent. of the alternating-current stations in the United Kingdom; an ornamental kiosk, suitable for transformers and switchgear up to 150 kw. single-phase or 100 kw. three-phase; a "Berry" patent regulating transformer for use on either high-tension feeders or low-tension network; "Berry" patent auto-transformers for use with metallic-filament lamps, and a porcelain protected terminal. Not only will the book form a handy and convenient reference, but it will also serve to keep the name of the British Electric Transformer Company before those who have to handle it.

We have received from the Remington Typewriter Company, 100, Gracechurch-street, London, E.C., a specimen of their artistic wall calendar for 1908, together with one of their pocket diaries for the forthcoming year. Both these seasonable mementoes are unusually attractive of their kind.

Messrs. T. W. Broadbent, Limited, electrical engineers, Huddersfield, have favoured us with one of their fine-art calendars for 1908 which they are sending to their friends this season. "Harvesting in Hertfordshire" is the title of the picture which illustrates the calendar, reproduced from an original painting by Mr. Alfred Elias. The colouring of the picture is extremely tasteful and the composition admirable. The original was "hung" in a prominent position in the 1906 Royal Academy. Mr. Broadbent asks us to notify our readers that he has a limited number of these calendars in hand, which he will distribute free on application.

Another wall calendar which is unusually neat is that sent out by the Key Engineering Company, 4, Queen Victoria-street, London, E.C. Instead of the usual tear-off sheets, four separate cardboard sheets are attached to one hanger, each of which contains a different illustration, and on each of which is printed the calendar for three months. On the first of these is given a beautiful illustration of an Ehrhardt and Sehmer 2,200-h.p. tandem gas-engine as fitted at Dortmund. Our readers will, doubtless, remember the full description of this and other plant which appeared in these columns a little while back. On the second sheet the illustration shows men carrying equal weights of stoneware and fibre conduit; nothing could better denote the great advantage which the latter possesses through its lightness. Andrews's patent circuit breakers and a time-limit relay are illustrated on the third sheet, while the fourth sheet depicts a storage of 250,000ft. of fibre conduits at Trafford Park Works.

METROPOLITAN AND DISTRICT RAILWAY PENSION SCHEME.

A pension scheme for the benefit of the uniform staff of the Metropolitan and District Railway Company (sanctioned by an Act of Parliament last year) was inaugurated on Jan. 1.

The fund is open to any servant of the company between the ages of 18 and 53 who wishes to contribute, and special powers have been obtained to enable the company to deal with meritorious employés who at the institution of the scheme are already over age. Membership is divided into four classes, according to the amount which each man chooses to contribute weekly. The annuities, dating from the age of 65, will be for £10, £15, £20, or £25 a year, and (take the age of 27) the employés will contribute weekly 2d., 3d., 4d., or 5d. respectively. The company undertakes to give a sum equal in amount to the total contributions of the members, and this will be invested at interest. Provision has been made for the possibility of men leaving the service of the company or dying under the age of 65, so that, as well as being a pension scheme, it partakes of the character of a savings bank and life insurance. If a member leaves the service he gets back the whole of his contributions with 3 per cent. interest, this clause being applicable even to those who are dismissed, with the exception of those discharged for fraud or embezzlement. In the case of a member dying before he become entitled to a pension his representatives will receive a sum equal to twice the amount he has contributed. The total number of the employés of the company who were eligible to begin contributing on Wednesday is nearly 2,000. The object of the directors in promoting the scheme is both to render the service more attractive and attach the men to the company, and also to put on a regular system the pensions which the company have been in the habit of conferring on old and tried servants in the past.

FORTHCOMING EVENTS.

SATURDAY, JAN. 4.

Royal Institution.—At 3 p.m., at Albemarle-street, Piccadilly, W., "Astronomy—New and Old," by Sir David Gill (Lecture IV.).

TUESDAY, JAN. 7.

Institution of Electrical Engineers (Manchester Local Section). At 7.30 p.m., at the University, Manchester, "Magnetic Oscillations in Alternators," by Mr. G. W. Worrall.

Royal Institution.—At 3 p.m., "Astronomy—New and Old," by Sir David Gill (Lecture V.).

WEDNESDAY, JAN. 8.

Junior Institution of Engineers.—At 8 p.m., at the Society of Arts, John-street, W.C., "Recent Improvements in Electric Conduit Traction Construction," by Mr. FitzRoy Roose.

Association of Engineers-in-Charge.—At 8 p.m., at St. Bride's Institute, Fleet-street, "Electrical Measuring Instruments and some other Weaknesses," by Mr. Kenelm Edgcumbe.

THURSDAY, JAN. 9.

Institution of Electrical Engineers.—At 8 p.m., "Cost of Electrical Power for Industrial Purposes," by Mr. J. F. C. Snell.

Royal Institution.—At 3 p.m., "Astronomy—New and Old," by Sir David Gill (Lecture VI.).

FRIDAY, JAN. 10.

Electro-Harmonic Society.—At 8 p.m., smoking concert at King's Hall, Holborn Restaurant.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at the Lit. and Phil., Newcastle-on-Tyne, the discussion on Mr. J. H. Hecks paper on "The Effect of Work and Time on the Properties of Mild Steel and Iron" will be resumed and closed; the discussion on Mr. G. W. Spence's paper on "Notes from Four Years' Working of the Educational Committee's Recommendations" will be resumed; paper on "Floating Docks," by Mr. H. R. Jarvis.

SATURDAY, JAN. 11.

Junior Institution of Engineers.—At 3 p.m., visit to the London County Council tramway reconstruction work in South Lambeth-road, and motor school, car-shed, and sub-station at Clapham.

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NOTES.

Electro-Harmonic Society. — The next smoking concert will be held this day week (Friday, Jan. 10) in the King's Hall, Holborn Restaurant. The chair will be taken by Mr D. Probert.

Manchester Electrical Exhibition.—We have been informed that Mr. H. Talbot, president of the Municipal Electrical Association, has accepted a seat on the exhibition committee to represent their interests and those of the Nottingham Corporation, who are supporting the scheme.

Electrical Enterprise in Bulgaria.—No efforts are being spared by the Bulgarian Government to promote the industrial, commercial, and agricultural welfare of the principality. The municipalities, too, are now showing exceptional activity in the promotion of various public works. The Municipality of Philippopolis has granted a concession to a Belgian syndicate for the exploitation of tramways and electric light. The power station will be at Stanimaka, 12 miles distant, which will also be connected with Philippopolis by tram. The necessary supply of water will be brought down from a ravine, at the foot of which the former town is situated, by a conduit 2½ miles in length, and blasting operations are now being actively pushed forward. The fall of water will be 200ft., giving 6,000 h p. to the engines. It is expected that trams will be running by the end of 1908. The town of Varna has, too, recently concluded a loan of £320,000 for waterworks, drainage, and street paving, and electric light and tramways are to follow.

Publications Received.—"Hazell's Annual, 1908," edited by Walter Palmer (Hazell, Watson, and Viney, Limited. This useful compilation of facts and figures which the busy man is likely to need during the ensuing year has now reached its twenty-third anniversary, and, if any thing, has improved with age. It contains a handy account of electrical progress in 1907, in which chief attention is devoted to the development of metallic-filament lamps. References are also made to events in connection with wireless telegraphy that have taken place during the year. On the whole, this annual provides an admirable cyclopædic record of men and affairs for use in 1908.—Another year-book to which attention need be drawn, both on account of its completeness and handy form, is the "'Daily Mail' Year-Book" (Amalgamated Press, Carmelite-street, London, E.C. 6d.). It is surprising that such a vast amount of information could be collected and presented in such a handy and convenient form at so low a price.

The American Financial Crisis.—According to various reports that reach here from the industrial centres of America the country is gradually recovering from the recent financial crisis, and the outlook is undoubtedly brighter. Quite a sensation was caused here when it was reported some weeks ago that a receiver had been appointed to go into the affairs of the Westinghouse companies, but, as we pointed out at the time, the alarm was quite needless; that the receiver had been appointed at the initiative of Mr. George Westinghouse as a measure of security for the company, and that the works were well occupied. It is gratifying to read in the *Times* of Monday last a communication from its New York correspondent that matters in connection with the Westinghouse Company have righted themselves in the way predicted. To show how great is the pressure of work, the *Times* states that one of the Westinghouse plants closed for repairs was obliged to resume work with its entire force a week ahead of the time arranged because of the receipt of large orders. There was also the announcement in the same issue that the interest coupons of the bonds of the Westinghouse Electric Company in the hands of the receiver were to be paid in cash as usual on Jan. 1.

Telegraphs in China.—From a consular report on the trade of China we gather that at the end of 1906 the Imperial Chinese Telegraph Administration had a system length of 22,419½ miles, with 33,473½ miles of wires and 946·11 nautical miles of submarine cables. Offices numbered 379, of which 62 were open for day and night service and 317 for day service only. The number of instruments in actual use was 768. The staff at the head office in Shanghai numbered 67 and the general staff 3,175, while inspectors, linesmen, etc., totalled 2,400. In addition, there are many provincial lines, usually constructed by the Administration, worked and managed independently by the provincial authorities. The telegraph companies having connection with China are the Great Northern, Eastern Extension, German-Dutch, and Commercial Pacific, while a French cable connects Tourane with Amoy, a German cable Shanghai with Kiaochow and Chefoo, and a third cable, partly Chinese, Chefoo with Port Arthur. The last was cut during the war between Japan and Russia, and is not yet repaired. China has also connections with Burma, Indo-China, and Russian Siberia.

Provisional Orders for Electric Lighting.—The list of applications for provisional orders for electric lighting to be made in the parliamentary session 1908 which have been deposited with the Board of Trade has now been issued, and appears elsewhere in the columns of this journal. There is nothing that calls for special comment in any of the applications, many of which relate to areas in outlying districts, while some few seek powers for extensions under existing orders. It will be noticed that the number of applications deposited with the Board of Trade up to Dec. 21, 1907, is less than in the two previous years. The applications to be made this year number 27, 10 of which are from local authorities and 17 from companies. Last year the total number of applications for powers was 33, compared with 54 for the preceding year. It is not to be wondered that the number of applications should show a tendency to grow less with advancing years, for the most important towns are now provided with powers, and only seek to be empowered to make extensions as occasion demands, while the smaller areas are likely to take supplies from power companies.

Davy's Discovery of Alkali Metals.—An interesting paper was recently read before the Faraday Society by Dr. F Mollwo Perkin, entitled "The Discovery of Alkali Metals by Davy: The Bearing of the Discovery upon Industry." After a short biographical sketch Dr. Perkin referred to Davy's early experiments on galvanism, which began in 1800 and culminated in 1807 in the electrolytic decomposition of the fused alkalis, caustic soda, and caustic potash, described on Nov. 19 in the Bakerian lecture before the Royal Society entitled, "On Some New Phenomena of Chemical Changes produced by Electricity, particularly the Decomposition of the Fixed Alkalis, and the Exhibition of the New Substances which constitute their Bases, and on the General Nature of Alkaline Bodies." Davy's experiments were described by Dr. Perkin in detail, and it was shown that the E.M.F. of his battery must have been about 220 volts and the current he used something under one ampere. The subsequent experiments on the decomposition of the alkaline earths, by which calcium, strontium, barium, and magnesium in the form of amalgams were obtained, were then described. The second part of the paper dealt, among other matters, with the industrial manufacture by Wöhler in 1827 of potassium, by Ste. Claire Deville in 1854 of

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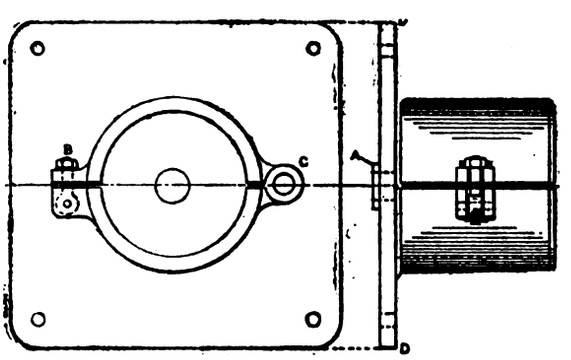
sodium, with Watt's suggestions (1851) for electrolysing fused sodium chloride, with Castner's chemical sodium process (1886) and his electrolytic process (1890), Rathenau and Suter's sodium process, Becker's process, and the process of Darling, who electrolysed fused sodium nitrate, using porous partitions.

Submarine Signalling.—The Admiralty are at present conducting important and extensive experiments in connection with the submarine fog signalling apparatus, with which four lightships have already been equipped by the Corporation of Trinity House. The lightships which have been equipped with the new apparatus are the "Tongue," at the mouth of the Thames; the "Royal Sovereign," in the English Channel; the "Outer Dowsing," off the Humber; and the "East Goodwin." For the purpose a sum of £1,200 was set aside in this year's estimates, and the results already achieved are so satisfactory that it is expected a similar amount will be expended in 1908. For a long time shipowners have urged the advantages of this invention, as its utility has been amply demonstrated on the American coast and between the Elbe and Cherbourg. It is now in use on over 300 vessels, representing an aggregate tonnage of nearly 1,500,000 tons. The unreliability of sound signals transmitted through the atmosphere has long been known, and it has been shown repeatedly that a vessel approaching an ordinary fog signal, after hearing it for a time, may miss it, although coming gradually nearer the source of the sound. On board ship the submarine bell equipment consists of two tanks fastened against the side of the vessel in the forepeak. Microphones are immersed in each, and wires connect them with an indicator box on the bridge or in the charthouse, and by means of telephonic receivers the officer on the watch can instantly locate his position when nearing a light vessel or buoy fitted with the bell. This is placed about 25ft. below the surface, and is controlled by a code-ringing device in the engine-room, or by the movement of the waves.

Three-Phase Motors for Railway Service.—The announcement that the Great Northern Railway Company (of U.S.A.) have placed orders for four 100-ton electric locomotives, to be used in hauling the trains through the Cascade tunnel, is of interest, inasmuch as this installation will be the first to employ three-phase alternating-current motors for railway service in America. This system of railway haulage is already in use on the Continent, but that about to be installed in America attracts attention inasmuch as the locomotives are larger and more powerful than any in use on the European lines. From particulars of the proposed equipment which appeared recently in an American contemporary, we gather that each locomotive will be equipped with four motors, rated at 325 h.p., or a total of 1,300 h.p. The driving wheels are 60in. in diameter. Current will be supplied to the locomotives at 6,600 volts at a frequency of 25 cycles. Each locomotive will be capable of hauling a 1,000-ton train at a speed of 15 miles an hour on a 2 per cent. grade. The motors will be used for braking down grade as well as hauling up grade. That is, the motors will be of the regenerative type and will act as generators on down grades, assisting in retarding the train and returning additional current to the line. The line on which these locomotives will be employed runs through a tunnel in the Cascade Mountains in Washington, which is three miles in length and on a 2 per cent. grade. It will be interesting to watch whether the three-phase system will prove its adaptability to American service conditions as well as it has done to European conditions. That this system has not hitherto been adopted in the States is to some extent surprising, but, nevertheless, is largely due to the success of the single-phase system.

Economies in Tramcar Depots.—Some interesting notes relating to improvements in labour-saving devices introduced into the shops of the Montreal Street Railway Company with a view to keeping down maintenance costs are given in the *Street Railway Journal*. We illustrate a jig for boring motor bearings and turning the collars of the same. The face of the lathe is recessed to receive the hub, A, and the bolt, B, is slacked to receive the bearing. The jig is bolted to the face plate at D. The boring bar used to bore the bearing is put through the hollow spindle of the lathe, which acts as a steady rest, and the shoulder of the bearing is then turned off without any further truing-up. At least eight bearings an hour can be bored or turned, as against one or two by the former method of truing every bearing separately in the chuck. The company also make use of the old trolley tubing. Instead of



consigning broken or bent tubing to the scrap heap, the poles are saved and rewelded on slack days in the blacksmiths' shop. The cost per weld is usually from 7½d. to 10d. During the past year the company has purchased little tubing in consequence of this policy.

The Late Lord Kelvin.—We are interested to learn that a movement is on foot to erect a monument to the late Lord Kelvin in the city in which he was born—Belfast. No doubt the citizens will furnish a sufficient sum for the erection of a monument which will be worthy of Kelvin's great genius and of Belfast's high appreciation thereof. Apropos of Kelvin's remarkable scientific versatility, many who were intimate with his researches in electrical science are apt to forget that his activities in other branches of science were as important and far-reaching as in the branch best known to them. Of particular importance were his geological investigations and inquiries into the question of utilising our vast stores of underground heat. His well-known deductions from tidal retardation and the rate in loss of the earth's underground heat, etc., are well known to geologists, as well as to those who were concerned in bringing about the now almost universal manifestation of radioactivity as a property of matter. In one of his addresses on the subject he said: "The age of the earth as an abode fitted for life is certainly a subject which largely interests mankind in general. For geology it is of vital and fundamental importance, as important as the date of the battle of Hastings is for English history. It is quite certain that a great mistake has been made, that British popular geology at the present time is in direct opposition to the principles of natural philosophy. Further as to the future, we may say with equal certainty that the inhabitants of the earth cannot continue to enjoy the light and heat essential to their life for many millions years longer, unless new sources, now unknown to us, are prepared in the great storehouse of creation." The work of Kelvin was in no small way instrumental in helping to shape out a new course for geological investigation, thus directing it towards considering the practicability of applying the inherent heat of the earth to the supply of energy at the surface, whether by

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conduction or by some simpler or more direct means of converting heat into electricity than we yet possess.

Junior Institution of Engineers.—By special permission of the exhibition executive and the other respective authorities, visits of this institution were recently paid to (1) the site of the Franco-British Exhibition at Shepherd's Bush, covering an area of 140 acres, for an inspection of the constructional engineering work, etc., in process of erection there; (2) the exhibition extension works of the Central London Railway; and (3) the generating station of that railway. The exhibition buildings, having advanced to about the half-finished stage in their construction, were examined with great interest, under the guidance of Mr. J. S. Ferguson, Mr. L. H. Rugg, and other gentlemen, the features calling for special observation being pointed out. The Central London Railway extension to the exhibition will form a loop at the end of the railway, running up from the present Shepherd's Bush Station, passing through the yard, where a station will be constructed convenient for the exhibition, and descending again by a tunnel that is now being constructed to the present Shepherd's Bush Station. In this way the trains will run round instead of being, as at present, "crossed over" at the terminus. At the generating station the chief engineer (Mr. E Grove), Mr. C. Forgan, and other officials, showed the members round. The current is generated at 5,000 volts alternating, and is sent out to transforming stations at Notting Hill-gate, Marble Arch, Bond-street, and Post Office, where it is reduced to 550 volts direct, and at that pressure delivered to the motors. The engines consist of six horizontal cross compound condensing, made by Allis, of Milwaukee, U.S.A., and run at 96 r.p.m. The electric generator is fixed directly to the flywheel. Each is of 850 kw. capacity, or about 1,000 h.p. Five engines only are required at time of greatest load. An additional engine for 2,000 kw capacity is now being installed. There are 16 Babcock and Wilcox boilers, and four of the Lancashire type. Klein and Wheeler cooling towers are used, and there is also a brick tower. The water supply is obtained from two artesian wells, one fitted with a deep-well pump, the other lifting by compressed air. The output of current amounts to about 50,000 units per diem. The car-sheds and repair shops were also seen. Before the members dispersed the chairman of the institution, Mr. Frank R. Durham, expressed their thanks for all the arrangements which had been made for their reception. At the ensuing meeting a paper on "The Conduit System of Electric Tramway Construction" is to be read by Mr Fitzroy Roose, of the London County Council tramways reconstruction department.

Medical Treatment by High-Frequency Currents.—High-frequency treatment has of late been receiving much attention in medical circles in this country, and there can be no doubt that it has been a valuable means of combating disease. Medical men now realise that it is useless to attempt to taboo high-frequency treatment, which there was a tendency to do in earlier times, simply because it was thought that that treatment claimed too much, and had been used for unworthy purposes. So strong was the opposition at one time in England and Germany that a French writer was aroused to appeal "to the body of medical men who work, who desire to know, and whose brain is not muddled by dull routine," to view the subject in a more reasonable light. "Le reste ne compte pas," he added. The importance of the study of electro-therapeutics was unmistakably emphasised by Mr. W. Deane Butcher in his recent inaugural address before the electro-therapeutic section of the Royal Society of Medicine, in which he also touched upon a point that is of importance to electricians as well as to medical men—namely, the use of the apparatus. His remarks on this point were as follows: "A high-frequency apparatus is a dangerous weapon in ignorant hands. It is not a plaything to be entrusted to an inexperienced operator, be he qualified or unqualified in a legal sense. Only recently I had an opportunity of seeing the dangerous results of a high-frequency application in an unsuitable manner. The case, one of cardiac debility, was treated by stimulation with a glass exciter over the solar plexus. . . . It has always been a matter of amazement to me how practitioners undertake the management of these powerful instruments with the gay insouciance of ignorance. *The most important advance in electro-therapeutics will be the adequate instruction of the practitioner in the use of such lethal weapons.* It is difficult to believe that the practitioners of the future will undertake so grave a responsibility as the application of X-rays and high-frequency currents with so little preparation and so small a stock of physical knowledge." It is in the words that we have italicised that lies the gravamen of the objection that divides medical men and electricians on this question. The arrogance of the former (at all events, of a section of it) in believing that its members alone are capable of administering X-rays, etc., is barely equalled by the claim of electricians to be permitted to deal with the apparatus themselves. It must be obvious that it is only a practical electrician with a working knowledge of electrical apparatus that can handle it with the care and delicacy required in cases of medical treatment, but an electrician is not expected to know anything about the "healing art," consequently it seems that the most reasonable plan is for the electrician to work the apparatus under the supervision of a medical man who has a thorough knowledge of electro-therapeutics.

Lightning Protection.—A good deal of attention has of late been given to the question of lightning protection for electric circuits. The provision of such protection differs somewhat from the means adopted for the protection of telegraph lines, for besides being able to divert lightning discharges to the ground, they must be made to interrupt the current from the generator after the lightning discharge has passed over the spark-gaps. On direct-current circuits the problem of interrupting the current from the generator was solved by the magnetic arc-rupturing devices, which blew out the arc as soon as it was fairly established. For alternating-current circuits use was made of the horn arrester principle, when the arc was ruptured by travelling upwards between a pair of horns, which gradually increased the length of the arc until the air currents blew it out. Dr. C. P. Steinmetz recently presented an interesting paper before the Chicago Section of the American Institute of Electrical Engineers, in which he discussed, *inter alia*, the recent developments in lightning arresters of the types which offer a counter E.M.F. to the line voltage. With a counter E.M.F. equal to that of the line, it is evident, said Dr. Steinmetz, that the current passing to the ground by a lightning discharge is equal to that produced by the excess of the discharge voltage over the line voltage. A storage battery would be one means of providing such a counter E.M.F., but would be impracticable. An electrolytic cell, in which aluminium is the positive terminal, allows no current to pass except that caused by a voltage over and above the regular line voltage, while voltages in excess of the line voltage will cause a discharge through the cell. For alternating current, both electrodes or plates of the cell are of aluminium. Aluminium cells have the peculiarity that they have no definite polarisation voltage. The counter E.M.F. which it opposes to the line builds up until it is equal to the line voltage. In the aluminium cell only a

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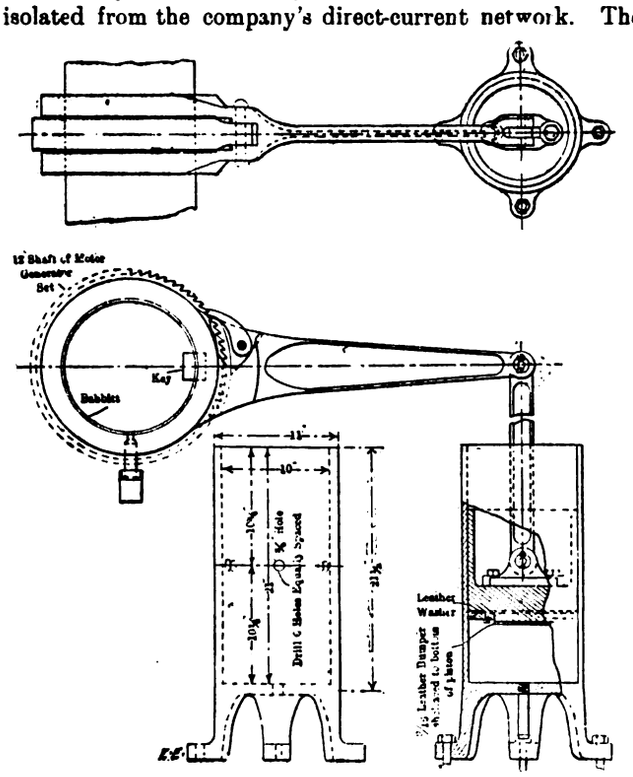
small continuous current can exist, since the cell has a resistance, as far as the line current is concerned, of about 30,000 ohms per square inch of plate surface. A spark-gap can be placed in series with the cell, but since the cell must then stand on open circuit it gradually loses the film which opposes a counter E.M F. to the line, and if left for several weeks becomes simply a water rheostat The cell can be kept built up by connecting it in circuit and having current in it once a day or so. The aluminium cell, while opposing very high resistance to the line voltage, offers only 10 ohms per square inch of resistance to current caused to exist in it by abnormal voltages. Dr. Steinmetz mentioned the experiments of Prof. Clayton in Colorado during the past summer, obtaining oscillograms on lightning discharges on a long unloaded transmission line. These showed that discharges follow each other rapidly. The frequencies of discharges were found to be of from one hundred to millions of cycles per second.

Jack for Starting Motor-Generators. — The Edison Illuminating Company of Detroit has a direct-current sub-station located in a factory district in the northern part of the city, which district is somewhat isolated from the company's direct-current network. The



starting of a 1,500-kw. motor-generator set recently installed in this sub-station would require, under ordinary conditions, such a large volume of current to overcome the initial friction of the bearings as to interfere seriously with the voltage regulation, and overload the machinery already running because of the small capacity of the other apparatus in the sub-station and the insufficiency of the feeders connecting this network with the principal direct-current district. The motor-generator set receives 4,600-volt, three-phase, 60-cycle current from the principal power plant at Delray, and gives 110 and 220 volt direct current. The starting is accomplished by direct current with a rheostat in series with the direct-current armature. To help in starting this motor-generator a pneumatic jack was designed, for a description of the construction and general principle of which (as shown herewith) we are indebted to the *Electrical World* of New York. It consists of an air cylinder with a piston connected to an arm, this arm having a pawl engaging a ratchet on the armature shaft. The idea is to have this jack give the armature a single impulse or kick to overcome the standing bearing friction, which is considerably higher than the running friction of any plain bearing, and also to overcome some of the inertia of the rotating parts. It is found by the use of this device that the machine can be started with a maximum current of 500 or 600 amperes, as against 1,500 amperes when it is started in the usual manner from standstill.

Inverted Synchronous Converters.—The use of a synchronous converter as a combined direct-current motor and inverted rotary converter is disclosed in an American

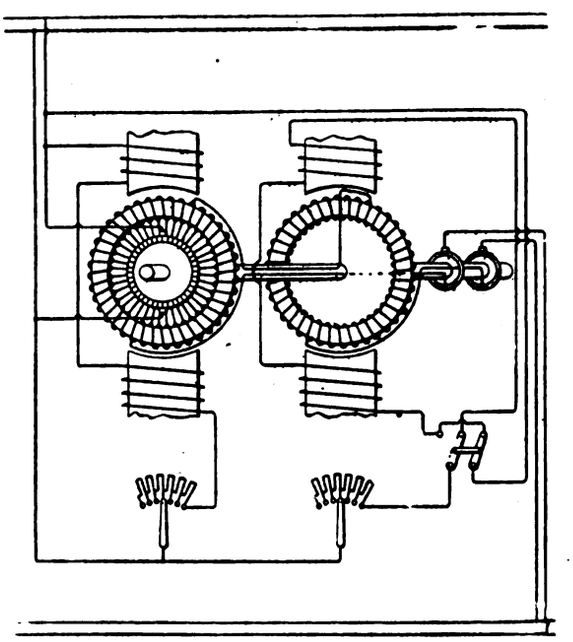


FIG. 1.

patent issued recently to Mr. Leonard Wilson. The arrangement employed is indicated in Fig. 1, where the equipment is used to convert direct current at constant voltage into alternating current at variable voltage. Instead of using a direct-current motor for driving an alternating-current generator, the inventor employs an inverted rotary converter and an alternating-current generator mechanically coupled to the converter and electrically connected in series with the alternating-current side of the converter. It is claimed that the machine is cheaper to construct than a motor-generator. Fig. 2 shows an arrangement of two rotary converters used as substitutes for the motor and generator heretofore employed in a synchronous frequency converter as patented by Mr. J. E. Noeggerath.

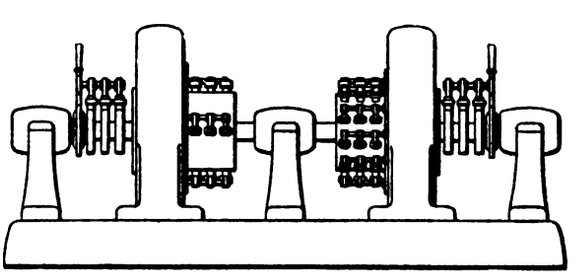


FIG. 2.

It is stated that this arrangement is cheaper to construct than the ordinary motor-generator set, both because the rotary converters are self-exciting, and, therefore, require no separate exciter, and because less armature and field circuit copper is required. Moreover, the direct current delivered by one converter to the other may be employed by inserting field coils in the direct-current connections between the two machines, so as automatically to compound the frequency changer to cause it to operate at unity power factor for varying loads, or to increase the voltage delivered as the load increases The above patents are fully described in the *Electrical World*.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE QUESTION 1,019—SINGLE-PHASE CURRENTS FROM THREE PHASE CIRCUITS.

SIR,—Referring to the letter on this subject in your last issue, I think Mr. Faye-Hansen is quite right in running down the static transformer method of producing this conversion—the method is of little practical utility. I cannot agree, however, that the single-armature rotary is equally bad. The flywheel action in this case should prove as beneficial as in the case of an ordinary direct current to single-phase rotary converter in which, although the alternating power varies from a maximum to zero and back again twice every cycle, the fluctuations on the direct-current side are almost obliterated by the flywheel action.—Yours, etc. Q.

SIR,—Mr. K. Faye-Hansen in his letter published in your issue of Dec. 27 contends that a one-armature rotary is no better than a static transformer system as regards unbalancing of the three-phase load, giving as his reason the statement that the momentary differences between the constant input and fluctuating output cannot be made up by flywheel effect. This latter view, though not strictly correct, may be accepted for purposes of discussion—*i.e.*, assume absolutely constant speed. For simplicity, assume double-wound armature.

If, now, the flux in the armature is also constant, the three-phase system must be balanced. But there is a fluctuating armature reaction which causes the total resultant ampere-turns to vary during the cycle, hence the E.M.F.'s induced in the three phases are unequal and the currents taken are unbalanced. Obviously the extent of the unbalancing must depend upon the amplitude of the flux variations, and these, again, upon the ratio of field ampere-turns to armature ampere-turns; or, to be more exact, the ratio of field ampere-turns to the maximum instantaneous value of the difference between the three-phase and single-phase armature reactions. This ratio can be given almost any desired value by suitably designing the magnetic circuit (saturation, long air-gap, etc.), cost being the limiting factor.

Another and cheaper method of smoothing out the flux curve is to use amortisseurs, which are useful in any case to prevent hunting. Even supposing that the flux fluctuates slightly, the E.M.F.'s induced in the three-phase windings may be made equal by making the number of turns in the three phases unequal; or an induction regulator may be used in one phase. If either of the last two methods are resorted to, mechanical storage of energy takes place, but otherwise the energy is stored in the form of a magnetic field.

In practice, a three-phase single-phase rotary would have a revolving field, double-wound armature, long gap, high saturation, large flywheel effect, and high speed, and would be specially designed on the above lines. It would be of interest if Mr. K. Faye-Hansen would be good enough to furnish details of the machines which he has tested.

It is not quite correct to say that flywheel effect cannot be utilised with synchronous machinery. The speed of any single-phase synchronous machine varies slightly during each alternation, and when a single-phase alternator is driven by a three-phase motor the three-phase load is slightly unbalanced, the degree being limited by flywheel effect only. Strictly speaking, therefore, a motor generator does *not* meet the case.—Yours, etc., J. S. MESSENT.

WESTINGHOUSE-BREMER PATENTS.

SIR,—Referring to the further statement of Messrs. D. Santoni and Co. (1906), Limited, we have now received the decision of the Comptroller General of Patents, referred to in our previous letter, and have, therefore, issued a writ against Messrs. Santoni for infringement of our flame arc lamp patent.—Yours, etc.,

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED.

1908.

As, when the new set's under steam,
The chief stands by with studious care—
All ready to run up the spare—
Of lower costs maybe to dream,

So face we now our new log-sheet
Of that machine called circumstance,
Which ever runs though oft perchance
The brushes spark or bearings heat.

The previous pages prove that though
We indicated week by week,
We have a remedy to seek:
Expansion's bad, admission slow.

Shall better records be obtained,
And our bright hopes be realised?
Shall we with phases synchronised
Let "lead" through "unity" be gained?

Internal losses have increased—
Or so it seems—with lessened fields;
For fewer markets fitter yields
In charges that should e'er be least.

But let this year no record show
Of low efficiency or worth.
May all go speedily to earth
Who wish that profits may not grow!

SIDNEY DENHAM.

THE RAILWAY CRISIS.

I have, I think, justified my use of the phrase, "the interests of labour and capital are identical." Other questions have been casually referred to, but my opponents have put forward two or three score of very interesting topics, which I am not entitled to discuss without permission for use of space, while I could claim liberty to support the original words I used.

I ask permission to refute the views put forth by "Lancastrian," and, I think, inferentially supported by "Staffordian" and "Mancurian," about "shareholders'" capital. I will not go so far as to say the views as put

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forward by professed Socialists on this question are a farago of nonsense, but I will say they are the views of ignorance. Please, "Staffordian" and Co., do not run over so great a field of controversy—stick to one point at a time. Now for the shareholder and his rights.

First, assume I am a farmer with capital. I employ 20 men, who work during certain hours, and receive their agreed upon share of the produce, called wages.

Next, I make or buy with my capital a machine or machines, which put into the hands of 10 men (who work no harder or longer) enable them to do exactly the same amount of work as had been done by the 20 men and to obtain exactly the same produce as before.

I can, if I choose, employ the 10 men superseded by the machines in other work, and get the usual return.

On the whole, by using capital in the shape of machines and the 20 men working no harder and no longer, I get 50 per cent. more produce.

Is not this logically, legitimately, and rightly the wages as the remuneration for the machines, or for the capital that provided the machines.

No man suffers; no man works harder or longer than before. The result is due solely and wholly to capital = machinery. What has labour to grumble at, or why should labour seek part of the return for which it does not turn a hair? And why should not the machinery = capital, so to speak, be paid the extra return, as long as the machinery lasts?

I say that the extra result given to the machine = capital = capitalist is what should rightly be received. By this assumption the machine or machinery is equivalent to 10 men's labour, and the return for the use of the equivalent to 10 men's labour should be the result obtained by 10 men's labour.

Take the result of 10 men's or one man's labour. It suffices to keep the man or men fit for labour with a surplus, hence the result of the machinery should be to keep it fit for work and give a surplus. Here we see how maintenance and renewal fund and a balance profit accrues.

Labour does not suffer by this, and, logically, has no say in the matter. It has no just claim to the results produced by the machinery = capital.

As a well-known matter of fact, labour always does obtain an advantage by the introduction of machinery, and this because of details not referred to in order not to complicate the argument.

Further, instead of my advancing the capital = machinery, suppose I borrowed the money or capital from one or more subscribers. These become shareholders. Surely the mere fact that they are shareholders does not mean that they are not to get the "wages" of the machine or machines.

If what I have said is at all true, logical, and just, we see how possible it is, under certain conditions, to get mathematical accuracy for the division of the result obtained by the combination of capital and visible labour.

My opponents cannot see why shareholders justly receive something year after year. As long ago as 1832 Babbage clearly explained why. In his "Economy of Manufactures," p. 306, paragraph 334, he says: "On the Manchester railroad, for example, above half a million persons travel annually; and supposing each person to save only one hour in the time of transit between Manchester and Liverpool, a saving of 500,000 hours, or of 50,000 working days of 10 hours each, is effected. Now, this is equivalent to an addition to the actual power of the country of 167 men, without increasing the quantity of food consumed," etc. Surely if there were no other saving through conveyance of goods, etc., the return logically, rightly, and justly due to the shareholders of the railway could be measured by the productive results of the work of 167 men working 10 hours a day as long as the railway lasts, even supposing the numbers carried and the hours saved to remain the same as in 1832.

The same argument holds good for every penny of capital advanced for labour-saving appliances throughout the world.

In every case (I am dealing with the rule, not with exceptions) the *visible labour* gets wages. The amount of wages is used (1) to maintain visible labour, (2) to form a renewal fund for visible labour, and (3) a surplus, used as visible labour thinks proper. The *invisible labour* (capital) also, of a right, gets wages, used (1) to maintain, (2) to form a renewal fund, and (3) a surplus. Really (1) and (2) are in both cases alike.

Apply this reasoning to the case of any existing railway and I venture to say it will be found that "capital" does not and never has received the return it is legitimately entitled to.

I will now go so far as to say:

1. I have effectively proved that "the interests of capital and labour are identical," a phrase I originally used and have justified.
2. That the periodic payments to shareholders who furnish capital for railways or other machinery are just and right, and interfere in no way with the emoluments or hardships or perquisites of labour.

Lastly, for a little desultory talk. Will "Lancastrian" tell me where to find formulated the socialistic moral code which Lodge, Wallace, and others *do* know about and I do not. I know personally some of the men named fairly well, and I do not think I should care to put Lodge and Shaw upon the same footing. The one would not agree with the other under any conceivable circumstances about Socialism, because the one would, when brought to the point, seek the inner inwardness of things, the other would be satisfied with superficialities that caught the eye and appealed to the ignorant multitude. If I understand Mill aright, *vide* book ii., chap. 1 (which, by the by, on turning up I find heavily scored with pencil marks from my old student days) he is non-committed. He merely discusses Socialism, Communism, St. Simonianism, Fourierism, etc., as ideals put forward by imaginative minds. He sums up that Fourierism is "the most skilfully combined" and has "the greatest foresight of objections of all the forms of Socialism." He thinks all the forms of Socialism ought to "have an opportunity of trial," though "on a moderate scale." Well, to pit myself against Mill, I do not think so, and I think this selfsame chapter shows how utterly impossible any hitherto suggested form of Socialism is. Mill is far more emphatic about labour and capital in the first paragraph of his next chapter, which will bear very careful study. If I am right or Mill is right, then "Mancurian" is wrong. His method of trying to convert me is illogical. He does not see that the use of capital *increases* the result of present visible labour, and it only asks for its share of the increase created by its being a factor in the combination. It gets nothing from present labour, and, though very Irish, it would get nothing without it. Mill put it, "The capitalists can do nothing without labourers." So far "Mancurian" grasps, but Mill goes on, "nor the labourers without capital." There's the rub—once understand and admit the mutual necessity, many false ideas vanish.

THE WRITER ON THE CRISIS.

THE RELUCTANCE OF THE AIR-GAP IN DYNAMO MACHINES.*

BY THOS. F. WALL, M.SC., B.ENG., STUDENT.

There appears to be, so far as the author is aware, a scarcity of experimental data concerning the reluctance of the air-gap in dynamo machines with slotted armatures, and also as to the distribution of the flux over the surface of the pole-shoes and on the surfaces of the teeth themselves. Although the estimation of the reluctance of the gap is of great importance in the design of machines, the only experiments which appear to have been made in this direction are those of Hele-Shaw, Hay, and Powell. In the following pages the results of some measurements are described which were carried out this year in the Electrotechnical Institute, Karlsruhe. These measurements have been employed to find the increase of the reluctance of the air-gap due to slotting the armature, and a comparison has been made of the values so found with those given by the methods generally used.

* Paper read before the Institution of Electrical Engineers.

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The apparatus was specially designed and made for these experiments, and is shown in Fig 1. It was made in two parts, one part built up of iron laminations and containing the exciting coils, which will hereafter be referred to as the pole-piece, the other part being simply a rectangular piece of laminated iron slotted on one side and smooth on the opposite side. This part will be referred to as the armature in what follows. All the slots were of the same dimensions—namely, 1·5cm.—and the teeth were made so that two were 1cm. wide, two 1 5cm. and 1·53cm. wide respectively, two 1 95cm. and 1 96cm. wide respectively, and one 3cm. wide. These parts were used together in the following way: When it was desired to measure the flux distribution on the pole-piece when used with the slotted armature the latter was placed on the pole-piece with the slot opposite the smooth portion, A B. The air-gap could be varied at will by inserting plates between the armature and pole-piece at C and D, each plate being 2mm. thick. When the flux distribution on the smooth surface of the armature was to be found, the pole-piece was turned over and the armature laid on it with the smooth side opposite the large polar projections. The air-gap could be varied as before. In order to explore the field a search coil was made of 2mm. width and having two turns. The sides of this coil were laid in grooves in a strip of vulcanite, and flush with the surface (see Fig. 2). By this arrangement the coil could be placed on the surface of the pole-piece or the surface of the armature, as desired,

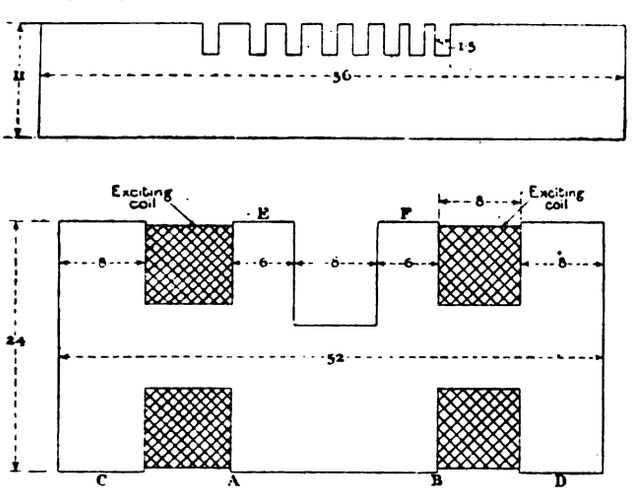

FIG. 1.—Experimental Model for the Determination of the Flux Distribution on the Flanks and Surfaces of the Teeth.

Dimensions in Centimetres.
Width of Apparatus perpendicular to Plane of Paper = 11 cms

and by means of ballistic measurements the distribution of flux could be completely examined. The ballistic throw was measured when the circuit of the exciting coils was broken, this having been found to give the most satisfactory results. The galvanometer had a period of swing of about 35 seconds. It was found that if the current in the exciting coils was large enough to cause much temperature rise in the iron, the change in permeability thus produced was sufficient to affect the throw, and the measurements had to be taken in every case when the iron had assumed a steady temperature.

I.—Experiments on the Surface and Flanks of the Polar Projections.

Experiment 1.—This experiment was made to examine the flux distribution on the surface and flanks of the polar projections, E F (Fig. 1), and also the corresponding flux distribution on the smooth surface of the armature. Although in practice pole-tips would never be so sharp as in this case, but would be more or less rounded off, yet these polar projections may be looked upon as large teeth, and the curves obtained will be similar to those for teeth of more normal dimensions, but having the same ratios of width of tooth to width of slot and width of tooth to length of gap. In this experiment:

Length of the air-gap = 1cm.
Width of polar projection = 5·8cm.

$$\text{Ratio } \frac{\text{width of pole}}{\text{length of air-gap}} = 5{\cdot}8\text{cm.}$$

Fig. 3 shows the flux distribution curve on the surface and flank of one of the polar projections. The characteristic feature of this curve is the large peak at each pole-tip. This indicates, of course, that the flux is much denser at the tips than at the middle of the pole surface. The explanation of the existence of these tips may be looked for in the fact that the flux tends to spread out on the armature surface in order to take up the path of least reluctance, and thus concentrates on the pole surface at the

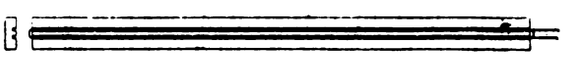

FIG. 2.—Search Coil.

tips. The case is, in fact, similar to that of electrified metallic plates separated by an air-gap, the density of the electric charge being greatest at the corners or edges. The peak on the tip adjacent to the existing coil is somewhat different to the peak at the other tip owing to the presence of this coil and the consequent unsymmetry of the arrangement. Fig. 4 shows the curve of flux distribution on the smooth surface of the armature. This curve has the shape usually shown, and it is seen that the flux density at a

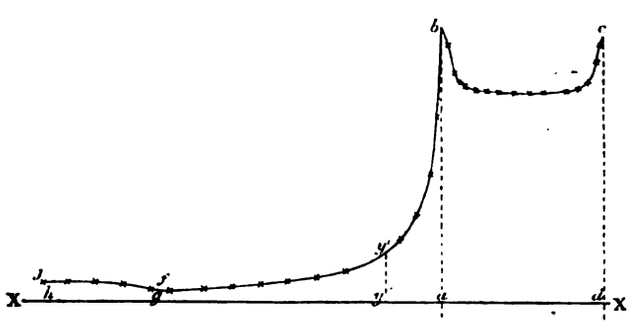

FIG. 3.—Curve showing Flux Distribution on Pole Face and Flank.

Air-gap = 1 cm. Width of Pole Face = 5·8 cms.
Length of Pole perpendicular to Plane of Paper = 11 cms.
Average Flux Density over Pole Surface = 16,000 lines per cm².

point immediately opposite the pole-tip is much smaller than it is at a point under the middle of the pole. The point at which the flux density falls off rapidly appears to be at a distance equal to the air-gap, from the point just under the pole-tip. The average flux density at the surface of the pole was about 16,000 lines per cm.², and the ratio of the maximum density at the pole-tip to the density at the middle of the pole was found, by measuring the curve, to be 1·32.

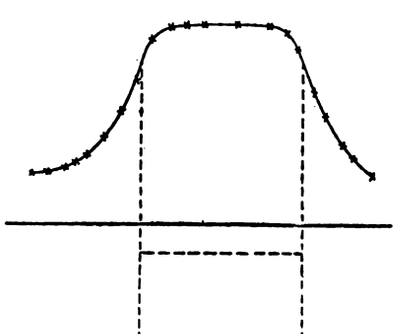

FIG. 4.—Curve showing Flux Distribution on Surface of Armature

Air-gap = 1 cm. Length of Armature perpendicular to Plane of Paper = 11 cms
Average Flux Density under the Pole = 16,000 lines per cm².

Experiment 2.—This experiment was similar to the previous one, except that the air-gap was smaller and the flux density much less less. In this case:

Air-gap = 2·3mm.

$$\text{Ratio } \frac{\text{width of pole}}{\text{length of air-gap}} = 25{\cdot}2.$$

The flux density under the pole was approximately 5,000 lines per cm².

The curve for the distribution of flux on the polar face shows again the peaks at the pole-tips, although they are now very much smaller than was the case in experiment 1, with a large air-gap. This indicates that the peaks are dependent on the size of the gap, or, more correctly, on the ratio of slot width to gap. The curve of flux distribu-

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tion on the armature surface has the usual shape, and the point at which the flux density begins to rapidly fall off is at a distance equal to about twice the air gap from the point on the armature just opposite a pole-tip. It is interesting to note from these curves that with a large gap the maximum flux density on the pole-face is greater than the maximum flux density on the armature surface. With a small gap the maximum flux density on the pole-face is about equal to the maximum flux density on the armature surface. The curves also show how much flux leaks out of the flanks of the pole and also how much passes from the root of the gap between the poles. In Fig. 3 the part *a b c d* gives the flux issuing from the polar surface, the part *a b j g* represents the flux issuing from the pole flank, and the part *f g h j* shows the flux issuing from half of the root of the gap between the polar projections. Thus the ordinates of the curve *b f* give the flux density at the various points of the flank measured from X X as abscissa. For example, at a point 2cm. down the pole flank the flux density is measured by the ordinate *y y'*, where *a y* = 2cm. This method of plotting the curves has been adopted throughout.

II.—Experiments with the Slotted Side of the Armature and Smooth Side of the Pole-Piece.

In these experiments the flux distribution on the surface of the pole-piece due to the armature teeth was ascertained

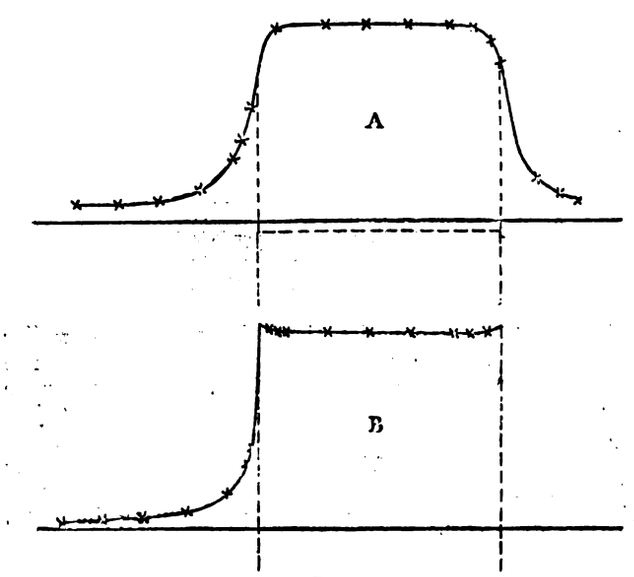

Fig. 5.

Air-gap = 2·3 mm.
Flux Density (average) at the Surface of the Pole about 5,000 lines per cm.².
Width of Pole Face = 5·8 cms. Length of Pole perpendicular to Plane of Paper = 11 cms.

for various values of the air-gap, and also the complete flux distribution over the surfaces and flanks of the teeth. This was done, as in the previous experiment, by placing the search coil at various parts of the surfaces of the armature and pole-piece.

Experiment 1.—

Air-gap = 2·3mm.

Ratio $\frac{\text{slot}}{\text{gap}}$ = 6·5.

Ratio $\frac{\text{tooth width}}{\text{gap}}$ for the various teeth = 4·35, 6·51, 6·66, 8·48, 8·52, 13·05.

Average flux density on the tooth surface, 5,000 lines per cm².

The curve in Fig. 6 shows the flux distribution on the pole surface. It is seen that the density varies very considerably at points under the teeth and under the slots. This really gives the case of the flux distribution on the surface of the pole in a direct-current machine when the slot and gap relations are as shown. As the teeth pass across the surface of the pole-shoe this wave moves with them and corresponding eddy currents are set up. It is noticeable that if the tooth is too narrow relatively to the air-gap the flux wave never becomes flat under the tooth. The points at which the curve of flux density on the pole-piece surface begins rapidly to diminish is approximately at distances from the tips of the teeth about equal to the width of the gap. The curves for the pole-piece surface have been measured, and the results are as follows:

Curve I.—Area = 1,460; mean height = 57·1; maximum height = 88 5; minimum height = 31 5.

Curve II.—Area = 1,927; mean height = 66 3; maximum height = 90·5; minimum height = 31·8.

Curve III.—Area = 2,004; mean height = 64 5; maximum height = 90·2; minimum height = 32·0.

Curve IV.—Area = 2,356; mean height = 67 3; maximum height = 91·0; minimum height = 31 8.

In Fig. 7 the flux distribution on the surfaces and flanks of the several teeth has been plotted—the air-gap and flux

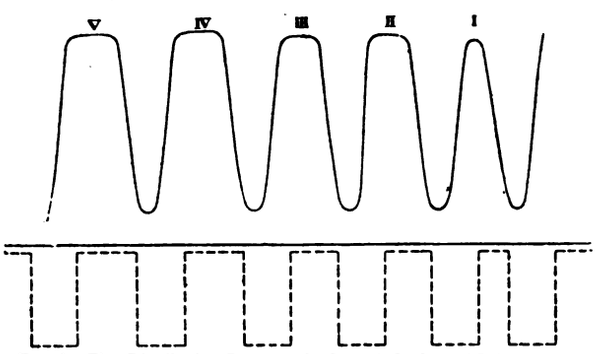

Fig. 6.—Flux Distribution Curve on the Smooth Surface of Pole-piece.
Air-gap = 2·3 mm. Average Flux Density under a Tooth = 5,000 lines per cm.²

density being the same as for the curves of Fig. 6. These curves in Fig. 7 have been plotted in precisely the same way as in Fig. 3, and the method has been already fully explained. The characteristic feature of these curves is the high flux density at the tooth tips. Thus in Curve I. (Fig. 7) the density at the tooth tip is greater than the density at the middle of the tooth surface by about 10 per cent. Moreover, the flux density at a point at the middle of the tooth surface is greater than at the point just opposite

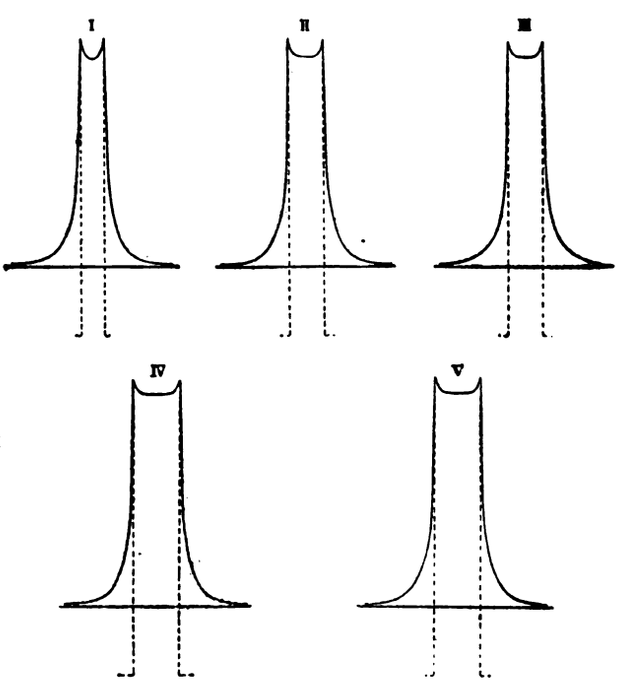

Fig. 7.—Flux Distribution on the Surfaces and Flanks of the Teeth.
Air-gap = 2·3 mm.

on the pole-piece, and the same features can be observed for all the teeth. The curves also show to what extent the flux leaks out from the flanks of the teeth into the pole-piece.

Curve I.—Area = 1,535; ratio, flux density at tip to flux density at middle of tooth surface = 1·11; minimum height for the surface of the tooth = 90 6.

Curve II.—Area = 1,944; ratio, flux density at tip to flux density at middle of tooth surface = 1·08; minimum height for the surface of the tooth = 91·8.

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Curve III.—Area = 2,019; ratio, flux density at tip to flux density at middle of tooth surface = 1·07; minimum height for the surface of the tooth = 91·8.

Curve IV.—Area = 2,366; ratio, flux density at tip to flux density at middle of tooth surface = 1 07; minimum height for the surface of the tooth = 90·2.

Experiment 2 —

Air-gap = 5·3mm.

Ratio $\frac{\text{slot}}{\text{gap}}$ = 2 83.

Ratio $\frac{\text{tooth width}}{\text{gap}}$ for the various teeth = 1·89, 2·83, 2·89, 3 68, 3 7, 5·66.

Average flux density on the tooth surface = 6,600 lines per cm².

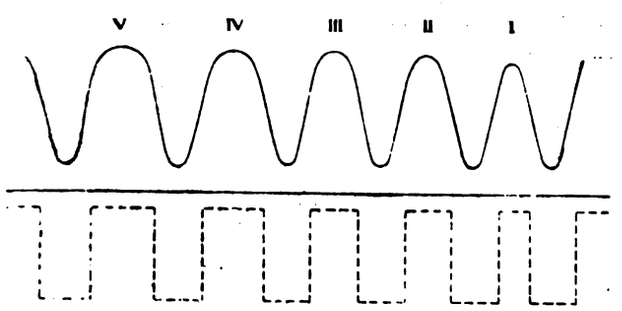

FIG. 8.—Flux Distribution Curve on the Smooth Surface of the Pole-piece.

Air-gap = 5·3 mm. Average Flux Density at Surface of a Tooth = 6,600 lines per cm.²

In Fig. 8 the flux distribution curves are given for the surface of the pole-piece under these conditions. It will be noticed that the flat tops of the curves have almost disappeared and the distribution takes a definite wave shape. Further, the fluctuations of the flux at any point on the pole-piece surface are much less than was the case with a smaller air-gap. The following gives the details of the several curves:

Curve I —Area = 1,820; mean height = 71·3; maximum height = 93 8; minimum height = 54·5.

Curve II.—Area = 2,218; mean height = 73·9; maximum height = 94 35; minimum height = 54 5.

Curve III.—Area = 2,278; mean height = 76·0; maximum height = 94·6; minimum height = 55 0.

Curve IV.—Area = 2 630; mean height = 76·3; maximum height = 94 5; minimum height = 55·0.

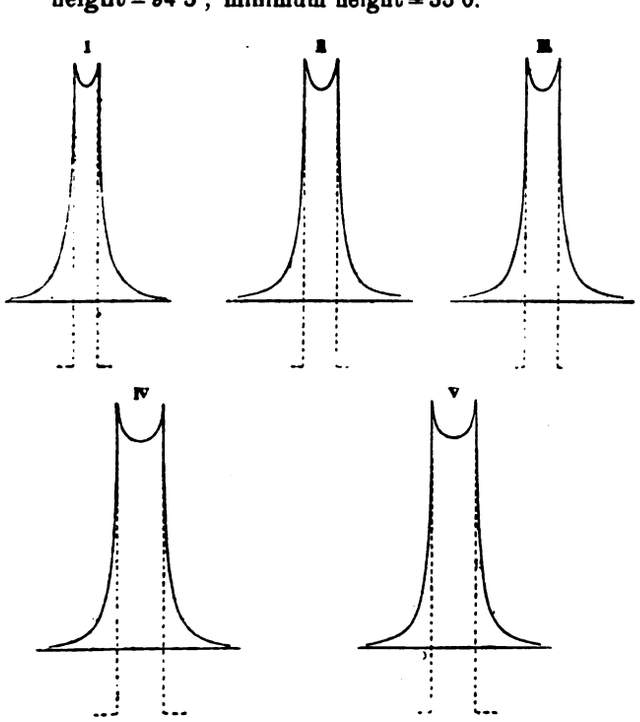

FIG. 9.—Flux Distribution on the Surfaces and Flanks of the Teeth.

Air-gap = 5·3 mm. Average Flux Density on Surface of a Tooth = 6,600 lines per cm.²

Fig. 9 shows the flux distribution on the surfaces and flanks of the various teeth for the same gap and flux density as for the curve in Fig. 8. In this case the peaks of flux concentration at the teeth tips are more marked than they were for the smaller air-gap.

Curve I —Area = 1.783; ratio, flux density at tip to flux density at middle of tooth surface = 1·11; minimum height for the surface of the tooth = 98 8.

Curve II —Area = 2,295; ratio, flux density at tip to flux density at middle of tooth surface = 1·15; minimum height for the surface of the tooth = 97 5.

Curve III —Area = 2,183; ratio, flux density at tip to flux density at middle of tooth surface = 1·16; minimum height for the surface of the tooth = 97·1.

Curve IV.—Area = 2 636; ratio, flux density at tip to flux density at middle of tooth surface = 1·18; minimum height for the surface of the tooth = 95·5.

(To be continued.)

PERSONAL.

We are informed that Mr. G. F Metzger, M.I.C.E., M.I.E.E., has removed to 22 Cooper-street, Manchester.

The annual dinner of the engineering staff of the Croydon Corporation tramways was held on the 14th ult. Mr H. B Harris, the tramway engineer, presided, and an enjoyable evening was spent.

Mr. J. C. Eves, A M I E E., meter superintendent at the St. Pancras Borough Council electricity department has been presented by friends on the staff with a handsome salad bowl, suitably engraved, on the occasion of his marriage

We are pleased to note that as a result of the examination held at the Electrical Standardising Testing and Training Institution on Dec. 17 and 18 the following awards have been made: Mr. B T. Alston, Bedford Grammar School, an exhibition of 25 guineas, tenable for two years; Mr J. H Shannon the Royal School, Dungannon, Ireland, an exhibition of 20 guineas, tenable for two years.

Some members of the staff of Messrs. Ferranti Limited of Hollinwood, held a smoking concert in the Queen's Hotel, Hollinwood, on the 19th ult. A very pleasant evening was spent, the company numbering about 23.

We are informed by Messrs. Drysdale and Co. that in future all business communications should be addressed to Bon-Accord Works, Ferry-road, Yoker, Glasgow.

Under the will of the late Lord Kelvin a legacy of £5 000 has been bequeathed to the University of Glasgow, which is to be applied by the senate of the University for promoting research and teaching in physical science in connection with natural philosophy.

Mr E. P. Barfield A M I E E., who has filled the position of lamp manager to the General Electric Co for the last eight years, has resigned his position with that company in order to take up a similar position with Messrs. Siemens Bros. Dynamo Works.

Mr. Arthur Jacob, M I.E.E., informs us that he has undertaken the control of the commercial organisation of the British Aluminium Co., 109 Queen Victoria street, London, E C., and has in consequence severed his connection with Siemens Bros. Dynamo Works, London.

The Phœnix Dynamo Manufacturing Co., of Thornbury Works, Bradford, notify the following additions to their staff: Dr. Pohl, who originally was with them as designer in direct and alternating current machinery, and who until recently was devoting a large portion of his time to the electrical department of the Bradford Technical College is now, owing to the pressure of work at the Phœnix Co., devoting the whole of his time to the firm as chief designer. They have recently made a change at their London office, and Mr. A. P. Whitehead, formerly with the Lancashire Dynamo and Motor Co., is now the Phœnix Dynamo Manufacturing Co.'s manager at 17 Victoria-street, Westminster. Mr. T. W. Ellis has been appointed the Phœnix Dynamo Manufacturing Co.'s representative and district manager for South Wales, with address at Charnwood House, St. George-street, Swansea. Mr. B. C. Noble has been appointed district manager on the North-East Coast, having charge of that district and the East of Scotland up to Edinburgh, with offices at 42, Pilgrim-street, Newcastle-on-Tyne. Mr. R. V. C. Brook has been appointed Birmingham district manager, with headquarters at Birmingham.

Thermit, Limited.—With reference to the late action of Thermit, Limited, against Weldite, Limited, for infringement of the former's patent rights for the production of pure metals and for welding metals by the well known Thermit process, in which Mr. Justice Warrington in April last gave judgment in favour of Thermit Limited, we learn that on Saturday, Dec. 31, an order was made by Mr. Justice Parker, on the petition of Thermit, Limited for the revocation of Patent No. 10 881 of 1905, granted to Claude Vautin for the process the use of which by Weldite, Limited, formed the subject of the above action.

Colonial Contract Gone to America.—Sir William Grey-Wilson, Governor of the Bahamas, who recently arrived in New York from England on board the White Star liner "Oceanic," has intimated, says the Central News that the contract for building and equipping a municipal electric lighting plant for Nassau will be given to an American firm. The specifications were drawn in London, and the value of the contract is about £16,000. The American newspapers comment on the placing of an important British Colonial contract in the United States.

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ELECTRIC LIGHTING PROVISIONAL ORDERS (SESSION 1908).

The following applications for provisional orders were deposited with the Board of Trade on or before Dec. 21, 1907, under the provisions of the Electric Lighting Acts, 1882 to 1890:

Title of Order and Description of Area.	Name of Promoters.
Barrhead Electric Lighting Order.—The Burgh of Barrhead.	The Strathclyde Electricity Supply Company, Limited.
Barton-upon-Irwell Electric Lighting Order.	The Rural District Council.
Bath Rural District Electric Lighting (Amendment) Order.	The Rural District Council.
Bispham - with - Norbreck Electric Lighting Order.—The Urban District of Bispham-with-Norbreck.	The Urban District Council.
Bridgend Electric Lighting (Extension) Order.—Portions of the Urban District of Bridgend, the Parishes of Newcastle Higher, St. Bride's Minor, Coity Higher, and Ewenny in the Rural District of Penybont.	The Urban District Council.
Caldy Manor Electric Lighting Order. Portion of the Parish of Caldy in the Rural District of Wirral.	The Caldy Manor Estate, Limited.
Carmarthen Electric Lighting Order. The County Borough of Carmarthen.	Messrs. J. B. Saunders and Co.
Clydebank Electric Lighting (Amendment) Order.	The Clyde Valley Electrical Power Company.
Dundee Electric Lighting (Extension) Order.—Portion of the City and Royal Burgh of Dundee.	The Dundee Gas Commissioners.
Fleetwood Electric Lighting Order.—The Urban District of Fleetwood.	The Urban District Council.
Fleetwood Electric Lighting Order.—The Urban District of Fleetwood.	Broadstone Limited.
Halesowen Electric Lighting Order.—The Rural District of Halesowen.	George Balfour, Esq.
Hendon Electric Lighting (Amendment) Order.	Messrs. Crompton and Co., Limited.
Heswall Electric Lighting Order.—The Township of Heswall-with-Oldfield in the Rural District of Wirral.	The Rural District Council of Wirral.
Johnstone Electric Lighting Order.—The Burgh of Johnstone.	The Strathclyde Electricity Supply Company, Limited.
Llandaff and Dinas Powis Electric Lighting Order, 1901 (Amendment) Order.	The Rural District Council.
Llansamlet Electric Lighting Order. The Parish of Llansamlet in the Rural District of Swansea.	The Rural District Council of Swansea.
Lowestoft Electric Lighting (Extension) Order.—The Urban District of Oulton Broad.	The Corporation.
Lymington (Extension) Electric Lighting Order.—The Parishes of Boldre and Sway, and portions of the Parishes of Milford and Hordle in the Rural District of Lymington.	The Lymington Electric Light and Power Company, Limited.
Macclesfield Electric Lighting (Amendment) Order	The Corporation.
Oulton Broad Electric Lighting Order. The Urban District of Oulton Broad.	The Urban District Council.
Portsmouth Electric Lighting Order.	The Corporation.
Rutherglen Electric Supply (Amendment) Order.	The Corporation.
Southampton Electric Lighting Order.	The Corporation.
Sowerby Bridge Electric Lighting Order.	The Urban District Council.
Tewkesbury Electric Lighting Order.	The Corporation.
Woking Electric Supply Company Electric Lighting (Extension) Order. The Urban Districts of Staines and Egham; the Parishes of Laleham and Littleton in the Rural District of Staines; the Parish of Thorpe in the Rural District of Chertsey; the Parish of Cobham in the Rural District of Epsom; the Parishes of Wisley, Ockham, Send, and Ripley, and Pirbright in the Rural District of Guildford.	The Woking Electric Supply Company, Limited.

LEGAL INTELLIGENCE.

WEST HAMPSTEAD ELECTRIC RAILWAY COLLISION.

At Marylebone, on Saturday last, William John Hollis, signalman, was again before Mr. Plowden to answer the charge of manslaughter of the three men who were killed in the collision of trains at West Hampstead Station on Oct. 26.

WILLIAM FITCH, the station foreman at West Hampstead at the time of the collision, was recalled, and admitted that there were rules that when occasion required a competent man should be put on duty on the platform; but these rules were not complied with on the day in question. He added that if the signalman could not see the trains, the witness relied upon the man's communicating with him by a whistle provided for that purpose.

EDWARD LYONS, chief traffic inspector on the Metropolitan Railway, stated that when the prisoner was seen after the collision and asked what had happened, he replied that he was busy booking up the trains, the disc broke down, and it was so foggy that he could not see the train in the station. He was very agitated, there were tears in his eyes, and he appeared to be broken down. The line at that time was blocked. All the signals were at "danger" except, he thought, the down home signal. The fog was thick but one could see a distance of 40 yards. The witness had known Hollis for 10 years, and considered him a good signalman.

WILLIAM SHEPHEARD, a signalman for 25 years on the Metropolitan Railway, stated that the disc which the prisoner said broke down worked all right when the witness tested it.

ALBERT CARVILL, lineman in charge of the telegraph, telephone, and train-signalling intruments and treadles in the West Hampstead section, denied that he opened the down additional disc instrument case after the collision. He did not interfere with any of the disc instruments that day.

EDWARD PHILLIPS, telegraph engineer to the Metropolitan Railway Co, who arrived at the station about three hours after the collision, stated that all the discs in the signal box were then showing "train on line," and as far as he could observe all the instruments were in order while Major Pringle were examining them. The down starting treadle was also in working order apparently. During the following fortnight, however, the treadle failed to release on one occasion, but the failure was on the safe side, for the signalman was unable to release the danger signal. Fifteen days later Major Pringle made a further examination of the instrument for about an hour, and it appeared to work perfectly. But once since there had been another failure of the instrument to release, which might have occurred through the signalman's pulling back his lever before the train had gone over the treadle.

At the close of the case for the prosecution, defendant's solicitor submitted that there was no case to go to a jury.

Mr. PLOWDEN observed that it was a case of great importance and raised many points which could only be satisfactorily cleared up by a judge and jury. Without, therefore, in any way prejudging the case, he committed the prisoner for trial, bail being accepted in two sureties in £50 each.

COMPANIES' MEETINGS AND REPORTS.

STRATFORD-ON-AVON ELECTRICITY.

The annual meeting of the shareholders of this Company was held last week, Mr. G. M. Bird (chairman of directors) presiding.

In moving the adoption of the report and accounts, the CHAIRMAN said that the revenue account only represented two months' work. On the face of it it looked as if they were doing but little, but since then the business had been growing every week, and the number of consumers was increasing, and the directors hoped at the end of the next 12 months to be able to show them a very good balance sheet. When they met at the last annual meeting they had not made a start with the buildings, but at the present moment everything was thoroughly complete, the mains had been laid, the engines and plant installed, and the building finished. They were now able to supply electricity in any form, and they were equal to any demand which might arise. Their contract of £7 600 was only exceeded by a small sum—under £80—by way of extras, which showed considerable foresight on the part of their engineer, Mr. Faleke, in arranging the specifications. They had already had to extend the main in some directions, which they were glad to do as opportunity arose, provided they saw sufficient consumption to justify their outlay on the capital account. The building was constructed so that it could be extended as required, and he only hoped it would soon be necessary. At the rate they were going on, in a year or two they would probably have to go in for enlarging the premises. They had now 50 consumers, including the three banks, the theatre was just being installed, and the hospital would probably take it up directly. There was also the church, while all the leading tradesmen were rapidly installing the new illuminant. Last year one or two of the shareholders took a little exception to the Company undertaking the business of wiring and fitting. The directors considered the matter carefully, and thought it would be in the best interests of the Company to go on with that branch, for two reasons. First of all, they were anxious that the people in the town should be able to install the electric light with as little expense as possible, and they felt that by tendering themselves they would be able to keep the cost down. They did not imagine they would make a profit out of the lighting for the first 12 months, but by taking up the wiring they were able to make a little profit and to pay some of the costs of the generating station. Perhaps the one weak point they had was the day load. Stratford was not a manufacturing centre, but at the same time several people used it by day, and the trial found it convenient in every way. They were anxious now to take up cooking and heating by electricity, and had reduced the price considerably. It was possible in the spring or some time they would organise an exhibition in the town with the view of educating people to the advantages of electricity. A great deal had been written and said about the relative merits of gas and electricity. However, the electric light had had a great benefit conferred on it by the introduction of the new Osram lamp, by means of which they were able to greatly increase the light at about a quarter of the current that was supplied under the old carbon-filament

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lamp, and they would be able to compete with any illuminant likely to be put in the market. From a profitable point of view it was not so advantageous, because it meant a considerably reduced current, but they had to look at the matter from a proper basis, and he thought these lamps, which were made with a metallic filament, would tend to induce people to try the light, and he had no doubt but that they would be satisfied with the results. He thought the Company had a future before it and another year a good balance-sheet might be anticipated.

Mr. FLOWER seconded the motion, which was carried.

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS.

The third annual general meeting of the Sunderland District Electric Tramways was held on Dec. 30, 1907, in London, Mr. C. S. Cockburn, J.P., chairman of the Company, presiding.

The CHAIRMAN regretted that he had not a more satisfactory tale to unfold and more favourable accounts to present. He did think however, that the situation was not much worse that day than with a receiver in possession and the interests of the preference and ordinary shareholders entirely wiped out. The directors had decided that it was sound policy to let the dead past bury its dead, and instead of litigation to change completely the policy and management of the undertaking, and by putting a united shoulder to the wheel to endeavour to put the tramcar on a sounder track than it had been running on up to date. Something in that way had been done during the past few months since the new management and policy had had time to get fairly to work. The traffic increased every single week for 16 weeks up to Dec. 25, the date of the last return. These increases totalled £800. 17s. 8d. For the eight weeks of their new year they had an average increase of £57 per week; beyond that the working expenses, which came out for the year just ended to 75·41 per cent., had for the past few weeks been 69 to 70 per cent. Since Nov. 1 they had reduced the car mileage 1,000 miles a week, and yet were carrying 4,000 more passengers per week. Until they spent some of the new money they were now asking for on the cars and on the track, he feared that they could not get the working expenses down below their present figure. Fifteen of their cars were French, and from the commencement had been a constant source of worry and expense. He quoted some figures showing the handicap they were under in regard to those cars. The total sum spent on car repairs for the year ended Oct. 31 last came to £2,929. 16s. 1d., of which some £1.200 was absolutely abnormal due to the faulty workmanship and type of the cars mentioned. In addition to heavy repairs bill there were four other items that had militated against the success of the Company. First, the bad name the Company acquired when it first opened. In order to hasten the opening, as the power station was not ready a gas plant was installed. This plant at that time had never been tried on a tramway of that description; in any case, it failed utterly and disastrously for the Company. Then they had had two serious accidents—both at the same spot and both necessitating Board of Trade inquiries. They now kept a pilot driver permanently stationed at this dangerous curve, who takes charge of each car until it has traversed the section. They had also had to pay out considerable sums for damages and for premiums on insurance. Another point of leakage had been the miners' tickets issued in books to miners going to and from their work at the pits. The sum asked for these tickets was much too low, and they were actually losing money on the contract. A new scale of rates came into force in November last. The fourth item affecting the receipts was the bad weather. A point which the chairman mentioned as a happy augury for the future was the fact that very considerable building operations were in progress in the districts their lines tapped. Working expenses were too high as it was, and they had the men, the staff, and the equipment on the spot to deal with almost three times their present weekly takings; consequently, for every additional £100 they took they needed only to spend some 20 to 22 per cent., instead of 76 per cent., which their present traffics had to bear. An adverse factor, however, was the question of track subsidences owing to colliery workings. Mr. Bird then presented statistics relating to the working of the trams. For the year from Nov. 1, 1906, to Oct. 31, 1907, receipts per car mile came out at 7·668d. Power costs per unit, ·790d. As a check against the items he was about to give, he gave the similar items averaged over 22 other English tramway companies. The Sunderland Co.'s operating costs per car mile came out at 2·154d., other companies at 2·42d. Their repairs per car mile, 1·169d.; other companies, ·98d. Their general charges gave 1·034d., other companies ·96d. Their total operating costs worked out at 4·373d., other companies 4·36 l. Their total power showed 1·370d., other companies 1·87d. Their total works costs showed 6 174d., other companies 6·23d. Their net revenue came out at 1·434d; units per car mile, 1 685; car mileage, 758 532; passengers carried, 3,741.096; average miles per car per day, 118 8.0; passengers per mile, 4 923; receipts per passenger, 1 542d; costs per passenger, 1·251d. Though the report mentioned a loss on the year's working, he pointed out that before debenture interest was paid the profit for the year came out at £4.600. He was sorry to say that arbitration with the Durham Collieries Electric Power Co. had not yet been settled. Turning to the balance-sheet, under the head of expenditure on construction work, there were additions to date to the amount of £745. Of that amount £160 went to the local authority for road widenings, £377 was a Post Office claim for moving telegraph poles. Of the £1 835 "less amounts previously charged, now allowed by contractors, etc.," £885 consisted of engineers' fees which they waived and returned to the Company, while the company which put in the gas plant returned £1 025. Turning to the revenue account of the £3,847 under the head of repairs and renewals, £2,929 had been spent on car repairs. Management expenses, including salaries, rents, rates, etc., amounted to £2,944, the rates included in that amount coming to £1,490. Office rent and salaries, £266, were now reduced to £150. With regard to the adjustment of accounts with the Durham Collieries Electric Power Co. and others, £1,360, those were amounts that were in the books as debts to the Company, but upon investigation they were proved to be worth nothing. They were more or less imaginary claims, and when they came to close quarters they were advised that they had not a leg to stand on, and, therefore, it became a question of compromise. The revenue account for the year had borne that charge of £1,360 which, of course, would not recur. He moved the adoption of the report and accounts.

Mr. SIDNEY seconded the motion, which was carried unanimously.

The Hon. Reginald Parker was elected a director of the Company.

EXTRAORDINARY GENERAL MEETING.

An extraordinary general meeting of the Company was afterwards held, at which, on the motion of Mr. Crisp seconded by the Hon. R. Parker, the following resolutions, separately submitted, were unanimously agreed to: (1) "That the directors be and they are hereby authorised, in addition to the sums already borrowed for the purposes of the Company, to borrow to an amount not exceeding in the aggregate £20 000 in addition to the bonus hereinafter mentioned) by the creation and issue of a new series of 200 debentures or prior lien bonds of £100 each, or an equivalent amount of debentures or bonds of such less amount each as the directors may think fit, repayable, together with a bonus of £5 per cent. (*a*) on Jan. 1, 1918, or (*b*) on such earlier day as the principal moneys may become payable in accordance with the conditions to be endorsed thereon or (*c*) at the option of the Company on or at any time after Jan. 1, 1909, on six months' notice, such debentures or bonds to carry interest at the rate of 5 per cent per annum, and to be in such form and to be secured in such manner and to be issued to such persons and with such provisions as to the creation of a sinking fund or otherwise, and on such terms as the directors may think expedient." (2) "That the provisional agreement dated Dec. 16, 1907, and made between Charles Stuart Cockburn, purporting to contract on behalf of all the holders of first debentures of the Company of the one part and the Company of the other part, and the provisional agreement dated Dec. 16, 1907, and made between Henry Roughton Hogg and Charles Birch Crisp of the one part and the Company of the other part be and the same are hereby ratified and confirmed, and that the directors be and they are hereby authorised to carry the same into effect as soon as they shall become absolute."

MEETING OF DEBENTURE HOLDERS.

A meeting of the holders of the first debentures of the Company was then held for the purpose of submitting a provisional agreement, dated Dec 16, 1907, providing for a modification of the rights of the holders of these debentures and of the provisions of the trust deed dated Dec. 8, 1903. The resolution was carried, as it was also at a meeting of the beneficiaries entitled to the benefit of the second charge upon the Company' undertaking.

BURMA ELECTRIC TRAMWAYS AND LIGHTING.

The report of the Burma Electric Tramways and Lighting Co. for the year ended July 31 last states that the receipts have barely covered the expenditure, in spite of the fact that the outgoings for current expenses have not appreciably increased. During the year the plague continued with unabated activity, and, it is stated, though not officially, that about one-third of the population left the city by reason of the epidemic, and the usual inflow of visitors from neighbouring districts ceased almost entirely, so that the directors consider the decrease in the receipts of about £1 000 is less than might reasonably have been expected, and that it indicates the usefulness of the undertaking, which may be expected to develop with a return to normal conditions. This is apparently proving to be the case, for since the date covered by the accounts—*i.e.*, since August last—when the plague was reported to have ceased, an improvement in the receipts has been manifested, small at first, but assuming later more considerable proportions. The directors report that in spite of their endeavours they have been unable as yet to evolve any satisfactory solution to the fuel difficulty. No coal has yet made its appearance in Mandalay, and the Company has still to rely upon wood for their heating power, and for this reason it has been impossible to effect any reduction in the charges for power, which continue abnormally high. In other directions some economies have been made, but it is impossible to make great reductions as long as efficiency in the service is to be maintained. The attention of the Board has been constantly directed to every means possible to popularise the undertaking by modifying the fares in such manner as to meet the requirements of the public, and by utilising the plant and machinery in carrying out such additional work as is possible in the supply of light and power. The new scheme of fares came into force in November last, and appears to have been attended with a measure of success, but it is difficult to form a precise opinion on the subject, as the improvement in general conditions, which undoubtedly exists, may be responsible for some of the increase. The Company commenced operations in 1905. For the first year the traffics, though not such as the information supplied to the directors led them to anticipate, showed a tendency to improve, but the improvement was checked by the outbreak of plague in February, 1906, which then appeared in Burma for the first time, and which continued in increasing volume until August last. Notwithstanding this unlooked for check a very large number of riders, about 50,000 per week, continued to use the tramways, so that it was evident that the want of expansion was not due to any hostility to the tramways, but to circumstances entirely apart. In the meantime the people were becoming familiarised with the use of the cars, and the moment the unfavourable circumstances disappeared an important addition to the riders took place, and is still continuing. The outlook seems generally to be more favourable.

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NEW COMPANIES REGISTERED.

Electric Loco Motor Propulsion Co., Limited.—Registered Dec 19. Capital, £1 000 in £1 shares. Objects: to carry on the business of electrical engineers, accumulator manufacturers, makers of electrical plant and machinery, manufacturers of and agents for the sale, purchase, and hire of motors, motorcars, etc. No initial public issue. Secretary and registered office: J. Bruce, 25, Brewer-street, Regent-street, W.

Mitcham Electric Fan Co., Limited—Registered Dec. 20. Capital, £10,000 in £1 shares. Objects: to acquire and turn to account inventions relating to the production, storage, application, distribution and use of electricity; to adopt an agreement with the Dynamic Syndicate Limited, and to carry on the business of manufacturers of and dealers in electric fans, electric tools induction coils, etc. No initial public issue. Registered office: 6, Broad-street-place, E C.

Electrical and Mechanical Exhibition, Limited.—Registered Dec. 13. Capital £5 250 in 5 000 5 per cent. preference shares of £1 each and 5 000 ordinary shares of 1s. each. Objects: to expose for sale and exhibit in London or elsewhere, electrical and mechanical apparatus, inventions, machinery, appliances, and manufactures of other companies, persons, and firms including storage accumulators gramophones and records, telephones, motorcars etc No initial public issue. Registered office: Carlton House, 11-13, Regent-street, S W.

British Westinghouse Engineers' Club, Limited.—Registered Dec. 13 Capital, £500 in £1 shares Objects: to adopt an agreement with N. Carlton and J. S. Peck for the acquisition of certain premises at Trafford Park, Manchester, leased to the said parties, and to provide a clubhouse and other conveniences for use of the members of the British Westinghouse Engineers' Club. No initial public issue. Registered office: British Westinghouse Electric and Manufacturing Co.'s Works, Trafford Park, Manchester.

Liens Registered.

Leicestershire and Warwickshire Electric Power Syndicate, Limited.—Issue on Dec 17 of £100 6 per cent. debentures part of series created July 9, 1907, to secure £5,000 charged on the company's undertaking and property, present and future, including uncalled capital No trustees. Total amount previously issued of same series, £750.

Minehead Electric Supply Co., Limited.—Trust deed registered Dec 9 for £5 000 debenture stock. Trustees: E. Clarke and R. Davis (freehold and leasehold land and hereditaments, together with the electric generating station, and all the other assets and uncalled capital).

BUSINESS NOTES.

LIGHTING AND GENERAL.

Brighton.—The Brighton and Hove Gas Co. have decided to increase the price of gas by 2d. per 1,000ft.

Maidenhead—An inquest has been held upon the body of Mr. E. K. Smart, who died as the result of a gas explosion.

San Francisco—The City Electric Co. has closed a contract for a 10,000-h p turbo-generator, the installation to cost 300,000dol.

Knighton—An inquest has been held upon the body of the master of the union workhouse, who died as the result of a gas explosion.

Lanchester.—The Guardians have appointed a committee to bring up a scheme for lighting the infirmary with either electricity or gas.

Canada.—The Government are proposing to erect five additional wireless stations, thus completing the wireless line to Prince Rupert.

Wombwell.—An explosion, followed by a fire, occurred at the gasworks, whereby four men were seriously injured, one of whom has since died.

Aylesbury.—The Aylesbury Electric Lighting Order, 1906, has been revoked. Another attempt to supply the county town with electricity has thus failed.

Bangor.—The Local Government Board have held an inquiry into the application of the Corporation for sanction to the borrowing of £1.000 for extensions to the electricity department.

Barrow-in-Furness.—The Local Government Board will hold an inquiry on Jan. 10 into the application of the Town Council for sanction to borrow £5,000 for the purposes of the electricity undertaking.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the five weeks ended Nov. 29, 1907, were 423.176 compared with 337,823 units in the corresponding five weeks of 1906.

Bispham—At the last Council meeting the clerk read a communication from the Council's parliamentary agent, pointing out that all the preliminary stages with regard to the Council's application for an electric lighting order were completed.

Partnership—The *London Gazette* announces that the partnership between F. J Robinson and W. J. Silvester Jones, carrying on business as electrical and general engineers at 21, Collingwood-street, Newcastle-on-Tyne, has been dissolved by mutual consent.

Manitoba.—The Manitoba Government has purchased the Bell telephone system in Manitoba, paying 3 300.000dol., the money being raised by an issue at par of 4 per cent. bonds redeemable in 40 years. The Government will take possession of the lines on Jan. 15.

Ingersoll (Ontario).—The Municipal Council are considering a proposal to purchase the plant of the Ingersoll Electric Co. for 50.000dol., to be used as a distributing plant.

Annfield Plain.—At a recent auction sale, 500 £10 7 per cent. ordinary shares in the Annfield Plain and District Gas Co were put up for disposal, but so poor was the response that only 261 were disposed of at par, and no offer whatever could be obtained above.

Treforest Electrical Consumers' Co—This company, having decided to extend its plant, has placed an order with the British Westinghouse Electric and Manufacturing Co for one 3 000 kw turbo-generator 1,500 r.p.m. and complete high-vacuum surface-condensing plant fitted with the Westinghouse-Leblanc dry air pump.

Newport.—At a meeting of the Electricity Committee it was reported that the Local Government Board had sanctioned a loan of £28,000 for carrying out extensions and sundry works at the power station. Discussion took place on the question of tramway transfer tickets but it was resolved not to make any alterations at Newport.

Battersea—The number of lamps connected for the fortnight ended the 31st ult. were 1.134, making a total number to date of 73 204. The motors connected during the fortnight were equivalent to 180 8-c.p. lamps, bringing the total under this heading to 41 378. For heating purposes there was connected the equivalent of 100 8-c.p. lamps, making a total of 4 832.

Easthampstead.—The district manager at Reading of the National Telephone Co has informed the Council that the company have decided that if Crowthorne was to be developed it should be from the Reading direction. Recently they had been canvassing for orders on that understanding, and they had now succeeded in getting a sufficient number to warrant his putting forward formal estimates for the consideration of the Board.

Wimbledon.—In November last from the profits of the municipal electric lighting undertaking the Council voted £1.500 in relief of the rates, which is equal to 1d. in the £. Following upon this, the Electric Lighting Committee have decided to recommend the Council at its meeting to order that £639. 8s. 10d., being a portion of the profits of the electric lighting undertaking, be transferred from the electric lighting account to the general district fund account in aid of the general district rate.

Acton.—The special committee of the District Council appointed to make arrangements for the holding of an electrical exhibition at the public baths have received a report from Mr J. Martin Blair electrical engineer, wherein he estimated that the receipts from an exhibition would be £152, £82 of which had been guaranteed by the hire of stalls and advertisements. The committee expressed satisfaction with the amount of support promised, and decided that an exhibition should be held from Jan. 18 to 25.

Spalding.—The district auditor (Mr. J. A. Cole) has surcharged members of the Urban Council with £66, being the amount incurred in opposing an electric lighting scheme. The expenditure in question was incurred in opposing electric lighting powers which were being applied for by an outside company. The ground of the surcharge is that the Local Government Board were not notified of the action the Council were taking in the matter. The Council are appealing to the Local Government Board against the decision.

Hanwell.—The Board of Trade has given notice to the Urban District Council that unless it takes advantage of the order giving it power to supply electric light in the district during the next 12 months the same will be revoked. On two previous occasions the Board has sanctioned an extension of the order, which cost the ratepayers £550 to obtain, and the present is to be regarded as the final notice. The Council has used every effort to get a company to take over the order, but satisfactory terms have not yet been arranged.

Halifax.—The Telephone Wayleaves Committee are recommending the Town Council to accept revised terms with the National Telephone Co., as agreed between Alderman R. D. Ward and Mr. G. Franklin, president of the company. The new arrangement is as follows: (1) 5s. per annum to be paid by the company to the Corporation for each subscriber through the local exchange up to and including 1,000 subscribers; (2) 2s. 6d. per annum for each subscriber beyond 1,000; (3) 2s. 6d. per annum to be paid by the company to the Corporation for each pole and bracket; (4) a rebate of 20 per cent. per annum to be allowed by the company off the tariff rates for telephones supplied to the Corporation.

Withernsea.—At the last meeting of the Urban Council a letter was read from the Postmaster-General in regard to the suggested telephone service, in which it was pointed out that the liability of Withernsea in regard to cost might be allotted, with Patrington, at £25. 10s., and Patrington's share of responsibility at £8. 10s. It was also suggested that these places might share with Keyingham. The liabilities, which are somewhat on the same lines as the institution of a telegraph office would be, it was suggested as follows: Withernsea, £24; Patrington, £8; and Keyingham, £6. It was decided to send an extract of the letter to the Parish Councils of the last two townships.

Aston.—The report of the Electricity Committee, which will be considered by the Town Council, contains recommendations with regard to the return of consumers' deposits They recommend that in cases where a consumer secures his cash discount four quarters in succession, or where a consumer has paid his account without securing discount for two years without special pressure having to be brought to bear upon him, his deposit shall be credited against his next quarter's accounts. Where a consumer has frequently been served with a cut-off notice before paying his account the committee advise that his deposit shall be retained indefinitely.

Rome.—A gas explosion occurred on the 31st ult. in the Stock Exchange, a dozen or more persons being injured, and considerable damage done to the Stock Exchange, which is one of the finest of the

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ancient remains in Rome, and was formerly the Temple of Neptune. The central portico, which was built by Agrippa, is composed of magnificent white marble, with Corinthian columns 43ft. high. The building has already suffered severely from fire. Another gas explosion occurred on the same date. A gasometer exploded near the Piazza Colunna. Several workmen were injured, and had to be taken to the hospital. The explosion caused a loud report, which brought crowds of people at once to the Piazza Colunna.

Orkney.—Through some unexplained cause a complete breakdown of the telegraphic system between Orkney, on one hand, and Shetland, on the other, with the mainland has taken place, and telegrams are being sent on by steamer. It is impossible to say what has occasioned the breakdown, which is remarkable in respect that the two groups of islands are supplied independently and that the cables lying in the Pentland Firth are 20 miles apart. The system to the northern islands is on land from Aberdeen to Burghead, where the Moray Firth is crossed by cable to Helmsdale. There is then a land line to Sinclair Bay for the Shetland Islands, the cable lying 20 miles to the east of the Orkney cable, which leaves the mainland at Dunnet Bay. The weather in the Pentland Firth has been very stormy, but the breakdown of the cables is not thereby explained.

Stock Exchange.—The Stock Exchange Committee has appointed special settling days as under: Jan. 6—Boston Consolidated Copper and Gold Mining Co.'s scrip certificates (50 per cent. paid) for £252,000 7 per cent. first debentures (in the denominations of £15 and £150); Jan. 9—Mexico Tramways Co.'s 6,000,000dol. common stock in shares of 100dol. each; Jan. 14—Société Française de Pétrole's 3,507 shares of £1 each, fully paid, Nos. 121,494 to 121,500 and 166,501 to 170,000, and 121,493 vendors' shares of £1 each, fully paid, Nos. 1 to 121,493. The committee have ordered the Mexico Tramways Co.'s 6,000,000dol. common stock in shares of 100dol. each to be quoted in the official list. Applications have been made to the Stock Exchange Committee to appoint a special settling day in the Java Rubber Plantations' 19,500 shares of £1 each, 15s. paid, Nos. 6,001 to 25,500; and to allow the United Electric Tramways of Monte Video £600,000 first debenture stock to be quoted in the official list.

Bridgend and Penybont.—At a meeting of the Penybont Rural District Council it was reported that a deputation of the Bridgend Urban District Council attended a committee of that Council with a view of coming to an arrangement respecting the Bridgend electric lighting (extension) order. It was pointed out that the Urban District Council would be prepared to insert new clauses in the order safeguarding the rights of the Rural District Council by undertaking to supply electricity to any part of the Rural District Council's area at the same charges as at Bridgend, and notwithstanding anything contained in the order the Rural District Council would be at liberty to apply for a provisional order to supply any part of the rural area covered by the order of the Bridgend Council. After a lengthy discussion it was resolved not to assent to the order of the Bridgend Council pending the receipt of a copy of the suggested additional clauses, and that the Bridgend Council be informed that power should be given to the Penybont Council to obtain electricity from any source other than Bridgend Urban District Council, though the area might be included in the order of the latter.

Cobham.—A special meeting of the Parish Council has been held to consider the application which is being made by the Woking Electric Electric Light Supply Co. for a provisional order to provide current in Cobham. Mr. W. F. Finn presided, and the Council, after hearing the statement of Mr. J. E. MacLean, the engineer to the company, decided unanimously not to oppose the application. Mr. A. A. Bennett, who was unable to be present, wrote in favour of the application. At the Epsom Rural District Council meeting a letter was read from the company asking the Council to pass a resolution giving consent to the grant of a provisional order authorising the company to supply electricity for public and private purposes in the parish of Cobham. The clerk reported that the notice of the intended application and plans in connection therewith had been deposited at his office. The surveyor reported that the roads affected were the Portsmouth-road, from the Antelope public-house to the brewery; High-street, Church Cobham, from Oakfield House to the Bear Hill; and Church street, from High street to opposite the church. The consideration of the matter was adjourned until the next meeting. The clerk was instructed to inform the Cobham Parish Council of the application.

Croydon.—The annual general meeting in connection with the employés' sick and benefit society in connection with the Corporation tramways was held at midnight on Dec. 21 at Thornton Heath depôt, a special car being run to convey the employés from Purley depôt. Mr. T. Goodyer, A.I.E.E., tramways manager (president), was in the chair, and was supported by Dr. F. G. Grapel, medical officer to the society. A large number of the members attended. The contributions to the society are based on a weekly payment of 1s. 1d., which entitles members to sick-pay allowance at the rate of 20s per week for a period of 13 weeks, and also to free medical attendance. In reviewing the work of the society during the year, the president stated that the audited accounts showed the total contributions to have amounted to £472. 10s. 2½d. The expenses were: sick-pay allowance, £85 6s 8d; medical officer's fees, £31 14s.; refunded to members withdrawing, £7. 2s.; death grant, £8; and incidental expenses, £9 2s 3d.; allowing of a share out of £2. 1s. 10d to 154 full members, and of 19s. 4d. to nine part members. Satisfaction being expressed at the result of the year's working, the whole of the officers, and the committee, were unanimously re-elected. The customary vote of thanks was awarded to the president.

Reyrolle's Annual Dinner.—On Saturday evening, the 21st ult., the employés of Messrs. A. Reyrolle and Co., Hebburn, held their fifth annual dinner. Mr. Reyrolle occupied the chair, with Mr. Coates as vice. The toast to the firm was proposed in suitable terms by Mr. Pyle, and responded to by Mr. Reyrolle and Mr. Norbert Merz. The former remarked that, although many other electrical firms had experienced a slackening of orders he was glad to say that they had had an extremely busy year. He acknowledged the support which he had received from the various members of the staff and the men. It was his ambition to make a name for the firm for good workmanship, the result of which would reflect not only upon the firm, but upon all who were associated with it. Mr Merz discussed the financial position, and said that they should not let the success of the year lead them into extravagances, but rather that they should take the advantage of it and put by for a rainy day. Mr. Clothier proposed the toast to the organisers of the dinner, which he was sure would strengthen the good feeling amongst the staff and other employés. The musical part of the evening was well appreciated, the names of the artists being as follows: Messrs. Adamson, Nicod (senior and junior), Lowery, Harris, Knapp, Barrow, Shepherd, Aynsley, Pyle, Wyllie, and Martin.

New Tredegar.—On Monday night a powerful electric pump was installed by the Powell Duffryn Co. at their New Tredegar Collieries, which it is expected will cope with any influx of water that may occur. Following on the flooding of the workings of the East and West Elliot pits some years ago, they laid down first two pumps of the Simpson type, and then a Reidler's pump. They have now installed an electric pump by Worthington, and a sixth stage pump, which will accomplish a far greater amount of work, and that in less than half the time. The pumping engine, which was tested on Monday night is of 915 h.p., with a capacity of forcing the water to a head of 1,645ft., and makes 1,450 strokes per minute, whilst the pump will raise 1,350 gallons per minute, or 81,000 gallons per hour, which is 21,000 gallons more during the same time than the capacity of the Reidler pump. What the latter can do if kept working day and night the former will perform during the night only. The trial proved most successful, for on starting at 11.35 p.m. the whole of the water was got rid of at 2.10 a.m., which is an unprecedented feat for the district. The electric motor is by the British Westinghouse Co. A special company of persons witnessed the test, and among the local officials present were Messrs. J. W. Price, head engineer of Elliott and New Tredegar Collieries; David Williams, mechanic, Elliot Pits; W. Lloyd electrician, etc.

York.—In their report to be presented at the next meeting of the City Council the Electricity Committee state: "Your committee have for some time past felt the necessity for a showroom and central depôt in the city for the display of the electric light, fittings, and appliances in connection therewith, and also for the convenience of customers and others who may require repairs and alterations, or desire information, instead of, as at present, having to proceed to Fose Islands at considerable inconvenience and loss of time to themselves, as well as to the electricity department itself. Your committee accordingly propose to open a showroom and central depôt in some convenient situation near the centre of the city. The Lighting Committee of the Streets and Buildings Committee have requested your committee to submit to them a scheme and estimate for improving the electric lighting of Blossom-street, with an extension to Dalton-terrace, and the city electrical engineer has been instructed to submit such a scheme and estimate to your committee for their consideration." The return for the month of November shows the following figures: units generated, 174,650; approximate units sold, 142,754; horse-power of motors connected during month, 4½; total horse-power of motors connected to date, 928¼; 8 c.p. lamps connected during month, 478; total 8-c.p. lamps connected to date, 58,942; equivalent 8-c.p. connected, 82,148.—At an exhibition on the premises of the York United Gas Co. the chairman gave some details as to the growth of the gas industry throughout the kingdom, and those present were handed a pamphlet containing a diagram from which it could be gathered that, in order to increase the number of gas consumers from 2,000,000 in 1885 to 5,500,000 in 1906, it had been necessary to increase the capital from £58,000,000 to £132,000,000 during the same period.

TRACTION.

Chicago.—Receivers have been appointed for the Chicago and Milwaukee Electric Railroad and allied corporations, representing a capital of nearly 30 million dollars.

Ossett.—The Council have decided to make application to the Local Government Board for sanction to a loan of £23,000 in connection with the Dewsbury and Ossett tramways.

Kingswood.—The Urban District Council have passed a resolution of opposition to any extension of time for the construction of tramways, which has been applied for by the tramways company.

Bolton.—It was announced on Monday that the local Tramways Committee had accepted the offer of Messrs. Sidney Straker and Squire and the Commercial Cars Limited, for a six months' trial of motor 'buses in certain parts of the borough.

Madras Electric Tramways (1904).—The traffic receipts for the fortnight ended Dec. 31 totalled Rs 20,285, an increase of 14 per cent. over those during the corresponding period of 1906. The gross receipts from Jan. 1 were Rs 416,750, an increase of 19·6 per cent.

Torquay.—The tramway company, who are seeking the permission of the Corporation to lay lines along Torbay-road as far as the railway station, have been asked if they will agree to put down a single track only, and that along one side of the road instead of in the centre.

Buenos Ayres and Belgrano Electric Tramway Co.—The receipts for the week ending Dec. 23, 1907, converted into gold were £3,789; week ending Dec. 23, 1906, £3,832—decrease, £43. Aggregate from Jan. 1, 1907, £197,536; 1906, £187,175—increase, £10,361.

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Norwich.—The management of the Norwich tramways have announced their intention of adopting a new system of return-transfer tickets, to come into force not later than the second week in January. Penny return-transfer tickets will be used both as return and as transfer tickets, and will be available any time during the day of issue.

Wyke.—Late on Christmas Eve a serious accident occurred on the Bradford Corporation tramway system in the neighbourhood of Storr Hill, Wyke. Whilst a car was on the outward journey the trolley pole broke when the car was passing St. Mark's Church, and the heavy metal end fell among the passengers, three of whom were injured.

Glasgow.—The Tramways Committee have decided, after hearing the report of the general manager relative to the losses on new routes, to recommend that the Corporation should delay in the meantime the construction of the line from Great Western-road along Kirklee-road to Gairbraid-street, and from the latter thoroughfare along Bilsland-drive to Springburn.

Edinburgh.—A mishap to a cable tramway car in South St. Andrew-street on Saturday evening resulted in minor injuries to two of the passengers, and caused a little interruption of the tramway traffic on that part of the system. The car, when proceeding southwards along South St. Andrew-street, overshot the stopping place, and came into violent contact with the underground pawl.

Jarrow and South Shields.—The announcement that the Jarrow Tramway Co. have arranged running powers over the lines of the South Shields Corporation has given satisfaction to Jarrow people. The lines join at Tyne Dock, and it has hitherto been a great inconvenience to the public to have to change cars when making the journey between the two towns. The extended facilities will doubtless be of business benefit to Shields.

Lucknow (India).—At a special meeting of the Municipality it was agreed to recommend to Government the extension of nine months to the British Eastern Electric Co. for the construction of the proposed electric tramway in Lucknow, but the Board agreed that this should be positively the last extension of time, and no further grace would be allowed the promoters, and the Board will in the meantime consider alternative lighting schemes to be prepared in the event of the company's failure.

Middlesex.—In connection with the London United Tramways Bill (1908) there is a proposal to link up the existing tramway in the Great Western main road, Brentford, with the tramway in Kew-road by carrying a double line over Kew Bridge. The Light Railways and Tramways Committee of the County Council are considering the matter, and will report when a print of the Bill has been obtained, and in the meantime they recommend that the county solicitor be instructed to oppose the Bill. This has been agreed to by the Council.

Bradford.—At an inquest in Bradford on the 31st ult. it was stated that several men, travelling on the top of a tramcar from Bradford to Wyke, stood up because the seats were wet. When they were nearing their destination the trolley pole left the wire, sprang upwards, and was then knocked down with great force by coming in contact with the next support. Several of the passengers received severe blows, but a moulder's apprentice named Atkinson was struck so violently that the base of his skull was fractured, and without regaining consciousness he died on Monday at the Bradford Royal Infirmary.

Milngavie.—At a special meeting of the Milngavie Town Council the result of the plebiscite of the ratepayers, taken in connection with the proposed introduction of the Glasgow Corporation tramways, was formally announced. Reply postcards were issued to no fewer than 1,079 ratepayers. Of these 491 declared themselves in favour of the cars, 240 against, three declined to vote, and one card was spoiled, the majority in favour being, therefore, 251. It was resolved that the result of the plebiscite should be communicated to Glasgow Corporation, and that negotiations should be opened on the question with the County Council of Dumbarton.

Clitheroe.—At the meeting of the Rural District Council mention was made of the proposed revival and extension of time for the Blackburn, Whalley, and Padiham light railway scheme. It was decided to offer strong opposition to the extension, it being stated that the Whalley and Cock Bridges were not wide enough for a light railway, and the fact that the matter had been hanging over so long had really prevented the County Council carrying out necessary improvements at Whitebirk Bridge. This was a bridge over which the light railway would pass, and if the scheme was to go forward the railway promoters would be expected to bear a share.

Ayr.—The provost, magistrates, and councillors of the burgh of Ayr ask for powers to extend the Corporation electric tramways. They desire to construct a tramway 6 furlongs 7·41 chains in length (6 furlongs 4·41 chains of double line and 3 chains of single line), beginning at the existing tramways in Main-street, Newton-on-Ayr, at the north end of the new bridge, and passing in an easterly direction along River-street, George-street, and Whitletts-road to the point where Whitletts-road is crossed by the municipal boundary of the burgh; and a tramway 4·25 chains in length (double line), commencing at a junction with the existing tramways at a point in Main-street, Newton-on-Ayr, opposite the Carnegie Library and passing in a south-easterly direction along River-street to a point in line with the west side of Garden-street. In connection with the extensions provision is made for the widening of Whitletts-road, and for certain subsidiary works. It is asked that the Corporation, in addition to any money which they may have borrowed independently of the order, or which they are or may be authorised to borrow under the provisions of any public general Act, may be empowered to borrow from time to time at interest on the security of the tramway revenue and of the police rate such sums of money, not exceeding in the whole the sum of £25,000, as shall be necessary for the purposes of the order, including so much of the expense of the street works as shall not be charged against the general improvement rate. Money borrowed for the purposes of the street works is to be paid off within 50 years, and money borrowed for the purposes of the tramways within 40 years.

Hastings.—Some 28 members of the Oxford Corporation visited Hastings on Tuesday in last week, including the mayor (Alderman Ansell), the town clerk (Mr. R. Bacon), the city solicitor (Mr. H. F. Galpin), and the city engineer (Mr. W. H. White). They were met by Mr. E. A. Mitchell, the chief engineer of the Dolter Electric Traction, Mr. Lancaster, the general manager, and Mr. Smyth, the resident engineer at Hastings. After luncheon an inspection of the tramway system took place, and through the hospitality of the Mayor of Hastings the members of the Oxford Corporation assembled for tea in the town hall at half-past four, after which a further inspection of the system was made in order that the members might see the cars when fully lighted. At 6.30 dinner was served at the Queen's Hotel, when, in addition to the Mayor of Hastings, Dr. Gray, chairman of the Tramways Committee, was present. The Mayor of Oxford proposed the health of the Mayor and Corporation of Hastings, coupled with the names of the Mayor and Dr. Gray. He said the city of Oxford had determined not to spoil their streets by the introduction of an overhead system of tramways. They were now deciding on the question of what system to lay, and he thought that day they had come to a decision. The Mayor of Hastings, in reply, stated that they really believed they had the best surface-contact in the town of Hastings. Dr. Gray, at the special desire of the Corporation of Oxford, responded, and narrated the difficulties under which the tramways had been first introduced into Hastings, and expressed himself as strongly in accord with the Mayor and Corporation of Oxford in not having overhead wires in their streets.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Rome.—The Italian Government Railways invite tenders for arc lamp carbons. Tenders by Jan. 15.

Bourges.—Tenders are invited by the military authorities for one five-ton electrical crane. Tenders by Jan. 11.

Manila.—The Municipality invite tenders for pumps and electric motors for sewage works. Tenders by Jan. 15.

Paris.—The Post and Telegraph Department invite tenders for the supply of galvanised iron wire. Tenders by Jan. 10.

Melbourne.—Tenders are invited by the Postmaster-General for switchboards and telephone sets. Tenders by May 26.

Poplar.—The Guardians invite tenders for their annual supply of stores, including electrical supplies. Tenders by Jan. 8.

Algiers.—The Post and Telegraph Department invite tenders for the supply of galvanised iron wire. Tenders by Jan. 10.

Sydney.—The Postmaster-General invites tenders for 33 switchboards for common-battery working. Tenders by March 4.

Madrid.—The Public Works Department invite tenders for the construction of a tramway at Santander. Tenders by Jan. 30.

Brest.—Tenders are invited by the Naval Authorities for the construction of 1m.-gauge electric tramway at Quelive. Tenders by Jan. 7.

Aranjuez.—The Municipality invite tenders for the installation and maintenance of public electric lighting for six years. Tenders by Jan. 14.

Valencia.—The Madrid Public Works Department invite tenders for the construction of electric tramways in Valencia. Tenders by Jan. 12.

Dresden.—Tenders are invited by the Municipality for three boilers, together with accessories, for electricity department. Tenders by Jan. 6.

Madrid.—The Post and Telegraph Department invite tenders for the installation and working of telephones in La Garriga. Tenders by Jan. 16.

Beckenham.—Tenders are invited by the Urban District Council for the extension of the destructor house at the electricity station. Tenders by Jan. 6.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Rotherham.—The Corporation invite tenders for the supply of tramway rails, fishplates, tie-bars, bolts and nuts, and special work. Tenders to the Town Clerk by Jan. 17.

Ghent.—Tenders are invited for 30 electric cranes for the new dock. Particulars from the Public Works Department, 15, Rue des Augustins, Brussels. Tenders by Feb. 1.

Kilkenny.—The District Lunatic Asylum Committee invite tenders for electric generators, accumulators, switchboard, underground mains, wiring, and fittings. Tenders by Jan. 18.

South Shields.—The Corporation invite tenders for the supply of uniforms for the tramway employés. Particulars from Mr. J. Wilson, the tramways manager. Tenders by Jan. 11.

Manchester.—The Corporation Tramways Department invite tenders for the supply of machine tools. Particulars from the Tramways Manager, 55, Piccadilly. Tenders by Jan. 14.

Armentieres.—Tenders are invited by the Northern District Municipal Authorities for electric motors and pumps in connection with water-sterilising apparatus. Tenders by Jan. 6.

Barnes.—The Urban District Council invite tenders for the delivery and erection of a two-ton electric locomotive crane at the Council's depôt, Mortlake, S.W. Tenders by Jan. 13.

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Melbourne.—The Postmaster-General invites tenders for the supply of visual vibrating indicators. Particulars from Captain Muirhead Collings, 72, Victoria-street, Westminster. Tenders by Jan. 21.

Oldham.—The Corporation Electricity Committee invite tenders for the supply of steam coal for the period Feb 1 to June 30, 1908. Tenders to Mr. S. Wilmott Newington, Electricity Offices, Oldham, by Jan. 7.

Worcester.—The Corporation invite tenders for the supply of one 400-kw. continuous-current steam generator and balancing dynamo and surface condenser. Tenders by Jan. 6, 1908. See advertisement in last issue.

London, S.W.—The Metropolitan Asylums Board invite tenders for the installation of electric lighting, etc., in the motor workshops and yard at the Mead ambulance station, Carnwathe-road, Fulham. Tenders by Jan. 8, 1908.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Camberwell.—The Borough Council invite tenders for the annual supply of various stores and materials, including maintenance of private telephones and electric bells, and rubber goods. Tenders to the Town Clerk by Jan. 20.

Finchley.—The Urban District Council invite tenders for the supply and erection of one 350-kw. high speed engine and dynamo combined, together with spare parts. Tenders by Jan. 20, 1908. See advertisement in last issue.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

London, E.C.—Tenders are invited for the supply of 15,456 incandescent lamps for the Bengal and North-Western Railway Co., as per specifications to be seen at the Company's Offices. Tenders to Mr. Alexander Izat, managing director, 237, Gresham House, Old Broad-street, London, E.C., by Jan. 13.

Adelaide.—Tenders are invited for the supply and delivery, c.i.f. Port Adelaide, of special work, points, and crossings for tramways. Specfication, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C. Tenders to the Chairman, Municipal Tramways Trust, Adelaide, by Feb. 11, 1908.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 500 tons of steel slot rails and about 190 tons of conductor rails required for the reconstruction on the underground conduit system of electric traction of certain sections of the Council's tramways. Particulars from the chief engineer, Mr. Maurice Fitzmaurice, C.M.G., County Hall, Spring-gardens, S.W. Tenders to the Clerk by Jan. 21.

RESULTS OF TENDERS.

Uruguay.—The Government has accepted the tender of Felten and Guilleaume for the supply of cable for the electric light station at Montevideo.

Cryselco, Limited.—We understand that the Midland Railway Co. have placed their contract with this company for the supply of incandescent electric lamps during the year ending Dec. 31, 1908. The Great Northern Railway Co. have also placed their contract with the company for the supply of lamps during the six months ending June 30, 1908.

Curtis Turbines.—The County of London Electric Supply Co. have just placed an order with the British Thomson-Houston Co., of Rugby, for a Curtis turbo-generator set of 2,500 kw. capacity, complete with sub-base condensing plant, for their City-road station, London. This is the fifth contract and the sixth Curtis turbo-generator set ordered by the County Co. from the British Thomson-Houston Co., aggregating 10,000 kw. in capacity.

Erith.—The Urban District Council have received the following tenders for the complete installation of electric light for 48 municipal cottages :

W. F. Cook, 150, High-street, Plumstead	£150	0	0
J. T. Jarvis and Sons, Pier-road, Erith	153	10	0
J. Cock and Co., 90, Battersea-rise, London, S.W.	165	0	0
A. F. McLean, Crayford-road, Erith	165	0	0
Woodville Electric Co., 21, Hengist-road, Northumberland Heath (accepted)	168	0	0
C. Pullan, 52, King's-arcade, Bradford	187	4	0
G. N. Haden and Sons, Trowbridge	195	0	0
Walsall Electrical Co., 116, City-road, London, E.C.	195	0	0
H. Hooper and Co., 220, Trafalgar-road, Greenwich	197	0	0
L. W. Drake, Croydon House, Frinton-on-Sea	209	7	8
G. T. Stares, 24, Mill-road, Northumberland Heath	218	8	0
Strange and Sons, 34, London-road, Tunbridge Wells	220	15	0
G. Weston and Sons, 153, Fenchurch-street, London, E.C.	228	8	0
Reliance Electrical Co., Durham-hill, Strand, W.C.	234	0	0
Electrical Co., 121-125, Charing Cross-road, London, W.C.	243	8	0
W. G. Cannon and Sons, 107, London-road, Southwark, S.E	247	4	0
S. Newton and Co., 210, Brixton-hill, London, S.W.	272	14	0
F. V. Slatter, 56, Fann-street, Aldersgate-street, London, E.C.	283	10	0
Bell Bros. and Co. (London), 72, Bishopsgate-street Within, London, E.C.	288	0	0
A. E. Belston, 303, Stapelton-road, Bristol	307	13	0
L. Roman, 136, Bennerley-road, Clapham Common, S.W.	320	0	0
J. Holman and Co., 100, Queen-street, Maidenhead	320	0	0
Venables and Co., 99, Broadway, Cricklewood, N.W.	320	0	0

OPENINGS FOR CONTRACTORS.

ABERDARE—Seventeen villas at Gadlys, Wayne's Building Club. Mr. Alec S. Cameron, architect.

ABERHAFESP — Elementary school (£900), Montgomery County Council.

ABERHOSAN—Elementary school (£900), Montgomery County Council.

ABERTRIDWR—Chapel, Committee of the Welsh Calvinistic Methodist Chapel.

ASHSTEAD—Fire station, Parish Council.

ATHY—Workmen's dwellings (£49,715), Urban District Council.

BARNOLDSWICK—Two houses, Richmond-road, Messrs. Waite and Lambert; alterations to warehouse, Mr. S. Slater.

BARROW—Additions to workhouse, Board of Guardians.

BARROW-IN-FURNESS — Electricity undertaking (£5,000), Town Council.

BATH—Secondary school on the market site (£10,000), Education Committee.

BECKENHAM—Extension of electric lighting works, etc. (£16,000), Urban District Council.

BIRR—Workmen's dwellings (£52,000), Rural District Council.

BOLTON—Elementary school on a site in Devonshire-road (£11,000), Corporation; schools for defective children, trustees of the Thomasson Memorial Fund.

BOURNEMOUTH — Enlargement of church at Winton (£360), Ecclesiastical Commissioners.

BOWCOMBE—Chapel and school. Mr. S. E. Tomkins, Castlehold-chambers, Newport, I.W., architect.

BRACEWELL—Elementary school, Board of Education.

BRADFORD—Conveniences, Rawson-square, Corporation.

BRIGHTLINGSEA—House, Church road, Mr. H. Chamberlain; house, Regent-road, Mr. H. Lord; shop, Tower-street, Mr. C. Kidley.

BROMLEY—Municipal buildings (£7,000), Town Council; alterations to Denbridge House, Denbridge-road, Mr. C. H. Quennells; sub-station, Lubbock-road, Bromley Electric Lighting Co.; house, Southborough-road, Messrs. Thompson and Walford; two houses, Alexandra-crescent, Kinnaird Park Estate Co.

BROUGHTY FERRY—Enlargement, Grove Academy (£3,000), School Board.

BURY—Salvation Army barracks, Moorgate (£1,700); vicarage for St. John's Church, Church Trustees.

BUXTON—Studio, Corbar-road, Mr. K. de la Mott; conversion of post office into shops, Town Council; additions to house, Macclesfield-road, Burbage, Mr. Kirk.

CAMBERWELL, S.E.—Baths and wash-houses (£9,000), Borough Council.

CASTLEFORD—Secondary school. Mr. W. S. Braithwaite, Leeds, architect.

CAVAN—Town hall, Urban District Council.

CHELMSFORD—Alterations to the central stores, Star Co-operative Society. Messrs. Chas. and W. H. Pertwee, architects.

CHESTER—Extension, Upton Asylum (£14,000), County Council.

CLAPHAM, S.W. — Secondary schools, Broomwood-road (£25,920), London County Council.

COLCHESTER—Lunatic asylum (£289,276), County Council.

COLTON—Additions to elementary schools, West Riding Education Committee.

COVENTRY—Conversion of Barr's Hill House, Radford-road, into a secondary school, Corporation.

CROOM—Workmen's dwellings (£36,060), Rural District Council.

CROYDON — Enlargement of the central baths (£9,000), Borough Council.

CWMPARK—Conversion of old hall into new caretaker's house, Committee of the Workmen's Institute. Mr. J. Rees, Pentre, architect.

CWMVELINVACH—Twenty-eight houses, Greig Building Club.

DARTMOUTH—Post office, South-parade (£1,350). Mr. E. H. Back, architect.

DARWEN—Elementary school, Education Committee.

DEVIZES—Twenty-two houses on plots in the Forty Acres. Mr. Ash, architect.

DEVONPORT—Laundry at the workhouse, Board of Guardians.

DEWSBURY—Residence in Willans-road, Springfield; alterations to Springfield House. Mr. B. Watson, Upper Taylor-street, Batley, architect.

DOVER—Alterations to St. Martin's School, Markland-road, Maxton, Education Committee.

DUBLIN—Conveniences at municipal buildings, Dublin Joint Hospital Board.

DUDLEY—Carnegie Free Library, St. Peter's-road, Corporation.

DUNSTAN—Soap factory, Co-operative Wholesale Society.

EARLSWOOD—Alterations to asylum (£6,000), Metropolitan Asylums Board.

EASTAGATE—New hall (£800), between Chichester and Barnham.

EAST HAM—Alterations to schools, Education Committee.

EGHAM—Fifty-four houses, Avenue Estate, Mr. Rogers; two houses, Bond-street, Englefield Green, Mr. J. Brown; two houses, Clarence-street, Mr. Brooks; additions to "Clouboy" Englefield Green, Viscountess de Vesci.

ETRURIA—Four houses, Porters'-terrace, Mr. J. Ferneyhough.

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ECCLES—Council school, Clarendon-road. Newchurch, parish of St. Paul, Monton Green (£7.500). Ecclesiastical Commissioners.
FALKIRK—Extension of burgh buildings (£3.755), Town Council.
FOLKESTONE—Elementary school, Chart-road, Corporation.
FULHAM, S W.—Installation of electric light in the motor workshops and yard at the Mead ambulance station, Carnwathe-road, Metropolitan Asylums Board.
FURNESS VALE—Church in new parish, Ecclesiastical Commissioners.
GOWERTON—Elementary school, Glamorgan County Council.
GREAT DRIFFIELD—Additions and alterations to the Council school, Education Committee.
GREETLAND—Fifteen houses off Clay House-lane. Messrs. Richard Horsfall and Son, Halifax, architects.
HAM—Public offices (£398), District Council.
HAREFIELD—Shops, Park-terrace, Messrs. C. Brown and Sons.
HAWICK—Rebuilding municipal slaughter-house (£3,000).
HECKMONDWIKE—Alterations to the Albion Hotel, Mr. J. Brook.
HENDON—Elementary school, Education Committee.
HODDESDON—Elementary school, Herts Education Committee.
HOYLAND—Erection of shed (£700), Urban District Council.
IRLAM—Soap works, Canal bank, Cooperative Society.
JERICHO—Church, Wesleyan Trustees.
KILLARNEY—Workmen's dwellings (£64,445), Urban District Council.
KILMACTHOMAS—Workmen's dwellings (£16,120), Urban District Council.
LEEDS—Alterations to and conversion of tramway offices, Boar-lane, into ladies' lavatory, waiting-room, etc., Sanitary Committee.
LEEDSTOWN—Sunday school (£300), Leedstown Wesleyan Society.
LEIGH (LANCS.)—Weaving sheds, 2,000 looms.
LEVEN—Hospital (£1,700). Mr. A. C. Dewar, architect.
LLANRHIAN—Additions and alterations to the Council school at Croesgoch, Pembrokeshire Education Committee.
LONGFORD—Workmen's dwellings (£48,808), Urban District Council.
MACCLESFIELD—Nurses' home (£500), Board of Guardians.
MANSFIELD—Pumping station (£3,000) at Clipstone, Town Council.
MARKET DRAYTON—Secondary school, Salop County Council.
MARSKE—Restoration of parish church.
MELLINGTON—Elementary school (£800), Montgomery County Council.
MILNROW—Cotton mill, Messrs. Butterworth, Hall, and Co.
MIRFIELD—Elementary school (£8,210), West Riding Education Committee.
MOORTOWN—Villas, Sandhill-lane. Mr. G. W. Atkinson, architect.
MORECAMBE—Six houses, Arnside-road, Mr. J. Tordoff.
MULLAHARAN—Workmen's dwellings (£7,010), Urban District Council.
NEWBURN-ON-TYNE—Council school to accommodate 480 scholars, Northumberland Education Committee.
NEWCASTLE—Soap factory, Co-operative Wholesale Society.
OLDBURY—Elementary schools, Urban District Council Education Committee.
PAISLEY—Block of buildings, Causeyside-street, Paisley Co-operative Society.
PENGE Fire station, Urban District Council.
PENMACHNO—Council school near Bettwyscoed, Education Committee.
PENTREACHAF—Council school, Education Committee. Mr. Royland Lloyd Jones, Pwllheli, architect.
PEWSEY—Two houses, near Chute Lodge, Mr. A. Grant-Meek.
PLYMOUTH—Abattoir (£650), Town Council.
PORTHCAWL—Ten houses, Porthcawl Building Club.
PRINCES RISBOROUGH—Church of England Home for Waifs and Strays, Board of Guardians.
PWLLHELI—Council school at Chwilog, Education Committee
RADCLIFFE—Blocks of shops District Council.
RAMSGATE—Elementary school, Town Council.
RHYL—Pavilion, sea-front (£8,500). Messrs. Smith, Maxwell, and Tuke, architects.
RICHMOND—County school (£12,000), Surrey Education Committee.
ROCHDALE—Branch baths (£7,500), Corporation.
ROPLEY—Parish hall, Churchwardens.
ST. PETER'S—Golf clubhouse, George Hill-road, Mr. W. C. Slaughter; additions to "Wellesley," Gladstone-road, Mr. Berry.
SAFFRON WALDEN—Enlargement of training college, Essex Education Committee.
SALFORD—Bakehouse (£800), Board of Guardians.
SALOP—Houses near Coalbrookdale, Great Western Railway Co.
SLIGO—466 cottages, District Council.
SLOUGH—Roman Catholic church, Mother Superior, St. Bernard's Convent.
SOUTHALL—Church of St. George (£7,000), Ecclesiastical Commissioners.
SOUTHEND—Two houses, Westborough-road, Mr. C. H. Jerrard; three houses, South-avenue, Mr. W. Goldsworthy; three houses, Inverness-avenue, Mr. T. J. Dennis; two houses, Ailsa-road, Mr. J. Poulton; alterations to houses Imperial avenue, Mr. R. Chadwick; eight houses, Chester-avenue, Mr. Geo. Bedwell; house, Crowstone-road, Mr. H. P. Smith; ditto for Mr. Geo. Murray; seven houses, Wenham-drive, Mr. H. J. Shearman; five houses, Southbourne-grove, Mr. A. W. Tibbetts; house, Kingsroad, Mr. J. C. Gaillard; additions, Normanhurst, the Cliffs, Mr. Edward Moxon; additions, London-road, Messrs. Truman, Hanbury, and Buxton; house, Leigh-road, Mr. G. Barnett; nine houses South-avenue, Mr. W. Goldsworthy; motor-house, rear of Sudbury, Hamlet Court-road, Dr. P. A. Ross; house and stable, Somerville-gardens, Mr. T. Barber; house, Beedell-avenue, Mr. G. H. Griffiths; additions, Ellerslie, Avenue road, Miss H. H. O'Meara; house and shop, Leigh-road, Mr. F. H. Whale; two houses and shops, Hamlet Court-road, Mr. G. Smart; two houses, Gloucester-terrace, Mr. F. Beadell; four houses, Hill-road, Mr. A. W. Knights; house, Whitefriars-crescent, Mr. J. Batchelor; two houses, Carnarvon-road, Southend Estates Co.; two houses and stable, Old Leigh-road, Mr. T. P. Pryor; four houses, Leigh-road and Southview-drive, Mr. W. G. Whitley; additions, Cobham House, Cobham-road, Mr. J. C. McLellan; four houses, Westborough-road, Mr. C. H. Jerrard; and two houses, Hainault-avenue, Mr. W. Gimbrett.
SOUTH HETTON—Elementary school, Durham County Council.
STARTFORTH—Isolation hospital (£7,000), Rural District Council.
STOKE ON-TRENT—Ten houses, Linley-road, Messrs. Jones and Hilton; additions to works, Messrs. Robinson and Leadbeater.
SWANSEA—Erection and additions to the girls' intermediate school, Water-road, Local Education Authority.
SWINTON—Cotton spinning mill, Swinton Cotton Spinning Co.
TEWKESBURY—Additions to Council school, Chance-street.
TODMORDEN—Twelve houses, Henshaw Estate, Walsden Co-operative Society.
TORQUAY—General post office, Fleet-street.
WALKDEN—Spinning mill, Walkden Spinning Mill Co.
WALTHAMSTOW—Extensions to public library (£7,500), Urban District Council.
WALTON—Pumping station, Metropolitan Water Board.
WARE—Enlargement of grammar school (£4,250), Herts Education Committee.
WARLEY—Elementary school, Oldbury Urban District Council.
WEST BROMWICH—Public conveniences (£1,200), Town Council.
WIGAN—Public slaughter-houses, Corporation; hospital, Joint Hospital Committee.
WISBECH—Houses, Gadd's-lane, Mr. A. Quince; six houses, Osborn-road, Mr. J. Rouse.
WILMCOTE—Houses at Wilmcote and Southam-road Stations, Warwickshire, Great Western Railway Co.
WOLD NEWTON—Additions and alterations to the Council school, Education Committee.
WOMBWELL—Restoration of the parish church, Ecclesiastical Commissioners.
WOOD GREEN—Secondary school, central fire station, elementary school, etc. (£22 000), Urban District Council.
WORKINGTON—Stock rooms at the Central Hotel, Workington Brewery Co.
WORKSOP—Four houses, Long Bank, Mr. T. C. Green.
WORSLEY—Blocks of houses, Lord Ellesmere.
WORTHING—Elementary school, Broadwater Education Committee.
YIEWSLEY—Additions to printing works, Tavistock-road, Messrs. Sargeant Bros.

PROVISIONAL PATENTS, 1907.

DEC. 16.

27672. Improvements relating to the driving of electric cranes and the like. Henri Pieper, 24, Temple-row, Birmingham. (Date applied for under Patents Act, 1901, Dec. 28, 1906, being date of application in Belgium.) (Complete specification.)

27675. Improvements in electrically-operated apparatus. Henry Stafford Hatfield, 18, Palmeira-square, Hove, Sussex.

27681. Improvements in electric resistances. Walter Frederick Jones, 166, Wellington-road, Eccles.

27682. Portable electric burglar alarm and like. Charles James Aylen, 11, Cornflower-terrace, East Dulwich, London.

27723. Improvements in and relating to gasaliers and electroliers for gas and electricity. Samuel Quincey and Charles Harrison, 136, Kentish Town-road, London.

27739. Arc lamp with a support electrode with which the other electrode is rigidly connected. Franz Janecek, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Dec. 20, 1906, being date of application in Germany.) (Complete specification.)

27744. Improvements in and relating to signalling systems and control systems for mines and the like. Allgemeine Elektricitats Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 17, 1906, being date of application in Germany.) (Complete specification.)

29639A/06. Improvements in retarding devices or dash-pots, more especially intended for use with electric circuit breakers. William Harding Scott, 47, Lincoln's-inn-fields, London. (Date applied for under Rule 5 of the Patents Rules, 1905, Dec. 29, 1906.)

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29639B/06. Improvement in connection with electric circuit breakers or switches. William Harding Scott, 47, Lincoln's-inn-fields, London. (Date applied for under Rule 5 of the Patents Rules, 1905, Dec. 29, 1906.)

DEC. 17.

27763. Invention to discharge the electricity produced in spinning and drawing wool and other textile fabrics. Howard Priestman. Hillfoot, Ben Rhydding, Leeds.

27768. Renewable electric accumulator terminal. James Hooley, 48, Derrington street, Crewe, Cheshire.

27783. Improvements in means for making electrical joints or connections. Claude William Denny, 24, Temple-row, Birmingham. (Cyril Charles Toulmin Eastgate and D. J. Horn, India.) (Complete specification.)

27790. Improved process and apparatus for oxidising atmospheric nitrogen by electricity. Demetrio Helbig, 111, Hatton garden, London. (Complete specification.)

27792. Improvements in or relating to electrical switches. Harry William Cox, 111, Hatton-garden, London.

27809. Improvements in and relating to incandescent electric lamps. Edward Charles Robert Marks, 18 Southampton-buildings, London. (Parker-Clark Electric Company, United States.) (Complete specification.)

27825. Improvements in connection with electrical igniters for internal-combustion engines. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges., 47, Lincoln's-inn-fields, London. (Date applied for under Patents Act, 1901, Dec. 19, 1906, being date of application in Germany.) (Complete specification.)

27830. Improvements in electrolytic cells. Arthur Edward Gibbs, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

27841. Improvements in clock-controlled mechanism for operating electric switches or other devices at predetermined times. Alexander McDonald Stuart and Edward John Williams, Norfolk House, Norfolk-street, Strand, London.

27849. Improvements in single-phase motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

27852. Improvements in and relating to secondary batteries. Herbert Durham, 27, Chancery-lane, London.

DEC. 18.

11594A. Improvements in and relating to electric motors specially adapted for rolling-mills. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, May 21, 1906, being date of application in Germany. An invention comprised in application No. 11,594, dated May 17, 1907.) (Complete specification.)

27856. Improvements in photographic printing frames. The Jandus Arc Lamp and Electric Company, Limited, and Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

27857. Improvements in electrically-operated switches. August Eckstein and Arthur Cecil Heap, Waverley Mills, St. Simon-street, Salford.

27864. Improvements in the manufacture of electric incandescence lamps. The Edison and Swan United Electric Light Company, Limited, and Edward Alfred Gimingham, Ponder's End, S.O., Middlesex.

27879. Improvements in or relating to magnetic electric machines. Hermann Willem van Raden, High-street-chambers, Coventry.

27891. Improvements in or connected with electrically signalling or communicating messages or signals to vehicles running on rails. Walter Barnett, 33, Chancery-lane, London.

27891. Process of and apparatus for inducing, taking, and transmitting without a wire magnetic fluxes. Camille Gabriel Guercin, 7, Southampton-buildings, London.

27924. Improvements in and relating to dynamo-electric machines. Albert Henry Midgley, 1, Queen Victoria-street, London.

27926. Apparatus for welding rings, hoops, chain links, and the like, by means of an electric current. Allgemeine Elektricitäts-Gesellschaft, 27, Chancery-lane, London. (Date applied for under Patents Act, 1901, Jan. 4, 1907, being date of application in Germany.) (Complete specification.)

27932. Improvements in testing apparatus for magneto-electric spark ignition apparatus. Gustaf Adolf Unterberg and Friedrich Helmle, trading as Unterberg and Helmle, 322, High Holborn, London. (Date applied for under Patents Act, 1901, Oct. 17, 1907, being date of application in Germany.) (Complete specification.)

27937. Improvements in and relating to single-phase alternating-current electric motors of the commutator type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

27945. Improvements in tachometers. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

DEC. 19.

27951. Sick-room electric light. John Henry Hill, Amor Matris, Park-grove, York.

27953. Improvements in and connected with devices for killing rats and other animals by electricity. William Colin Morison, Highfield, Clifton-road, Wolverhampton.

27956. Improvements in electric time switches. Gottlieb Lüthi, 4 Corporation-street, Manchester. (Complete specification.)

27989. Improvements in and relating to electric railway installations. Ernst Woltmann, 51, Deansgate-arcade, Manchester. (Complete specification.)

28003. Improvements in loose-handle single-pole electric breakers. Samuel Whipp, Frank Whipp, and Charles Bourne, 9, Exchange-buildings, St. Mary's-gate, Manchester. (Complete specification.)

28004. Improvements in or relating to searchlights or projectors. Siemens Bros. Dynamo Works, Limited, and George Sylvester Grimston, 139, Queen Victoria-street, London.

28014. Improvements in and relating to magnetic separating machines. The Rapid Magnetting Machine Company, Limited, Herbert Huband Thompson, and Alfred Evan Davies, 77, Colmore-row, Birmingham.

28015. Improvement in and relating to magnetic separating machines. The Rapid Magnetting Machine Company, Limited, Herbert Huband Thompson, and Alfred Evan Davies, 77, Colmore-row, Birmingham.

28040. Improvement relating to the control of alternating-current electric induction motors and of the means driven thereby. Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

28042. Improvements in or relating to electrical heating apparatus. Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

DEC. 20.

28062. Improvements in electric switches. John Child Meredith, Limited, Hubert Augustus Meredith, and John William Ewart, Prudential-buildings, Corporation-street, Birmingham.

28080. Improvements in electric measuring instruments. Walker Moseley, Orrell House, Lamberhead Green, near Wigan.

28081. Improvements in telephone transmitters. Walker Moseley, Orrell House, Gathurst, near Wigan.

28100. Improvements in prepaid electric meters. Wilfred Bertram Thorpe, 185 Fleet-street, London.

28106. Improvements in storage battery plates. Alfred Ord Tate, 7, Southampton-buildings, London. (Complete specification.)

28111. Improvements in supports for electric and other lamps. John Norris Frost, 37, Chancery-lane, London.

28132. Improvement in storage battery plates. Alfred Ord Tate, 7, Southampton-buildings, London. (Complete specification.)

28133. Improved thermal device for use in protecting electrical circuits carrying alternating, polyphase, and direct currents. Arthur Herbert Curtis, 11, Southampton-buildings, London. (Complete specification.)

28134. Improvements in fog signalling apparatus for railways. Siemens Bros. and Co., Limited, and George Healey, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

28137. Improvements in alternating-current electric motors of the induction type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

28138. Improvements in and relating to electric lamps. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Dec. 27, 1906, being date of application in Germany.) (Complete specification.)

28143. Improvements in and relating to the generation, control, and transmission of electric energy particularly applicable for use on automobiles and the like vehicles. Albert Henry Midgley, 1, Queen Victoria-street, London.

DEC. 21.

1099A. Improvements in and relating to electric switches. The British Thomson-Houston Company Limited 83, Cannon-street, London. (General Electric Company, United States.) (Date applied for under Rule 5 of the Patents Rules, 1905, Jan. 15, 1907.)

28151. Improvements in long-distance and wireless telephony. Walker Moseley, 23, Trossachs-road, East Dulwich, London.

28164. Improvements in the traction wheels of electric tramcars. Mountain and Gibson, Limited, and William Renison, jun., 55, Market-street, Manchester.

28199. Improvements in connection with electric circuit breakers. William Harding Scott, 47, Lincoln's-inn-fields, London.

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28175. Improvements in arc lamps. Frank Michael Lewis, 11, Buckingham-road, Brighton.

28212. Improvements in electrical locking apparatus for railway signals. John Aitken Hoffe and George Henry Jelfs, Birkbeck Bank-chambers, Chancery-lane, London. (Complete specification.)

28218. Improvements in and relating to electric apparatus for generating current and for starting up the machinery of automobiles. Albert Henry Midgley, 1, Queen Victoria-street, London.

28220. Improvements relating to starting means for vapour-electric devices. Percy Holbrook Thomas, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Patent Act, 1901, Dec. 24, 1906, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Jan. 9.)

1906.

22500. Earthing and protecting electric conductors. Collyer.

23069. Electric arc lamps. British Thomson-Houston Company and Dalton.

26066. Trucks for electrically-propelled vehicles. British Thomson-Houston Company. (General Electric Company.)

27520. Control of multiphase motors. Kando.

28503. Method of controlling dynamo-electric machines and apparatus therefor. Bonine. (Date applied for under International Convention, Feb. 17, 1905.)

28579. Lid bolt for storage battery boxes and the like. Chloride Electrical Storage Company and Heap.

28830. Electric treadles or rail deflection contact makers for railway signalling and the like. Haywood, and McKenzie and Holland, Limited.

29019. Electric induction furnaces. Gründal Kjellin Company and Härdén.

29072. Electrically-operated railway and like signals. Brown.

29120. Electric heaters for fluids. British Thomson-Houston Company. (General Electric Company.)

29300. Electro-deposition of iron. Cowper-Coles.

1907.

97. Protective devices for electric transmission systems. British Thomson-Houston Company. (General Electric Company.)

1197A. Treatment of refractory materials by electricity. British Thomson-Houston Company. (General Electric Company.) (Date applied for under Rule 5, Patents Rules, 1905, Jan. 16, 1907.)

1348. Insulation of dynamo armatures. Electric Ignition Company and Hall.

1587. Party-line telephone systems and apparatus therefor. Lake. (Kellogg Switchboard Supply Company.)

3078. Electric steam radiator for heating buildings or the like. Nobbs and Nobbs.

3214. Counting trains for electricity meters and the like. Hookham and Sprague.

3278. Electric distributors for use in internal-combustion engines. Barnett.

4338. Receivers for wireless and other telegraphy. Austin.

4801. Receivers for wireless signalling. Poulsen.

5155. Magneto-electric generators. Albion Motorcar Company and Murray.

5574. Insulating material and processes for making the same. British Thomson-Houston Company. (General Electric Company.)

5904. Electric measuring and recording instruments of the thermal type. Foster.

7800. Conduits for electrical cables and wires. Goodman and Ackland.

9463. Electrolytic electricity meters. North and Pohl.

10369. Commutation of dynamo-electric machines. Ateliers Thomson-Houston (Anciens Etablissements Postel-Vinay). (Date applied for under International Convention, May 10, 1906.)

11163. Lightning arresters. Gifford and Dixon.

12360. Contact or commutater for dynamo-electric machines. Rivers-Moore and Donald.

13021. Brush-holders and carriers for electric generaters and motors. Woodhouse.

13259. Brush-holders for dynamos and motors. Hickley.

15017. Electric incandescence lamps with metal filaments. Kuzel.

15769. Electrical railway systems. Beecher.

17492. Anode for electrolysis. Finlay.

18020. Electrical switches. Lundberg, Lundberg, and Lundberg.

18082. Carbon electrodes. Szek.

18398. Manufacture of steel and electro-metallurgical induction furnaces for use therein. Biewend. (Date applied for under International Convention, Aug. 14, 1906.)

22612. Electric switches. Kjellberg. (Date applied for under International Convention, Nov. 1, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70 000	1	..	½-⅝
—— Ord., 1,125 000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	9/16-11/16
—— Ordinary Nos 1 125,000	1	..	5/32 9/32
British Aluminium Co., Ordinary, 2 001-40 000	5	..	3¼-4¼
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4¼ 5
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4¼ 4½
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100 102
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	95 98
British Insulated and Helsby Cables, Ord., 1-100 000	5	..	6¼ 6⅜
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅞-6¼
—— 4½ per cent. Mortgage Debentures	100	..	102-103 xd
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock Red.	100	..	85-89
British Westinghouse Elec and Manuf. 6 per cent Pref., 275 001-375 000	3	..	2-1½
—— 4 per cent. Mortgage Debenture Stock	100	..	4 50 xd
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2	..	0-¼
—— Non Cum., 6 per cent., Pref.	2	..	¾-1
—— 4½ per cent 1st Debenture Stock	100	..	85-86
—— 4½ per cent. 2nd Debenture Stock	100	..	86-88
Callender's Cable, Debentures	100	..	104-106 xd
—— Ordinary	5	..	9½ 10¼
—— 5 per cent. Pref.	5	..	5¼ 5⅜
Consolidated Electrical Co., Ordinary 1 110,000	1	..	7/16-⅝/16
Crompton and Co.	3	..	1-1⅛
—— 5 per cent Debentures	100	..	96-99
Dick Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅛
—— 6 per cent. Cum. Pref., 1 300 000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock. Red.	100	..	99 102 xd
Edison and Swan United, "A" Shares, 1-9 361	5	..	⅞-1⅛
—— "A" Shares, 01-017,139	5	..	1⅛-2⅛
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	79-82
Electric Construction, Nos. 1 to 112 100	2	..	¼-½
—— 7 per cent. Cumulative Pref.	2	..	⅝-1⅛
—— 4 per cent. Perp. 1st Mort. Deb	100	..	58-63
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red.	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅞-8¼ xd
—— 4 per cent. 1st Mort. Deb Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10¼-11½
—— 4½ per cent. Preference	5	..	5-⅝
—— 4½ per cent. Debentures	100	..	104½-106½
India Rubber, Gutta Percha, and Telegraph Works	10	..	1⅛-1⅝ xd
—— 4 per cent. Debentures	100	..	6-8
National Electric Construction Co. 1-170 000	1	..	11/16-13/16
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5	..	—
Telegraph Construction and Maintenance	12	..	28½-30½
—— 5 per cent Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9 xd

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4½-5
Bournemouth and Poole, Ordinary	10	..	9½-10¼
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	9¼-10
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	9⅞-10⅛
—— 4½ per cent. Debenture Stock. Red.	100	..	88-91 x i
Bromley (Kent) Electric Light and Power Co	5	..	4⅜-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	95-98
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6 6¼
—— Nos. 80,000-100 000	5	..	5⅜ 6¼ xd
Cambridge Electric Supply Company £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	96-100 xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	96-99
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3¼-4⅜
—— 4½ per cent. Cum Pref. 1-80 000	5	..	3⅜-4¼
—— 4 per cent. Debenture Stock, Red.	100	..	95-98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	3⅜-4¼ xd
—— ditto (1905) 40,001-80 000	5	..	3¼-4¼
Chelsea Electricity Supply	5	..	3¼ 4¼
—— 4½ per cent. Debentures	100	..	100-103 xd
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9¼-10
—— 6 per cent. Cumulative Pref.	10	..	11-12¼
—— 5 per cent. Debenture Stock	100	..	120-123 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	93-96 xd
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50,000	5	..	3¼-4¼
—— 5 per cent Preference, 1-50,000	5	..	4⅛-4⅜
County of London Elec. Supply, Ordinary	10	..	6¼-7¼
—— 6 per cent. Cum Pref.	10	..	10¼-11
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100	..	103-106 xd
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	95-98
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	¾-⅞
—— 6 per cent. Cum Pref.	5	..	¾-1⅛
—— 4½ per cent. First Mort. Deb.	100	..	70-80
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	—	..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2¼-2¾
—— 5 per cent Debenture Stock, Red.	100	..	83-87 xd
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	92-94 xd
Folkestone Electric Supply, Ord., Nos. 1-10 000	5	..	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	4⅞-5⅛
—— 4½ per cent. First Deb. Stock Red.	100	..	96-99
Hove Electric Lighting, Ord. 1-13 000	5	..	6⅜-6¾
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	98-101 xd
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Deb. Stk., Red.	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150 000	1	..	1/16 3/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	98-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¼-10½

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1¼-1½
—— 6 per cent. Pref.	5 ..	4-4½
—— 4 per cent 1st Mortgage Debenture Stock, Red	100 ..	87-91
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100 ..	92-95
Metropolitan Ordinary, 00 001- 00,000	5 ..	5⅜-5¾
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	100 Ord xd
—— 4½ per cent. Cum. Pref.	5 ..	4⅜ 4⅞ xd
—— 4½ per cent. Mortgage Debenture, Red	100 ..	89-90 xd
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1933, C 1 1 000 ($100), D 1-1,000 ($500), M 1 4,000 ($1 000)	— ..	76-78 p.c.
Mexican Light and Power Co., Capital stock	$100 ..	49-51
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4 000 ($500), 4,001 14 000 ($1,000)	— ..	84-86
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb	— ..	9-97 xd
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57 009	5 ..	6¼-6¾
—— do., 57 010 75 000	5 ..	6¼-6¾
—— do., 75,001-87 500 (issued at £2 prem., 16s. paid)	5 ..	6¼-6¾
—— 5 per cent. Pref., 1-57,009	5 ..	5-5¼
—— do. 75,001-87,500 (issued at 10s. prem., 4s paid)	5 ..	5-5¼
North Hill Electric Lighting	10 ..	10½ 11½
—— 4 per cent. First Mort. Deb. Nos. 1 500 (Reg.)	100 ..	96-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5 ..	5½ 6
—— 4 per cent. Debenture Stock	100 ..	96-97
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1 ..	9/16 1 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	13/16-15/ 6
—— 5 per cent. Debenture Stock, Red	100 ..	95-96 xd
Rosario Electric Co 6 per cent Cum Pref., 1-20 000	5 ..	4¾ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15 000	5 ..	4¼-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	— ..	98-100 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	½-1½
—— 4 per cent. Debenture Stock	100 ..	71-75
South London Ordinary	5 ..	2½-3
South Metropolitan Electric Light and Power, Ord.	1 ..	⅝-¾
—— 7 per cent Cum Pref.	1 ..	15/16-1 3/16
—— 4½ per cent 1st Mort. Deb.	100 ..	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7¼ 8¼
—— 7 per cent. Pref.	5 ..	6½-7¼
—— 3½ per cent. Deb.	100 ..	85-90 xd
Urban Electric Supply Co., Ordinary, 8-30 007	5 ..	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	1¾-2⅜
Westminster, Ordinary	5 ..	7⅜-8⅜
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	4½-5 xd

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-2'0 00'	5 ..	5¾-6 xd
—— 10 per cent. Non-Cum 2nd Pref., 2 0 008 80 007	5 ..	7 -8½
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	12 -128 xd
Auckland Elec Trams, 5 p.c. 1st Mor. Deb Stk, Red.	100 ..	101-104
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref shares, 1 10 000	10 ..	—
—— 5 per cent Deb., Red., 1 000	100 ..	—
—— 4½ per cent. Red. Deb Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord Shares, 75,001-1:0,606	1 ..	11/16 13/16
—— 5 per cent. Cum Pref. Shares, 1-75 000	1 ..	1316/-15/16 xd
Birmingham and Midland Trams., 4½ p.c 1st Db. Stk, Red.	100 ..	91-94 xd
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 1 ⅝
Bombay Elec Supply and Trams Co, 6 per cent. Cum. Pref	10 ..	9⅜-9¾
—— 4½ per cent. Deb. Stock, Red.	100 ..	91 93 xd
Brisbane Tramway Invest., Ord., 1-75 000	5 ..	3¼ 3⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜ 4¾
—— 4½ per cent Deb. Stk, Red., Prov. Certs. all pd	100 ..	94-98 xd
British Columbia Electric Railway Co., Ord Def.	100 ..	124-1 7
—— Ord Pref.	100 ..	10 -109
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	99 103
—— 4½ per cent 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	98-101
—— 4½ per cent. Vancouver Power Deb.	100 ..	100-103
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10 ..	1¼-1⅜
—— 6 per cent. Cm Pf., 3 0001-60 000	10 ..	5 5½
—— 5 per cent. Perpetual Debenture stock	100 ..	9 -93
—— 4½ per cent 2nd Deb. Stock	100 ..	7 -75
Buenos Ayres and Belgrano Trams	5 ..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-4 000	5 ..	4⅜-5¼
—— "B" 6 per cent Cm. Pf., 1 27 500	5 ..	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	105 115
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c Deb Stk., Red.	100 ..	89-91 xd
Buenos Ayres Gd Na. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red. 1-1,500	100 ..	99-103
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	91-94
Calcutta Tramways, Ord., Nos 1-137,610	5 ..	6⅜-6¾
—— 5 per cent. Cum. Pref., Nos. 1 20 000	5 ..	4¼-5⅜ xd
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	98-103 xd
Cape Electric Tramways, Nos. 1-480,000	1 ..	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum Pref	5 ..	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	96-99
City of Buenos Ayres Trams. Co. (1'04), 1-248,000	5 ..	5-5¼
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	97-101 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10 ..	12¼-13½
—— 6 per cent. Pref., Nos. within 1-60 000	10 ..	12⅜-13⅜
—— 3½ per cent. Mort Debs., 1-3,000 Red.	100 ..	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk., Red..	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1 000 ..	82-87
Imperial Tramways Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum Pref., Nos. 1 0 001-60 000	5 ..	½-⅝
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	58-63 xd
Kalgoorlie Electric Tramways, 1-250 000	1 ..	1/16-¼
—— 5 per cent "A" Deb. Stock	100 ..	87-91
—— 6 per cent "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10- 0½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	92 95 xd
—— £236 500 2nd Mort. Deb. Stock	— ..	—
—— £283, 30 Preferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord Nos. 1-594,188	1 ..	½-1½
—— 6 per cent. Cum. Pref., Nos 1-425 553	1	13/16-1 1/16 xd
—— 5 per cent. Mort Deb., 1-5,000 Red.	100 ..	92-97
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7½-8½ xd
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	79-83 xd

Name.	Amount paid.	Last price.
	£	£
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	94-97 xd
Manila Elec. R.R. and Lightg. Corp., 5 p.c 1st Lien and Coll Tr Sinkg Fund Gold Bonds of 1953, Red. 1-1,635	$1 000 ..	88-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 201-21 635 and 23,436 25 000	— ..	4½ 5
—— 4½ per cent 1st Mort. Deb Stock Red.	100 ..	98-98
Metropolitan Elec Trams., Defd., 1 000 001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref. 500,001 1 000 000	1 ..	13/16- 5/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	91-94 xd
Mexico Trams. Co, Gen Cons 1st Mort 50-year 5 per cent. Gold Bonds	— ..	81-83 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1 000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb. £01-2 000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5 ..	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W.A.) 5 per cent 1 Mrt. Deb. Stk.	100 ..	97 101
Potteries Electric Traction Ordinary 1-245 000	1 ..	5/16-9/16
—— 5 per cent Cum Pref. 300 001 545 000	1 ..	½-⅝
—— 4½ per cent Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary 1-24 912	10 ..	4⅜-5¼
—— 6 per cent. Cum. Pref., 1-10 000	10 ..	10-11 xd
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref., 1-20,000	5 ..	4⅜-5¼ xd
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	95-97
Sao Paulo Tramway, Light, and Power Co	$100 ..	112½-11⅝ xd
—— 5 per cent. 1st Mort Deb., Red. 1929 1-11,000	$500 ..	91-93 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum Pref., 19,571-169 570, Prov Certs.	1 ..	½-1⅛
—— 4 per cent. Deb Stock, Red. 1 40	100 ..	78-82 xd
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red. 1-1 600	100 ..	77-81
Yorkshire (West Riding) Elec Tram Co., Ord., 70 001-110 000	5 ..	1-1½
—— 6 per cent Cum Pref., 1-46,261	5 ..	3⅛ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	78-81 xd

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	63-66
—— 4 per cent. Pref.	100 ..	83-85
—— " " deferred	100 ..	42-45
—— 4 p.c. Deb. Stock (Prov Scrip Certs., fully paid)	100 ..	10 -104
City and South London, Consolidated Ordinary	100 ..	43-45
—— 4 per cent Debenture Stock	100 ..	100 103
—— 5 per cent. Pref Stock '91	100 ..	116-119
—— " " " '96	100 ..	113-116
—— " " " '01	100 ..	113 116
—— " " " '05	100 ..	108-111
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10½
—— Ordinary, 1-50 000	10 ..	3¾-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1 700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	— ..	35-39

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2¼-3¼
—— 5 per cent Debs. Red., within 1-1,069	100 ..	84-87 xd
American Telephone and Telegraph Coll. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000 ..	88-90
Anglo-American Telegraph Co. Ordinary	100 ..	55-58
—— 6 per cent. Preferred Ordinary	100 ..	99-101
—— Deferred Ordinary	100 ..	16-16½
Anglo-Portuguese Telephone Co., 5 per cent 1st Mort. Deb. Stock, Red	100 ..	99-102
Chili Telephone Co., 1-44 000	5 ..	6⅜-7¼
Commercial Cable Co., Sts., 500-year 4 p.c. Deb. Stk., Red..	100 ..	80-84 xd
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10 ..	6-7
—— 10 per cent Preference, 1-6 000	10 ..	15-16
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-3¾
—— 10 per cent Cum. Preference	5 ..	8¼-8⅝
—— 4½ per cent Debs, 1 000	50 ..	48-101
Direct United States Cable Co.	20 ..	13⅜-13¾
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1 200 Red.	100 ..	89-101 xd
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000, 1913	25 ..	98¼-100⅛
Eastern Extension, Australasia and China, 1-300 000	10 ..	12⅜-12⅞
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	98½-102⅛
Eastern Telegraph Co., Ordinary Stock	100 ..	130-135
—— 3½ per cent. Preference Stock	100 ..	85-86
—— 4 per cent. Mortgage Debenture Stock	100 ..	99-102
Great Northern Telegraph Co. (of Copenhagen)	10 ..	30½-32½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs, within 1-1,200, Red.	100 ..	99-10
Indo-European Telegraph Co.	25 ..	52-55
Marconi's Wireless Telegraph Co., Nos 25'1,128-'84,190	1 ..	9/16-11/16
Monte Video Telephone Co., Ordinary 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	⅛-¼
National Telephone, Preferred	100 ..	109-111
—— Deferred Stock	100 ..	107-109
—— 6 per cent Cum. First Pref.	10 ..	10¼-12½
—— 6 per cent Cum., Second Pref.	10 ..	10-12
—— 5 per cent Non Cum. Third Pref.	5 ..	5 3/16-5 7/16
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-98 xd
—— 4 per cent Deb. Stock, Red.	100 ..	98-100 xd
Oriental Telephone and Electric Company	1 ..	1 1/16-1 3/16
—— 6 per cent Cum Pref	1 ..	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs Red., 1-1 000	100 ..	97-100 xd
United River Plate Tele. Co., Ordinary 1-100 000	5 ..	6½-7 xd
—— 5 per cent Cum. Pref., 1-40 000	5 ..	4¾-5¼ xd
—— 5 per cent. Debenture Stock, Red	100 ..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	98-101
West African Telegraph	10 ..	10-10½
West Coast of America 1 '0 000 and 53 001-53,008	2½ ..	1-1⅛
—— 4 p.c. Debs., 1 1 500 guar. by Western Telegraph	100 ..	97-100
West India and Panama Telegraph Co., Ordinary	10 ..	⅜-¾
—— 6 per cent. Cum 1st Preference	10 ..	7¼-7⅜
—— 6 per cent. Cum 2nd Preference	10 ..	7¼-7⅜
—— 5 per cent. Debs., Red., 1-800	100 ..	98-101 xd
Western Telegraph Co., 1-207,930	10 ..	12⅜-13¼
—— 4 per cent. Debenture Stock, Red.	100 ..	97-100 xd

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of track open		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Dec. 28	1 281	1 227	+ 53	— h	27½	27½	May 31	72 605	17,676 000	1,529 682	0 98	11·39	4,987	6 34
Ayr Corporation	Nov. 17	1,019	960	+ 53	— 176	8	8	,, 15	15,283	3,603,783	378,894	·97	9·28	1,917	5 35
Baker Street and Waterloo Ry	Dec. 28	2 865	2,195	+ 670	21,705	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 29	1,0 8	967	+ 41	+ 70	23·53	23·53	March 31	55,408	11,696,691	1,324 743	—	—	—	6·1
Birmingham Corporation	,, 28	6 965	—	—	—	56	5 ½	,, 31	18 557	5,352 038	215 345	·87	6·2	9,228	—
Blackburn Corporation	,, 25	1,216	1,191	+ 25	+ 2 980	23·80	23·80	,, 25	54,951	10,09·,028	1,002 372	1 25	·2 64	2,309	8 02
Blackpool Corporation	,, 26	3 3	342	+ 51	- 1 235	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	6½	Dec. 31	34,819	2.707,9.8	625,110	3·03	12 903	—	7·795
Bolton Corporation	Dec. 29	2 15?	1,877	+ 275	· 5 632	42	42	March 31	111 294	2?,410,690	2,411,8?9	1·14	1·03	2 649	6·12
Bournemouth Corporation	,, 2?	1,558	1,442	· 9?	+ 1,502	23½	24½	,, 31	85,665	13,503,010	1,765,0?8	(48	.1 37	2.860	7·28
Bradford Corporation	,, 28	4,921	4,491	+ 435	+ 1,257	8	95	,, 31	232 427	46 728,977	5,167 26	1·19	10 7?	2,421	—
Brighton Corporation	,, 2·	805	740	+ 65	- 2,980	17·191	17·131	,, 31	50,652	10 7?9,310	1,798,105	1·09	·0·43	2,844	7·4
Bristol Tramway Company	,, ?7	5 730	5,432	+ 358	—	53½	51½	,, 31	265,768	?6,902,257	6 178,?86	—	—	—	—
Burnley Corporation	,, 28	1,426	1 264	+ 162	—	19?	19?	,, 31	62 6?9	11,967,4?8	1,205,830	1·31	2 48	5,825	8 21
Burton Corporation	,, 29	2?8	274	- 6	- 549	9?	8?	,, 31	15 576	3,383 527	421 317	·07	8 87	1,7 8	5 14
Cardiff Corporation	—	—	—	—	—	32 0?	†32·26	,, 31	106,550	24,428,.64	2,624,504	1·04	9 74	3,2?6	6
Carlisle Tramways Company	,, 28	193	168	+ 25	- 484	8·5	8·5	Dec. 31	10 254	2 790 699	350.417	—	—	—	7 96
Central London Railway	,, 28	4 781	5,0??	- 2??	- 19,910	6	6	,, 31	349 2?8	43 057,897	1,279,698c	1·85	?2·29c	55,357	5 22c
Charing X. Euston, & Hamp. Ry	,, 28	3 030	—	—	—	7?	6½	—	—	—	—	—	—	—	—
City and South London Railway	,, 29	3,5·8	3 214	+ 331	+ 0 778	9	6½	h June 30	82,45?	10.048,780	—	—	—	—	—
Colchester Corporation	,, 25	2?1	184	+ 37	—	8	8	March 3	10,588	2 457 ·53	?20,788	·97	·47	1,401	6·12
Cork E. C. and L. Company	,, 26	503	453	+ 47	- 251	15½	15½	Dec 31	?5.03?	5 966 3?4	891 9 8	—	5 ?4	—	4 78
Croydon Corporation	,, 27	1,5?5	—	—	—	12 c	12 c	March 3	62,065	13,51· 9 8	1, 02 408	1 08	·76	3,12?	6 67
Darwen Corporation	,, 27	?85	290	5	- 17	7 2?	7·?5	—	—	—	—	—	—	—	—
Dover Corporation	,, ?8	181	169	+ 12	- 1,124	4?	4?	,, 31	12 468	3 178,063	328,406	·94	·11	2,625	—
Dublin and Lucan Electric Ry.	,, 27	129	120	+ 9	+ 2??h	6?	6?	—	—	—	—	—	—	—	—
Dublin U.T.	,, ?7	5 414	4.8?2	+ 592	· 31 7 8	5½	48?	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 25	1,232	1 066	+ 16	+36 870	22	22	May 1?	57 6?2	15 554 905	1,162 782	878	1·9	4,362	·3
East Ham Corporation	,, 28	9·8	8.4	· 114	· 5·2	14	14	—	—	—	—	-	—	—	—
Glasgow Corporation	,, 28	17, 35	16,108	+ 1 0??	+16,042h	177½	169	,, 31	987 391	21,?63 0?8	?0 350,?67	95	0·47	5,035	5 21
Gloucester Corporation	,, 2?	?70	?65	+ 7	—	15	1?	March 31	15,?33	3 182,11·	579,996	06	6 94	1,0 ?	? 1
G N., Piccadilly and Brompton	,, 28	4 96?	3,?55	+1 ?05	—	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·57?	37	,, 31	77 996	?8 89?,?42	1,62? 275	—	1 52	—	8·65
Huddersfield Corporation	,, 28	1,556	1,3 8	+ 138	+ 2,989	35½	35	,, 31	8?,196	15 2?2,150	1 804 745	? 22	0 7?	2 770	5 92
Hull Corporation	,, 28	2 7 5	4,?65	203	· 5,4 4	26	26	,, 31	121 186	29,151,543	2,956,?06	1	·84	—	—
Ilford Corporation	,, ?8	496	413	+ 8?	— 661	10½	10½	,, 31	26,499	6,?86,754	615,117	?9	9 58	2,225	6 5
Ilkeston Corporation	,, ?5	1·9	10?	+ ?9	+ ?55	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	13,702	4,640,618	466 919	6·?2	7 55	1 7?3	1 85
Lancashire United Tramways	,, 25	1,29?	1,?45	+ 256	+ 14,434	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 28	7,03?	6 32?	+ 713	+11,071	96½	96½	March 31	327,794	73,?24,?53	7,358,185	1 ?6	0·69	3,352	5 58
Leicester Corporation	,, 28	2,415	2 260	+ 155	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 21	11,394	11,405	— 11	+ 7 ?80	104	104	Dec. 3?	56? 793	122 094 528	12.115 934	1 108	1 17	5,421	7·75
Liverpool Overhead Railway	,, 29	1,191	1,119	+ 72	+ 1,776h	9 25	6 65	June 30	77 568	10 9?7.148	1,102 803	—	—	—	—
London County Council	,, 21	32,017	27,?56	+4,?61	+197,170	98	98	Marc· 31	1?78,01?	314 227 030	30 130 ?97	1·05	10 98	—	8 56
Lowestoft Corporation	,, 28	174	110	+ 64	+ ?8	3½	—	Sept. 30	11 0?9	2,? 2 922	343,190	1 03	7 9	2,156	6 39
Maidstone Corporation	,, 26	2·9	95	+ 124	+ 649	4½	2	March 31	5,?1?	1 186 5?6	157.050	1 1	8 6	2 ?56	6 2
Manchester Corporation	,, 21	14,780	13 839	+ 8?1	+ 33 978	172	161	,, 31	719,673	143.264 501	15,523,45·	1 19	·1 ·2	4,556	7 03
Metropolitan District Railway	,, 28	8,128	7 2?3	+ 8 5	+ 2,194	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, ?9	16,227	15 ?1	+ 426	+ 7, ?0	23½	?3½	June ?0	627,794	?7 639,331	—	1·39	—	—	—
Nelson Corporation	,, 2?	·5?	143	+ 10	—	2?	2?	March 31	7,?19	2 ?35,300	203 203	8?	8 64	1.892	8·69
Newcastle-on-Tyne Corporation	,, 28	4,301	3,805	· 498	+ 1,1?0	59?	57½	,, 31	2 0 491	45 5 6,468	4,263 174	1 11	·1 ?5	3 560	6·?4
Newport (Mon.) Corporation	,, 28	705	661	+ 44	2 02?	14½	14½	,, 31	32 421	7 76· 403	7?2 ?53	1 03	0 01	1.52?	5 87
Oldham Corporation	,, 8	1 ?05	1,744	· 61	+ 4, 50	35?	35?	,, 25	4 948	18 647,7?1	1 818,444	1 19	?2 53	2,603	7 2·9
Portsmouth Corporation	May 2?	2,330	1 578	+ 752	+ 632	28½	28½	,, 31	98 911	2? 668 ?25	2 199,8?3	1·?5	0 79	—	—
Reading Corporation	Dec. 5	567	?53	+ 9	- ?88	13½	13½	,, 31	32,6?1	8,1?0 ·79	918 825	9	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20 9	,, 31	54,138	9,749 202	1 201,364	1·32	0·75	2.638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	2?,?16	5,?43,298	?18,?11	1 12	10 45	2,691	7·32
Salford Corporation	,, 23	4 538	4,663	- 125	+ 4 606	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78c	4 78c	Dec 31	7,779	1 537 845	228 235	1 21	8 2	1,640	·01
Sheffield Corporation	,, 22	5 6?0	5,412	+ 258	+ 9 978	6?½	65?	March 25	276 ?00	73 966,293	6,804 ·56	898	9 767	4,174	5 ?4
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,18·	9 ?37,?96	1,1?3.085	1 25	?0 71	—	7 7
Southend-on-Sea Corporation	,, 25	301	2?3	· 58	+ 64	9	9	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8 617,127	1,248 656	—	9 464	—	4 849
Sunderland Corporation	,, 2?	1,3?6	1,346	- 10	- 1,181	2?	20	,, 31	72,3?6	17 4?3 132	1 5?5 425	1·0?6	·?·?1	3,687	·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,3??	2,?75,221	224,417	·8	9 94	1,968	7 79
Torquay Tramways	Dec. ?6	237	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 28	763	718	+ 45	+ 727	13 68	13·43	,, 31	43,6?7	7,995,451	862,123	1·?6	?2·14	3,439	7 5
Warrington Corporation	—	—	—	—	—	6½	6	,, 31	19 2?4	4 ?65 2?6	479 785	—	10 72?	1 989	6 95
West Ham Corporation	,, 26	2,704	2,304	· 400	2 146	14 7	14 7	,, 31	1 2 881	35.602 836	2,556 854	?·9	10 96	4,4?7	6 79
Wolverhampton Corporation	,, 25	867	769	+ 98	+ 268	20	20	,, 31	43,823	9 ?76.023	965.153	—	?0 8?6	2,159	6·035

1906-7 figures. † And 98 miles of interlacing track. c Train mile. h Per mile of single track. c Miles of route. h Half-year's figures. d Double track.

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THE

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1908 BUSINESS.

A number of our engineering and commercial contemporaries have given *résumés* of the work done during the past year, and drawn discouraging conclusions as to the prosperity of the electrical industry. That our industry is suffering from over-competition must be acknowledged, and up to the present all attempts to lessen the cutting of prices by firms short of work have been futile. We regret to say that one of the oldest firms in the country, whose reputation ten years ago brought to it the bulk of its work at prices higher than competition rates, has been one of the chief offenders. This firm has overfilled its shops with contracts obtained by undercutting its competitors in the futile attempt to mee the standing charges and pay a small dividend on the capital invested. We believe that neither of these objects have been accomplished, and regret to say that in certain cases the quality of the material supplied was far from satisfactory. In fact, this cutting of quality is bound to follow the cutting in prices. There is in the cases we have in mind no chance of repeat orders being given to the firm by those users of electrical plant who have suffered from the defects in quality of the machinery already delivered, hence the firm will find that it must continue to take work at the lowest market rates because this work will have to be obtained from firms who are either ignorant or doubtful of the quality of the goods offered. Obviously it would have paid the firm better to do one-half or two-thirds of the business if the prices obtained had carried a reasonable profit. This applies generally throughout the industry. There was last year ample business put through in the manufacturing line and also in installation work to give a fair return on all the capital invested for the production of the plant and its erection. It has been the struggle between rival firms to keep their shops full of work which has led to the slump prices. Advice given free is so cheap that few care to take it, but we hope that the electrical manufacturers in this country will reconsider their policy as a whole. We see no chance of a combination for raising prices, and do not think that a ring, if formed, would conduce to the ultimate good of the industry. What is needed is more individuality amongst the designers, so that quality may be improved and individual firms obtain remunerative prices for specialities. If these specialities are supplied cheaply, and turned out in such large quantities that the small manufacturers cannot compete in consequence of a limited output, there are still profits to be made by the manufacturer. With such apparatus repeat orders will flow in without trouble, so that the cost of obtaining business is reduced. This is a marked contrast to the existing state of affairs when reputable firms spend from 10 to 20 per cent. of their turnover to acquire contracts at prices which will only cover the cost of material, labour, and standing works charges. In conclusion, there might perhaps be some general arrangement come to between the larger firms which would conduce to the non-interference in special lines of manufacture. In all this the success of any firm lies with one or at the most two individuals who make themselves responsible for its policy both in commercial and technical matters. This truism can be proved by looking round the electrical firms, and it shows that a board of directors can only supplement and not replace that individual control which is necessary for the highest success. In all the largest and most successful engineering undertakings it will be found that one man is sufficiently powerful to control the designing of the plant manufactured and to organise the staff to secure the efficient production of the same. These individual leaders may, and we trust will, make the business done during

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1908 both more profitable and larger in volume than that put through last year.

ELECTRICITY SUPPLY TO SMALL TOWNS.

There are still hundreds of small towns in England having no electricity supply, though every year witnesses some attempt to reduce this number by the application of power companies and local authorities to obtain powers for giving a supply. Electricity is now no longer only at the service of the larger towns of more compact areas, and it is not unlikely that at no very remote date small boroughs will have their electrical supplies with all their concomitant advantages. The question to be faced, however, is that of the means of supply; is it more economical for electrical supplies to be taken from small local stations or from power companies? It is now more generally recognised, especially in the industrial areas of England, that it is more advantageous to take supplies from some central source rather than to generate at private plant, largely owing to the fact that experience has shown that capital expenditure per kilowatt of generating plant is generally reduced in proportion to the increased size of units, and also owing to the desire to reduce wages and management charges, and to avoid the necessity of stand-by plant. These arguments hold good in the case of factories situated in an industrial area in which it is possible to obtain a cheap supply of power from a supply company. But when it comes to the question of a small borough taking a bulk supply from some large undertaking, other considerations enter. Provision must then be made for losses in transmission and conversion, while there is to be made allowance for extra capital expenditure on transmission. These questions are not incapable, however, of meeting with solution. By means of the power companies' overhead transmission and overhead distribution a stage nearer that solution has been reached. Mr. J. F. C. Snell has advocated, as the most economical way of supplying small districts, that these districts should take the supply from an outside source, when available at reasonable rates, rather than install local generating plant. He has also urged that facilities must be given to overhead transmission from power stations—which, no doubt, the power companies will take care to obtain. These, he concludes, are the only means for economical supply. Underground distribution, in his opinion, would almost invariably put electricity "out of court" in competition with local gas supply. A means by which the use of electricity may be encouraged in small districts is by the fire insurance companies showing encouragement to householders to enable surface wiring to be adopted at a low pressure.

MILLING CUTTERS.

It is so unusual an occurrence that any one of the processes of manufacture in Government workshops should be made public for the benefit of engineers and engineering in general, that particular attention should be drawn to the "Notes on the Manufacture and Upkeep of Milling Cutters" which Dr. H. T. Ashton recently presented to a meeting of the Institution of Mechanical Engineers. Dr. Ashton is connected with the Royal Small-Arms Factory at Enfield Lock (a department in which secrecy is strictly enforced), and it is to his credit, as well as to the credit of those who have control of the department in question, that much valuable information respecting a class of tool whose merits are not, perhaps, sufficiently appreciated should be made public. The Institution of Mechanical Engineers is also to be congratulated on being the medium through which the communication was made. Dr. Ashton detailed a system of manufacture developed particularly to meet the difficulties of extending the use of high-speed steel to milling cutters of complicated shape, required when cutting to give an accurate finish and a good surface. Perhaps the advantages to be obtained by the use of high-speed steels for milling cutters are not so obvious as they are for the heavy lathe or planer tools, where the almost red-hot chips that they can be made to produce appeal to the least observant onlooker. When, however, it is considered that this class of steel not only has the property of keeping a cutting edge for a reasonable time when taking very heavy cuts at a previously unattainable speed, but also keeps its cutting edge when used with a moderate cut and speed for a far longer period than was previously obtainable, its advantages, if applicable to complicated milling cutters, are clearly just as great as for the simpler tools taking the heavy cuts. Dr. Ashton indicated the methods by which the cutters are prepared. He dealt first of all with the quality of the steel, which is annealed by being placed in the annealing furnace first thing in a morning and then gradually heated up to 700deg. to 750deg. C.; this heat is usually reached by one o'clock, and is maintained until about five o'clock, when the dampers are closed and the furnace is allowed to cool gradually for 48 hours. Annealing in this manner has given thoroughly satisfactory results. The cutters are hardened in a coke-fired furnace having a forced draught. Temperatures up to 2,300deg. F. can be obtained. The making of the cutters requires particular care and accuracy, and Dr. Ashton described two machines, one designed for forming cutter teeth and the other for grinding the teeth. By standardisation of the pitches of the teeth of their angles, and by the provision of suitable templates for each of the cutters commonly required, the use of these machines has been found to result in distinct economy both in the upkeep of cutters and also in the quality of the work turned out. The life of some milling cutters prepared by the methods indicated by Dr. Ashton has been extraordinary. For example, a cutter working in a self-acting cross milling machine and operating upon the bodies of the service rifle at an average cutting speed of 69ft. per minute, with a feed of $1\frac{3}{4}$in. per minute and a depth of 0·08in, and taking a cut of an average width of $1\frac{1}{16}$in. and $\frac{7}{8}$in. long, has produced 39,170 bodies, and is still good for about half as many more. This particular cutter has been reground across its face 25 times. The composition of the steel upon which it operates is 0·5 to 0·6 carbon, with an ultimate tensile strength of not less than 35 tons per square inch.

MAXIMUM DEMAND SHOP CONSUMERS.

The Christmas season which has just passed brought into prominence one serious failing of the maximum demand system as applied to shop consumers, and which to a certain extent accounted for the fact that shop people do not appreciate the value of special electric light display at festive seasons so much as they might otherwise do. This is because any extra lighting brings up the maximum demand as shown on the indicator, and produces an inflated price for all electricity consumed for the period under observation. This argument applies to a certain extent at all times of the year where an increased effort is being made by the business proprietor. Take, for example, the spring and autumn sales. One will here find display bills lavishly used in the windows and an immense amount of ticket writing done, but any suggestion on the part of the electricity supply man that these bills and tickets

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should be made more attractive by being electrically illuminated, or that special flashing devices should be used on the counters or over the shops to attract attention, is at once negatived by the fact that the demand indicator will register the current so consumed. It would, therefore, seem advisable to include a clause in the agreement with maximum demand shop consumers that a customer may, upon giving, say, two days' clear notice in writing to the supply authority, be able to have his demand indicator cut out for one night in each month, thus enabling him to get a special display without interfering with his ordinary rate. There should even be no objection to allowing some customers, if they like, to lump all twelve of these special nights into one series at Christmas, and others at the spring sales.

INDUCTIVE VOLTAGE DROP ON THREE-PHASE TRANSMISSION, WITH THE CONDUCTORS LYING IN THE SAME PLANE.

BY ALFRED STILL, A.M.I.C.E., M.I.E.E.

In a series of articles dealing with the transmission of power by alternating currents, which appeared in the *Electrical Engineer* during the autumn of 1905, the writer explained* how the effects of self-induction might readily be calculated in the case of a three-phase transmission with

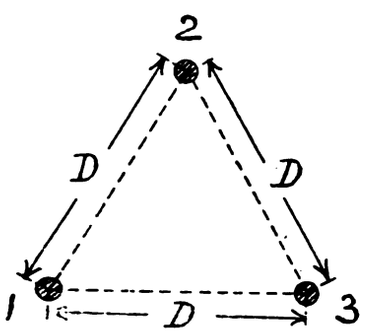

FIG. 1.

the conductors arranged in the usual way—*i.e.*, occupying the vertices of an equilateral triangle. This arrangement is shown in Fig. 1. It is clear that, when the conductors are arranged symmetrically in this manner, the magnetic flux due to any one of the three conductors is not linked with the loop formed by the other two conductors. The resultant total flux of induction through any one of the three loops can, therefore, readily be calculated by merely adding together the inductions due respectively to the two conductors forming the loop. A simple graphical method of performing this addition, while paying due regard to the phase relations of the separate fluxes, is given in the article referred to.

There is another way of stating the case of the symmetrically arranged three-phase transmission line. In any electric transmission system one of the conductors may be considered as carrying the outgoing current, while the remaining conductors, between them, may be looked upon as carrying the return current. It does not matter whether the system is a continuous-current or a polyphase one, nor how many separate conductors are used for the transmission of the total power; the algebraic sum of the current in all the conductors must be zero. Hence, in a three-phase three-wire transmission, with currents C_1, C_2, and C_3 in the respective conductors, the statement that, at any instant of time, the current $C_1 = -(C_2 + C_3)$ is always true. Now, if the wires occupy the vertices of an equilateral triangle, as indicated in Fig. 1, the whole of the return current is at a distance D from any one of the three conductors, and the resultant flux of induction in air round any one conductor—*i.e.*, that portion of its total self-induction which is not neutralised by the induction due to the return currents—is the number of magnetic lines enclosed between the surface of the conductor itself and the surface of an imaginary concentric cylinder of radius D, equal to the distance of the conductors carrying the return current.

The problem is somewhat complicated if the symmetry of the conductors is disturbed. It is not proposed to treat, in this article, of various possible unsymmetrical arrangements of the three conductors, but merely to explain a practical method of calculating the inductive effects, when the three wires are arranged as indicated in Fig. 2. Comparing Fig. 2 with Fig. 1, it will be seen that the conductor No. 2 has been brought down so as to lie midway on a straight line joining 1 and 3, and, at the same time, the conductors 1 and 3 have been moved farther apart, so as to maintain a minimum distance D between any two of the wires. It may be observed that, in regard to the middle conductor (No. 2), the conditions are not altered, since the total return current $(C_1 + C_3)$ still flows at a distance D from the current C_2 considered as the outgoing current. In the case of conductors Nos 1 and 3 the conditions have altered, because part of the return current is at a distance D and the balance at a distance 2 D. The inductive effects on conductors 1 and 3 respectively will also depend upon whether the phase rotation is in the order 1, 2, 3, or 3, 2, 1. The resultant effective flux surrounding the conductor No. 1 may be considered as the algebraic sum of half the total flux in the loop 1–2, due to the current C_2 in conductor No. 2 and $-C_2$ in conductor No. 1, and half the total flux in loop 1–3, due to the current C_3 in conductor No. 3 and $-C_3$ in conductor No. 1. This flux is, therefore, equal in magnitude but opposite in phase to the resultant flux obtained by adding—with due regard to phase relations—the inductions due to the current C_2 in conductor No. 2 up to a radius D and the induction due to the current C_3 in the conductor No. 3 up to a radius 2 D.

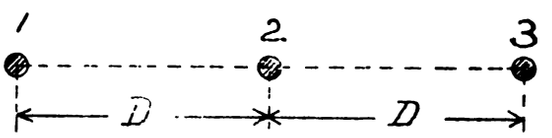

FIG. 2.

The formula for the calculation of the total flux of induction in air surrounding a circular conductor up to a distance d from the centre of the conductor is

$$N = \frac{2C}{10} \log_\epsilon \frac{d}{R},$$

where N is the flux in C.G.S. lines per unit length (1cm.) of the conductor, R is the radius of the (circular) conductor, and C is the current in amperes.

The total effective flux round conductor No. 1 (Fig. 2) is therefore

$$N_1 = \frac{2}{10}\left[-C_2 \log_\epsilon \frac{D}{R} - C_3 \log_\epsilon \frac{2D}{R}\right]$$

$$= \frac{2}{10}\left[-(C_2 + C_3) \log_\epsilon \frac{D}{R} - C_3 \log_\epsilon 2\right]$$

But the quantity $-(C_2 + C_3)$ is equal to C_1; hence the formula can be written

$$N_1 = \frac{2}{10}\left[C_1 \log_\epsilon \frac{D}{R} - C_3 \log_\epsilon 2\right] \quad . \quad . \quad (1)$$

In a similar manner we obtain for the flux round conductor No. 3

$$N_3 = \frac{2}{10}\left[C_3 \log_\epsilon \frac{D}{R} - C_1 \log_\epsilon 2\right] \quad . \quad . \quad (2)$$

The flux round the middle conductor is evidently

$$N_2 = \frac{2}{10} C_2 \log_\epsilon \frac{D}{R} \quad . \quad . \quad . \quad . \quad (3)$$

With the aid of these three formulæ it is an easy matter to calculate the inductive E.M.F. generated in each of the three line wires; but before proceeding to the working out of a practical example it will be interesting to note that the disturbing element in the case of the two outside wires (the quantities $C_3 \log 2$ and $C_1 \log 2$ respectively) induces an E.M.F. component either 30deg. or 150deg. behind the phase of the line current, depending on the order of the

* *Electrical Engineer*, Oct. 20, 1905, p. 560.

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phase rotation. The magnitude of this component relatively to the total induced E.M.F. will depend on the value of $\frac{D}{R}$. If this is large, as in the case of overhead high-pressure lines, the disturbing effect due to the unsymmetrical arrangement of the conductors, as in Fig. 2, will be so small as to be generally negligible; but in the case of three separate insulated cables laid side by side in a trench, where the distance D is comparatively small, the disturbing element is of far greater relative importance. At the same time it must not be overlooked that the total inductive effects in the case of either a three-core cable or three separate cables laid close together in one trench, are necessarily small as compared with the voltage drop due to ohmic resistance.

It will be noticed that the flux component, represented by the quantity $\frac{2}{10}\log_e 2 \times$ *current in line*, does not depend upon the diameter of the conductors or their distance apart. This expression gives the flux in C.G.S. lines *per centimetre length of the conductor*, when the current—in this case the *maximum* value of the current wave—is measured in amperes. It works out at about 22,300 C.G.S. lines *per mile* of conductor when the maximum value of the current is one ampere.

The *mean* value of the induced voltage if the frequency is n periods per second will be

$$\text{mean volts} = \frac{4\,\mathbf{N}\,n}{10^8}$$
$$= \cdot 000892\ n.$$

If, now, we assume the sine curve wave form for the current—the $\sqrt{\text{mean square}}$ value of which is $\frac{n}{2\sqrt{2}}$ times the mean value, while the maximum value is $\sqrt{2}$ times the mean value—we obtain the expression

$$C \times n \times \cdot 0014 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

for that component of the total induced voltage which appears only in the two outside conductors and not in the middle conductor. In this expression C stands for the current in amperes as measured by an ammeter.

Practical Example.—Consider the case of three single cables, without lead or other metallic sheathing, laid side by side in a trench, and transmitting three-phase power. We shall assume the following data: total distance of transmission = one mile; current per phase = 100 amperes; periodicity = n = 50; cross-section of each cable = ·1 square inch; diameter over copper = ·41 (R = ·205); resistance of each conductor = ·44 ohm; centres between conductors = D = 3in.; voltage at generator end = 500; power factor = ·8. It will be noted that the distance of transmission has been taken as one mile. This is partly to simplify the calculations, but also in order that the inductive and ohmic voltage drop may be a fairly large percentage of the initial voltage (500), and so allow of the accompanying diagrams being drawn to scale. In practice, so long a transmission would not generally be allowable without altering some of the other conditions which have been assumed. From the figures stated above we get

$$\frac{D}{R} = \frac{3}{\cdot 205}$$
$$= 14 \cdot 6,$$

and the ratio $\frac{\log 2}{\log 14 \cdot 6} = \cdot 258$,

from which we see that what has been called the disturbing element—appearing as the second term between brackets in formulæ (1) and (2)—has, in this example, a numerical value just over 25 per cent. of the more important term which affects all three conductors similarly.

In Fig. 3 the vector diagram has been drawn to show the phase relations of the various components of the induced E.M.F.'s. The vectors C_1, C_2, and C_3 represent the currents in the three conductors, the phase rotation being in the order C_1, C_2, C_3—that is to say, C_2 lags behind C_1 by one-third of a complete period, while C_3 lags behind C_2 by the same interval of time. The actual value of the E.M.F. component, which appears only in the two outside conductors, is, by formula (4),

$$C \times n \times \cdot 0014$$
$$= 100 \times 50 \times \cdot 0014$$
$$= 7 \text{ volts per mile of conductor,}$$

and the value of the other E.M.F. component due to the flux $\frac{2\,C}{10}\log_e \frac{D}{R}$ is

$$\frac{7}{\cdot 258} = \text{(say) } 27 \text{ volts per mile of conductor.}$$

We must, therefore, draw the vectors O N, O E_2, and O S each to such a scale as to represent 27 volts and exactly

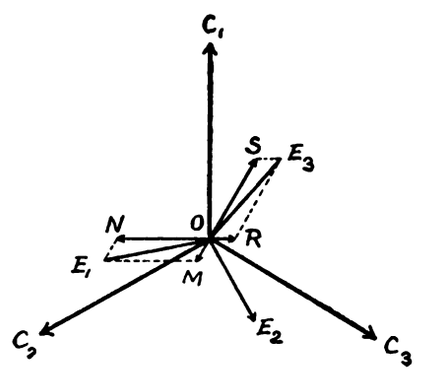

Fig. 3.

one quarter period (90deg.) behind their respective current vectors, C_1, C_2, and C_3. In the case of the middle conductors—carrying the current C_2—the vector E_2 will represent the whole of the E.M.F. of self-induction; but in the case of the outer conductor No. 1, we must draw O M 90deg. in *advance* of O C_3, and of such a length as to represent seven volts. This vector, combined with O N, gives O E_1 as the total induced E.M.F. in conductor No. 1. Similarly, by drawing O R 90deg. in advance of C_1 and combining with O S, we obtain O E_3 as the total induced E.M.F. in conductor No. 3. It will be understood that the reason for drawing O M and O R in advance of O C_3 and O C_1 respectively, is that these components of the total induced E.M.F.'s have to be *subtracted*, as indicated by formulæ (1) and (2).

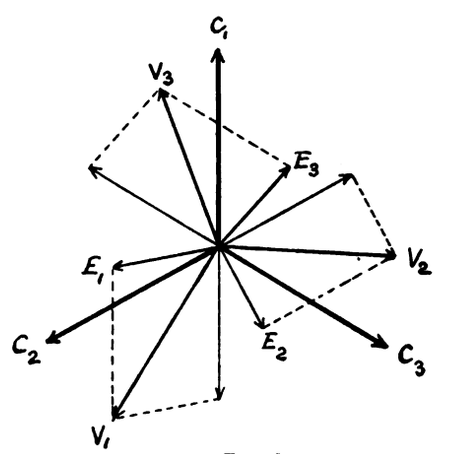

Fig. 4.

In Fig. 4 the E.M.F. vectors E_1, E_2, and E_3 of Fig. 3 have been combined with the vectors representing ohmic drop of volts—these last being equal to 44 volts, drawn in a direction exactly opposite to that of the respective current vectors. The result is the set of vectors V_1, V_2, and V_3, representing in magnitude and phase relation the combined ohmic and inductive voltage drop in the three conductors.

Fig. 5 has been drawn to show the relation between the impressed potential difference at generating end and the pressures between conductors available at the receiving end. The large equilateral triangle, P_1 P_2 P_3, represents the pressures at generating end (500 volts between terminals). The equivalent "star" vectors are O P_1, O P_2, and O P_3,

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drawn 36° 52′ in advance of the current vectors, because cos 36° 52′ = ·8, the assumed power factor of the load. The vectors V_1, V_2, and V_3 of Fig. 4—which have been redrawn to the same scale as the large triangle—have to be added to the vectors $O P_1$, $O P_2$, and $O P_3$ respectively in order to obtain the triangle, $R_1 R_2 R_3$, representing the pressures available at

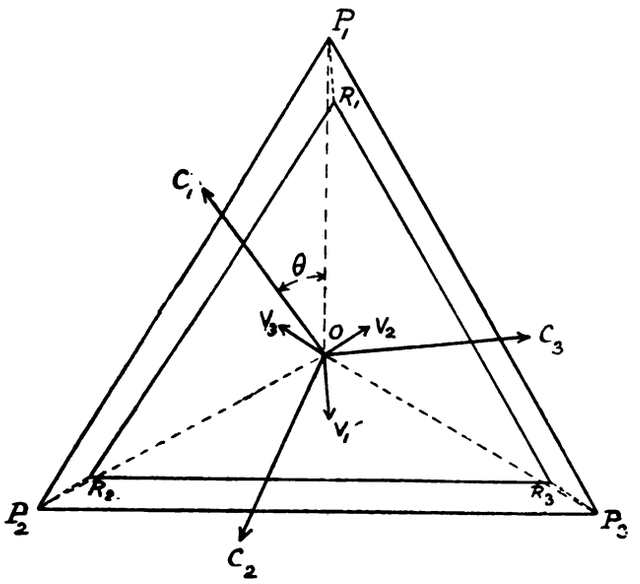

FIG. 5.

the receiving end. These pressures are not all equal in value, as would be the case with a symmetrical arrangement of conductors, but the differences are small. The voltages at receiving end, as scaled off the diagram, are approximately: between conductors 1 and 2 = $R_1 R_2$ = 405 volts; between conductors 2 and 3 = $R_2 R_3$ = 414 volts; between conductors 3 and 1 = $R_3 R_1$ = 400 volts. These figures show that the want of symmetry of the conductors is not likely to introduce serious troubles in practical working, even in the case of cables run side by side with a comparatively small distance between centres.

COST OF ELECTRICAL POWER FOR INDUSTRIAL PURPOSES.*

BY JOHN F. C. SNELL, MEMBER.

The fundamental elements and details of design of large power stations and transmission systems are now so generally accepted that there appears to be but little to add to the available information; but the author thinks there is yet a good deal to be discussed in connection with the economics of electricity supply, more especially now that a large demand has arisen for cheap supplies of power. Indeed, it may be said that electrical supply—whether under municipal or company administration—appears to-day to have reached a critical point. There is no disguising the competition of the gas industry, which has been thoroughly awakened by its newer rival, with consequent improvements by gas engineers both in its utilisation for lighting and also for power. This has, for the time being, checked the hitherto steady growth of electric lighting, and, together with other sources of power, has become a serious competitor with electrical power. It will be wise to recognise this present position of electrical supply, and thus enable us to develop undertakings along sound engineering and financial lines. To do this we must take a dispassionate view of the limitations of badly-situated stations, and also of those power companies which require a heavy expenditure on transmission and distribution. It is proposed to compare the costs of supply from town installations and power companies, and their relation to the cost of production from plant of various kinds installed in factories. For instance, if a manufacturer can install plant wherewith he can obtain power at a cheaper rate than he can be supplied from an outside source, surely it is in the ultimate real interest of our industry to say so. Or again, if any town can obtain a supply from a power company more cheaply than it can hope to produce from its local station, then, again, it is in the interest of that town that the supply should be taken from without. Or if a number of suppliers can benefit their collective consumers by combination, then the Legislature should remove the present obstacles to such co-operation in the manner contemplated by the Electricity Supply Bill, recently promoted by the Board of Trade, which has, unfortunately, not yet passed into law.

The author suggests that the following economical axioms apply to electrical supply; these are the result of experience, and will be admitted by members who have had any extensive experience of supply from stations, and who also have investigated the economics of local plant: (1) There is generally a critical load factor and size of plant within which no outside supply can hope to compete with a user's local plant—*i.e.*, at and beyond this critical point a user can produce more cheaply from his own plant. (2) There is a real limit to the economical radius of distribution from any power station—whatever the pressure of transmission—or whether by underground cables or overhead lines. This is in the abstract, of course, self-evident; but the author means that this radius is much less than is usually advanced by power company promoters. (3) Minimum outlay of capital is indispensable in power supply, and can only be obtained in the power-house by the centralisation of large units. But this can be neutralised in any particular case, and the capital per kilowatt raised beyond the critical value by attempting transmission over too great a distance. (4) Successful power supply depends upon: (*a*) the geographical positions of the user and supplier, because the capital cost of the supplier's plant, plus transmission and transformation, may exceed the capital cost of the user's own plant; and (*b*) the resultant diversity factor arising from multiplicity of industries. Arising from this latter point, great care has to be exercised in the districts where the industries are all practically of one nature, for the diversity factor will be almost *nil* in such cases.

The competition of the older established rival, gas, must be met by improvements in, and the greater economy of, metallic filaments, or other new types of lamps, rather than by the cheapening of the cost of production. The effect of power supply superadded to lighting supply must of necessity reduce the general cost of production, because of the greater resultant diversity factor and consequent improved load factor, and in this country probably 2·0d. per unit may eventually be reached as an average cost of lighting units. The price of lighting must always be considerably in excess of average power prices, both because of its lower load factor and also of the greater cost of low-tension distribution systems and requisite service connections. This reduction of price, however, cannot be compared with the importance of a probable reduction of energy per candle-power from 4 watts to, say, 1·5 watts. No doubt this present competition is really healthy for the electrical industry, if hard upon the present workers, for from the struggle for existence will spring improvements which will result in the survival of the fittest, which for lighting and power—bias apart—must prove to be electricity rather than gas or other systems, if only from its inherent better characteristics affecting health, cleanliness, safety, and adaptability. It is to power supply, then—after lamp manufacturers have evolved their best—that suppliers must look for increased output and steady growth. The author does not mean by this that power should be supplied at rash speculative prices—power supplied at any price, as it were—or at less than cost price, as so many electrical undertakers, particularly in London, are now doing, and some of them to their sorrow. What is meant is that power should be obtained as a result of a rational system of charges based upon an economically designed power station and distributing system, together with a sound foresight into the effects of such an added load upon any undertaking. Unfortunately, so many of the present smaller systems have so high an expenditure per kilowatt installed that such reasonable charges cannot be made by them, except at the cost of other more profitable consumers.

* Paper read before the Institution of Electrical Engineers.

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It is to show some remedies for this difficulty that this paper is attempted. It will be well first to examine what are the economical possibilities from other sources of power, such as town gas, suction or producer gas plants, oil-engines, and small local steam-driven electrical plants, and then to see what order of prices must be reached by electrical suppliers to enable electricity to compete successfully with the above-mentioned plants, and at what load factor or under what conditions the one will be generally more economical than the other. Such a comparison can only be made in general figures, but those given in this paper are based upon general rates for coal or gas and average capital costs for plant. The author will then endeavour to apply these figures to various trades and industries, many of which are based largely upon his own experience. He then will give statistics of works of different kinds which may be useful for reference, and will then set out the charges which must be adopted in order to compete successfully with these other sources of power. Finally, the probable chances of existing undertakers in London and the provinces meeting this competition successfully will be discussed, and also what steps must be taken by them to supply this demand for power at marketable charges while maintaining their systems on a thoroughly sound financial basis.

Section I.

Table I. sets forth the cost at various load factors of gas-engines supplied with town gas, suction gas engines, oil-engines, and small local steam plants of from 20 h.p. to 100 h.p. with generators and auxiliaries. These figures have been obtained from actual users, and the author has taken great pains to ensure that the figures are reliable.

Table I.

Ascertained Cost of Power per Unit Generated for Independent Installations up to 100 H.P.

Annual Load Factor	Equivalent Hours per Annum.	Town Gas at 2s. per 1,000 cub. ft.	Suction or Producer Gas.	Oil.	Steam.	Average Costs.
Per cent		d	d.	d	d	d
10	876	1·423	1·520	1·286	1·342	1·388
15	1,314	1·210	1·270	0·972	1·031	1·121
20	1,752	1·090	1·040	0·813	0·876	0·954
25	2,190	1·007	0·904	0·715	0·806	0·879
30	2,628	0·944	0·812	0·650	0·705	0·778
35	3,066	0·892	0·744	0·600	0·646	0·720
40	3,504	0·844	0·694	0·563	0·598	0·675
50	4,380	0·791	0·625	0·511	0·542	0·617
60	5,256	0·745	0·576	0·475	0·498	0·574
70	6,132	0·706	0·540	0·448	0·460	0·538
80	7,008	0·670	0·514	0·426	0·429	0·500

Table II.

Ascertained Cost of Power per Unit Generated for Independent Plant from 100 to 500 H.P. Installed.

Annual Load Factor.	Equivalent Hours per Annum.	Suction or Producer Gas.	Oil.	Steam.	Average Costs.
Per cent		d.	d.	d.	d
10	876	1·273	1·007	1·086	1·122
15	1,314	0·944	0·778	0·811	0·844
20	1,752	0·760	0·650	0·673	0·696
25	2,190	0·670	0·584	0·590	0·615
30	2,628	0·596	0·536	0·534	0·555
35	3,066	0·540	0·498	0·494	0·511
40	3,504	0·502	0·469	0·464	0·478
50	4,380	0·447	0·430	0·421	0·433
60	5,256	0·406	0·404	0·393	0·401
70	6,132	0·377	0·382	0·373	0·377
80	7,008	0·358	0·366	0·357	0·360

On the one hand, they are not merely test figures, which afford no real criteria of the commercial working of such plants; nor, on the other, are they figures of obsolete engines, which would be unfair to take as a basis. The author has taken town gas at an average price of 2s. per 1,000 cubic feet, and, in the case of suction or producer gas engines, anthracite coal at 22s. per ton or small peas at 10s. per ton, and oil at 42s. 6d. per ton. In the figures water is taken at an average price of 6d. per 1,000 gallons. Repairs and lubricating oils are taken from actual figures, and depreciation and interest on capital outlay are taken throughout at 10 per cent. These are the real figures with which manufacturers debit themselves, although it is fair to point out that in nearly every case there is no proportionate charge for supervision or general establishment charges, or for rating. Attendance is frequently not debited to the cost of power, and, therefore, on all points the figures given are decidedly fair to these sources of power, and are even somewhat unfair to electricity supply. Table II. sets out comparative figures for larger and less frequent installations of 100 h.p. to 500 h.p. In the final column of each of the two tables the average results of these figures are given, with which comparisons are made later with the electrical schedule of charges. The author sets out below actual statistics of independent tests taken from different industrial plants, and it is interesting to compare the actual figures of these several cases with the above-mentioned tables, when it will be found that the figures in these tables are, if anything, on the low side.

Section II.

Some actual data of different industries are now given, most of which were taken by the author himself through the courtesy of the directors and officials of the various works, and for the electrification of many of which he has either been responsible or is officially connected with.

Graving Docks.—As might be expected, some priority is given to shipyards, engine works, and docks, being those with which the author has been more intimately connected for so many years. Take first the cost of an electrically-driven pontoon which is capable of berthing vessels up to nearly 4,000 tons displacement. The pumps are four in number, and are electrically-driven centrifugal pumps, each 18in. diameter. The following are official figures obtained when actually docking a vessel of 2,600 tons:

Tons of water pumped	3,875
Maximum head on pumps	27ft.
Average head on pumps	16ft.
Time taken to empty	25 minutes.
Cost of power supply (outside source)	1·375d. per unit.
Number of units consumed	123

The actual total cost per ton of vessel docked was:

Power	0·064d.
Wages, etc.	0·100d.
Interest and depreciation at 10 per cent.	0·159d.
	0·323d.

For comparison take another case—viz, that of a graving dock driven by two gas-engines, 40 h.p. each, each driving horizontal centrifugal pumps, each 21in. diameter, with a capacity of 9,320 gallons per minute, with a maximum head of 28ft., and an average head of 17ft. The following are the data when docking a vessel of 1,760 tons:

Tons of water emptied	10,632
Time taken to empty	128 minutes.
Cost of gas per 1,000 cubic feet	1s. 6d.
Gas consumption	4,600 cubic feet.

The actual cost per ton of vessel docked was:

Power	0·046d.
Wages, etc.	0·412d.
Interest and depreciation at 10 per cent.	0·587d.
	1·045d.

It will be observed in this comparison that the graving dock represented a much longer run and a better load factor, and yet the cost of docking by gas-driven plant was three times that of electrically-driven plant. It is fair to say, however, that the electrically-driven plant is of recent design, whereas the gas plant cannot be said to be modern. Supply to docks will not, however, represent an important item, as they must necessarily be limited in number. Electrical suppliers will do well to adopt a method suggested by the author, which was to stipulate that during "peak" loads in the restricted winter months only one-half of the pumps should be worked, the docking on these occasions, therefore, taking approximately twice the usual time. It is surprising, however, how few are the occasions when this restriction has to be enforced. In the above-cited gas installation, the price being so low per 1,000 cubic feet, it is improbable that any great economy would have been gained from an independent suction or gas producer plant. Dock installations require an extensive system of jib and other cranes, capstans, and other auxiliaries. These, however, are so demonstrably better than hydraulic cranes and

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capstans, both in speed of working and annual cost, that it is unnecessary to dwell upon them. The author has been associated with an extensive application of three-phase power to travelling jib cranes and capstans, which have been both successful and economical. It is found that plant of this description has a very low annual load factor, consumes but few units, and brings in a very small revenue. Care has, therefore, to be exercised in fixing prices for such a supply.

Shipyards.—We are enabled to compare the actual costs of gas-driven and steam-driven local plant of two neighbouring shipyards. Both the yards were electrically equipped, the local generating plant in the one case being driven by gas-engines supplied from the town mains, and in the other by modern steam-engines. In the gas-driven plant the following are the data given by the authorities themselves, and carefully checked by the author:

Duration of test, 4 months; ordinary working conditions.
Number of gas-engines, 3.
Total b.h.p., 360.
Total kilowatts, 225.
Belt-driven shunt-wound dynamos, 230 volts.
Maximum load recorded on switchboard, 207 kw.
Total units generated, 83,125.
Load factor, 14 per cent.
Cost of gas, 1s. 6d. per 1,000 cubic feet.

The cost of power actually ascertained (but excluding any item of supervision, general establishment charges, or rating of machinery) was as follows:

Gas, 3,000,828 cubic feet	£225	0	10
Engine and dynamo oils	24	1	7
Water at 6d. per 1,000 gallons	2	0	0
Waste and stores	5	9	10
Repairs (material)	5	16	8
Attendance and repairs (labour)	84	12	1
Interest and depreciation at 10 per cent.	60	0	0
Total cost for four months	£407	1	0

representing a total cost per unit of 1·173d. It is only fair to point out that the item "attendance and repairs (labour)" is an excessive one, but the figures are, nevertheless, a statement of fact. The plant was under the care of engineers and an engineering firm, and this high cost can only be ascribed to the fact that the plant was not so well maintained as it should have been. Attention is also called to the large gas consumption, which amounted to 36 cubic feet per kilowatt-hour, a large figure even on so low an annual load factor as 14 per cent. The plant load factor was 48 per cent.

For comparison we may take the following particulars of an independent steam-driven plant in a combined shipyard and engine works:

Duration of test, 1 year; ordinary working conditions.
Four triple-expansion condensing steam-engines, high speed enclosed, each 250 h.p. Total, 1,000 h.p., 672 kw.
Cooling towers.
Boiler pressure, 160lb. No superheat. Marine boilers, close to engines.
Maximum load observed, 504 kw.
Total units metered at switchboard, 891,655.
Load factor, 22 per cent.
Class of coal used, small at 11s. per ton.
Lbs. of coal per unit generated, 7·3.

The following was the ascertained cost of generation:

Labour	£665	0	0
Coal, 2,924 tons at 11s.	1,608	11	11
Feed water	59	0	6
Circulating water and make-up	31	19	6
Lubricating oils	58	8	5
Repairs and general stores	141	2	10
Interest and depreciation at 10 per cent.	1,042	6	4
	£3,606	9	6

representing a total of 0·97d. per unit generated. It may be observed that a shilling per ton rise or fall in the price of coal per ton would have raised or lowered the price per unit by 0·039d., or 4 per cent. The condensing appliances were somewhat faulty, and better figures would no doubt have been obtained with an improved vacuum, and with superheat. In another case of an engine works driven by modern enclosed engines, representing a total of 1,000 h.p. with a load factor of 24 per cent., and where there were both superheat and a good vacuum, the author obtained the total figure of 0·71d. per unit metered at the switchboard. These cases are actual records. It may be said that improvements could be made by users if they evinced greater care, as in the above case 0·97 per unit generated, even with small coal, is a high figure, and could be reduced on test. The author's experience, however, leads him to think that whatever may be the results obtained on test—whether with gas or oil engines or steam—the consumers do not give that attention to the upkeep of their plant which might be expected, and the figures quoted are really reasonable average figures obtained in practice, and this is an argument in favour of generating plant being in expert hands in a centralised power station.

In a paper read before this Institution some time since, Mr. Williamson gave the following interesting particulars of various stations installed at large works:

Plant installed. Kilowatts.	Capital cost per kilowatt. £	Generating cost per unit. d.	Load factor. Per cent.
375	26·25	—	—
600	22·50	—	—
640	20·50	0·716	37
750	24·20	—	—
1,325	25·80	0·675	—
2,000	23·50	0·970	—

Paper Mills.—The following are particulars of a paper mill which came under the author's notice. These figures could undoubtedly have been improved upon, for the reason that some of the boilers were low pressure (80lb.), and could have been replaced with advantage by high-pressure boilers with resulting economy. On the other hand, this paper mill is a successful one, and typical, the author believes, of very many throughout the country which offer a field to electrical enterprise:

Duration of test, 1 year; ordinary working conditions.
Number of engines, 25. Total b.h.p., 1,820.
Total coal consumed for power driving, 17,680 tons
Average horse-power, 1,760.
Running hours per annum, 7,000.
Total horse-power hours, 12,320,000.
Annual load factor, 79 per cent.

The cost of power was as follows:

Coal	£9,724
Oils and stores	156
Wages	1,524
Repairs	700
Interest and depreciation at 10 per cent.	2,730
	£14,834

representing 0·29d. per horse-power hour, or an equivalent of 0·41d. per unit generated. In works of this class, however, it must not be forgotten that boilers have to be installed in any case, and much coal used, for boiling the esparto grass, heating and drying the pulp, and heating the calenders. In this case, out of a total of 26,000 tons used per annum, no less than 8,320 tons were used for heating and drying purposes, the balance being required for power. The works in question have, in addition to the grass boilers, washers, and calendering machines, all of which require live steam, paper-making machinery, half-strip machines for straining, beaters, cutting and rolling machines. There are thus a number of machines which are usually at some distance from the main drive. These auxiliaries, which represent from 10 to 15 per cent. of the total power, and are usually from 10 h.p. to 30 h.p. each, could certainly be driven more economically by electrical means, either from generators driven from the main mill engines or supplied independently from an outside source. Works of this class have so high an annual load factor, and, in the author's opinion, are of such a size and nature, that it becomes a difficult problem for a central power supply (unless of very large dimensions) to compete successfully with the manufacturer's own plant, more especially as the very nature of this day-and-night load does not permit of any improvement of the general diversity factor at the power station. The author calculated that this consumer could have reduced the annual cost by 20 per cent. by installing high-pressure boilers and by substituting motors for the

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wasteful steam-engines situated at the outskirts of the mill. This would have reduced the cost of the manufacturer's own power from his own plant to an equivalent of 0·33d. per unit. Reference to the schedule given later in this paper (Table XIII.) shows for 80 per cent. load factor and transformed three-phase current a large power supply could hope to compete successfully with this low figure, but this can obviously only apply to very large power stations, and to mills situated at a reasonable distance only from such stations, and thus not involving a large special expenditure on cables.

Jute Mills and Cotton Mills.—A jute mill is another difficult class of factory for the successful competition of electricity, and is very similar to cotton and other textile mills. The running hours are usually about 2,750 per annum, and the load is practically constant. This represents an annual load factor of 32 per cent., but a plant load factor of 92 per cent.—thus the cost of power is exceedingly low. In an actual modern mill having a total horse-power of 900 the annual costs were as follows:

Coal	£1,444
Water	124
Wages and repairs	720
Interest and depreciation at 10 per cent.	1,350
	£3,638

which is equivalent to 0·37d. per horse-power hour. On an annual output of 2,284,500 horse-power hours this is equivalent to a price of 0·48d. per unit. In this class of mill the main engines represent about 83 per cent. of the total power installed, the remaining 17 per cent. being made up of auxiliaries scattered about the place, which it would certainly repay to equip with motors, not only because of their isolation from the main drive, but also because the auxiliaries generally require to run for longer periods than the main engines in order to keep pace with the output from the spindles, spinning frames, and general machinery. It is interesting to know that in a mill of this description the shafting losses represent 25 per cent. of the total power. Regularity of speed is absolutely essential, and a three-phase motor is the most beautiful application possible, not only giving regular speed, but also freedom from fire risk, which is imortant in this class of works. Mr. Wilson, in 1905, quoted some figures of a new mill engine whose full-load diagram was 738 i.h.p. and the light-load friction diagram 300 i.h.p., showing an apparent efficiency of only 59 per cent. In such a case there must obviously be a good opportunity for electrical driving. He went on to say that the total cost per indicated horse-power year comes out to something of the order of £2. 5s. to £2. 10s. for large mills—*i.e.*, equivalent to £3 to £3. 7s. per kilowatt-year—and in the case of small mills from £3. 7s. to £4. 7s. per kilowatt-year. Although he does not give the figure, this really means that, based upon the usual running hours of 2,700 per annum, the cost per unit ranges from 0·257d. to 0·287d. for large mills, and from 0·287d. to 0·373d. for smaller mills. These figures appear to the author to be too low. It is obvious, therefore, that only by the greater efficiency of electrical driving—*i.e*, by competing with the cost per useful horse-power at at the spindles, etc.—can these mills be successfully dealt with by electrical power. If the 59 per cent. efficiency mentioned above is, however, a usual figure, there can be no question that the cost of providing motors could be successfully met. In the investigations of jute mills, however, the author has not been able to make the friction losses greater than 30 per cent., and information on this point from engineers who have to deal with mills will be of value.

Collieries.—Several figures have been quoted recently as to the cost of independent plants at collieries, but the author may be excused for quoting the following figures again in order to complete this list of possible large power users. In a paper read before this Institution, Mr. C. P. Sparks quoted the following figures for the installation at the Powell Duffryn Collieries. Power-house, 3,000 kw. installed. Average horse-power of motors at work:

Haulage	2,900 h.p.
Winding	180 ,,
Fans	380 ,,
Pumps	340 ,,
Screens	240 h.p.
Auxiliary motors	480 ,,
	4,500 ,,

Total cost:

Power-house	£11·5
Distribution and sub-stations	2·6
	£14·1 per kw. installed.

Annual output in units, 4,800,000.
Average load factor, 36 per cent.
Coal consumption per unit, 3·7lb.
Cost of coal, 5s. per ton.

The cost of power was as follows:

Running cost	0·12d.
Interest and depreciation, 10 per cent. on £34,000	0·17d.
Total cost	0·35d.

In such a case it would appear to be impossible for an outside power supply to compete successfully with the colliery's own plant; for reference to the schedule of charges in Table XIII. will show that for an annual load factor of 36 per cent. a price of 0·47d. should be obtained for transformed alternating current as against 0·35d. obtained by the local plant. It is estimated that this local cost will be reduced to below 0·3d. as the installation becomes completed and as the load factor rises to 46 per cent., which then will make competition from outside quite impossible. While this is true, however, of so large a local plant as 3,000 kw., it would not, of course, apply to smaller collieries involving an installation of, say, 1,000 kw., in which case the power station would no doubt successfully compete, as the capital and standing charges would raise the cost materially. A reference to the Institution *Proceedings* (for 1906) will show the ascertained load factors of various parts of the equipment, which need not be repeated here.

Steel and other Large Works.—The remarks that have been previously made upon the cost of supply to engine works apply generally to works of this description. Annual load factors of from 20 to 25 per cent. are obtained, and the prices are found to range between 0·7d. and 0·6d. per unit. Therefore, on referring to the schedule of charges, it will be seen that a large power company could compete successfully with works of this description. Of course, some deduction must be made in certain cases for the utilisation by steelworks of their blast-furnace gases, which are utilisable in gas-engines. The load factor of such works can be improved by the adoption of some such system as the Ilgner and by kinetic storage, and thus prevent the abnormal fluctuations in the loads of the rolling-mills. Although this system is costly to install, on the other hand, of course, it considerably reduces the amount of generating plant which would otherwise be required to meet the "peak" loads. That this fluctuation is important the author has found from the fluctuation of load on comparatively small rolls in shipyards, and the additional cost of such a levelling-out system will be more than repaid.

Rope-Making Works.—In the case of a rope-making works which the author investigated it was found that the cost represented practically 0·5d. per horse-power hour, equivalent to 0·67d. per unit, the running hours being 2,700 per annum and the load being practically constant. The annual load factor being 30 per cent., and the equivalent price in the schedule quoted by the author being a little over 0·5d. per unit supplied, it would obviously be possible to supply such works from an outside source.

Breweries.—The author investigated the driving of a brewery equipped with modern plant. The prime movers were gas-engines, developing in all 194 h p. The following were the annual costs:

Gas at 1s. 6d. per 1,000 cubic feet	£338 14 9
Wages and repairs	516 12 4
Oils and stores	111 4 0
Interest and depreciation not given.	£966 11 1

The cost of driving the shafting amounted to no less than £270 per annum: thus the net cost of useful power amounted to £696. 11s. 1d. The shafting was very lengthy, but owing to the positions of the various machines this was unavoidable, and explains the reason of so great an annual loss. The wages and repairs are certainly very high indeed, but, nevertheless, the figures are the real

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figures given to the author by the authorities of the brewery. The electrical cost after conversion was as follows:

66,550 units at 1·5d.	£416
Oils and stores	20
Wages and repairs	78
Interest and depreciation on new plant	112
or 2·25d. per unit.	£626

In addition there was a great deal of saving of room by clearing out much of the shafting, and absence of vibration and noise and of dirt from the oil-cups of the shafting.

Sawmills.—The author was responsible for the electrification of a small sawmill which was driven by steam-engines, the cost being over 2d. per horse-power hour, or, say, 2·6d. per unit. This cost was only approximate, because of the necessity of calculating the actual horse-power hours. The calculation was, however, fairly close, as the subsequent ascertained cost of electrical driving proved. Seven motors were installed, ranging from 4 h.p. to 50 h.p. each, with a total horse-power of 179. After one year's run it was ascertained that the total consumption was 50,785 units. The suppliers found the static transformers and high-tension switchboard, the low-tension switchgear and fireproof transformer chamber being found by the user. The cost to the consumer was as follows:

Electricity	£264	10	2
Oils and stores	9	3	4
Interest on sub-station building	12	0	0
	£285	13	6

or 1·35d. per unit, exclusive of capital charges on motors and wiring.

Miscellaneous Works.—Turning now to the general smaller power users within towns, there is no question that it is possible to supply these successfully from a central source, as none of these works are likely to exceed the running hours of, or the load factor from, a sawmill and joinery works when the annual hours are 2,700 and the load fairly constant; and it has been demonstated that the latter works can be supplied economically from a central source, and at a cheaper rate than it can be generated by local plant. In each case of small power supply the author has found it quite easy to compete successfully with local plant, whether steam or gas driven, when each case is carefully tested and dealt with. Moreover, in works of this nature space is of the utmost importance, and the ability to switch the outside supply on or off at will constitutes a very great boon to the user. In Sunderland at the time of the last census, for which the author was responsible, and omitting the large engine works and shipyards, there were 587 motors, representing a total horse-power of 1,634, or an equivalent to 1,220 kw. The maximum demand on the station plant was only about 500 kw. There was thus a diversity factor of 2·4, the total units for the year being 404,999, or 332 per kilowatt installed. This represented a consumption of 810 units per kilowatt demanded for this particular load, and was thus under an average load factor of 10 per cent. Table III. will be of value as giving statistical information of the horse-power which may be estimated for works of various kinds.

TABLE III.

Description of Works	H.P. Installed.	Number of Persons Employed.	H.P. per Capita.	Annual Units.	Units per Capita per Annum.
Corn mill	378	43	8·79	—	—
Printing (daily papers)	118	32	3·70	15,770	493
Saw mills	190	84	2·26	50,780	604
Steel-rolling mills	712	448	1·59	87,117	194
Mineral waters	40	32	1·25	10,483	327
Engine and boiler works	485	412	1·18	—	—
Engine and boiler works	750	1,020	0·75	1,031,892	1,012
Glass merchants	10	11	0·90	—	—
Coppersmith and foundry	120	199	0·60	12,172	61
Printing (general)	37	69	0·53	21,240	308
Printing (general)	8	16	0·50	5,504	347
Laundries (average of several)	10·8	40	0·27	25,054	626
Shipyard	2,099	1,874	1·12	700,000	373
Shipyard	477	446	1·07	198,000	444
Shipyard (with compressors)	6,900	5,564	1·24	2,980,000	536
Paper mill	1,820	410	4·43	—	—

This will be found useful in prospecting any district, as, short of a complete census of the actual power installed, the only way is to compute the horse-power *per capita* of the several factories. It is interesting also to note the relation of the maximum demand in works to the motors installed, though such figures are difficult to obtain, as manufacturers are not generally inclined to give this information. The following particulars are, therefore, somewhat limited, and, perhaps, a discussion on this paper will educe particulars of other classes of works which must be of general interest to the industry.

TABLE IV.

Description of Works.	1. H.P. of Motors Installed.	2. H.P. of Transformers Installed.	3. Maximum Demand H.P.	— Ratio 2/1	— Ratio 3/1
Shipyard	1,576	1,200	900	0·76	0·57
Engine works	5,538	3,200	2,400	0·57	0·43
Printing	37	—	37	—	1·00
Saw mills	179	200	140	1·12	0·78

There is an enormous scope in this country for electrical applications among all classes of works. In the preparation of particulars for the recent London County Council Power Bills, the author and his colleagues ascertained that in the area of Greater London alone there are factories utilising altogether some 400,000 h.p, while in the evidence brought forward in support of the Administrative Company's Bill, 1906, this figure was given as 535,742 h.p., of which only 29,053 h.p was then supplied from electrical undertakings. In most of these it would obviously pay the consumer and be in the interest of London and of the nation that these works should be electrified. In course of time this is bound to be. If Greater London were cleared of factory chimneys, coal dust, and ash wagons, and if mechanically-propelled vehicles replaced horse vehicles, there would result an enormous change for the better in the physical conditions of life. Moreover, a cheap supply of power would assist to prevent the migration of power users and the consequent reduction in rateable value—a factor which reacts unfavourably on the remaining inhabitants. As there are some 400,000 h.p. in factories to be equipped within the Greater London area, what must be the enormous total to be electrified within Great Britain? That a very great impetus has been already given to the adoption of electrical power there is no question. In the town of which until recently the author was engineer, within four years the power load connected had grown from 2,000 h.p. to over 10,000 h.p. Other towns must have experienced a like growth, particularly cities like Manchester and others, where a proper and flexible system has been adopted, such as a high-tension three-phase transmission, and every encouragement given to the power user. Those towns are fortunate which have installed a flexible system wherewith, at a minimum cost of transmission, to reach large power users situated at some distance from the power stations; but those other towns where only low-tension systems are at present available will certainly have to face the problem of adopting a high-pressure system in order to reach works situated at some distance away, and it is these which will find the problem most difficult.

It is these smaller boroughs, and the undertakers in and about London principally, to which additional means must be given to enable electricity to become available for industrial purposes. These means are discussed at a later stage in this paper.

SECTION III.

A modern power station of important magnitude and favourably situated can be now equipped completely for £12 or £13 per kilowatt installed. One cannot imagine that this figure is likely to be reduced materially. A transmission system in which the cables are designed to allow for diversity of loads supplied over a large area could be laid down also for £12 per kilowatt supplied; thus the all-round cost of an electrical installation is some £25 per kilowatt, excluding transformers. The author's experience obtained in providing and equipping a large number of sub-stations has been as follows,

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TABLE V.

Cost of Static Transformer Sub-stations.

Kilowatts Installed.	Kilowatt Demand.	Cost of Buildings, Plant, and Switchgear.	Cost per Kilowatt Installed.	Cost per Kilowatt Demand.
		£	£	£
150	100	501	3·34	5·01
900	600	1,557	1·74	2·59
		Average ...	£2·54	£3·80

Cost of Rotary Sub-stations.

Kilowatts Installed.	Kilowatt Demand.	Cost of Buildings, Plant, and Switchgear.	Cost per Kilowatt Installed.	Cost per Kilowatt Demand.
		£	£	£
650	400	3,238	4·98	8·09
1,000	750	5,553	5·55	7·40
1,400	1,150	5,968	4·26	5·19
		Average ...	£4·93	£6·89

In new ground, of course, it is in the interest of everyone concerned to use static transformers, not only because of their lower capital cost, but also because of the minimum space required by them, the absence of attendants, and the saving in running stores and repairs. Incidentally, the automatic arrangement of Mr. Berry should prove useful in factories, for, as a general rule, either offices in works require to be lit after the main power is shut down, or small repairing shifts are required at night, and lights required for watchmen in case of outbreaks of fire. The transformer losses in the larger sizes then become an important item if allowed to continue on circuit to supply these trivial loads.

There are, however, many large works which are already electrified and supplied from their own plant. If direct-current motors are already installed, then a rotary sub-station must be put in at a greater cost to both supplier and user. It then becomes a matter for calculation to the latter whether it will better pay him to replace his existing motors by three-phase, or to pay a necessarily higher annual sum for transformed and converted current. In other words, the user has to decide whether the capital charges on the change-over of his motors will be less or more than the increased annual charge from a rotary as distinct from a static sub-station. Here, again, in power supply the difference between an all-round 85 per cent. efficiency for rotaries and 95 per cent. for statics cannot be overlooked. The total capital cost per kilowatt installed at the power-house, therefore, from the power station up to and including the user's sub-station, will be as follows:

TABLE VI.

Cost of Stations, Transmission Systems, and Static Sub-stations.

Capacity of Sub-station	Cost of Power House per Kilowatt	Cost of Transmission System per Kilowatt.	Cost of Static Sub-station per Kilowatt.	Total.	Equivalent Cost at 1·66 Diversity Factor.
	£	£	£	£	£
100–250	13	12	3·33	28·33	18·33
250–1,100	13	·12	1·75	26·75	16·75
			Average	£27·54	£17·54

Cost of Stations, Transmission Systems, and Rotary Sub-stations.

Capacity of Sub-station.	Cost of Power House per Kilowatt.	Cost of Transmission System per Kilowatt	Cost of Rotary Sub-Station per Kilowatt	Total	Equivalent Cost at 1·66 Diversity Factor
	£	£	£	£	£
250–500	13	12	5·20	30·20	20·20
500–1,500	13	12	4·26	29·26	19·26
			Average	£29·73	£19·73

These are, however, not the real figures to take when fixing a schedule of charges, because of the influence of diversity factor. This figure will be found to vary in different localities and among different industries. For instance, the ratio of the sum of maxima observed at the several sub-stations in Sunderland to the actual observed maximum demand on the plant supplying them was only 1·25, because the industries supplied were very much of the same nature; but it is more general to find a diversity factor of 1·66 in a more varied set of industries. The author is here speaking of the diversity of sub station maximum loads compared with the observed maximum at the power station. Of course, the ratio of the sub-station load to the horse-power of motors installed in factories is really only about 50 per cent., representing a diversity factor of 2. The following statistics may be useful:

TABLE VIa.

	Total Kilowatts Installed	Maximum Load Observed	Ratio	Diversity Factor
Engine works	1,574	750	0·50	2·00
Engine works	1,000	434	0·40	2·25
Shipyard	310	200	0·66	1·50
Shipyard	950	450	0·47	2·12
Shipyard	357	175	0·50	2·00
Dock cranes, etc. ...	223	56	0·25	4·00
Saw mills	135	88	0·65	1·50

Obviously the capital cost per available kilowatt at the power station depends very much on the diversity factor, for the figure which may be taken as the assessable value of a power-house and transmission system in the one case is £25 ÷ 1·25, or £20; and in the other case, £25 ÷ 1·66, or £15. Thus the total capital cost of plant, including a static transformer sub-station, will be either £22 54 or £17·54, and the total cost of a rotary sub-station, £24 73 or £19 73, according to size. It is obvious that some differentiation must be made between a low-tension supply of direct current and one of alternating current when one is preparing a schedule of charges, for at any load factor, say 20 per cent, the capital charges as between the two systems represent an additional 5 per cent. for the rotary over the cost of static sub-stations, without counting the addition to standing charges from attendance or from stores, etc., required by the former type or the less efficiency of rotary sub-stations. It is of little use straining to reduce the capital outlay per kilowatt on the power-house and distribution system if one is going to sink an additional £2 or £3 per kilowatt on rotary sub-stations, so that there can be no doubt as to the wisdom of applying static sub-stations to all industrial purposes, wherever possible; and it is useless designing a highly efficient power-house and transmission system if one throws away 10 per cent. at least in a sub-station. Space is of great importance to the manufacturer, and so much less is required, of course, by the static sub-station (about 0 8 square foot per kilowatt installed, as against 1·75 square feet required in a rotary sub-station). Power suppliers will do well, therefore, so to arrange their transmission system that works requiring 100 kw. or more shall be supplied whenever possible from their own local static sub-stations. If the works can be grouped, a centralised sub-station can be put down with overhead low-tension mains to each of the works supplied from it, so as to minimise expenditure on this item. In the published tables of 1907 of the London County Council Electric Supply Bill a differential tariff was adopted by the advising engineers to the Council, but in no other Power Bill has this been specifically quoted. It is true that all Power Bills have maximum scales of charges, and can differentiate to various classes of consumer within those limits; but that is not the same thing as actually publishing a definite tariff which takes into account the differences above mentioned. Of course, the lighting charges will represent a curve higher at every point than the power curve. This is obvious from the fact that one does not get the same diversity factor with lighting consumers as with power consumers. It is a comparatively easy matter to

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estimate closely the cost of a power station, and even of the transmission or distributing systems and sub-stations; and the one factor which is really unknown, but upon which the scale of charges so much depends, is this diversity factor. 1·66 may be all right in one district, but if applied universally will certainly lead to trouble, for the revenue would be too small if the consumers were charged on a scale dependent upon a diversity factor of 1·66 if in practice this factor only proved to be 1·25. Therefore, in fixing maximum scales it is wise always to base the *maximum* rates upon a diversity factor of unity, and the actual commercial scales which will thereafter be charged will, no doubt, depend upon the experience which is gained by the supplier after some years of working. To some extent the load factor can be raised artificially and by arrangement. In one locality the author got manufacturers to modify their dinner hours, so that instead of all shutting down synchronously, approximately half shut down from 12 to 1 p.m. and half from 1 p.m. to 2 p m. Some power companies are also arranging to supply chemical works, in some of which certain processes can be shut down during restricted hours. This all helps, of course, and as a matter of fact is really about the sole reason why such very small charges are made to such consumers.

Section IV.

The severest handicap to power supply from existing London and provincial stations—whether administered by

Table VII.

Comparison of Actual and Correct Charges for Power by Local Authorities.

Local Authority	Actual Charge.	Correct Charge	Probable Charge from Power Supply Company
	d.	d	d
Barking...	1·686	1·747	
Barnes	1·658	1·677	
Battersea	1·500	1·975	
Bermondsey	2·060	1·792	
Croydon...	2·500	1·775	
Ealing	2·351	2·361	
East Ham	1·570	1·535	
Erith	1·581	1·595	
Fulham	1·000	2·024	
Gravesend	2·000	1·638	0·83 for
Hackney	1·240	1·384	direct
Hammersmith	1·240	1·201	current;
Hampstead	2·090	1·839	
Hornsey...	1·270	2·225	
Ilford	1·324	1·440	0·68 for
Islington	1·370	2·214	transformed
Kingston-on-Thames ...	2·000	2·370	alternating
Leyton	1·623	1·857	current
Poplar	1·430	1·686	
St. Pancras	1·000	1·838	
Shoreditch	1·400	1·958	
Southwark	1·900	2·034	
Stepney...	1·000	1·549	
Walthamstow	2·044	3·129	
West Ham	1·234	1·340	
Willesden	1·431	2·988	

Comparison of Actual and Correct Charges for Power by Metropolitan Companies.

Name of Company.	Actual Charge	Correct Charge	Probable Charge from Power Supply Company
	d.	d	d
Brompton and Kensington	1·000	1·979	
Charing Cross (City) ...	1·940	2·198	
Ditto (West End)	1·940	2·511	
Chelsea	1·500	2·388	0·83 for
City of London ...	1·700	1·554	direct
County of London ...	1·800	2·267	current
Kensington and Knightsbridge ...	2·140	2·082	
London Electric ...	1·860	1·862	0·68 for
Metropolitan	2·460	2·093	transformed
Notting Hill	3·—½	3·378	alternating
St. James' and Pall Mall	2·370	1·928	current
South London	1·780	1·518	
South Metropolitan ...	1·048	2·367	
Westminster	1·830	2·404	

companies or municipalities—is, in the majority of cases, their present high capital cost per kilowatt. It is true that with each extension this figure is reduced; still, it will be found very difficult, especially in the case of London undertakers, to reduce their total much below £60 per kilowatt, or, in the case of large provincial stations, to reduce their capital much below £40 per kilowatt, or smaller stations to £50, taking into account all existing capital outlay. This is where the modern power company comes in with the benefits of latest electrical practice, much cheaper buildings, larger and cheaper units of plant, and generally an altogether lower cost per kilowatt. Even with a power company, however, there is a danger that the capital, while minimised in the power-house, may be unduly raised by the cost of transmission over too great a distance. The present capital expenditure per kilowatt on London municipal systems averages £93 and London company stations £103, while the present expenditure on provincial municipal stations is £70·8 and provincial companies £90. Table VII. shows the average prices charged by existing undertakings for power in 1906 within the area proposed to be covered by the various London Power Bills. Side by side are given the figures which ought to have been charged, assuming that the average load factor of power supply is 20 per cent. and the diversity factor 1·66. The average load factor will certainly not be more than 20 per cent.; and if it really has a lower value, then the author's criticisms tells so much the more against the present suppliers. It will be seen that in the case of the South Metropolitan Company the average price charged for power was 1·048d. per unit, whereas the real charge should have been 2·367d.; or take the Westminster Company, the charge was 1·83d., whereas it should have been 2·4d. Or take the municipal cases: Battersea, where the average charge is 1·5d., and the real charge should have been 1·975d.; Islington, where the charge was 1·37d., and the real charge 2·2d.; or St. Pancras, average charge of 1d., and the real charge should have been 1·83d. This means, obviously, that the power user is being supplied by these undertakers at the expense of their lighting consumers, who are paying an unduly high rate for their supply, or in the case of certain London municipalities at too high a cost of public lighting. This system may do very well where there is only a small amount of power to be given, and where the proportionate revenue is only a small fraction of the gross receipts; but let there be a big increase in the amount of power supplied at the same rates (and despite its effect in the general reduction of generating costs), it will be found then that the total receipts are not commensurate with the total costs, and the result will be an unsuccessful undertaking.

(To be continued.)

THE RELUCTANCE OF THE AIR-GAP IN DYNAMO MACHINES.*

BY THOS. F. WALL, M.SC., B.ENG., STUDENT.

(Concluded from page 25.)

Experiment 3.—

Air-gap = 7·3mm.

Ratio $\frac{\text{slot}}{\text{gap}} = 2·05$.

Ratio $\frac{\text{tooth width}}{\text{gap}}$ for the various teeth = 1·37, 2·05, 2·09, 2·67, 2·68, 4·1.

Average flux density on the tooth surface = 5,000 lines per cm².

Fig. 10.—Curve showing Flux Distribution on Smooth Surface of Pole-piece. Air-gap = 7·3 mms. Average Flux Density at Surface of a Tooth = 5,000 lines per cm².

Fig. 10 shows the curve of flux distribution on the pole-piece surface, and it is seen that the effect of increasing the air-gap has been again to diminish the fluctuation of the field. The measurements of the several curves are as follows:

* Paper read before the Institution of Electrical Engineers,

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Curve I.—Area = 1,525; mean height = 62·3; maximum height = 73·0; minimum height = 53·0.
Curve II.—Area = 1,846; mean height = 61·5; maximum height = 72·7; minimum height = 53·0.
Curve III.—Area = 1,973; mean height = 64·6; maximum height = 74·2; minimum height = 53·5.
Curve IV.—Area = 2,309; mean height = 67·0; maximum height = 74·5; minimum height = 54·0.

The flux distribution on the surfaces and flanks of the teeth for the above air-gap and density is shown in Fig. 11. The effect of the larger gap is to further increase the relative flux density at the tips of the teeth.

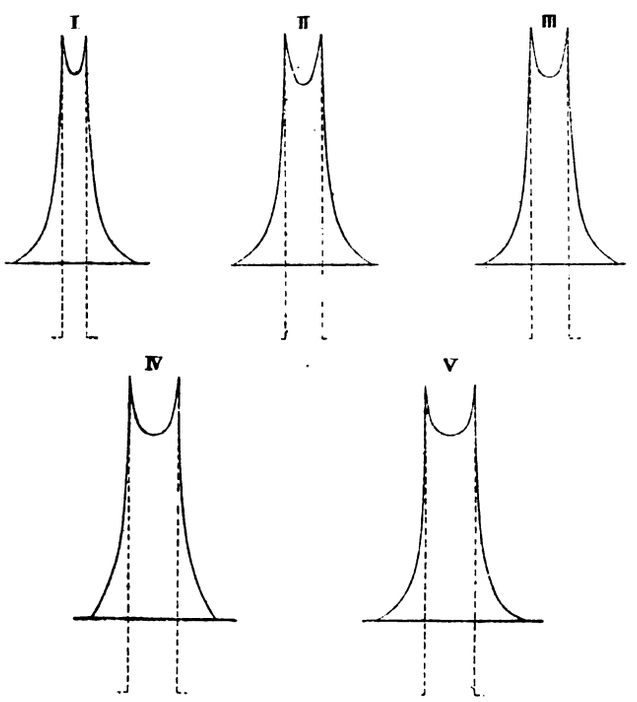

FIG. 11.—Flux Distribution on Surfaces and Flanks of the Teeth
Air-gap = 7·1 mm. Average Flux Density at the Surface of a Tooth = 5,000 lines per cm.²

Curve I.—Area = 1,439; ratio, flux density at tip to flux density at middle of tooth surface = 1·21; minimum height for the surface of the tooth = 76·0.
Curve II.—Area = 1,810; ratio, flux density at tip to flux density at middle of tooth surface = 1·29; minimum height over the surface of the tooth = 72·5.
Curve III.—Area = 1,879; ratio, flux density at tip to flux density at middle of tooth surface = 1 28; minimum height over the surface of the tooth = 75·0.
Curve IV —Area = 2,232; ratio, flux density at tip to flux density at middle of tooth surface = 1 34; minimum height over the surface of the tooth = 73·3.

These curves also show that the leakage of flux from the flanks of the teeth to the surface of the pole-piece is increased with increased gap, as would, of course, be expected.

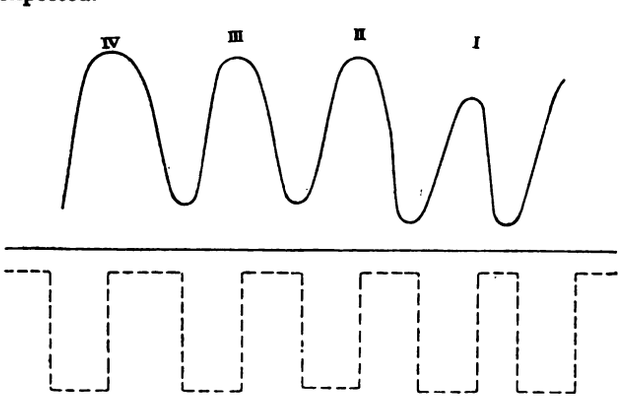

FIG. 12.—Flux Distribution Curve on Smooth Surface of the Pole-piece.
Air-gap = 5·3 mm. Average Flux Density at the Surface of a Tooth = 13,500 lines per cm.²

Experiment 4.—A second experiment was made with a gap of 5·3mm., but with a much higher flux density than previously—viz., 13,500 lines per cm.² The curves so obtained are plotted in Fig. 12, and the numerical results are as follows:

Curve I.—Area = 1,813; mean height = 73·5; maximum height = 92 7; minimum height = 57·0.
Curve II.—Area = 2,416; mean height = 80 5; maximum height = 99 7; minimum height = 60 0.
Curve III.—Area = 2,445; mean height = 81·5; maximum height = 99·8; minimum height = 60 0.
Curve IV.—Area = 2,905; mean height = 84·0; maximum height = 102·0; minimum height = 61·0.

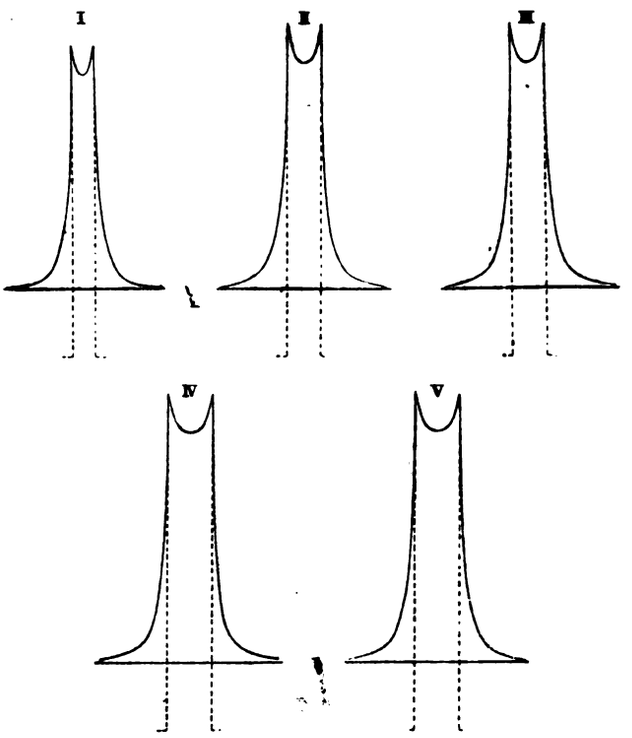

FIG. 13.—Flux Distribution on the Surfaces and Flanks of the Teeth
Air-gap = 5·3 mm. Average Flux Density at the Surface of a Tooth = 13,500 lines per cm.²

The curves of Fig. 13 show the corresponding flux distribution on the surfaces and flanks of the teeth. The increase of flux density has apparently had the effect of increasing the relative magnitude of the flux peak at the tooth tips.

Curve I.—Area = 1,760; ratio, flux density at tip to flux density at middle of tooth surface = 1·14; minimum height for the surface of the tooth = 96·3.
Curve II.—Area = 2,408; ratio, flux density at tip to flux density at middle of tooth surface = 1·18; minimum height over the surface of the tooth = 102 0.
Curve III.—Area = 2,372; ratio, flux density at tip to flux density at middle of tooth surface = 1·18; minimum height over the surface of the tooth = 102·0.
Curve IV.—Area = 2,754; ratio, flux density at tip to flux density at middle of tooth surface = 1·18; minimum height over the surface of the tooth = 103 5.

Application of the Experimental Results.

The results of the foregoing experiments may be used to find the effect of slotting the armature on the reluctance of the air-gap. It is necessary to know this in order to calculate the ampere-turns, and there are two methods of considering the matter. First, when the armature is slotted the number of ampere-turns necessary to send the flux through the gap is determined by the maximum flux density under the teeth; the average flux density, however, is smaller than this maximum value, and the ratio of the maximum density to the mean density is the ratio of the number of ampere-turns necessary to send a given flux through the air-gap with a slotted armature, to the number of ampere-turns necessary to send the same flux through the same air-gap with a smooth armature. This ratio is a factor which Arnold calls k, and is a kind of contraction coefficient which enables the necessary ampere-turns to be at once calculated. For a smooth armature k_1 is, of course, equal to 1, and for all other cases is greater than 1.

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Arnold has given a curve showing how to find the value of this coefficient for all practical values of slot, gap, and tooth width. The factor k_1 is given as equal to $\frac{t_1}{z_1 + X\,\delta}$ where t_1 is the slot-pitch; z_1 is the tooth width at the circumference of the armature; X is a factor dependent on the ratio $\frac{\text{slot}}{\text{gap}}$, and δ is the length of the air-gap. The factor X was determined by drawing the lines of force between the armature teeth and pole surfaces for various proportions of slot, gap, and tooth width. The lines of force are drawn by trial so that the total flux as measured from the drawing has a maximum value. By this means a curve was obtained showing the relationship of X to $\frac{\text{slot}}{\text{gap}}$. This curve is reproduced in Fig. 14.

From the experimental results given in the first part of this paper it is easy to deduce the values of X for different values of the ratio $\frac{\text{slot}}{\text{gap}}$, for k_1 can be obtained from the figures already given. Thus

$$k_1 = \frac{\text{maximum flux density in air-gap}}{\text{mean flux density in air-gap}}.$$

It must be remembered that the maximum flux density in the air-gap is to be taken as the mean of the flux density at the middle of the surface of a tooth and the maximum flux density at the surface of the armature just opposite. For, as was pointed out above, the flux density at the middle of the tooth face is, in general, higher than at a point on the

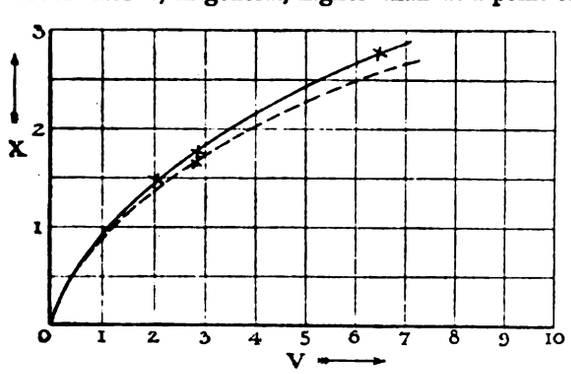

FIG. 14.

The Full-line Curve shows the Values obtained Experimentally.
The Dotted Curve shows the Values as given by Arnold

pole surface just opposite, especially if the gap is large compared with the slot width. All the factors, except X, in the expression $k_1 = \frac{t_1}{z_1 + X\,.\,\delta}$ are thus known. In Table I. the values of the ratio of slot to gap and the values of k_1 obtained from the curves are given. In the third column the corresponding values deduced for X are to be found.

TABLE I.—In this table the "equivalent" slots have been used to find the ratio $\frac{\text{slot}}{\text{gap}}$—*i.e.*, the slot width has been taken as equal to the distance between the minimum ordinates in the curves of flux distribution on the smooth face of the pole-piece.

Ratio $\frac{\text{slot}}{\text{gap}}$.	k_1.	X.	
1·99	1·15	1·49	From Figs. 10 and 11.
2·05	1·18	1·43	
2·05	1·15	1·51	
2·05	1·11	1·59	
2·83	1·26	1·88	From Figs. 12 and 13.
2·93	1·26	1·88	
2·77	1·23	1·69	
2·83	1·22	1·60	
2·92	1·31	1·79	From Figs. 8 and 9.
2·83	1·28	1·61	
2·83	1·25	1·60	
2·83	1·24	1·59	
6·73	1·55	2·81	From Figs. 6 and 7.
6·10	1·37	2·70	
6·30	1·40	2·90	
6·70	1·35	2·78	

Thus each of the Figs. 6, 7, 8, 9, 10, 11, 12, 13 give a set of values for $\frac{\text{slot}}{\text{gap}}$ and X, and the means of the values for each set have been plotted as the full-line curve in Fig. 14, the ratio $\frac{\text{slot}}{\text{gap}}$ being denoted by V. It is seen from this curve and the corresponding curve for the values as deduced from pictures of the lines of force that the experiments give slightly higher values for X than the graphical method; that is, the experimental values of k_1 are less, and, therefore, the reluctance of the air-gap is less.

Another method of taking account of the presence of slots in the armature and their effect on the reluctance of the air-gap is as follows: The total flux issuing from a tooth being known, the effective width of the tooth is taken as that width which would give the same flux if the density were constant and equal to the maximum density actually existent under a tooth, and the width of the pole is taken as equal to the number of teeth under the pole multiplied by the effective width of a tooth as given above. The amount of fringing from the flanks of the teeth as dependent on the proportions of slot, tooth, and gap was given by Carter as a coefficient. From the formula given by him a curve has been deduced showing how the amount, which must be added to the actual width of the tooth in order to get the ideal width, may be found for any practical value of the ratio of $\frac{\text{slot}}{\text{gap}}$. From the experimental results this effective width is found as follows: amount by which the actual width of the tooth is to be increased $= \frac{\text{area of flux curve}}{\text{maximum ordinate}}$ minus the tooth width, and $\Delta = \frac{\text{amount added}}{\text{slot}}$. In this way the values of Δ have been deduced for the various ratios of $\frac{\text{slot}}{\text{gap}}$. Thus:

$\frac{\text{Slot}}{\text{Gap}}$	Δ (Experiment).	Δ (Carter).
2·85	0·574	0·640
2·84	0·620	0·640
2·03	0·730	0·712
6·45	0·458	0·435
0·0	—	1·000

APPLICATION TO INDUCTION MOTORS.

When both the stator and rotor are slotted, as in an induction motor, the flux distribution curve for the air-gap becomes very complex, and, moreover, changes its shape as we proceed from the stator surface across the gap to the rotor surface. Further, the curve of flux distribution on the stator periphery has a period of pulsation corresponding to the movement of the rotor over a distance equal to the pitch of the rotor teeth, and the curve of flux distribution on the rotor periphery has a period of pulsation corresponding to the movement of the rotor over a distance equal to the pitch of the stator teeth.

In order to draw the flux distribution curve on the periphery of either the stator or the rotor the following may be considered: Suppose it is desired to find the flux distribution over the periphery of the stator. First imagine that the stator has a smooth surface; we can then draw the flux distribution curve on the surface due to the slotted rotor (Curve I., Fig. 15). The method of drawing curves of flux distribution has been already indicated, and an examination of the various curves given will be of assistance as a general guide as to the shape of the curves for any given proportions of slots, teeth, and gap. After a little practice these curves of flux distribution can be drawn with considerable rapidity. Next, suppose that the rotor has a smooth surface and the stator is slotted; we can then draw the flux distribution curve on the surface of stator teeth from the results of the experiments previously described. This curve is shown in Fig. 15 as Curve II. Now take the actual case in which both the stator and rotor are slotted, then the actual curve of flux distribution on the stator surface will be found from a combination of the two curves. Thus, in Fig. 15 the ordinates of Curve I. are to be reduced in the ratio of the corresponding ordinate of Curve II. to the value the flux density would have if both stator and rotor were smooth. In this manner the resultant Curve III. has been deduced from Curves I. and II.—*i.e.*, the ordinates of Curve III. are equal to the corresponding ordinates of Curve I. multiplied by the ratio of the corresponding ordinates of Curve II. to the height of the horizontal line,

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which gives the constant density which would exist in the air-gap if both stator and rotor had smooth cores. This horizontal line touches the peaks of Curve I. Curve III. only holds for the relative position of stator and rotor teeth shown, and the curve will vary in shape as the rotor surface moves through a distance equal to the pitch of the stator teeth. The corresponding curve for the flux distribution over the periphery of the rotor may be found in a similar way. It has been assumed in the above that the magneto-motive force is constant at all points of the air-gap. For any given curve of magneto-motive force a simple modification must be introduced.

In order to find the reluctance of the air-gap in induction motors, we may say that if the reluctance is unity when the rotor and stator surfaces are smooth, suppose k_1 is the coefficient when the rotor alone has slots—*i.e.*, the reluctance of the gap with slotted rotor and smooth stator is k_1. Suppose, further, the gap coefficient to be k_2 when the stator is slotted and the rotor has a smooth surface. Then the reluctance of the gap when the stator and rotor are both slotted will be given without any great error by the product $k_1 k_2$. Now k_1 and k_2 can be found by the method previously described, from the dimensions of the teeth, slots, and air-gap, and, therefore, the reluctance of the gap can be at once determined.

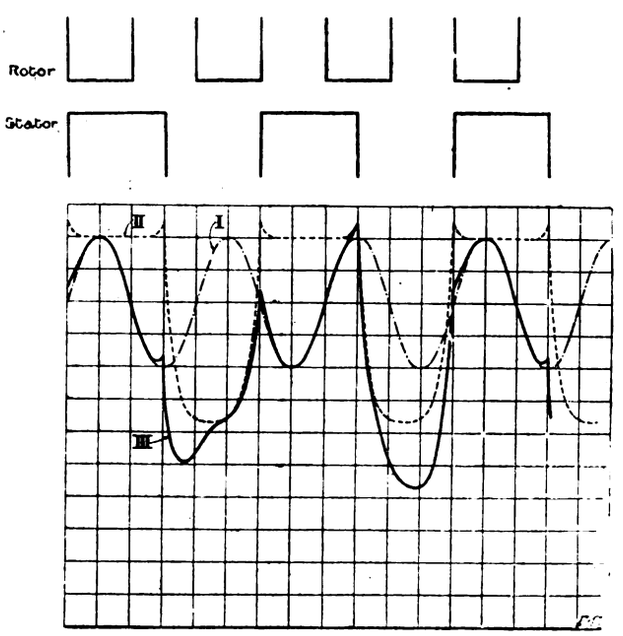

FIG. 15.—Showing Flux Distribution at the Periphery of the Stator.

In conclusion, the author would like to express his appreciation of the facilities placed at his disposal for this work by Prof. E. Arnold; for the valuable advice given and the interest shown in the experiments by Prof. Bragstad; and, further, to acknowledge Dr. Kloss's kindness in critically reading the paper through.

FALLACIES CONCERNING BOILER COMPOSITIONS.

BY CENTRAL-STATION MAN.

One of the most extraordinary things about compositions for removing boiler scale is that every agent or representative who calls on the unsuspecting station man in order to dispose of a certain quantity of his particular valve seating destroyer has the only completely reliable composition in the market, and, if used in one's boiler, is calculated to remove scale in the twinkling of the eye, and the only thing that mars the enthusiastic happiness of the representative is the depravity of rival boiler composition agents who have the audacity to sell feeble imitations of his article which are absolutely no use. Buy the composition of Mr. A. Ananias, whose card has just been presented to you, and he will stake his reputation that his boiler composition will not only remove the existing scale, but will prevent it from ever appearing again.

So much for the mythical or fallacious side of the question. When one comes to practical facts, the experience of the writer is, after having experience with all classes of boilers and waters of all degrees of hardness and impurity, that boiler compositions are not worth the money one has to pay for them. Perhaps one need not go so far as to say that they are absolutely useless, but the good that they do never compensates for the cost. A solution to put into a boiler to remove by corrosion a hard scale must of necessity be used freely, and because it is thus used it must certainly damage the mountings and valves connected with the boiler. One is ever "between the devil and the deep blue sea," inasmuch as if the solution is so weak as not to affect brass or gunmetal when carried over with the steam it is not strong enough to eat away scale. The real solution of difficulties of this sort is proper attention to the boilers—that is to say, proper care must be taken to see that the feed water is free from grease and oil, that the necessary soda is used for the feed, and that the boiler is opened out and cleaned before the scale has the upper hand. With these reasonable precautions there is little need for any form of boiler composition.

The area along the basin of the River Medway is one of the most trying districts for boilers, because not only is the water very hard and highly charged with scale-forming ingredients, and as the district is the centre of the cement industry the feed waters are often charged with impurities from this source, yet in spite of these difficulties there are boilers working in that area without the use of any fluids or composition that keep free from serious scale troubles. As an illustration of the other side of the question, the writer has in his possession a piece of scale $\frac{7}{8}$in. thick from a boiler at Burton-on-Trent so hard that it takes a polish like marble, and this very boiler was dosed with every scale-removing imposture in creation.

The practice of putting fluids into a boiler after cleaning is as useless as putting them in before. Some people believe that paraffin will soften and remove scale. This is a most useless and dangerous thing to do, and the paraffin is likely to cause pitting on the plates along the water-line, and likely to produce highly explosive gases, which collect under the manhole covers and such like places in order to astonish the unfortunate boiler cleaners when they commence to open out the boiler.

It is remarkable that after so much has been written and said about the scientific treatment of feed waters, and the number of firms who are now prepared to elaborate apparatus for dealing with the feed before it gets anywhere near the boiler, there should still be recurrences of disastrous explosions due to heavy incrustations and inexperienced tampering with compositions. In course of time, perhaps by the process of the survival of the fittest, the rest of so-called mechanics who still believe in boiler compositions will be eliminated by more or less painful explosions, but in the meantime one can only keep pegging away at the elementary truth that boiler compositions are not safe and are costly.

FRANCO-BRITISH EXHIBITION.

The movement to organise a co-operative electrical exhibit at the Franco-British Exhibition, as between the electrical supply companies' committee of London and the electrical manufacturers, mentioned by us in a previous issue, is meeting with success. The undermentioned firms have expressed their willingness to take part in the scheme: Armorduct Company, Berry, Skinner, and Co., British Thomson-Houston, British Prometheus, British Westinghouse, Bertram Thomas, Crompton and Co., Dowsing Radiant Heat Company, Edison and Swan, Foster Arc Lamp Company, Huntalite Company, Imperial Lighting Company, Langdon-Davies Motor Company, Linolite Company, Marconi, Oliver Arc Lamp Company, Perfecta Seamless Tube Company, Robertson Electric Lamps Company, Simmonds Bros., Sun Electric Company, Union Electric Company.

Full details of the scheme are now being prepared, and we hope to publish them as soon as ready. In the meantime, we would urge upon any of our readers who are desirous of supporting the movement to communicate with Mr. C. S. Northcote, 2, Queen Anne's-gate, Westminster.

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B.T.H. PROGRESS IN 1907.

The British Thomson-Houston Company, of Rugby, have kindly furnished us with the following *résumé* of special work undertaken by the firm last year, which indicates the many businesses of which the electrical engineer requires to have expert knowledge. It is, of course, impossible for one man to be *au fait* in all these special trades, but the British Thomson-Houston Company have overcome the difficulty by appointing well-trained engineers as their representatives in each of the commercial centres of Great Britain. These gentlemen specialise in the particular industries in their district and give gratis valuable advice on any electrical problems to the customers of the firm. The following notes show how varied the requirements from the firm are.

Mold Collieries—A somewhat unique application of the electric motor is one 500-h.p. motor operating at the high speed of 1,450 r.p.m., designed for 500 volts, 50 cycles, three-phase, to be direct connected to a turbine pump which will operate against a head of approximately 600ft. In the same pump-house will be erected two 275-h.p. motors direct connected to slow-speed pumps running at 180 r.p.m., all supplied by the British Thomson-Houston Company.

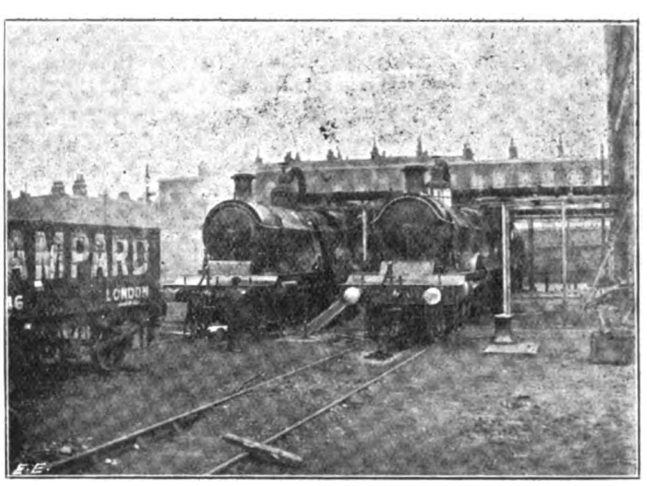
Moss Hall Coal Company.—A further interesting colliery equipment, the contract for which has been placed with the British Thomson-Houston Company, is that for the Moss Hall Company, which includes the complete electrical equipment of this company's Maypole and Lowhall pits, including the provision of the necessary equipment for a new generating station, which comprises two 350 kw. steam-driven generators, with the necessary switchboard, the whole of the cable work for the same, and a small lighting set of 40 kw. capacity. The equipment of the Maypole pits includes four sets of electrically-driven pumps, complete with the necessary switchgear, and the whole of the cable work, both on the surface and underground, together with all the overhead transmission line. The primary voltage is 3,000 volts, and the current three-phase 50 cycles. The equipment of the Lowhall pit, which will be operated from the same generating station, includes three sets of pumps of the horizontal three-throw type of large capacity, to which will be coupled three 135-h.p. motors, and three sets of haulage gear, together with the complete cable equipment, both surface and underground. The equipment of this colliery is particularly complete, and is one of the largest contracts for the equipment of a colliery that has been placed during the past year.

Dorman, Long, and Co., Limited.—Another very important contract which we understand has been placed with the British Thomson-Houston Company during the past year is the electrical equipment of a reversible cogging mill for Messrs. Dorman, Long, and Co., Limited, of Middlesbrough. This is the first electrical equipment of this nature that has been placed with a British firm. It involves the supply of very heavy electrical machinery, including the main mill motor, which has a continuous capacity of 1,200 h.p. and a maximum torque capacity up to 3,600 h.p., developing these powers at a speed of 70 r.p.m. This complete equipment marks one of the first steps in the application of electrical power in this country to the operation of the heavy machinery in steelworks. The smaller machines have been operated electrically for many years past, but it has always been considered, up to recent times, that anything of the nature of a heavy rolling-mill could best be operated by steam. It is interesting to note that this development indicates what has been consistently advocated by electrical engineers for many years past, that there is no practical limit to the application of electric power to any duty; the only condition to be considered is the commercial efficiency of the application in each case. It is of interest to note that electrically operated rolling-mills are expected by many steelworks experts to show an increased production in a given time over the older methods, the mill itself being so directly under the control of the operator.

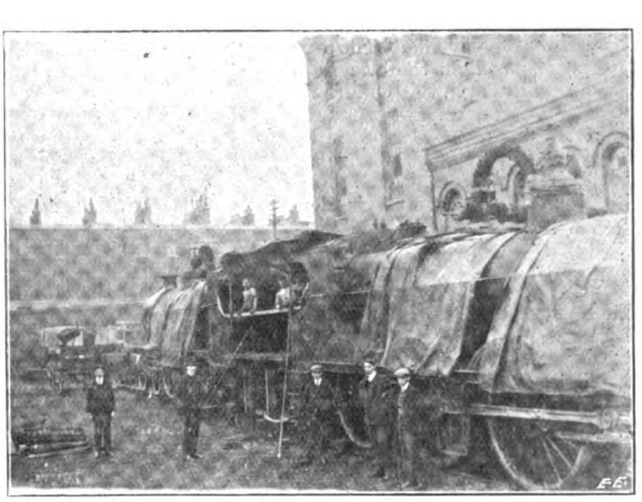
Textile Developments.—Another important development in the application of electrical power for industrial purposes is the advance that has been made in connection with the electrical operation of textile mills. The British Thomson-Houston Company have now installed upwards of 10,000 h.p. in motors in textile mills in the United Kingdom, and are at present engaged in the electrical equipment of a large mill in the Manchester district which involves the installation of upwards of 75 motors, varying in capacity from 7½ h.p. to 170 h.p. each. The British Thomson-Houston Company, who were among the pioneers of electric driving of textile mills in this country, have made a speciality of this class of work, and have installed the greater portion of the electrical equipments in the various mills in this country at present in operation.

GREAT CENTRAL RAILWAY ELECTRIC POWER-HOUSE, MARYLEBONE.

The accompanying photographs show a somewhat novel method of supplying steam to the electric power station



at Marylebone whilst the boilers were undergoing a course of cleaning. Four engines of the latest type were used,



the steam from which was forced through pipes affixed to the domes and connected with the engine-house.

THE ARTIFICIAL LIGHTING OF SCHOOLROOMS.

An important investigation concerning the illumination of classrooms was carried out by Mr. Bishop Harman for the Education Committee of the London County Council, the results of which are incorporated in the report of the medical officer (education) to the committee. Mr. Harman has furnished a report as to the best positions of the sources of light and the best distribution of the light, and has suggested simple improvements. Handiness, simplicity, and ease of distributing points of light, complete absence of shadows below the lamp, the possibility of perfect reflection, healthiness in freedom from consumption of air and production of fumes, and noiseless, he

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says, make lighting by the electric incandescent lamp the most perfect means now available for school use, the only drawback being its present greater cost, which worked out in 1905 at about 1·7 times that of gas.

The following experimental examination of the illumination given by a incandescent lamp under different shades will give an indication of the value of the light. A 16-c.p. lamp was used with 100 volts of the Strand Supply. The lamp was hanging in a room chosen for its convenience, and measurements made in a plane 4ft. below the level of the lamp :

Shade.	Below lamp.	One yard.	Two yards.	Three yards.	Four yards.
None	5 m.c.	...+3	...+1	... 1	... 1
110deg., 3½in. deep	20	... 9	... 5	... 3	... 1
80deg., 5in. deep	30	... 9	... 5	... 2	... 1

Two sorts of opal shades are in use in schools ; one subtends 110deg. in the sides, and has a vertical depth of 3½in. This shade does not cover the lamp, and the incandescent filament is exposed to the teacher's eyes. The other shade has sides subtending an angle of 80deg., and with a vertical depth of 5in. ; this shade completely screens the lamp from the teacher, and is the one to be preferred for classroom purposes, as the light below is also increased by one-third. These lamps throw an image of the filaments. If a sheet of white paper be held under the lamp at the distance of a yard, four bright stars, each with a bright tail outwards, will be seen marking the corners of a square of 1ft. side. At the distance of two yards the separation of the points is 2ft. The better the reflector over the lamp the less noticeable are these lines. Ground glass bulbs obscure the lamps completely, but frosting the glass reduces the illumination by 25 to 30 per cent. The only suggestion to be made as to bulbs is that these should be as large as possible, and the filament twisted in as long a loop as possible. Mr. Harman has also examined the tantalum and the Nernst lamps. The former appears very good, but the latter is unsuitable for schoolrooms.

With regard to the distribution of lamps, beginning at the left hand of the children's portion of the classroom, a lamp should be hung over the centre of the first dual desk, and from these across the breadth of the room at distances of not less than 6ft., and not more than 9ft. for 16-c.p. lamps with 90deg. shades. With gas the fewest possible number of burners is desirable, for the more burners the worse the atmosphere ; but with electricity the points of light may with advantage be more generally disposed, and a cross room spacing of 6ft. might be uniformly arranged. A second row of lamps should be hung in the same relation over the third row of desks. The lamps as usually hung err in being hung too far back ; for instance, over a back row of desks, with the idea of their illuminating the desks in front, which they, however, fail to do when the children are present in their seats. The use of a front row of lamps with tilting shades, to light the blackboard in the teachers' section of the room, or desks in the children's portion, fails to serve both purposes in practice. It would be better to use a lamp to illuminate the desk and blackboard, and completely shaded from the children's portion of the room. The most common complaint in electrically-lighted schools is want of light owing to low pressure in the supply. Sudden and total failure also occurs occasionally. In installing electric light it should be used in classrooms only. Staircases and passages should be lighted with gas, naked jets with wire frames.

Refraction and reflection in certain forms of shades have been much recommended in America for school use. The "Prismatic" and "Holophane" globes were examined. The "Prismatic" globe has the outer surface of a glass bowl moulded into a series of prisms running round the bowl, and so placed as to throw light downwards. It is very effective, especially when a flattened opal shade closes the mouth of the bowl. The combination is costly and heavy, and an equally good effect can be obtained with the 90deg. shade bowl. Indirect illumination by reflection is now a very favourite method in the newer German schools. By this method powerful lights, usually arc lamps, are hung from the ceiling with metal reflectors below them ; the light is thrown on to the white ceiling or to special reflectors, and reflected as a delightfully uniform and soft radiance over the whole room. The effect is not unlike daylight of modified brilliance, and it is most successfully employed in shops and showrooms, where the deep shadows of direct light would be destructive of the general effects of mass and colour required to be shown. It is, however, not good where continuous and detailed work at a desk is required. The system was adopted in the new anatomical laboratories of Cambridge University, but has had to be superseded by direct incandescent lamp illumination.

With the increase of evening continuation schools the lighting of the gateways and entrances of the schools becomes a matter of importance. At present the precincts of a school at night are generally the darkest part of a street, and the dark exterior is scarcely a fair indication of the light that shines within

FORTHCOMING EVENTS.

FRIDAY, JAN. 10.

Electro-Harmonic Society.—At 8 p.m., smoking concert in the King's Hall, Holborn Restaurant.

Institution of Civil Engineers (Yorkshire Students).—At 7.30 p.m., at Philosophical Hall, Leeds, "Some Aspects of High-Tension Electric Transmission Schemes," by Mr. E. H. Crapper.

Institution of Civil Engineers (London Students).—At 8 p.m., at Great George-street, S.W., "The Principles of Engineering Geology," by Dr. H. Lapworth (Lecture I.).

SATURDAY, JAN. 11.

Institution of Electrical Engineers (Manchester Students' Section).—Visit to works of Messrs. Craven Bros., Limited.

Junior Institution of Engineers.—At 3 p.m., visit to the London County Council tramway reconstruction work in South Lambeth-road, and motor school, car-shed, and sub-station at Clapham.

Rugby Engineering Society.—Visit to Franco-British Exhibition buildings at Shepherd's Bush ; leave Rugby at 12.42 p.m.

Liverpool and District Electrical Association.—Visit to Lister-drive power station, 3 p.m.

MONDAY, JAN. 13.

Institution of Electrical Engineers (Newcastle Local Section). At 8 p.m., at Armstrong College, "Electrical Power in Railway Goods Warehouses," by Mr. H. Henderson.

Institution of Mechanical Engineers (Graduates' Section).—At 8 p.m., "The Manufacture of Constructional Steelwork," by Mr. A. J. Aitken.

Dick-Kerr Engineering Society.—At 8 p.m., "Electric Lighting of Railway Trains," by Mr. H. A. Cox.

TUESDAY, JAN. 14.

Institution of Electrical Engineers (Manchester Local Section). At 7.30 p.m., at the Physical Laboratory of the University, "Magnetic Oscillations in Alternators," by Mr. J. W. Worrall.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., at Municipal School of Technology, Whitworth-street, "Starters and Control Gear," by Mr. P. C. Jones.

Institution of Electrical Engineers (Glasgow Local Section).—At 8 p.m., at 207, Bath-street, "Cost of Power for Industrial Purposes," by Mr. J. F. C. Snell.

Institution of Civil Engineers.—At 8 p.m., at Great George-street, discussion of papers on "Keyham Dockyard Extension."

Manchester Geological and Mining Society.—At 4 p.m., at Queen's-chambers, 5, John Dalton-street, discussion on following papers : "By-Products from Coke Ovens," by Mr. W. H. Coleman ; "A By-Product Coking Plant at Clay Cross," by Mr. W. B. M. Jackson ; "Notes on By-Product Coke Ovens, with special reference to the Koppers Oven," by Mr. A. Victor Kochs.

Liverpool and District Electrical Association.—At 8 p.m., at the Common Hall, "Fuel Economy in Steam Generating Plants," by Mr. J. Greenhalgh.

WEDNESDAY, JAN. 15.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., at 92, Victoria-street, "Electrification of Mansfield Copper Mines," by Mr. H. R. Speyer.

Royal Meteorological Society.—At 7.30 p.m., Institution of Civil Engineers, "Map Studies of Rainfall," by Dr. H. R. Mill.

THURSDAY, JAN. 16.

Optical Society.—At 8 p.m., at 20, Hanover-square, W., "The Relative Value of Parts in Spectacle Frame Manufacture," by Mr. H. L. Taylor.

FRIDAY, JAN. 17.

Royal Institution of Great Britain.—At 9 p.m., at Albemarle-street, Piccadilly, W., "The Centenary of Davy's Discovery of the Metals of the Alkalis," by Prof. T. E. Thorpe.

Institution of Civil Engineers (Students' Section).—At 8 p.m., "The Principles of Engineering Geology," by Dr. Herbert Lapworth (Lecture II.).

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate, St. James's Park, S.W., "Third Report to the Gas-Engine Research Committee," Prof. T. W. Burstall.

SATURDAY, JAN. 18.

Royal Institution of Great Britain.—At 3 p.m., "The Electrification of Railways," by Prof. Gisbert Kapp (Lecture I.).

Birmingham and District Electric Club.—At 7 p.m., at Colonnade Hotel, New-street, presidential address by Mr. E. C. R. Marks.

Institution of Electrical Engineers (Students' Section).—At 10 a.m., visit to Elliot Bros.' works.

APPOINTMENTS VACANT.

Junior Assistant, Ipswich Corporation Electric Supply and Tramways Departments. Applications to Chief Engineer by Jan. 11.

Assistant Rolling-Stock Superintendent, London County Council Tramway Department. Salary, £250 per annum. Applications to Mr. G. L. Gomme, clerk, County Hall, Spring-gardens, S.W., by Jan. 13. See advertisement in last issue.

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NOTES.

Royal Institution.—On Tuesday next, Jan. 14, at 3 o'clock, Dr. A. A. Gray delivers the first of two lectures at the Royal Institution on the "Internal Ear of Different Animals"; on Thursday, Jan. 16, Prof. W. W. Watts will deliver a lecture on "The Building of Britain"; on Saturday, Jan. 18, Prof. Gisbert Kapp commences a course of two lectures on "The Electrification of Railways." The Friday evening discourse on Jan. 17 will be delivered by Prof. T. E. Thorpe on "The Centenary of Davy's Discovery of the Metals of the Alkalis"; and on Jan. 24 by Colonel David Bruce on "The Extinction of Malta Fever."

Electrically v. Hydraulically Operated Cranes. These two types of cranes are compared as follows by M. Gasquet in a recent number of *Genie Civil*: The electrical crane does not require such skilled attention as the hydraulic one. The latter, however, allows the finer adjustment to be obtained. Electrical mains are more easily laid and maintained than water-mains, although neither involves much trouble as regards upkeep. Hydraulic cranes are not suitable for cold, exposed positions, because of the danger of damage through frost. The theoretical efficiency at full load is given as 58·2 per cent. for hydraulic and as 56·6 per cent. for electrical cranes. The power consumption is, however, less dependent on the load in hydraulic than in electrical cranes. The average power of a hydraulic crane is ·155 kilowatt-hour per ton, and of an electrical one ·14 kilowatt-hour per ton. The initial cost is greater in the electrical case, but is less important if a central station already exists or if the electrical power is required for other purposes as well. The writer recommends electrical cranes for new installations.

Association of Engineers-in-Charge.—An engineering society can scarcely be said to have reached its full sphere of usefulness without making it possible for its members to consult technical literature, hence the fact that one of the features of such a society is its reference library. The Association of Engineers-in-Charge propose to place themselves ahead of usual practice in this respect, however, by forming a lending library in connection with the association, so that members may be able to borrow books, etc., connected with engineering. Through the instrumentality of Mr. A. E. Penn, chairman of the Educational Committee, the association have agreed with the governors of St. Bride's Institute upon a scheme that will enable the association to receive any books which may be forwarded by their patron-authors and supporters, and whilst such books will be placed under the control of the institute librarian for the use of members, and subject to the existing rules and regulations, they will still be the property of the association. Moreover, the governors of St. Bride's Institute have promised (so far as possible) to add to their library any books dealing with engineering subjects that may be suggested by members of the association, and the result of this co-operation between the two bodies should result in a considerable increase in the number of engineering books in this useful library, while it should at the same time enhance the educational advantages to be derived from the institute.

Parent Substance of Radium.—An interesting account of a series of investigations carried out by Otto Hahn regarding the substance from which radium was directly derived appears in the latest volume of the *Journal* of the Chemical Society. Old specimens of commercially pure thorium nitrate were found to contain relatively large quantities of radium, and the fact that a sample of this salt, nine years old, contained about 100 times more radium than a freshly prepared sample obtained from the same firm led to the conclusion that there is present in the pure commercial thorium nitrate the substance from which radium is derived directly. That this supposition is correct follows from the fact that the quantity of radium in a solution of recently prepared pure commercial thorium nitrate increased considerably when kept for about six months. An acidified solution of the salt was treated with oxalic acid, and the quantity of radium present in the filtrate estimated. Since this did not increase on keeping, it follows that the parent substance of radium is precipitated by the oxalic acid. This is in accord with Boltwood's statement, that the parent substance of radium, named by him "ionium," is an element which reacts like thorium. From a consideration of the quantities present in samples of thorium nitrate of various ages, Hahn calculates the disintegration constant of radium to be, roughly, 3,000 years. This is of the same order of magnitude as the value arrived at by Rutherford, and differs considerably from the value obtained by Rutherford and Cameron.

Finsbury Technical College. — The Finsbury Technical College Old Students' Association have now a publication of their own, and in the first number of the association magazine we welcome a promising addition to the list of periodicals published in connection with the various technical colleges. The first number opens with a note from the editor, Mr. W. J. Tennant, in which he expresses the opinion that there is in the old students of the college a body of men sufficiently capable of maintaining the work of the association in general and the magazine in particular. There is an instalment of an article on "Boilers," and other articles on "The Unguided Student," "What should constitute an Assistant Engineer's Training," "The Older Men at Finsbury," etc. Throughout the volume are scattered numerous notes, some personal and others of a diverting character. Prof. Perry is among those who send greetings to the magazine, to which we offer our best wishes.—The dance held under the auspices of the Old Students' Association on Feb. 9 last was so well appreciated that the council are arranging another to be held in the present season, at the Caxton Hall, Westminster, on Saturday, Feb. 15, at 6.30 p.m. Applicants for tickets should communicate with one or other of the following gentlemen: Mr. E. W. Moss (hon. secretary, electrical section), 20, Huddleston-road, Tuffnell-park, N.; Mr. S. E. Gritton (hon. secretary, mechanical section), Talfourd Cottage, Reigate, Surrey; Mr. F. H. Carr (hon secretary, chemical section), Kelvin. Church-avenue, Sidcup.

Electric Nursing Outfit.—We understand from a correspondent in New York that he has been made acquainted with a very convenient arrangement, instituted by the Edison Lighting Company, whereby electrical nursing outfits may be obtained on hire for any period covering a patient's illness, and owing to the reasonable rate at which these can be obtained the system is being taken up by professional nurses practising within the area of supply. The outfit consists of an electric fan for purifying and ventilating the sickroom, provided with a plug attachment for fitting to the ordinary lampholder. A portable lampstand is arranged so as to be available for lighting the bedside, and which is equipped either with an ordinary incandescent lamp or with a turn-down lamp. This latter arrangement provides for giving a dull light during the night watches, and can be instantly transformed into a bright light in case of need at a moment's notice. A large and a small electric heating pad are also provided for warming the bed, these taking the place of the ordinary water-bottle, which is likely to develop leaks. For cooking

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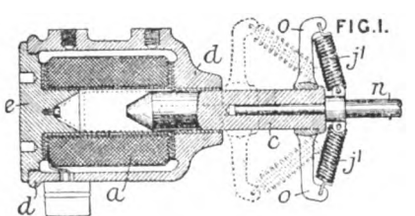
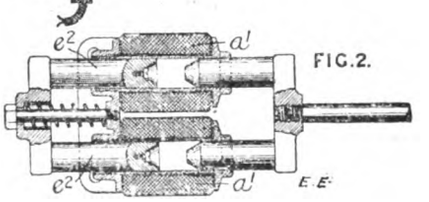
light dishes for invalid consumption a small electric stove is included in the outfit, and for heating milk and other liquids a small electric milk warmer is provided. The necessary flexible leads and plug adaptors for connecting the outfit to the existing installation are also provided. The whole of this outfit is securely packed in a strong box, and is sent out on the call of any physician who requires this outfit for any case which he is attending. This idea seems worth the consideration of electric supply authorities operating on this side of the water.

Iron and Steel Institute.—We are able to announce that a research scholarship or scholarships, of such value as may appear expedient to the council of the Iron and Steel Institute, from time to time founded by Mr. Andrew Carnegie (past-president), who has presented to the Iron and Steel Institute 89 1,000dol. 5 per cent. debenture bonds for the purpose, will be awarded annually, irrespective of sex or nationality, on the recommendation of the council of the institute. Candidates, who must be under 35 years of age, must apply on a special form before the end of February to the secretary of the institute. The object of this scheme of scholarships is not to facilitate ordinary collegiate studies, but to enable students who have passed through a college curriculum, or have been trained in industrial establishments, to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. There is no restriction as to the place of research which may be selected, whether university, technical school, or works, provided it be properly equipped for the prosecution of metallurgical investigations. The appointment to a scholarship shall be for one year, but the council may at their discretion renew the scholarship for a further period instead of proceeding to a new election. The results of the research shall be communicated to the Iron and Steel Institute in the form of a paper to be submitted to the annual general meeting of members, and if the council consider the paper to be of sufficient merit, the Andrew Carnegie gold medal shall be awarded to its author. Should the paper in any year not be of sufficient merit, the medal will not be awarded in that year.

Australian Post Office and Line Insulators.—One of the most important items in the export of electrical goods from this country to Australia is the supply of line insulators for the Government telegraph and telephone departments. The demand for this article is of great dimensions, and in the past has been met principally by British manufacturers. But there are clear indications that we are not to be allowed to have it all our own way in the matter, and that an attempt is to be made to satisfy future requirements with home-made goods. No one can blame the Commonwealth Government for offering substantial inducements to manufacturers in their own country with a view to developing the home industry; still less can the same manufacturers be blamed for accepting the inducements thus offered, which provides free scope for the play of capital and enterprise under the protecting wing of the Government. From an Australian friend we learn that, in order to encourage Australian pottery-makers to embark in the business of making insulators for Government telephone and telegraph lines, the Postmaster-General has decided to extend the contract which he recently threw open to them. Tenders are now invited for no fewer than 100,000 Australian-made insulators. This action is greatly appreciated by the manufacturers, who feared to embark on the purchase of special plant for so small an order as was at first made available—viz., 10,000 insulators. Particulars are also to hand giving estimates of the number of insulators to be required during the current year. The total quantity of large porcelain is 183,666, and the price of the last supplies ranged from 4¼d. each in Queensland to 5¼d. in Tasmania. Of the small variety it is estimated that about 387,250 will be wanted, and the price last paid varied from $1\frac{4}{5}\frac{1}{0}$d. to $2\frac{7}{1}\frac{}{0}$d. About 27,000 button insulators will also be required, last prices ranging from 0·625d. to 1·25d. each. It is estimated that the cost of machinery and plant necessary to enter on the manufacture of insulators in the Commonwealth will be from £5,000, according to the output of the kilns. It is, however, understood that there are certain firms in Australia which already have the necessary facilities for making insulators, with very little, if any, new expenditure on plant.

Electromagnets.—In a patent recently granted to Messrs. Belliss and Morcom and relating to the above, the armature of an electromagnet is connected through a spring, etc., to a member for operating railway points and signals, for starting and stopping an engine, or for opening a valve to admit air to a condenser, this connection allowing the armature to apply an impulsive stroke to the member. The solenoid winding, *a*, is mounted in a casing, *d*, the armature, *c*, being guided into the electromagnet through a lined opening in this casing. At the other end of the electromagnet a pole-piece, *e*, serves to further attract the armature, a stud of non-magnetic material





preventing contact. To a cross-head, *o*, carried on the armature, springs, j^1, are pivoted, and complete the connection to the operating member, *n*. Alternative arrangements of spring connection may be used. A duplicate electromagnet (Fig. 2) wound so that the two bobbins, a^1, from opposite poles, may be employed in connection with a duplicate armature, both bobbins carrying pole-pieces, e^2 at their other extremities. The magnetic circuit is completed in the case of armature and electromagnet by magnetic material. The pole-pieces may be fixed to the electromagnets or mounted on a carrier, which, controlled by a spring, allows them to enter into the electromagnets and further strengthen the attraction on the armature.

Copper.—Writers have been busy during the past few days raking up the ashes of the dead year. Numerous reviews have appeared in which the various sections of the engineering trade and industry have been critically inquired into, and the general lessons to be drawn from all is one of hopefulness for 1908. One of the most important of the raw materials used in the electrical industries is copper, and the vagarious course of the markets during the past 18 months has been followed with keen interest by electrical engineers. The scarcity of copper in the early months of 1907 caused prices to advance to record figures during the memory of dealers in the article. Attention was directed, therefore, towards the question of substituting aluminium for copper for certain purposes, and one important firm went so far as to announce that they were undertaking the supply of aluminium cables for commercial

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purposes. At the same time manufacturers, spared no effort in replenishing their copper stocks with old copper that would otherwise have found its way to the scrap heap, and we know of one company who set to work to have their old and useless cable stripped, and in a short space of time recovered copper the value of which ran into four figures. During the summer months the copper markets became considerably relieved, though not to the extent that buyers desired. At the present time the outlook is not particularly brilliant, if we may judge from the symptoms indicated in the annual trade review of Messrs. Bolling and Lowe. True, the stocks formerly held in America have been, to a very large extent, realised in Europe, mainly for the purpose of procuring gold, but there are large invisible stocks of copper now in the hands of dealers and others on this side of the Atlantic, and these being in existence at a time when trade everywhere shows signs of severe retrogression is by no means an encouraging factor. On the other hand, the chief American producers, in order, so far as possible, to adjust their position, have made drastic curtailments of output, particular in their Montana Mines, while the wholesale discharge of employés in such important copper camps as those of Mexico and Australia may have a stimulating effect upon prices when to day's accumulation is substantially eaten into by the actual demands of consumers. In attempting to look ahead it must not be forgotten, however, that somewhere in the neighbourhood of £65 per ton for refined copper is a very fair price over a long average of years.

Birmingham Tramway Accident.—In another column we give a *résumé* of Colonel Yorke's report to the Board of Trade giving the result of his inquiry into the accident that occurred on the Birmingham Corporation tramways in October last. The immediate cause of the accident is ascribed by Colonel Yorke to the man in charge of the car at the time, who happened to be an inspector. The latter had been informed by the driver that the magnetic track brake was defective, yet in despite of this warning he took it upon himself to experiment with the brake on a steep gradient, the end of which was rounded by sharp curves. The duty of the inspector after being informed by the driver that the brake was not working satisfactorily was clearly to order the car to be returned to the depôt, and in failing to do so he showed a woeful lack of judgment. Moreover, his action was entirely contrary to the rules made by the Corporation, which strictly forbids motormen taking the risk of running a car which is not under proper control. This apart, however, there is one question to which it would be very useful to have a definite answer, but which can scarcely be said to have been satisfactorily answered. That is the question of the failure of the magnetic track brake to act. A broken "grid" in the fourth resistance box on the car is said to be the cause. The theory of Mr. Hill, the Corporation tramways electrical engineer, is that the pressure of current for driving purposes would be sufficiently great to bridge the gap formed by the fracture, whereas, in the initial stages of braking, current generated by the motors acting as generators would have a low pressure, and would not be able to overcome the interruption in the circuit. This theory, however, is hardly borne out by Mr. Trotter's experiments, which showed quite clearly that a current of 10 amperes (which is probably less than the usual current passing when cars are starting from rest) is sufficient to cause fusing to take place between the two opposing ends of the fracture, and between the sides of the broken and adjacent members of the grid. No such signs of fusing were, however, discernible in this case, states Colonel Yorke, consequently it is difficult to explain the failure of the brake. The Board of Trade inquiry has not thrown any light on the cause of the failure, but it has made it abundantly clear that the accident need not have occurred and lives need not have been sacrificed had the man who was in charge of the car at the moment only obeyed the rules laid down by the Corporation.

Steel Conduit Wiring.—It may be taken that the rapid increase during the past few years in the use of steel conduits for electric wiring purposes shows the growing favour with which this system is regarded for installing electric wires for lighting and power purposes. But old practices die hard, and there is still a wide use of wood casing in installation work. That system has its advantages, chief among which is that of cheapness. But, on the other hand, the numerous disadvantages attendant upon its use, which increase fire and other risks, render its economy in many cases rather questionable, and render it advisable to use a more solid protection for the wiring. No very great purpose could be served in again discussing the relative merits of the various systems of wiring in vogue, which must be left to the test of experience. In this respect the attitude of the fire insurance companies serves as a very fair guide, and the opinions held among them seem to be unanimous in favour of conduit wiring with suitable accessories, the adoption of which is advocated on the grounds of safety and efficiency. One of the leading authorities on installation work that we have in this country, Mr. Lester Taylor, who, as electrical adviser to two of the largest fire insurance offices, has an experience extending over the greater part of the United Kingdom, recently paid a glowing tribute to the conduit wiring system. He instanced a recent case where fire office advice was sought in respect to a building of great historic interest, and a Simplex heavy screwed conduit system was suggested by them to the authorities, as furnishing the greatest degree of security, notwithstanding that in the case referred to obviously initial cost was not the primary consideration. With the advent of a practicable wire filament lamp with an efficiency which brings electric lighting directly to gas prices, we want more than ever cheap but reasonably good wiring methods, so that poorer electricity consumers can be reached by the electric supply people. This once more brings forward the usefulness of the open-seam conduit, and its use is to be welcomed as extending the use of electric lighting, and at the same time reducing the fire risk as compared with gas or any other form of artificial lighting. The points which have influenced Mr. Taylor in favour of the open-seam system are the simplicity of the system and the great advantages of the socket joint accompanying it, together with the confirmation of its reasonable security (even with very ordinary qualities of insulated wiring). The system is already recognised by being standardised by the Engineering Standards Committee.

New Publications. — Among the many annual publications that make their appearance about this time of the year, there are few that can surpass "The Science Year-Book," ably edited by Major B. F. S. Baden-Powell. Messrs. King, Sell, and Olding, Limited, 27, Chancery-lane, W.C., have just published at 5s. net the 1908 issue, which includes the usual astronomical, physical, and chemical tables (thoroughly revised and brought up to date by the incorporation of much new matter), summary of progress in science, directory, biographies, and spacious diary. The general science summary for 1907 deals with astronomy, bacteriology, physics, etc. In the physics sections a great amount of work has been done. The year has witnessed controversies upon various points that have engaged the attention of physicists for many years.

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Chief among the controversies has been the unending one on the structure of the atom and the relevancy of atomic and electrotonic theories to the phenomena of radio-activity. An account is also given of the experiments of Sir William Ramsay with radium emanations.—The *American Physical Review* in its December issue contains the following among other contributions: "Spectrophotometry of Normal and Colour-Blind Eyes," F. L. Tufts; "General Law for Vapour Pressures—II.," Sandford A Moss; "On the Density, Electrical Conductivity, and Viscosity of Fused Salts and their Mixtures—I.," H. M. Goodwin and R. D. Mailey; "The Vapour Pressure of Carbonic Acid," John Zeleny; "A Transportable Form of Standard Cell," R. E Dulury; "A Device for Preventing Bumping in the Mercury Air-Pump," R. E. Dulury.—Included among the contents of the December issue of the *Journal* of the Chemical Society (London: Gurney and Jackson, 10, Paternoster-row) is a communication relating to the "Electrolytic Preparation of Disulphides," by Thomas Slater Price and Douglas Frank Twiss.—There has come to hand a booklet in which is described the "Electrical Distribution System for the Town of Grenoble," by M. F. Jenny, the municipal electrical engineer. The system was described at a convention held by the Société pour le développement de l'Enseignement technique près l'Université de Grenoble. It is published by Gratier and Rey, 23, Rue Grande, Grenoble.—The current month's issue of the *Faraday House Journal*, the organ of the Electrical Standardising, Testing, and Training Institution, contains some interesting articles, including some on "Modern Sub-Station Working," "Notes on Turbo-Alternators," and "Boiler-House Efficiency," contributed by Faradians.

Electric Mine Haulage at Eisleben. — Electric haulage on the Illgner system is installed in a pit 3¾ miles from the generating station, which contains two three-phase gas dynamos of 850 kw. each at 3,000 volts, 50 ~. The supply is carried by two cables of 3 × 70 square millimetres section each. The pit depth is 1,080ft, and the loads when dealing with material are 4,900lb. at a maximum speed of 33ft., and when dealing with passengers they are 2,700lb. at a maximum speed of 21ft. From 1,200 to 1,400 wagons have to be forwarded in seven hours. Four wagons at a time are lifted mechanically (hydraulically) into the cage, which is raised by means of a 1¾in. rope working on a 16ft. 6in. drum. At the two sides of the latter are braking flanges, against which four brake checks press. The shaft (14in.) runs in two bearings, and is connected by means of a flanged coupling to the motor spindle resting in a third outer bearing. The motor has to develop between 380 h.p. and 585 h p. at a speed of 38·5 r.p m. It is a 12-pole motor with 12 commutating poles (connected in parallel and excited in series with the armature). This motor receives current from a converter set, consisting of a 300-h.p. motor connected by flexible coupling to the dynamo spindle. The flywheel (1½ tons and 12ft. in diameter) is arranged between the two machines, and runs in two ball bearings. The starting dynamo (also fitted with commutating poles) and the haulage motor are excited from two 33-kw., 220-volt, three phase, direct-current motor-generators with compound winding. The starting dynamo can give up to 480 volts (direct current). A small (30-kw.) dynamo, belt driven from the starting dynamo, can supply the exciting current in the absence of any supply from the generating station. Regulation is carried out by the well-known Ward Leonard arrangement by means of a separate regulating apparatus. The compressed air (six atmospheres) for the brake is supplied by a separate three-phase 500-volt compressor. There is also a safety brake with automatic release in case the excitation fails. With the safety brake is interlocked the emergency switch which opens the exciting circuit as soon as the brake operates. A liquid resistance slip-regulator is inserted in the three-phase rotor circuit to keep the load constant. The cost of the installation (including erection, but excluding the cables) was £8,500. The energy consumption, based on six months' operation, is 1·55 kilowatt-hours per horse-power hour on the rope, and the cost of this energy is: for 10 per cent. interest and amortisation, ·372d.; cost of current, ·484d.; attendance, upkeep, cleaning, and lubricating material, ·24d.—total, 1·096d. A fuller account of the foregoing appeared in our contemporary *Elektrotechnik und Maschinenbau* recently.

New Acts in Force in 1908.—During the past year certain Acts of Parliament of no small importance to the engineering world were passed, several of which came into force on the 1st inst., while others do not take effect until later in the year. The Patents and Designs Act came into force on the 1st inst., and as electrical engineers form a considerable proportion of the applicants for patents in the United Kingdom, a *résumé* of the Act passed in the last session of Parliament should interest them a great deal. The new Act transfers from the Judicial Committee to the High Court jurisdiction in respect of revocation and compulsory licences, the Lord Chancellor being empowered to name a judge to deal with appeals from the Comptroller. The system of investigation into originality is extended so as to deal with specifications published after the application which leads to investigation, and the grounds of opposition are also extended so as to include claims in a complete specification for a British patent prior in date by not more than 50 years to the application challenged, and questions of the sufficiency or fairness of description of the invention or the mode of performing it. Within two years the Comptroller is empowered to revoke a patent on any of the grounds of opposition. The Comptroller is empowered to revoke patents not adequately worked in Great Britain, but application for revocation must be lodged within a prescribed time. In regard to compulsory licences, the definition of "reasonable requirements of the public" is extended so as to require reasonable prices. Section 39 overrides conditions to sales, leases, or licences prohibiting the user of articles patented or not supplied or owned by persons other than the seller, or requiring purchasers to acquire from the seller articles not protected by the patent, as being in restraint of trade and contrary to the policy of the law. The clauses relating to designs extend the term of copyright protection to 15 years by optional renewals, and provide that the omission to mark articles bearing the registered design shall not involve loss of the entire copyright, but only stop the remedy by way of penalties or damages in the absence of other notice to the infringer. An important feature of the new Act is that failure to manufacture mainly within the United Kingdom will be a ground for application for cancellation, and a ground of defence to any action for infringement. A great change in commercial law is brought about by the Limited Partnerships Act Heretofore, when two or more persons combined in business have desired to limit their liability to a fixed amount, their only resort has been to the formation of a limited liability company. It has not been permissible for a single partner to limit his liability. By this Act he is able to do so under certain restrictions. Among the other Acts that came into force at the beginning of the year we may mention the Lights on Vehicles Act, the Factory and Workshops Act, and the Companies' Act, neither of which are of especial importance to electrical engineers to require treatment here.

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CORRESPONDENCE.

"One man's word is no man's word.
Justice needs that both be heard."

THE RAILWAY CRISIS.

SIR,—Owing to the holidays I find that I have two articles of the "Writer" to deal with, and as it will be more convenient to controvert the second in order to show the fallacy of the first, I will answer them in that order:

1. The shareholder and his rights: "Writer" gives an ideal case, and as it is fairly typical and will serve to illustrate my views, I will repeat its chief points. He assumes he is a farmer with capital employing 20 men. He makes or buys a machine which enables 10 men to do as much work as the 20 did, and he employs the other 10 on similar work to that which they did before. The result is that the men get the same wages and the farmer gets 50 per cent. more produce.

2. "Writer" thinks the farmer has a perfect right to all the increase. He says, "I make or buy with my capital," and imagines that that is the end of the matter, and that the machine and its produce are his to do what he likes with, forgetting that for the existence of the machine to be possible an advanced state of industrial development is necessary.

3. Modern transit facilities which have been built up by the labour and abstinence of innumerable people have been used to collect the material for this machine.

4. Devices which bygone inventors have discovered and given to the common fund of knowledge have been incorporated in its design.

5. Science, the result of research undertaken by men actuated by a desire to further the common good, has contributed in countless ways to its perfection. Men of all classes have helped to make the machine possible, and yet "Writer" claims that its results belong to one individual only.

6. I hold that the system which allows the machine and the capital it typifies, which are the heritage of the whole community, to pass into the hands of individuals to use to their own interest is fundamentally unjust.

And now to apply the particular case to industry at large:

7. The community has advanced from the primitive laborious inefficiency of savage existence, when men working almost without implements could obtain but a bare subsistence, to its present condition, where power, machinery, plentiful coal, steel, and electricity, and the developing convenience of ways of communication, could make life easy and comfortable for everyone were these vast resources but equitably managed.

8. Millions of people have contributed to the result, which is often called civilisation, but which is more strictly only industrialism, pre-eminently the great scientists and inventors of modern times, and the first smelter of metal and the inventor of the plough in primitive ages. In the face of this, "Writer" claims that the whole of the increased productivity should benefit "logically, legally, and rightly" one small class. On the other hand, I contend that the present owners of capital have no right to withhold these advantages from the mass of the people. "Writer" holds that the workers can expect no better return for their labour than their ancestors obtained in the days of savagery.

9. He says, "No man suffers; no man need work harder or longer than before"—in other words, that civilisation has not made his condition worse than it was for his predecessors who dug for roots with their bare hands. "What has labour to grumble at, or why should labour seek part of the return for which it does not turn a hair?"

10. To which the worker might reply, "What have these idlers done that they should reap the entire fruits of all the triumphs man has won over Nature?" A system which permits this is artificial and unjust.

11. That this is no new theory of justice must be admitted, for it is always recognised that no man can in fairness be allowed liberty to interfere with the liberty of other people. For example, in England men are not allowed liberty to import slaves in the old sense, although they may be prepared to pay for them; in the same way it should not be permitted to any individual or class to own the implements without which others cannot earn a living.

12. And now to return to the original question, Are the interests of capital and labour identical? I reply that they are not only not identical, but the points on which they diametrically opposed are vastly more important than any on which agreement may be.

The chief points of opposition are these:

(*a*) It is to the interests of capital to maintain the present system under which, on "Writer's" showing, they obtain practically all the benefits of industrial progress. It is to the interests of the workers, both by ham and brain, that the present system should be abolished and the said advantages be equitably distributed.

(*b*) While the system continues it is to the advantage of shareholders to get as much work out of their employés for as little pay as possible. It is to the advantage of the workers to get as high a rate of pay for their services as possible, and to get this rate increased they have often endured the privations of a strike.

The principal points of agreement are these: It may pay a group of capitalists and workers to combine to produce and sell cheaply, so that they may gain business at the expense of other groups, and in this way ultimately reduce competition, so that they may raise the prices of their goods and then divide the profits they extort from the public.

(*c*) As "Writer" says when he compares workers to machines, it is to the interest of capital to maintain labour in a state of efficiency and provide for renewals, but this is a case of identity of interest not generally recognised among capitalists, judging from the evidences on all hands of the physical deterioration of the workers.

If "Writer" can still say that the interests of capital and labour are identical, I can only reply that I cannot, and we must agree to differ.—Yours, etc.,

STAFFORDIAN.

SIR,—Your "Writer" in proving his case has carefully ignored or failed to understand the letters he has received. *Re* his remarks Dec. 27 about Brown and Smith. I did not say capital was never advanced. I said wages were not paid out of capital. The capital advanced by Brown is required *because the grain has to be stored*, and not for wages. If the grain was sold at once the money would be there to pay Brown, and it is owing to the credit system that capital has to be advanced. The capital for a dock wall is not advanced to pay wages, but to accumulate dock wall.

With reference to his remarks on Jan. 3. If, as the "Writer" admits, capital is stored-up labour, then to labour should the fruits belong, and not to idleness. That is, the large community of previous workers has provided the capital which is now held by a small community of non-workers. The latter obtained it by claims, past and

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present, on labour's earnings—these claims being mostly claims resting on claims, and not on service performed. The dividends from capital provided by labour go to idlers, who use it to further tax labour. These non-workers hold the means of life, and not only compel the workers to take care of their capital (which previous workers produced), but exact an everlasting toll from the present and future workers for the privilege.

In order to justify his case, "Writer" talks of capital and labour as abstractions quite apart from the human beings who represent them. But the question of agreement between employers and employed depends entirely on the justness of their relationship as classes of individuals. The interests of capital class and worker class cannot be identical when the first preys on the latter, and there is *no* justice in the fruits of stored-up labour produced by a working community going to a small community of idlers. Of 11½ billions of accumulated wealth in the United Kingdom, $10\frac{9}{10}$ billions is held by five million out of 44 million people. Does the "Writer" think the five million or their ancestors earned it?

His farmer's machine is bought out of the toll exacted from the labour of a community of 21 men, and should belong to the community of labour who produced it, and be used in the interests of this community. Instead, it throws 10 men out of work, though their very labour has helped to produce it. It should lighten labour, but it doesn't, because it is used for the profit of the farmer solely, and though he legally owns it he has no moral right to exclusive use for his sole benefit, or to the added power of exploiting his 10 men which 10 more unemployed competitors give him.

The community of labour made modern capital, and has the right to its results.

The railway shareholders don't save the community's time. Their capital is the labour of previous workers, and this, along with present railway workers, does the saving. Surely "Writer" doesn't want us to believe the comparatively few railway shareholders *earned* this capital themselves.

When he talks about the workers getting their share of results, I wonder if he knows that one-third of the national income is enjoyed by less than one-thirtieth of the population, leaving 42½ millions with an average wage of 10s. 6d. per week; that the rent, interest, and profits received by a small class which does not work for them absorb about half the wealth produced annually; that according to Booth and Rowntree one quarter to one-third of the people in our centres of industry do not get sufficient wages to keep them physically fit.

As regards the morality of Socialism, see "Fabian Essays on Socialism," essay No. 4, by Sydney Olivier. With regard to Mill, cannot the "Writer" think of some forms of Socialism having a trial *now* (though no doubt an imperfect one and a "moderate" one).—Yours, etc.,

LANCASTRIAN.

STEAM FEED HEATING.

SIR,—My attention has been called to some observations in the December issue of the *Engineering Review* on "Live-Steam Feed Heating" by Mr. Wm. Patterson, in which he states that there "has been quite a resurrection of appliances for live-steam heating," but he "is doubtful as to the economy resulting from such apparatus in everyday working." Mr. Patterson then goes on to state that these appliances are not new, and states that a reference to the Patent Office records will prove this. Finally, he winds up by extolling the virtues of exhaust feed-water heating and purifying plant.

That the latter class of plant is, under certain conditions, both useful and economical I can testify after long experience, and that Mr. Patterson, being a manufacturer of this class of plant, advocates its use so ably I can also understand. When, however, this gentleman advocates his own system at the expense of damning live-steam heating, which, when properly applied, is capable of furnishing as great or greater economies than the former plant, I, as an interested party, am compelled to join issue with him. Further, live-steam heating of the feed can and does furnish an economy which is superimposed upon economies capable of attainment either by Mr. Patterson's apparatus or by improved combustion, or by both. On what grounds Mr. Patterson poses as an authority on live-steam feed heating he does not inform us, but the very fact of his stating that "internal live-steam heaters are simply a resurrection of appliances adopted and abandoned years ago" proves that his knowledge is quite out of date.

None of the obsolete forms of live-steam heaters and very few of the modern types of live-steam heaters furnish to the boilers water which is hot enough to give good economy. This economy goes up with great rapidity with the last few degrees increment of heat, bringing the feed water bang up to the temperature of the steam, hence the importance of employing an internal heater which will give full steam temperature to the feed water and at the same time furnish drier steam from the boiler.

There is no subject in connection with boiler-house plant upon which there are wider or more emphatic differences of opinion between engineers than as to the economy or otherwise of using live-steam heated feed water for boiler-feeding purposes, the reason being that the subject is very imperfectly understood, and there are numbers of manufacturers selling live-steam heaters who are evidently not conversant with the conditions necessary to produce economical results. In numbers of cases live-steam heaters are at work ostensibly for the purpose of economising coal, but, as a matter of fact, they are entailing a heavier consumption of fuel than would be required were the boilers minus the live steam heaters.

Live-steam heating, under certain circumstances, substantially economises coal and greatly increases the output of steam for the boilers, but there are distinct limitations to the economy which can be obtained, and it is important that all steam users contemplating the adoption of such apparatus should seek competent advice on the matter, otherwise, after having spent their money, they may find that their consumption of coal, instead of decreasing, has increased. In view of the present high prices and prospective increasing cost of fuel, it is a matter of considerable importance that manufacturers and steam users who are wise enough to avail themselves of every economy should be carefully advised in this matter, or they may increase their coal bill and entirely miss the substantial economies and lessened fuel cost which live-steam heaters are capable of producing.—Yours, etc.,

Harrogate, Jan. 4, 1908. GEO. WILKINSON.

THE DEVELOPMENT OF TURBO-GENERATORS.

SIR,—In reply to Mr. L. Schuler's letter on the subject of hot shunts in your issue of Dec. 27, I cannot trace the date of experiments, but find the device properly embodied in the design of an over-compound generator of the Phœnix Dynamo Company, dated April 20, 1905. I have used it from time to time parallel to the series winding of feeder boosters and over-compound dynamos in cases where special requirements made desirable an exactly straight line characteristic of the main field, but wish to point out that I never had a case in my experience like the one referred to in Mr. Schuler's letter, in which it was found necessary to correct in this manner faults in the design of ordinary interpole machines, for which I consider the device a quite unnecessary complication. I mentioned it in my paper as one of the methods—though I prefer others—which may permit of a higher speed being successfully employed for large turbo-generators.—Yours, etc., R. POHL.

Bradford, Jan. 7, 1908.

QUESTION No. 1,023.

SIR,—*Re* Question No. 1,023, and the first answer thereto, on p. 17A of current issue of *Electrical Engineer*. On reading this answer, and looking at the diagram of connections, we were surprised to see that it is awarded first prize, as it is obviously incorrect both in the diagram and in the descriptive matter.

We should like to know how the reversing action of the motor is effected, as the descriptive matter refers to a series motor, and the diagram shows a field in series with the armature of the motor connected across the change-over switch. This, of course, should be that the armature only

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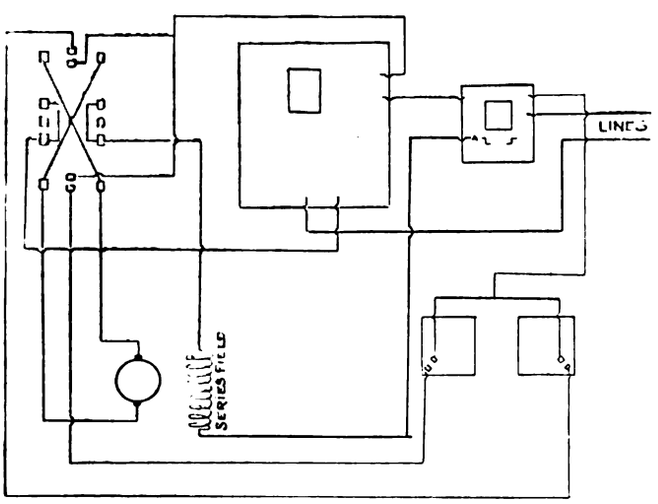
was connected across the change-over switch, and the series field could be connected between the one side of the centre of change-over switch and terminal A, or it could be between the line and the terminal of self-starter, or between the other side of the centre of change-over switch and other terminal of the solenoid starter.

Your correspondent says, "In the system about to be described the motor brushes would be directly connected to the slippers or sliding contacts, which would make contact on the two insulated third rails, these two third rails being treated as the terminals of the motor." We should like to know, if the motor brushes are the terminals of the machine, what has become of the series field. Apparently it is a negligible item.

We would also point out on the twenty-fifth line down on p. 18A, that "the main switch would only be broken by the main switch."



Corrected Diagram of Connections.

The whole of this answer seems to indicate that your correspondent, "T. Y. P.," is evidently an infant in such matters.—Yours, etc., SMADA.

SIR,—In "T. Y. P's" answer in yours of the 3rd inst. there is a slight error, which please allow me to point out. To reverse the direction of a continuous-current motor, it is necessary to reserve the current through the field leaving the armature current flowing in the original direction, or by leaving the field current flowing in one direction and reversing the armature current. Reversing the direction of the armature and field currents will not reverse the direction of the motor; this is all the reversing switch does in the sketch.—Yours, etc., J. HYDE.

Sheffield, Jan. 7, 1908.

WESTINGHOUSE-BREMER PATENTS.

SIR,—We owe you and your readers an apology for again referring to this subject, but we find Messrs. Santoni and Co. (1906), Limited, have issued yet another statement to the Press in which they say that the object of our communication to you was misconceived. We recall to your readers that the sole object of our communications was to set Messrs. Santoni right on a point voluntarily and aggressively raised by themselves.

We now say, further, that they are incorrect in stating that the proceedings taken by us against them are premature. The fact that they have given notice of appeal against the decision of the Comptroller-General does not in any way affect these proceedings, which will take their normal course.—Yours, etc.,

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

SLIDE RULES.

SIR,—We have been so overwhelmed with inquiries for the little 6in. slide-rule memento since the notice appeared in your journal that the manufacturers have completely run out of stock. If, therefore, any of your readers have not received their rules, would you kindly inform them that we are doing our utmost to keep our promise, and hope to be able to forward them during the next 10 to 14 days?—Yours, etc., MARPLES, LEACH, AND CO.

London, E.C., Jan. 7, 1908.

WIRELESS TELEGRAPHY.

Developments in connection with wireless telegraphy continue steadily, and in addition to the improvements that are being made in the various systems now in use, wireless telegraphy is being adopted wherever possible. A system of wireless telegraphy is to be erected between the ports on the Benardir coast and Zanzibar, and it is reported from Aden that an Italian transport, having on board the necessary plant, is leaving for the purpose.

The Telefunken system of wireless telegraphy, described some time ago in the *Electrical Engineer*, is reported to have been the means of dispatching some remarkably long-distance messages. Experiments in that system have been carried out in the station at Nauen, in Brandenburg, and great improvements have been made. According to advices received, the experiments already made this year show quite exceptionally good results. Some weeks ago telegrams were received from Nauen at a small portable military station at Korneuburg, near Vienna, and the steamship "Cap Blanco," of the Hamburg-South America Line, on the voyage from Hamburg to Buenos Ayres, daily received telegraphic news from Nauen. The last telegram reached her at Teneriffe, when she was eight days out from Hamburg. The distance to Teneriffe is about 2,300 miles.

OFFICIAL REPORT ON THE BIRMINGHAM TRAMWAY ACCIDENT.

The official report by Colonel Yorke to the Board of Trade as to the circumstances attending the accident that occurred on the Birmingham Corporation tramways on Oct. 1, 1907, has now been issued, a summary of which appears below.

In this case, as tramcar No. 22 was descending the incline in Warstone-lane, the motorman lost control of it, with the result that it ran away down the incline, and was overturned at the corner of Warstone-lane and Icknield-street, striking an overhead standard as it fell. Two passengers died from injuries received, and 12 were injured more or less seriously.

The car was a four wheeled, double-decked cars, fitted with the hand brake, electric rheostatic brake, and the magnetic track brake, and also with four sanders—namely, two at each end—and a lifeguard of the trigger type. The total length of the car was 27ft. 6in., the wheel base being 6ft. The gauge of the tramway is 3ft. 6in. At the time of the accident there were about 16 passengers on the car, half of whom were inside and the other half on the top. Most of the inside passengers succeeded in jumping off before the upset, receiving slight injuries in so doing. The passengers who received the fatal or serious injuries were those on the top of the car. Warstone-lane is about a quarter of a mile long, the gradients in it being as follows, commencing from the top of the hill: 1 in 143·8, 1 in 22·7, 1 in 17, 1 in 19·7, and 1 in 36·6. Warstone-lane itself is straight, but there are curves at the top and bottom of it, that at the foot of the hill being the worst. There is a double line of tramway along the lane, and the curve of the line upon which the car was travelling, between Warstone-lane and Hingeston-street, which is at the foot of the hill, has a radius of 40ft., the curvature being to the right. The super-elevation of the outer rail at the centre of the curve is 1¾in. In consequence of the gradients in Warstone-lane, the regulations of the Corporation provide that all cars shall stop at both the top and bottom of the hill, and that the speed round the curves shall not exceed four miles an hour. The motorman who took the car out first says that he made the usual examination before starting and found that everything was right, and that the sand hoppers were full of sand. The car had to proceed from Rosebery-street depôt to the city terminus at Edmund-street before coming into service. On the way to Edmund-street he says he tested his magnetic brake, and found that it had no effect when the brake handle was on the first and second notches, acted indifferently at the third notch, and did not come into full effect until the handle was on the fourth notch, when it brought the car up with a jerk. He was then using the controller at "No. 2" end of the car, which was at that time the leading end. He left Edmund-street at 5.9 a.m.

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for the other terminus of the route at Foundry-road, and descended the hill in Warstone-lane with safety by means of the hand brake. On returning from Foundry-road he was driving at "No. 1" end of the car, when he states that he found that the magnetic brake acted satisfactorily on all the notches. On arriving again at Edmund-street he met Inspector Hall, and informed him that there was something wrong with the magnetic brake at "No. 2" end of the car, and arranged that he should meet him on the following journey from Foundry-road and try the brake. Mountford (the motorman) then proceeded to Foundry-road, still being at "No. 1" end of of the car. On the return trip from Foundry-road he was driving from "No. 2" end, and on nearing Edmund-street terminus he picked up Inspector Hall. The car left Edmund-street for the third trip to Foundry-road at 6.29 a.m., with Inspector Hall in charge of the car, and Motorman Mountford standing alongside of him but not taking any part in the handling of the car, which was still being driven from "No. 2" end. Inspector Hall seems to have tried the magnetic brake when going down the incline in Summer-row, with the result that on the first, second, and third notches it did not act properly, but brought the car up with a jerk when the handle was moved to the fourth notch. Inspector Hall continued on the journey and stopped, as required by the regulations, at the corner of Frederick-street and Warstone-lane. When he reached the incline in Warstone-lane he again tried the magnetic brake, which on this occasion seems to have completely failed on all notches. He then moved the handle to the "off" position and tried the brake a second time, but still without effect. He then tried to stop the car by reversing the handle from the forward to the back position and moving the controller handle to the sixth notch of power, but still without effect. By this time he was more than half-way down the hill, and had entirely lost control of the car. He then applied his hand brake for the first time, to the fullest possible extent, but the speed of the car was such that the hand brake had little or no effect in checking it. On reaching the curve at the bottom of Warstone-lane hill the wheels skidded, and almost immediately afterwards the car turned over to the outside of the curve and fell on its side, striking a trolley wire standard in its fall, the passengers on the top being thrown on to the pavement and one of them crushed between the standard and the car.

The immediate cause of this disaster was the action of Inspector Hall in taking the car down Warstone-lane with a defective magnetic track brake, and experimenting with that brake on the incline. Had he applied the hand brake before starting down the incline, no accident would have occurred, as the gradients are such that the car might well have been controlled by means of the hand-brake only, the only precaution necessary being that the hand brake should be applied at the commencement of the hill, so that the speed of the car should be checked from the outset. That this is the case is proved by the fact that Motorman Mountford had already taken the car down the hill that morning by means of the hand brake only. Inspector Hall seems, however, to have selected this hill for the purpose of testing the magnetic brake, and did not attempt to apply the hand brake until the speed of the car was far beyond its control. Rule 28 of the printed rules and regulations issued by the Corporation for the guidance of their motormen is as follows: "Any defect in the mechanical or electrical equipment of the car, whether the result of an accident or otherwise, must be reported in the book provided for that purpose in the car-shed. If a defect is discovered on the road and cannot be remedied by the motorman, the attention of the nearest inspector should be called to it. *Motormen must in no case* take the risk of running a car which is not under absolute control." In drawing the attention of Inspector Hall to the defect in the magnetic brake, Motorman Mountford seems to have complied with this rule, and the responsibility for the accident must rest upon Inspector Hall, whose action was entirely contrary to the spirit of the last sentence in the rule.

The failure of the magnetic track brake to act on this occasion is said to have been due to a broken "grid" in the fourth resistance box on the car. According to a statement made by Mr. C. W. Hill, electrical engineer of the Corporation tramways, the controller at "No. 2" end of the car, and the insulation of the cabling and wiring of the car, was after the accident found to be in good order, and the only defect that could be discovered was the broken grid. The resistance boxes, of which there are five, are in use both for propelling and braking purposes, and it might be thought that such a fracture would be discoverable, not only when the magnetic brake was in use, but also when current was being supplied from the trolley wire for the purpose of starting the car. Mr. Hill's theory is that the electrical pressure of the current for driving purposes would be sufficiently great to bridge the gap formed by the fracture, whereas in the initial stages of braking, current generated by the motors acting as generators would have a low pressure, and would not be able to overcome the interruption in the circuit. Experiments made in my presence by Mr. Trotter, the electrical adviser to the Board of Trade, at 8, Richmond-terrace, however, hardly support this theory, as it was found that a current of 10 amperes, which is probably less than the usual current passing when cars are starting from rest, is sufficient to cause fusing to take place between the two opposing ends of the fracture and between the sides of the broken and adjacent members of the grid. No such signs of fusing were, however, discernible in this case. It is, therefore, impossible for me to say whether the above explanation of the failure of the magnetic track brake is the correct one or not.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Chili Telephone Co.—The directors have declared an interim dividend of 6 per cent. per annum (3s. per share).

Croydon.—The Croydon Gas Co. have decided to increase the price of gas from 2s. 8d. to 2s. 10d. per 1,000 cubic feet.

Hastings.—The Hastings and St. Leonards Gas Co. have given notice of an increase in the price of gas of 2d. per 1,000 cubic feet.

Bishop's Stortford.—The Guardians have agreed to an installation of telephones at the workhouse and infirmary by the National Telephone Co.

Institute of Sanitary Engineers.—We are asked to state that the address of the above institute is now 120 and 122, Victoria-street, Westminster, S.W.

Salford.—The Local Government Board have sanctioned the borrowing of £4 220 by the Corporation for extensions to the electricity undertaking.

Caterham.—Not satisfied with the very high charge of 3s. 4d. per 1,000 cubic feet, the Croydon Gas Co. have decided to extract a further 2d. per 1,000 from their customers.

Bethnal Green.—The Borough Council have agreed to allow the Post Office Department to lay a 3in. underground telegraphic wire pipe in the footway of Bethnal Green-road.

Aberdeen.—On the 23th ult. a serious gas explosion occurred at 59, Beechgrove-terrace, resulting in damage to the premises and contents and serious injury to the occupant.

Simplex Conduits.—The usual 6 per cent. dividend on the preference shares has been paid for the half-year ending Dec. 31, 1907. The dividend warrants have been posted.

Wath.—The Board of Trade have notified the Council that, not having discharged their obligations under their provisional order for electric lighting, the same would be revoked.

Nelson.—The electrical engineer's report for the past month was submitted at the last meeting of the Town Council, and showed that the total number of units generated was 100,375.

Hammersmith.—The Electricity and Lighting Committee are recommending the Council to construct sub-stations at King-street and Hythe-road at an estimated cost of £9,209.

Stretford.—The Local Government Board will hold an inquiry into the application of the Council for sanction to borrow £42,718 for purposes of the electricity undertaking on Jan. 17.

Germany.—It is stated that the Imperial Postal Department is contemplating the establishment of an Imperial monopoly in wireless telegraphy and submarine signalling for sea-going vessels.

Sowerby Bridge.—The Urban District Council have decided to make application to the Board of Trade for a provisional order authorising the transfer of the electric lighting order to a company.

Hackney.—The Board of Guardians have decided to petition the Borough Council to forthwith complete the electric lighting of that portion of High-street, Homerton, which faces the infirmary gates.

Hoylake.—A Local Government Board inquiry will be held on Jan. 14 into the Council's application for sanction to borrow £2,000 for electric lighting purposes and £300 for a sewer at the electricity station.

Spen Valley.—The steam-engine at Firth Penny's works, Union Mills, Spen Valley, is being taken out, as electrical driving is to be adopted. Other industrial concerns in this part of Yorkshire are also to be electrified.

Swinton.—Several industrial concerns here are about to adopt electrical driving in place of steam. The local District Council now supply current in bulk, which they in turn obtain from the Lancashire Electric Power Co.

Dewsbury.—The borough electrical engineer has been instructed to submit to the Electricity Committee a specification and tenders for the erection of an additional condenser and cooling plant at the electric light works.

Acton.—An electrical exhibition will be held from 20th to 25th inst. in the grand hall of the public baths, Salisbury-street, Acton, W. The exhibition will be opened by Mr. Herbert Nield, M.P., on the 20th inst. at 4 o'clock.

Stockton.—Strong complaints are being made by the medical officer of the fever hospital as to the poor lighting by gas throughout that institution. It is likely that his complaints will result in the installation of an up-to-date system.

Newcastle-on-Tyne.—Serious injuries were sustained by the members of the household at 87, St. John's-road on the 6th inst. Owing to a defective gas chandelier a violent explosion occurred, which also damaged the premises and contents.

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Leeds.—Accidental death was the verdict brought in by the jury who attended an inquest upon the body of George Smith, aged 17, on the 7th inst. The cause was attributed to suffocation by fumes from a gas stove in the bedroom of the deceased.

Worthing.—It is proposed to apply to the Local Government Board for sanction to borrow £1,710 for carrying out the alterations agreed upon to the street-lighting by electricity and the provision of new condensing plant at the generating station.

Derby.—The buildings of the new Corporation electric lighting station have been insured against fire in the sum of £10,000 and the contents in the sum of £20,000, and the new economiser has been insured against explosion in the sum of £600.

Explosion in the Sloyne.—The large mooring buoy belonging to the Cunard Shipping Co., in the Sloyne, which is about 20 tons weight, and which, when the liners are not in port, is kept lighted by gas for the proper and safe navigation of the river, has been wrecked by an explosion of gas.

Wigan.—The Board of Trade have revoked the Wigan Rural District Council Electric Lighting Order, 1903, as confirmed by the Electric Lighting Orders Confirmation (No. 5) Act, 1903, as to the whole of the area of supply as from Nov. 30, 1907, and the revocation is to take effect from that date.

Stevenage.—The Urban District Council, at their last meeting, received a letter from the Electric Supply Corporation, stating that it was impossible to proceed for some time with the work of supplying Stevenage with electric light according to a standing agreement. It was agreed that the clerk seek counsel's opinion as to the best way to proceed in the matter.

Newark.—To a special meeting of the Council Messrs. Bell and Co., agents to the Newark and District Light Railways Co., sent a copy of notice of application to be made for an extension of time limit. The Council decided to consent to the extension, and to ask also for two years' extension to the Council in which to supply electricity to the company.

Arbroath.—At a meeting of the Arbroath Dean of Guild Court on the 6th inst. a petition, with accompanying plans, was presented for the erection of an electric power station at South Grimsby-street, Arbroath. The buildings are to be erected by Mr. George Balfour, electrical engineer, London, on behalf of the Arbroath Electric Lighting Co. The work is to be proceeded with immediately.

Longton.—The number of electricity units generated for the three weeks ending Dec. 12 at the Corporation works was 21,333, against 18,136 for the corresponding period of last year. During the past three weeks 84 additional lamps have been fixed. The committee have decided to extend the electricity main from High-street to Chatfield Works, a distance of 75 yards, at an estimated cost of £40.

Chelmsford.—At the last Council meeting the surveyor reported that he had interviewed the local G.P.O. engineer with reference to the 15 telegraph poles in Moulsham-street and London-road, which are very much decayed at the ground level, and, in his (the surveyor's) opinion, dangerous. The Post Office authorities were willing to replace them with new poles similar to those erected in Springfield-road, and permission was given to erect them.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 15 a special settling day in the International Copper Co.'s further issue of 25,000 shares of £1 each, fully paid, Nos. 50,001 to 75,000, and the New Einasleigh Copper Mines' 74,500 vendors' shares of £1 each, fully paid, Nos. 76,001 to 150,500; and have ordered the Underground Electric Railways Co. of London £1,100,000 deposit receipts for 5 per cent. profit-sharing secured notes to be quoted in the official list.

Burgess Hill.—At the last meeting of the Urban Council the receipt was reported of a letter from the Board of Trade, with a print of a notice served by the Board on the Burgess Hill and District Electric Supply Co, requiring the company to comply with the regulations of the Board prescribed under Section 4 of the Electric Lighting Act, 1888. The chairman explained that the letter referred to the requirements of the Board as to the height at which the company put the wires, and regulations to be observed by the company.

Sunderland.—The Corporation have recently installed a new turbo-generator at their electricity works on the Hylton-road, and the machine, which has cost £10,531, was started on the 6th inst. by Alderman Wm. Bruce, the chairman of the Electricity Committee. It was decided by the committee to name the turbo-generator "The Bruce," and in order that the ratepayers should not complain the members decided to pay for the brass plate themselves. Alderman Bruce afterwards entertained the members to tea and refreshments.

Colchester.—The engineer's report to the Council committee contained the following particulars: output of electricity in units during November, 1907—lighting, 98,633 (against 87,449 in 1906, and 84,721 in 1905); ditto traction, 39,128 (against 39,996 in 1906, and 31,832 in 1905); used in generating station, 22,854 (against 14,758 in 1906, and 8,076 in 1905). The chairman reported that an offer had been received for the purchase of lead oxide from the battery, and submitted cheque received for £219. 7s. 10d. in respect thereof. The report was adopted.

Liquidations.—The *London Gazette* announces that the Electric Power Development Co. has been wound up voluntarily, and Mr. G. Rowley Bostock, 21, Ironmonger-lane, London, E.C., appointed liquidator. A general meeting of the members of the Phodyne Electrical Co. will be held at 66, Victoria-street, London, S.W., on Feb. 4 at 12 noon for the purpose of receiving the liquidator's report. The creditors of the Electric Power Development Co. are required to send their names and addresses and the particulars of their debts or claims to Mr. G. Rowley Bostock, 21, Ironmonger-lane, London, E.C., the liquidator, by Feb. 28,

Longford.—It was reported at the last Council meeting that the output of gas for the three weeks ended Dec. 12 showed an increase of 79,000 cubic feet as compared with the corresponding period of the previous year. In the electricity department, the number of units generated was 21,333, against 18,136 for the corresponding period of last year, being an increase of 18 per cent. During the past three weeks 84 additional lamps had been fixed. It was recommended that the electricity main be extended from High-street to Chatfield Works, a distance of 75 yards, at an estimated cost of £40.

Fermoy.—For some time past it has been well known that leakages were taking place from mains supplying gas from the gas company. The Urban District Council were called upon to give permission to open roads, etc., in order to repair them. In order to secure some kind of relief from the heavy charges of the gas monopoly, the Council refused to give consent until the gas company lowered its charges to a reasonable sum. This the company refused to do, and at the busy hours of Saturday last reduced the pressure, thereby plunging the district into darkness. It is nearly time that a competitor appeared.

Exeter.—At the last meeting of the Council the electrical engineer stated that by the end of the current financial year the amount of the loan sanctioned for mains would be exhausted, and there would remain in hand on the amount sanctioned for transformers and switchgear £360, and for meters £260. He estimated that the capital expenditure for the next three years from March 31 would be: mains, £8,100; transformers and switchgear, £900; meters, £800—total, £9,800. Against this there should be a balance of sanctions on the two latter items of £600. It was decided that application be made to the Local Government Board for sanction to the borrowing of the money required.

Canterbury.—The rector of St. Martin's and St. Paul's has a good word to say for the electric light as supplied by the Canterbury Corporation. In the course of a new year's circular to the parishioners he remarks that owing to the expense incurred over the electric light the church had a deficit of some £30 at Easter, but says that he is "glad to say that the new arrangement of lighting is much more economical, and our bills are considerably lower. . . Thanks to the rummage sale we have installed the electric light in the parish room. We can now see splendidly and breathe more freely, and we pay 2d. an hour as against 3½d. an hour for the old hot gloom which we endured."

Merthyr.—At a meeting of the Public Works Committee of the Borough Council it was resolved to substitute electric lighting for gas on the main road from Swan-street, Merthyr, to the New-road, Dowlais. The Board of Trade wrote informing the Council that they were advised that there was no danger to be apprehended from an overhead main for street-lighting purposes conveying a continuous current, and it was agreed to allow the Merthyr Electric Traction Co. to carry the current by an overhead main. It was mentioned that the present cost of lighting the road from Swan-street to the Bush Hotel, Dowlais, by gas and electricity was £364. 10s., and the new system which would provide double the number of lights, would only be £321.

Folkestone.—Under the present agreement with the Folkestone Electricity Supply Co. all the electric lamps on the Leas are lighted every evening during the months of April, May, June, July, August, and September, and alternate lamps only are lighted during the remaining months of the year, except when Easter falls in the month of March, and then the whole of the lamps are lighted for one week. The committee have considered the desirability of altering the time of year when all the lamps on the Leas should be lighted, and have resolved that, subject to the Folkestone Electricity Supply Co. agreeing, all the lamps on the Leas shall be lighted from April 15 to Oct. 15, with the same arrangement as to Easter if it falls before April 15 in any year.

Rugby Engineering Society.—By the kind permission of Messrs. Alex. Findlay and Co., of Motherwell, arrangements have been made for members of the above society to visit the exhibition buildings in the course of construction on Saturday, Jan. 11, leaving Rugby Station (L. and N.W.R.) for Willesden by the 12.42 p.m. At Willesden, members will change and book to St. Quinton's Park Station by the 2.20 p.m., this latter station being only five minutes' walk from the exhibition grounds. The ordinary week-end tickets to London will be available for the 12.42 p.m. luncheon train. Mr. J. S. Ferguson, of the above firm, has kindly undertaken to meet the party at No. 2 gate in Wood-lane, at 2.45 p.m., and conduct them over the exhibition grounds, buildings, etc.

Swansea.—At the ordinary meeting of the Corporation Electricity Committee the engineer reported an increase in the consumption of electricity, and the chairman said if the same rate of progress was made next quarter the annual results should be most satisfactory, notwithstanding that the newer pattern lamps reduced the consumption by one-third. The London and North-Western Railway Co. asked for terms for electrically lighting its sidings. It was said the mains would cost from £425 to £570, while the number of lamps required would only be eight, but as these would be burning all night they would give an excellent total. The engineer said he hoped soon to obtain an order for electrically lighting the Midland station. The committee decided to have further information.

Newcastle (Staffs).—At the meeting of the Town Council the tariff of the National Telephone Co. was considered, and the following resolution passed: "That in the opinion of this Town Council the imposition of a new tariff by the National Telephone Co. and his Majesty's Postmaster-General, which abolishes the inclusive rates in force and entails an increased cost for the telephone on the large majority of users, is unnecessary and uncalled for, and this Council requests the National Telephone Co. and his Majesty's Postmaster-General to withdraw the new rates and continue the facilities hitherto in force, and that the town clerk be instructed to forward a copy of this resolution to the Postmaster-General, the National Telephone Co., and to J. C. Wedgwood, Esq., M.P."

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Tunbridge Wells.—The proposal of the Council to substitute 200 electric lamps in place of a similar number of those now lighted by gas on the incandescent gas system has caused some considerable amount of consternation to the gas company. They have now threatened that if a reduction in the number of gas lamps is made as suggested, they will raise the cost of the remaining lamps from £3. 9s. 4d. to £3. 14s. 4d. per annum. On the other hand, if the Council will still retain the gas lamps, the company are prepared to reduce the present charges down to £3 4s. 4d., and further, if the Council will undertake to contract for three years, the charge will be reduced to £3. 1s. 10d. It is evident that between threats of increased charges and offers of reduction, the gas company admits its fear of municipal electric lighting.

Wrexham.—At a meeting of the Electricity Supply Committee the electrical engineer submitted his monthly report, including the following statement: Connections and supply—used for tramways, November, 1907, units 12,844; lighting, etc., 48.750—total units generated, 61,594; October, 1907, units 13,433; 44 714—total, 58 147. Eight new consumers had been connected during November. The engineer also reported that an order for the foundations required for the proposed 60-kw. set had been placed with Mr. H. A. Jones, at a cost of £8. 5s., and it was resolved that the order be confirmed. The electrical engineer asked for instructions with regard to the piping required for the proposed set and the rearrangement of the connections of the present steam and exhaust mains, and the committee resolved to empower the chairman and the engineer to accept a tender for the execution of this work.

Wilkinson Full Steam Temperature Feed-Water Heater.—From the commencement of the year the London and district agency for the above apparatus has been transferred from Messrs. Hall and Co. to Messrs. J. L. Cateaux and Co., of 10, Bush-lane, Cannon-street, E.C. Although these heaters are of recent design we understand that a large and rapidly-increasing business is now being done, both at home and abroad. Amongst the recent orders received may be mentioned the following: the Calico Printers' Association, Manchester, the Associated Portland Cement Co., Messrs. Pease and Partners, Messrs. Clarke, Chapman, and Co., Messrs. Goodwin and Co. (the two latter being repeat orders), Messrs. Pilkington Bros., St. Helens, and the Hucknall Torkard Collieries Co., near Nottingham; also the electricity works at Blackpool, Blackburn, Londonderry, Bedford, Ashton-under-Lyne, and repeat orders from the Luton and the Wakefield electricity works.

Aston.—The various works in connection with the extension to Erdington have been completed, and supply is now being continuously given to 23 consumers in that district; and the extension to Witton has also been completed, and supply is being given to the Armorduct Co. and the Wolseley Sheep-Shearing Machine Co. The engineer has reported the cost of the foregoing work to the committee as follows: Generating station, £1,810. 8s 6d.; sub-stations (three), £785; cables (including strengthening of main to Salford Bridge), £13 207. 1s. 11d —total, £15 802. 10s. 5d. The estimated cost was £16.169. (Included in the cost of cables are various small sums, amounting in the aggregate to £267. 3s. 6d., which may be described as extras to the original contract.) Witton extension including sub-station at the Armorduct Co.'s work (the cost of the sub-station at the Wolseley Co.'s works not being included, as the Wolseley Co. are paying for this work) cost £1 347. 6s. 5d.; estimate, £1,373. 3s. 3d. The number of units sold for the month of November was 290,744, against 200,668 in the corresponding month of 1906.

Books, etc., Received.—Englebert and Co., of 119, Finsbury-pavement, have produced a useful tear-off calendar.—Messrs. Harrison, Jehring, and Co. prove the excellence of their printing by the wall calendar which they have put up.—A dozen different up-to-date fire appliances are illustrated in the almanac presented by Messrs Shand, Mason, and Co.—A dainty and attractive wall calendar has been issued by Messrs. A. C. W. Hobman and Co., of South Bermondsey, S.E.—The D.P. Battery Co. have forwarded a picturesque calendar, the centre piece of which is an illustration of their Lumford Works, Bakewell, Derbyshire.—All about Winnipeg, with numerous photographs, is contained in the sheet forwarded by the Commissioner of the Winnipeg Development and Industrial Bureau.—The wall calendar of Watts, Fincham, and Co., Billiter-buildings, E.C., contains a water scene illustrating some of the uses to which the products of the firm are put.—The Flexible Metallic Tubing Co. have issued a wall calendar with a "reminder" attachment, consisting of an adjustable bar for each week, and an indicator for marking each day.—The greeting card from the Consolidated Accessories, Limited, of St. Clement's-lane, E.C., contains particulars which prove the rapidly-increasing popularity of the "Peacock" car brake.

TRACTION.

Metropolitan Asylums Board.—Two ambulance tramway cars for use at the small-pox hospitals are to be purchased by the Metropolitan Asylums Board at a cost of £425.

Delhi.—The Electric Light and Tramways Co. are applying to Government for permission to raise a debenture loan of £50,000 on the security of the existing works.

Moscow.—Agents for the city of Moscow state that the municipal loan for 10 million roubles for tramway and other purposes has been purchased by an Anglo-American syndicate.

River Plate.—The La Plata Senate have approved in general the Bill granting a concession to Messrs. Otto Franke and Co. for an electric railway between La Plata and Buenos Ayres.

Huddersfield.—The Town Council have agreed to a proposal by the Tramways Committee to double several sections of single track during the current year at an estimated cost of £12,000.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways.—The traffic receipts for the week ended Dec. 28, 1907, amounted to £769. 15s. 5½d.; corresponding week last year, £622. 0s. 5½d.

Colchester.—The Council Tramways Committee have empowered the manager to carry out the necessary repairs and alterations to the tramway overhead equipment, the estimated cost of which is £260.

Accrington.—The Corporation are pushing on with the laying of tramways to the outlying village of Baxenden, and, what is more satisfactory, the local system is now proving remunerative on practically all routes.

Brisbane Electric Tramways Investment Co.—Traffic receipts of the Brisbane tramways for the month ended Dec. 31, 1907, amounted to £15,320; corresponding week last year, £13,491—increase, £1,829.

Wednesbury.—The General Purposes Committee of the Town Council are in communication with the tramway company respecting the lighting of tramcars during unloading, the provision of ½d. fares, and the renewal of the practice of issuing children's tickets.

Torquay.—The Torquay Tramways Co. has been registered with a capital of £120,000 in £1 shares. The objects are to adopt an agreement with the Dolter Electric Traction, and to construct, maintain, and work tramways authorised by the Torquay Tramways Act, 1904.

Buenos Ayres and Belgrano Electric Tramway Co.—Receipts for the eight days ending Dec. 31, 1907, converted to gold were £4,664; corresponding period last year, £4,793—decrease, £129. Aggregate from Jan. 1, 1907, £202,200; aggregate from Jan. 1, 1906, £191,968—increase, £10,232.

Croydon.—A copy of the resolution passed at the recent public meeting at South Norwood in favour of the construction of tramways along the Morland and Portland roads has been before the members of the County Council, who have referred the matter to the Tramways Committee for consideration and report.

Islington.—The London County Council have intimated to the town clerk that they propose to proceed at an early date with the reconstruction for electric traction on the conduit system of the existing tramways from King's Cross, *via* Caledonian-road and Camden-road, to Holloway-road, and then *via* Seven Sisters-road to Finsbury Park.

Glasgow.—On the evening of the 3rd inst. an electric car running down a deep incline got out of control, dashed at great speed down the street, crashing into several vehicles, and knocking down many persons. A dense fog prevailed at the time, which prevented the people in the street from seeing the approaching danger. Several were removed to the infirmary.

Edinburgh.—The new cable tramway route in Gilmore-place, Edinburgh, will not be opened until the summer. It will be two months yet before the laying of the track is completed, and after that the pits will have to be constructed. Two hundred men are at work on the undertaking, and the lines are being laid just now from the old car terminus to the city boundary at Craiglockhart.

Leicester.—A pit worker named Michael Egan, 54, of Coalville, died at the Leicester Infirmary on the 8th inst. as the result of being knocked down by a tramcar in Gallowtree-gate on Saturday night. The base of the skull was fractured, but on being treated at the infirmary he was reported to be going on favourably. However, a sudden relapse occurred, and death took place as stated.

Derby.—The receipts of the Corporation tramways during the four weeks ended Dec. 21 amounted to £3,112. 13s. 1d., being an increase of £293. 19s. 6d. as compared with the corresponding period last year. The committee decided not to run the cars on Christmas Day, and to pay the tramway employés wages for that day. A gratuity of £1 has been awarded to Conductor Francis for his courageous conduct in stopping a runaway horse.

Hatfield Moor.—The contract for the construction of the short line of light railway from the Axholme Railway at Epworth to Hatfield Moor, near Thorne, has been let to Messrs. Moffatt, contractors, of Manchester. The line has been set out, and work will be commenced very shortly. The railway will be about 5½ miles in length, and is on a practically dead level all the way, presenting no engineering difficulties. There will be a single line all the way, which is intended to afford access to the peat works on the moors and serve the intervening agricultural district.

Dundee.—Tramcar traffic in Reform-street, Dundee, was considerably delayed on the evening of the 5th inst. in consequence of the trolley of a Constitution-road route vehicle becoming jammed on the wire. The occurrence took place at the south end of the thoroughfare, where the Lochee and Fairmuir cars reverse. It was found impossible at the time to release the trolley, and an hour elapsed before the tower-wagon could be procured. Pending the arrival of that vehicle all the traffic between High-street and the foot of Constitution-road had of necessity to be worked on the single-line system.

Morecambe.—A crowded ratepayers' meeting was held at Morecambe on the 8th inst. to approve or otherwise of the promotion of a Bill in Parliament by the Corporation to purchase so much of the tramway undertaking as is within the borough. The mayor presided. The proceedings were rowdy. A great majority of those present were opposed to the proposals, and the members of the Town Council who advocated them were hooted and ironically cheered. Shortly before 11 o'clock the mayor put the resolution, and by an overwhelming majority the meeting declined to approve of the promotion of the Bill, the result being greeted with loud cheers.

Cambuslang.—The name of the cabdriver who was killed about midnight on Tuesday on the car rails between Blantyre and Cambuslang is William Horan (24), and he resided at 8, Steel-street, Glasgow. It appears from the official report of the occurrence that the deceased was returning with three gentlemen in a hansom cab from Hamilton to Glasgow. When near Dalton he was met by a car of the Lanarkshire Tramways Co., at which his horse shied, backed on to the rails

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in front of it, with the result that the fender of the car struck the rear part of the hansom, knocking it over on its side and throwing the driver on his head on the roadway. His skull was fractured, and death was instantaneous.

Hazel Grove to Macclesfield Tramways.—The Bill of the Macclesfield and District Tramways Co. authorises the abandonment of the proposed tramway between Hazel Grove and Macclesfield. The abandonment, however, will not be quite total. The small sections of the line which lie nearer to Stockport will be retained, they having been vested in the Urban District Council of Hazel Grove and Bramall, but the other portions nearer Macclesfield will not be dealt with at all, and there is no prospect of the company taking over the electric lighting order which was granted years ago to the Macclesfield Corporation, and with the exception of small private installations there is no present prospect of Macclesfield getting the electric light.

Leeds.—The Tramways Committee of the City Council have had under consideration an application from the conductors and drivers for a reduction of hours from 60 to 54 a week. The general manager, Mr. J. B. Hamilton, had prepared a report based upon information received from other towns, which was placed before the committee. In five out of eleven towns named, it was stated, the official number of hours worked was 60 per week, while in the six remaining centres the hours varied from 54 to 56 per week. In the matter of wages, with the exception of Sheffield, the rate of wages in Leeds was higher than that in any other city, being from 36s. 8d. to 39s. 2d. per week for drivers and 29s. 2d. to 34s. 2d. for conductors. The average for the other towns is 30s. 10d. to 35s. 1d. and 27s. 1d. to 31s. 1d. respectively. The Leeds employés urge that the granting of their application will reduce cost, as a nine hours' day will lend itself to a large percentage of through duties, and will, therefore, save "spread over" money. Further consideration of the question was adjourned for a week.

Halesowen.—At the meeting of the District Council Mr. Marsland, in submitting the report of the Light Railways Committee, said satisfactory progress had been made with respect to the transfer of the light railways order to the Halesowen Light Railway Co., and providing no objection were made the Board of Trade would sanction the transfer on Jan. 20 on terms which were satisfactory to the Council, the promoters, and the County Council. The promoters would pay the costs the Council had been put to within 14 days after the signing of the transfer, £325 would be paid 60 days afterwards, and a similar sum at the expiration of six months and 60 days. There was not likely to be any objection to the transfer, or, in fact, anything to cause friction. The same company also proposed to apply for the transfer of the electric lighting order, but it was necessary that the interests of that Council should be safeguarded with respect to charges, and also with respect to street-lighting and, consequently, the necessary instructions had been given for application to be made for certain clauses to be amended, especially that having reference to the maximum charge.

Birmingham.—The Board of Trade report has been issued relative to the accident which occurred on the Corporation tramways on the morning of Oct 1, when a car ran away down an incline and overturned, striking on overhead standard as it fell. Two passengers lost their lives, and 12 others were injured. Colonel Yorke, R E, says the immediate cause of the disaster was the action of the motorman, Inspector Hall, in taking the car down Warstone-lane with a defective magnetic track brake and experimenting with that brake on the incline. Had he applied the hand brake before starting down the incline no accident would have occurred. That this is the case is proved by the fact that the Motorman Mountford had already taken the car down the hill that morning by means of the hand brake only. Inspector Hall seems, however, to have selected this hill for the purpose of testing the magnetic brake, and did not attempt to apply the hand brake until the speed of the car was far beyond its control. In drawing the attention of Inspector Hall to the defect in the magnetic brake Motorman Mountford complied with the rule, and responsibility for the accident must rest upon Inspector Hall.

Paddington.—The Metropolitan Electric Tramways Co. have sent the Borough Council a copy of their correspondence with the Board of Trade as to the London County Council's intention to acquire that portion of the Harrow-road tramway which is within the county of London. The company point out the public inconvenience that would be caused by the stoppage, at the boundary of the counties of London and Middlesex, of the cars now running from Willesden to Lock Bridge, Harrow-road, and they ask the Borough Council whether the latter are prepared to make representations to the Board of Trade on the subject. The Works Committee of the Council are, after having had an interview with the Improvements Committee of the London County Council, recommending that, subject to the Metropolitan Electric Tramways agreeing with the Paddington Council with regard to widening Harrow-road, no opposition be offered the company's Bill for extending their lines within the borough. The Works Committee also recommend that such representations be made to the Board of Trade as may appear necessary concerning "the inconvenience which would result in the event of there being dual control of the tramway lines in Paddington."

King's Cross Accident.—A Board of Trade inquiry was held on Wednesday last at the Stamford-hill tramway depôt of the London County Council in order to look into the circumstances relating to an accident which happened to two of the Council's trams on the evening of Christmas Day. The tram in question had been running between Moorgate-street and King's Cross during the whole of that day, but on its last journey got out of control at Pentonville-road, the hill which descends to King's Cross, and dashed into a stationary car at the bottom, severely damaging both cars, but fortunately without any fatalities. The first witness called upon was Mr. E. W. Conbrough, a passenger by the car at the time of the accident. He stated that he boarded the car at the Angel with his wife and two sons, and that all seemed right until the summit of the hill was reached. The speed of the car then appeared to increase very much until within about 100 yards of the stationary car, when he thought the brakes had been applied for the first time, reducing the velocity a little, but not preventing the collision, which took place immediately after, he being severely bruised and his son cut with broken glass. The driver of the car, Chas. Turner, was next called, and stated that he had qualified to be a motorman in 1907, and passed on July 22 of that year. He went on duty at 11 56 a.m. on morning of Christmas Day, and everything worked satisfactorily until the top of Pentonville-road was reached on last journey. He proceeded down the hill on the first and second notches of magnetic brake, this being sufficient to keep the car under control. After Penton-place was reached half-way down, the car seemed to increase in speed, and he then applied magnetic brake up to seven notches, but as this did not have proper effect, seeming to catch and release, he released brake altogether and applied again, but without effect, and as the car was then travelling between 16 and 18 miles he used hand brake, which considerably reduced speed, but was not sufficient to prevent a serious collision with stationary car. Several other witnesses were called, amongst them being Mr. J. Bowden, rolling-stock superintendent of London County Council. He stated that he had personally inspected damaged car, and found nothing wrong with controller, and magnetic brakes in satisfactory condition. He also said that the car could be safely taken down Pentonville-hill on the hand-brake alone. The report of the Board of Trade has not yet been issued, but will be given in a future issue.

PERSONAL.

Mr. C. Fawcett, electrical engineer to the Darwen Town Council, has had his salary increased from £250 to £275 per annum.

The Nelson Town Council have increased the salary of Mr. G. F. Nayler, assistant electrical engineer, from 45s. to 50s. per week.

We understand that Mr. O. F. Francis, burgh electrical engineer and tramways general manager, Kirkcaldy, has been appointed electrical engineer of Carlisle.

The Woolwich Borough Council have appointed Mr. Keats, the acting electrical engineer, as borough electrical engineer at a commencing salary of £325 per annum, rising by annual increments of £25 to £400.

The Manchester City Council have decided to reappoint Mr. S. L. Pearce as chief electrical engineer for a period of four years, at a salary of £1,100 per annum for the first and second years and £1,200 for the third and fourth years.

Mr. H. Heys, assistant clerk to the Burnley electricity works, has been presented by the staff with a completely fitted up travelling trunk on the occasion of his leaving to take up the position of chief clerk at the Mansfield electricity works.

Mr. J. C. Brown M I M.E., for many years connected with the firm of Roland Carr and Co., and well known to electrical engineers throughout the country, has been appointed manager for the London division for W. H. Keys, of West Bromwich.

The third annual entertainment of the employés of Messrs. Mountain and Gibson, Elton Fold Electrical Works, together with their wives and children, was held on Dec. 28. Mr. and Mrs. Mountain were assiduous in their attention to the guests, and the proceedings passed off satisfactorily and to the delight of everyone.

On Dec. 30 and 31, 1907, the first annual meeting of branch managers, agents, and representatives of the firm of Charles Pullan, 52, King's-arcade, Bradford, was held. On the evening of the 31st the whole party were entertained at the Talbot Hotel to dinner by Mr. Chas. Pullan, and a very enjoyable evening was spent.

The directors of the Edinburgh and District Tramways Co. gave the first of three entertainments to their employés in the Drill Hall, Forrest-road, Edinburgh, on Jan. 7. The company, to the number of about 700, including the wives of the workmen and their lady friends, sat down to dinner, and afterwards were entertained to a concert.

Mr. J. D. Caird, of Aberdeen, has been appointed traffic superintendent of the Halifax Corporation tramways at a salary of £250, rising to £350 per annum. Mr. Caird is 33 years of age, and at present occupies a similar position in connection with the Aberdeen Corporation tramways.

Mr. C. H. Spencer, who has resigned from the position of rolling-stock superintendent of the Halifax tramways, has been the recipient of four useful technical volumes by experts, bearing on electricity—current windings, motors, wiring, etc., and the commercial applications of each—by the employés of the shed and workshops, as a token of esteem.

Messrs. G. J. Bird and F. J. Moorhouse, formerly on the engineering staff of Mr. Robert Green, M I.C.E.; consulting engineer, of 37, Waterloo-street, Birmingham, and engaged by him upon several important electric tramways, light railways, sewerage, and other engineering works, have been appointed on the engineering staff of the Government of Queensland railways.

The annual Christmas entertainment for the wives and children of the members of the Arc Works Club, of Messrs. Crompton and Co., was held at Chelmsford on Jan. 4. Many distinguished persons were present, including Colonel and Mrs. Crompton, Miss Crompton, Mr. and Mrs. Claud Crompton, Bernard Gibson, Esq., Lady Gooch, the Mayor and Mayoress of Chelmsford Mr. and Mrs. E. Copeland Gray, W. P. Copp, Esq., Rev. Canon and Miss Lake, Rev. T. M. Mundle, A. J. Hodgson, Esq. (works manager), Mr. and Mrs. James C. MacFarlane, the Revs. Thurlow, Pressey, and Prior, etc. From first to last everything went off most successfully, and hearty congratulations are due to the committee, and especially to the hon. secretary (Mr. P. G. Cheverton) and the assistant hon. secretary (Mr. H. Preston).

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TRADE NOTES AND NOVELTIES.

"Victor" Arc Lamps.

Messrs. the Electrical and Ordnance Accessories Company, Limited, Stellite Works, Cheston-road, Aston, Birmingham, are making the "Victor" arc lamps, of which three distinct types have been standardised—namely, the "Standard," the "Miniature," and "Flame" lamps—each possessing distinctive and important features. The special features of the first-named lamp are well brought out in Fig. 1.

The "Victor" lamp has only one moving part, which is contained inside a sealed tube. This, with the general arrangement of all parts perfectly balanced round a central tube, renders the lamp at once unique, and it is claimed to be the only one of its kind on the market to-day. There are no soldered connections in the lamp, all leads being run direct unbroken to their respective points of contact. The coils are all impregnated, making them impervious to moisure; therefore there is less chance of breaking down. Its mechanical construction and the absence of moving parts will appeal to all engineers who desire a lamp at once pleasing in design, strongly built throughout, and yet easy and cheap to maintain. The design of the "Victor" lamp is such that interchangeability is an important feature; that is to say, the lamp will work well

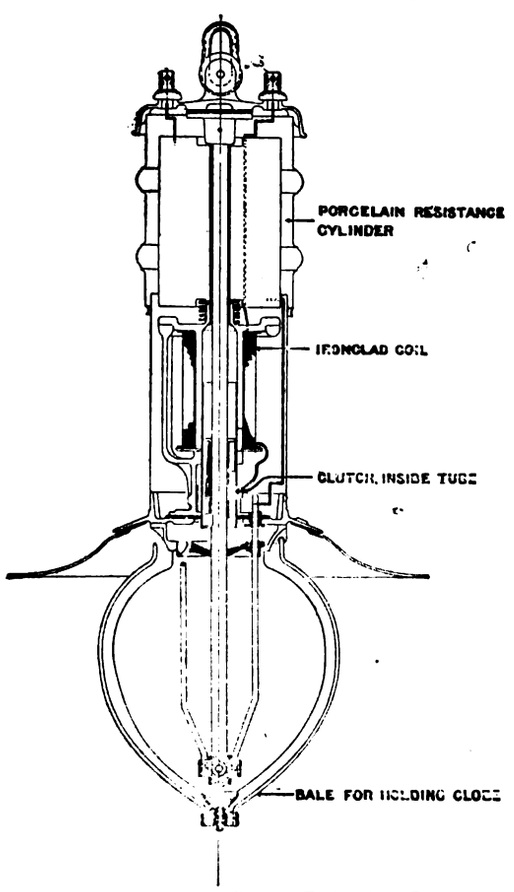

FIG. 1.—Details of "Victor" Enclosed Arc Lamp.

either singly or in multiple series with other lamps of same make. This point will be appreciated by corporation engineers when considering the lighting of a big area with a large number of lamps, for the number of "stand-by" lamps can be kept very low. This also applies favourably to an installation which is likely to be extended, for lamps can always be supplied which will work satisfactorily with those already in use.

The "Miniature" arc lamps are standardised in two sizes—1½ amperes, 2½ amperes (in each of the two different patterns); they are made for working in parallel on 100 to 125 volts or two in series on 200 to 250 volts. Also for high voltages working singly on 200 to 250 volts with external resistances. The "Bayonet" pattern (Fig. 2) is intended to replace incandescent glow lamps, and is for indoor use only. It has the top portion of the case fitted with an ordinary adapter, round which is a loop having at the top a porcelain shackle wheel by which it can be supported. The connection to lamp is then made by placing the lampholder on to the special adapter. The loop is large enough to allow of any ordinary switch lampholder being used. The general construction of the lamp is exactly the same as that of the "Standard" type, and only mica and porcelain are used for insulating purposes.

The type of lamp shown in Fig. 3 (which is intended for outdoor use) is of the same interior construction as the "Bayonet" pattern except the top. The crown is fitted with standard terminals insulated from the lamp, with watershed porcelain insulators. The case is designed on the same principle as the "Standard"—namely, in two parts—so that inspection of the interior may easily be made. All "Miniature" lamps are made single and double enclosure.

Automatic Time Switch.

The Reason Manufacturing Company, Limited, Lewes-road, Brighton, have placed upon the market a new time switch, for which certain important advantages are claimed. We have been enabled to present a description of one of the Reason Company's automatic time switches of 10 amperes 230 volts capacity, which we believe will be of interest to them. The principle on which this time switch works is as follows: A high-class clock movement of the best French manufacture is driven by means of a spring, which is wound electrically a small amount very 2½ minutes, the spring being of sufficient length to keep the clock going and working the switch for 10 hours if the current is switched off. The winding is effected by the clock releasing a substantial carbon switch, which falls together and makes a circuit through a shunt coil, the shunt coil pulling up a plunger and winding the spring through a ratchet. On the plunger reaching the end of its upward stroke the carbon switch is opened with a quick break, and the mechanism is in a position to be released by the clock for the same cycle of operations 2½ minutes later. The switch consists of a laminated copper switch on the end of a pivoted arm, which is pushed home through a link, the other end of which is pivoted eccentrically on the arbor of a spring similar to that which works the clock. The clock in running keeps this second

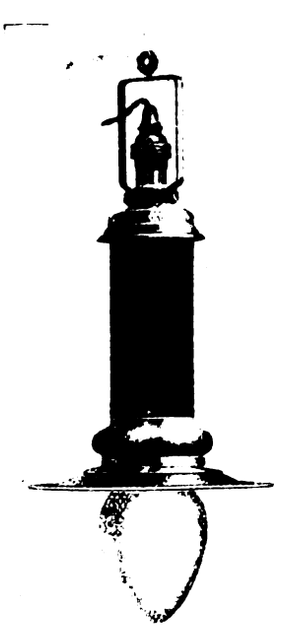

FIG. 2.—"Victor" Miniature Arc Lamp, Bayonet Pattern (Indoor Use).

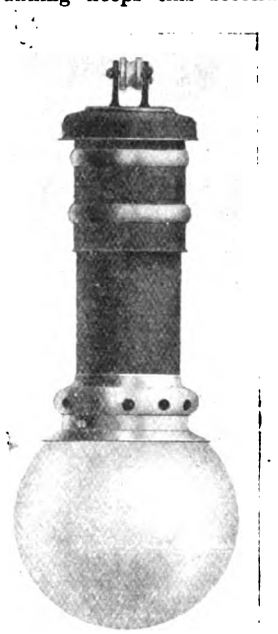

FIG. 3.—"Victor" Miniature Arc Lamp for Outdoor Use.

spring fully wound, and the sole function of the clock is to realise the power of this spring to actuate the switch. The clock mechanism and the solenoid and winding gear are fixed to the back of a stout brass bed-plate, which is screwed to a ledge halfway in the depth of the same, and are thus doubly enclosed from outside influences, such as dust, etc. One of the chief points which has been kept in mind in this design is to protect the necessarily delicate clock mechanism from unauthorised handling, and this being at the back of the bed-plate, no access can be gained to it except by removing two screws in opposite corners of the bed-plate. One of these is sealed with the company's seal, but since the clock will require cleaning at periods of about three years or thereabouts, the Reason Company recommend their customers to instruct their testing departments not to allow the company's seal to be broken and the back of the case to be opened except by a competent watchmaker. It will be found on taking the instrument out of its case that a clockmaker can easily remove the movement and clean it and replace it without interfering in the slightest with any of the electrical connections or winding gear. The carbon contacts may require to be replaced from time to time at long intervals, but so far, we understand, it has been impossible to detect any wear in them. It is, however, advisable, as a matter of routine on inspecting the clock, that the insulating gauge supplied therewith should be inserted between the contacts in order that any wear may be noticed; there is, however, provision for about ¼in. of wear. Fig. 4 shows a Cantie switch operated electrically by a controlling time switch, Fig. 5 shows the working parts, while Fig. 6 presents a view of the front with the cover removed.

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Catalogues, etc.

MESSRS. FERRANTI LIMITED, Hollinwood, Lancashire, have sent us a copy of their new continuous-current meter pamphlet. This type of meter is of the mercury motor type for the measurement of electrical quantity when supplied on the constant-potential system. It is made in sizes ranging from 3 amperes to 1,200 amperes; above 50 amperes the meters are of the shunted type. In a later issue we hope to present

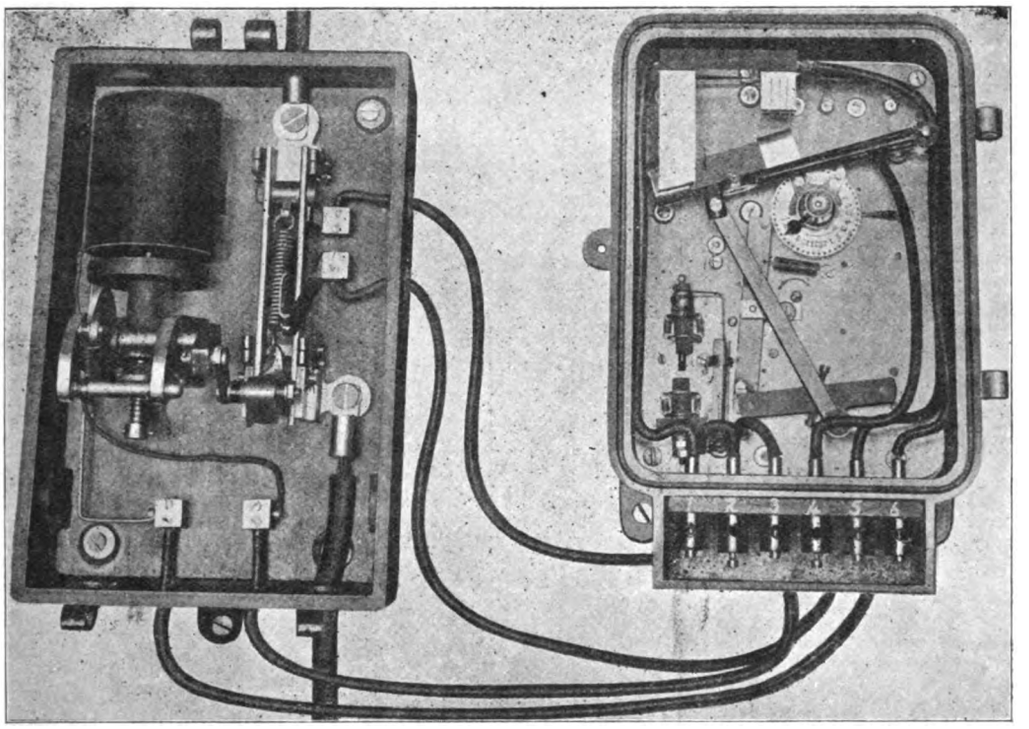

FIG. 4.—Cantie Standard Switch, Operated Electrically, and Controlling Time Switch, Operating Cantie Switch.

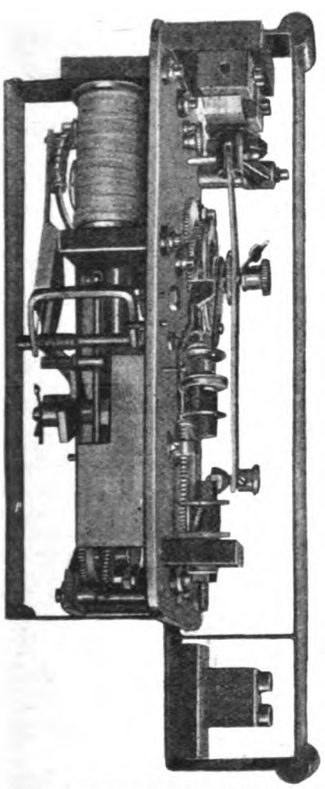

FIG. 5.—Section Showing Working Parts of Time Switch.

FIG. 6.—View of Front of Switch with Cover Removed

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one or two illustrations depicting the various types of ampere-hour meters and battery meters made by Messrs. Ferranti. We need only state that the thousands of these new type meters in use furnish convincing evidence that their 17 years' experience with mercury motor meters has enabled them to overcome the difficulties involved in the use of mercury.

THE GENERAL ELECTRIC COMPANY, LIMITED, 71, Queen Victoria-street, London, E.C., have issued a new complete catalogue of Osram fittings and accessories, in which a good deal of attention is paid to the "adapters" for burning Osram lamps in series. The glass shades have also been specially constructed, the length of the Osram being excellently adapted to elegant forms in glassware. The second quarterly issue (No. 70) of the "General" electrical progress sheet has also come to hand. It contains an illustrated article on motor-generators supplied to the London County Council. Attention is also devoted to the latest types of testing instruments, switches, fittings, heating apparatus (by convection), and central-battery telephone and telephone switchboards.

LEGAL INTELLIGENCE.

MOTOR-BOAT DISPUTE.

In the City of London Court on Wednesday a claim was made by J. W. Brooke and Co., electrical and motor launch engineers, Adrian Works, Lowestoft, against Mr. C. Algernon Moreing, mining engineer, 20, Copthall-avenue, E.C., to recover £34, the balance of £154 for work done to his motor-boat launch "Albicore." Mr. Pridham Whippell appeared for the plaintiffs and Mr. Hamar Greenwood, M.P., for the defendant. The case was partly heard a month ago. The defendant raised a counterclaim for about £200, alleging that the plaintiffs' work had been so badly done that he had to call in the Daimler Co. He had had to get some of the work done again by the Daimler Co., and he now claimed for the return of the £125 paid by mistake to the plaintiffs. He raised a claim, too, for £50 for the loss of the use of the boat owing to the defective work which he asserted the plaintiffs had put in. The engines, he suggested, were very badly done, and there were many defects in the boat. There were loose electrical connections in the engine, the reversing gear would not act, and the engine was ¾in. out of true. In fact, during one of the trial trips the boat broke down, and he and his friends had to walk five miles to a railway station. Plaintiffs said that their work was in every way satisfactory, and when the boat was finished it was in good order. Defendant changed his plans, and the boat remained hanging about for some months. That caused some little untidiness. The case was now settled on defendant paying £30 in full settlement of debt and costs, his counterclaim being withdrawn.

ACTION AGAINST THE POTTERIES TRAMWAY CO.

An action against the Potteries Electric Traction Co. was heard before his Honour Justice Ruegg at Longton County Court on the 7th inst.

Plaintiff was a Miss Anderson, who claimed damages for personal injuries sustained through the negligence of the defendant company's servants on Sept. 11. Plaintiff was knocked down by the off step of a tramcar when she was in the act of crossing the road.

The DRIVER said that he did all he could to avoid the accident. The car was going at from six to seven miles an hour, and was under perfect control.

HIS HONOUR remarked he had heard it said that emergency brakes were often responsible for accidents; the drivers trusted too much to them, and applied them when too late.

COUNSEL explained that they were only applied on special occasions, as the wrench did damage to the car.

HIS HONOUR held that defendants were responsible for the accident. The only possible defence to this action was that there had been contributory negligence on the part of the plaintiff in not taking proper precautions by looking round. Assuming the plaintiff was deaf, and did not hear the warnings of the driver, persons with infirmities must cross roads, and there was not much negligence on her part. Neither was there serious negligence on the part of the driver. He evidently thought the old lady was nimble enough to get clear of the car, but, having seen her 30 yards away, he should have taken the steps to prevent a collision. In relying on the old lady to get clear he committed an error of judgment which amounted to negligence. Judgment would be entered for the £11 claimed.

COMPANIES' MEETINGS AND REPORTS.

GENEVA TRAMWAYS.

The report of the Geneva Tramways Co. (1906) for the period from the date of incorporation, Dec. 17, 1906, to Sept. 30, 1907, states that, it having been found impossible for the Geneva Tramways Co. (old company) to meet the full 4½ per cent. interest on the £850,000 debentures, the company went into voluntary liquidation on Oct. 4, 1906, and the present company was registered under a scheme of arrangement sanctioned by the court on Nov. 10, 1906. The scheme (shortly) provided for the sale of the old company's assets to this Company. The 4½ per cent. debenture holders of the old company are entitled under the scheme to 510,000 shares of £1 each (fully paid) and £255,000 4 per cent. debentures of this Company, to be distributed amongst them *pro rata* in lieu of their holding in the old company. The third (5 per cent.) debenture holders of the old company received under the scheme in lieu of their holding and all accrued interest thereon a *pro rata* distribution of 30 000 £1 shares fully paid in the capital of this Company. The rights of the shareholders and income certificate holders of the old company were under the scheme extinguished. Applications for 4 per cent. debentures and shares in the Company had been received to the date of closing the accounts in respect of £811,200 4½ per cent. debentures of the old company, and the equivalent 4 per cent. debentures and shares in this Company have been allotted in exchange. Since the closing of the accounts further 4½ per cent. debentures of the old company have been surrendered, the total to date being £843,700, in exchange for which £253,110 4 per cent. debentures and 506,220 shares of this Company have been allotted. The profit and loss account of the Swiss company shows a gross profit on working of 562,148·20fr., and, including the credit balance of 227,652·20fr. brought forward from the previous period, makes a total of 789 800·40fr., and after making provision for the necessary contributions to amortisation, renewal, and reserve funds, amounting together to 179,332·65fr., there remained a balance of 610,467·75fr., out of which a dividend of 1½ per cent., amounting to 300,000fr., has since been paid, leaving a balance of 310,467·75fr. to be carried forward. Of the dividend of 300,000fr. above referred to, 299,940fr. have been received by this Company in respect of its holding of shares in the Swiss company, as shown in the revenue account. In connection with the Swiss company's profit for 1906, after making provision for a dividend of 1½ per cent., the balance was set aside for the purpose of providing for the necessary increase in rolling-stock, and likewise a proportion of the profits for the year 1907 has been employed for a similar purpose, so that the Company may effectively deal with the increased traffics.

SOUTH LONDON ELECTRIC SUPPLY.

An extraordinary general meeting of the South London Electric Supply Corporation was held on the 7th inst., Mr. J. Atherton presiding.

The following resolutions, which were passed at the extraordinary general meeting held on the 20th ult., were confirmed: "That by virtue of the powers contained in the Companies Acts, 1867 and 1877, and the Company's regulations, the conditions contained in the memorandum of association be modified by the reduction of the existing nominal capital of the Company from the sum of £325,000 to the sum of £260,000, thus reducing the capital of the Company by £65,000, and that such reduction be carried into effect by the alteration of the 65,000 shares of £5 each now forming the capital of the Company into 65,000 shares of £4 each." (2) "That, in accordance with the above resolution the capital of the Company shall henceforth stand as follows—namely, the nominal capital of the Company shall be £260,000 divided into 65,000 shares of £4 each."

In reply to questions, the CHAIRMAN said that the expenses in connection with the reduction of capital would amount to about £200. It was difficult to say what profit the refuse destructor had produced, but he thought they might regard the amount as lost. The maximum charge for current for lighting purposes was about 4½d. per unit, and the minimum for power about 1d. per unit.

NEW COMPANIES REGISTERED.

I. Harris.—Registered Dec. 28. Capital, £1,000 in £1 shares. Objects: to acquire business of dealer in talking machines and electrical and optical goods carried on by B. Harris at Manchester as I. Harris and Sons. Office: 4, Blue Boar-court, Manchester.

Electrical Apparatus Co.—Registered Dec. 23. Capital, £3,500 in £1 shares. Objects: to acquire business of electrical engineers carried on by E. Schattner, F. H. Epstein, R. Amberton, and R. Behrens, at Caxton House, Westminster, as Electrical Apparatus Co.

British Electrics (Moseley's Patents).—Registered Dec. 31. Capital, £10,000 in £1 shares. Objects: to acquire inventions relating to manufacture of electric, magnetic, and other appliances, and certain patent rights and property referred to in an agreement between W. Moseley and F. de H. Larpent.

Checkogram (1908).—Registered Jan. 3. Capital, £51,000 in £1 shares. Objects: to acquire the undertaking of Checkogram (incorporated in 1904), and to carry on the business of manufacturers of and dealers in mechanical and electrical appliances for delivering, receiving, counting, checking, or other operations, and mechanical and electrical indicators, turnstiles, gates, tickets, checks, perforating and stamping presses, etc. Registered office: 150, Oxford-street, W.

Electrical Apparatus Co., Limited.—Registered Dec. 23. Capital, £3,500 in £1 shares. Objects: to acquire the business of electrical engineers carried on by E. Schattner, F. H. Epstein, R. Amberton, and R. Behrens at Caxton House, Westminster, as the Electrical Apparatus Co., and to carry on the same and the business of electricians, suppliers of electricity, manufacturers of and dealers in motors dynamos, accumulators storage cells, insulators, lamps, and other electrical apparatus and appliances, etc. No initial public issue.

Liens Registered.

New Electric Rifle and Target Co., Limited, London, W.—Discharge Dec. 15, extent of £500, debenture June 13, 1906, £2,000.

Llangollen and District Electric Light and Power Co., Limited.—Debenture and mortgage Dec. 20 for securing £400 (leasehold property and other assets).

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La Estrella Copper Mines, Limited, London, E.C.—Particulars required by Sub-Section 4, Section 14, of the Companies Act, 1900, Dec. 12, £1,500 debentures. No trustees (property and assets).

Appliances and General Engineering Co., Limited, London, E.C.—Lien Dec. 31, £300 7½ per cent. debentures, part of £2,000. Amount previously issued, £700. No trustees. Whole of the assets.

Gloucester Railway Carriage and Wagon Co., Limited.—Lien registered Dec. 12 for £300 4 per cent. debentures, part of series not to exceed nominal capital. Amount previously issued, £382,534. No trustees. Secured on the general assets.

Cleveland and Durham Electric Power Co., Limited.—Issue on Dec. 11 of £105,000 5 per cent. debentures, being the whole of a series created same date. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

La Estrella Copper Mines, Limited.—Particulars of £1,500 debentures, created by resolution of Dec. 6, 1907, have been filed pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: the company's property, present and future, including uncalled capital. No trustees.

Llangollen and District Electric Light and Power Co., Limited.—A 5 per cent. debenture, dated Dec. 14, 1907, to secure £400, charged on the company's undertaking and property present and future, including uncalled capital, and (as collateral security) a second mortgage of certain leasehold property, have been registered. Holder: A. W. Blake, Cusop, Hay, Hereford.

Northern Counties Electricity Supply Co., Limited.—A trust deed, dated Dec. 11, 1907, securing £100,000 second debenture stock, has been registered. Property charged: freehold lands and hereditaments at Cowpen Quay, Merrington, Alnwick, Felling, Thirsk, Hirst, and Shildon; leaseholds at Egypt, Hartlepool, and at Ilcworth, Hebburn, and Malton, and the company's general assets, present and future (except uncalled capital), subject to £100,000 first debenture stock. Trustees: F. A. E. Samuelson, Breckenbrough, near Thirsk, and J. R. Hanson, Cliffden, Saltburn-by-the-Sea.

Egyptian Delta Light Railways, Limited.—A trust deed, dated Dec. 23, 1907, securing a further £25,000 debentures (supplemental to a trust deed of March 25, 1897, securing £170,000 debentures, and to trust deeds of July 25, 1900, March 7, 1904, June 8, 1904, and Sept. 17, 1907, securing respectively £100,000, £60,000, £130,000, and £20,000 additional debentures), has been registered, making the total amount secured £505,000. Property charged: all the company's securities, railways, undertaking, and property, present and future (subject, as to property purchased from La Compagnie des Chemins de fer Economiques de l'Est Egyptien, to £242,180 3½ per cent. debentures, and subject also, as to property purchased from the Metropolitan and Cairo Helouan Railway Société Anonyme, to £E.96,000 4 per cent. debentures). Trustees: Sir Gerald Fitzgerald, K.C.M.G., 18, Cadogan-gardens, S.W., and Sir John R. Heron-Maxwell, Bart., 9, Wilbraham-place, London.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Bolivia.—The Municipality invite tenders for the construction of an electric light station.

Brussels.—Tenders are invited for electric overhead railway material. Tenders by Jan. 15.

Rome.—The Italian Government Railways invite tenders for arc lamp carbons. Tenders by Jan. 15.

Manila.—The Municipality invite tenders for pumps and electric motors for sewage works. Tenders by Jan. 15.

Ilford.—The Urban District Council invite tenders for feeder cable for the Electricity Department. Tenders by Jan. 14.

Melbourne.—Tenders are invited by the Postmaster-General for switchboards and telephone sets. Tenders by May 26.

Sydney.—The Postmaster-General invites tenders for 33 switchboards for common-battery working. Tenders by March 4.

Madrid.—The Public Works Department invite tenders for the construction of a tramway at Santander. Tenders by Jan. 30.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Cadiz. Tenders by Jan. 22.

Aranjuez.—The Municipality invite tenders for the installation and maintenance of public electric lighting for six years. Tenders by Jan. 14.

Valencia.—The Madrid Public Works Department invite tenders for the construction of electric tramways in Valencia. Tenders by Jan. 12.

Madrid.—The Post and Telegraph Department invite tenders for the installation and working of telephones in La Garriga. Tenders by Jan. 16.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Rotherham.—The Corporation invite tenders for the supply of tramway rails, fishplates, tie-bars, bolts and nuts, and special work. Tenders to the Town Clerk by Jan. 17.

Ghent.—Tenders are invited for 30 electric cranes for the new dock. Particulars from the Public Works Department, 15, Rue des Augustins, Brussels. Tenders by Feb. 1.

Kilkenny.—The District Lunatic Asylum Committee invite tenders for electric generators, accumulators, switchboard, underground mains, wiring, and fittings. Tenders by Jan. 18.

South Shields.—The Corporation invite tenders for the supply of uniforms for the tramway employés. Particulars from Mr. J. Wilson, the tramways manager. Tenders by Jan. 11.

Manchester.—The Corporation Tramways Department invite tenders for the supply of machine tools. Particulars from the Tramways Manager, 55, Piccadilly. Tenders by Jan. 14.

Worcester.—The Corporation invite tenders for the supply of one 400-kw. continuous-current steam generator and balancing dynamo and surface condenser. Tenders by Jan. 11, 1908. See advertisement in last issue.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1, 1908.

Camberwell.—The Borough Council invite tenders for the annual supply of various stores and materials, including maintenance of private telephones and electric bells, and rubber goods. Tenders to the Town Clerk by Jan. 20.

Finchley.—The Urban District Council invite tenders for the supply and erection of one 350-kw. high-speed engine and dynamo combined, together with spare parts. Tenders by Jan. 20, 1908. See advertisement in last issue.

Glasgow.—Tenders are invited by the Corporation Electricity Department for the supply of 4,000-kw. turbo-alternators. Particulars from Mr. W. W. Lackie, the chief engineer. Tenders by Jan. 14. See advertisement in last issue.

Fleetwood (Lancs.).—Tenders are invited for lighting the Primitive Methodist new Sunday school, Fleetwood. Plans and specifications to be seen at Rev. E. Mather's, Promenade-road, Fleetwood. Tenders to be in by Jan. 16.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1, 1908.

London, E.C.—Tenders are invited for the supply of 15,456 incandescent lamps for the Bengal and North-Western Railway Co., as per specifications to be seen at the Company's Offices. Tenders to Mr. Alexander Izat, managing director, 237, Gresham House, Old Broad-street, London, E.C., by Jan. 13.

Adelaide.—Tenders are invited for the supply and delivery, c.i.f. Port Adelaide, of special work, points, and crossings for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C. Tenders to the Chairman, Municipal Tramways Trust, Adelaide, by Feb. 11, 1908.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 500 tons of steel slot rails and about 190 tons of conductor rails required for the reconstruction on the underground conduit system of electric traction of certain sections of the Council's tramways. Particulars from the chief engineer, Mr. Maurice Fitzmaurice, C.M.G., County Hall, Spring-gardens, S.W. Tenders to the Clerk by Jan. 21.

Plymouth.—The Corporation Electricity and Street Lighting Department invite tenders for the supply of the following stores during 12 months ending March 31, 1909: (1) arc lamp carbons; (2) electricity meters; (3) transformers; (4) cables (paper-insulated); (5) lubricating oils, etc.; (6) engine waste, etc.; (7) gas mantles, etc. Specifications may be obtained on application to Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by Jan. 23.

London, N.—The London County Council invite tenders for the road work and platelaying required for the reconstruction for electric traction on the conduit system of the Council's existing tramways in Caledonian-road and Seven Sisters-road. The total length of the above-mentioned lines is about 5¼ miles, single track. Particulars from the chief engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W. Tenders to the Clerk by Jan. 28.

RESULTS OF TENDERS.

Fulbourn.—The tender of the Alliance Electrical Co. for the installation of electric fire alarms at the Fulbourn Asylum has been accepted.

Darwen.—The Town Council have accepted the tender of the Clifton and Kearsley Coal Co. for the supply of coal to the electricity works for six months.

Cardiff.—Messrs. Bruce Peebles and Co. have received from the Corporation an order for a 250-kw. Peebles-La Cour motor converter, this being a duplicate of the unit previously ordered.

Stepney.—Messrs. Bruce Peebles and Co. have secured, through Willans and Robinson, the order for a 2,000-kw. 6,000-volt 50-cycle three-phase turbo-alternator to be driven at 1,500 r.p.m. by Willans and Robinson steam-turbine, for the Borough Council.

OPENINGS FOR CONTRACTORS.

ABERDEEN — Two houses, Willowbank-road, Mr. Duncan Hodge, architect; two houses, Willowbank-road, Messrs. Henderson and Son, architects; reconstruction of premises, Spring-garden, Mr. W. Smith, architect; dwelling-house, south side Polmuir-road, Caledonian Railway Co. (Messrs. Macqueen and Knox); additions to engine-house, west side of North-esplanade (West), Mr. Duncan Hodge, architect; offices and stores, Albert-quay, Mr. William Stewart.

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ABERGAVENNY—Conversion of houses into shops, Mr. T. S. Foster; dwelling-house, Oxford-street, Mr. B. J. Francis; pair of villas, Avenue-road, Mr. D. M. Scott; house, Grosvenor-road, Mr. T. S. Foster.

ABERTRIDWR—Chapel, Welsh Calvinistic Methodist Connexion.

ACCRINGTON — Elementary school, Peel-park (£14,634), Roydsdale-street (£13,730).

ADDINGHAM — Alterations and additions to high school (£570), Education Committee.

AINSDALE—Erection of station buildings, L. and Y. Railway Co.

ALBURY—Two houses, Mr. Maurice Glyn.

ALDERSHOT—Stables, War Office.

ALSTON—Secondary school, Cumberland Education Committee.

ANERLEY—Residence, Managers of the North Surrey District School. Mr. C. A. Sharp, architect.

ARLESFORD—Infirmary (£1,930), Board of Guardians.

BACUP—Post office, site in Market-street, Commissioners of Public Works.

BALDRIDGEBURN—Branch library, Carnegie Dumfermline Trust.

BALLYWARD—One house, Ballyward Station, Great Northern Railway Co.

BANGOR—Electric lighting (£1,000), Town Council.

BARNET—Alterations to Clare Hall Hospital, South Mimms, Middlesex District Joint Small-pox Hospital Board.

BARSHAM—Extensions to Council school (£330).

BATLEY—Completion of town hall (£22,729), erection of fire station, Town Council.

BEESTON—Alterations and additions to Council school, Education Committee.

BELFAST—Pumping station, Park-avenue, Corporation.

BILSTON—Elementary schools, Staffordshire Education Committee.

BIRMINGHAM—Twenty-three houses on the Birmingham and North Warwickshire Railway at Shirley, Earlswood, etc., Great Western Railway.

BISHOP'S STORTFORD—Extension of engine-house at waterworks (£284), Town Council.

BLAENAVON—Classrooms and additions to Hillside School, Mr. C. Dauncey, Newport.

BLAYDON—Council school, Durham County Council.

BOLTON—Central business premises, Messrs. Adamson and Barlow.

BRADFORD—Public mortuary, Wilton-street, conveniences, Rawson-square, City Architect, Whitaker-buildings, Brewery-street.

BRIXHAM—Dwelling-houses and shops, Fore-street, Lords of the Manor. Mr. F. W. Vanstone, architect.

BRODSWORTH—Store, Colliery Village, Doncaster Mutual Co-operative and Industrial Society.

BUNDORAN—Running sheds, Great Northern Railway (Ireland) Co.

BURGHEAD—Church (£882), Messrs. Wilson and Walker, Aberdeen.

BYFLEET—Parish church, Ecclesiastical Commissioners.

CAERPHILLY—Post office, Commissioners of Public Works.

CARLISLE—St. Patrick's Boys' School (£2,000), Albert-street. Mr. Foxhall, architect.

CARRICK—Workmen's dwellings (£15,720), Rural District Council.

CELBRIDGE—Two houses, Tea-lane, Rural District Council.

CHELMSFORD—Waiting hall and porter's lodge at Hospital, Joint Hospital Board.

CHESILBORNE—Elementary school, Dorset County Council.

CHESTER—Underground public conveniences (£2,200), Town Council.

CHESTER-LE-STREET—Council school, Durham County Council.

CLACTON-ON-SEA—Petty sessional court house, etc., Essex Standing Joint Committee.

CLEADON—Council school (£3,196), Durham County Council.

COALVILLE—Council schools, Bridge-road (£9,125). Messrs. McCarthy and Co., architects.

COLCHESTER—Extensions to grammar school (£556), Education Committee.

CORNWALL—House, Gwinear-road Station, directors of the Great Western Railway.

COVENTRY—Alterations at the public baths, Priory-street, Town Council.

CROSSKEYS—Thirty houses. Mr. R. L. Roberts, Abercarn, architect.

DARWEN—Extensions, Anaglypta Branch, the Wall Paper Manufacturers, Limited; alterations and additions, Plantation Cottage, Mr. John Lomax; two houses, Earnsdale-avenue, Mr. E. Brooks; Conservative clubroom, etc., at Chapels, Chapels Conservative Club; alterations and additions, Primitive Methodist schools, Redearth-road, trustees of Primitive Methodist Schools.

DIPTON—Police building, Durham County Council.

DORCHESTER—New mortuary at Dorset County Hospital. Mr. Walter J. Fletcher, Wimborne, architect.

DUNDALK—Workmen's dwellings (£112,728), Rural District Council.

DUNDEE—Church at the west end of Dundee, Ecclesiastical Commissioners.

EAST HAM—Extensions to isolation hospital, Town Council.

EDGBASTON—Roman Catholic school, Vernon-road (£15,000).

EDINBURGH—Electric light installation at Portobello Higher Grade School, Edinburgh School Board.

EGLINGHAM—Villa. Mr. M. Temple Wilson, Alnwick, architect.

ELGIN—Reconstruction of laundry, Moray and Nairn Laundry Co.

ELLAND—Houses, Victoria-road, Mr. T. Kershaw, Halifax.

EVESHAM—Public hall (£6,000), Town Council.

EXETER—Extension to middle school (£4,115), City Council.

FAKENHAM—Buckenham Memorial Church. Mr. A. F. Scott, Norwich, architect.

FINTONA—Three houses, Fintona Station, Great Northern Railway Co.

FLEETWOOD—Lighting Primitive Methodist Sunday school, Rev. E. Mather.

FOLKESTONE—Houses, Grimston-gardens, Mr. A. Bromley.

FRODINGHAM—Twenty houses, Mr. A. Cobban, Scunthorpe.

GARSWOOD—Motor houses, Garswood Hall Colliery Co.

GATESHEAD—Church institute and parish hall, Churchwardens.

GIGGLESWICK—Two villas, Mains Estate, Craven Estate Co.

GLUSBURN—Elementary school, Education Committee.

GOODMAYES—Public elementary school, Ilford Urban District Council.

GOOLE—School and caretaker's house, Education Authority.

GORT—Workmen's dwellings (£21,134), Rural District Council.

GOSPORT—Erection of 16 "B" soldiers' quarters at the barracks.

GREAT HARWOOD—Public elementary school and technical instruction block to accommodate 900 scholars, Lancashire Education Committee.

HALIFAX — Warehouse, St. John's-place. Messrs. Utley, Hebblethwaite, and Utley, architects.

HERTFORD—Municipal buildings (£3,500), Town Council.

HOUGHTON CONQUEST — Elementary school, Bedfordshire County Council.

HULL—Shops and offices, Victoria-square, North-Eastern Railway Co.

HULME—Artisans' dwellings (£29,200), Manchester City Council.

HUNSTANTON—Alterations and additions to school. Mr. Green, Norwich, architect.

INVERURIE—Higher-grade school (£5,000). Mr. G. Gray, architect.

KERSLEY—Mission church, St. Stephen's parish.

KILKENNY—Workmen's dwellings (£35,000), Rural District Council.

KINLOCHLEVEN—Factory and buildings (£100,000), Aluminium Co.

LEATHERHEAD—Public mortuary (£100), Urban District Council.

LEEDS—Alterations to warehouse, Corporation; two houses, Nickleby-road, Mr. F. Mitchell.

LEYLAND—Manse, Trustees Wesleyan Church.

LEYTON—Iron isolation hospital, Urban District Council.

LICHFIELD—Alterations to house, etc., Breadmarket-street, City Council.

LIVERPOOL—Fitting of offices, Toxteth Guardians.

LLANDDEINIOLEN—Cloakrooms, alterations to Rhiwlas Council School, Education Committee.

LLANDUDNO—Public convenience, Town Council.

LONDON, W.C.—Rebuilding in Oxford-street. Messrs. Pilditch and Co, architects.

LONGTON—Alterations to Sea Lion public-house, John-street, Messrs. Bunting's Brewery Co.; additions to manufactory, Edensor-road, Mr. T. C. Wild; warehouse, Portland Works, Sutherland-road, Messrs. Aynsley and Sons.

MARGATE—Concert halls, pavilions, reading-rooms, etc., Corporation.

MERRIOTT—Alterations at the elementary schools, Somerset County Council.

MERTHYR—Two pavilions at the isolation hospital (£3,000), Merthyr Hospital Committee.

MOIRA—Fifty labourers' dwellings, Lurgan Rural District Council.

MULBEN—Houses, Glentauchers Distillery, Mr. C. Doig, Elgin.

NEVERN—Parish-room, Mr. L. Lewis, Cardigan.

NEW BASFORD—Methodist church. Mr. H. Harper, architect.

NEWPORT—Extensions to electricity works (£28,000), Town Council.

OYSTERMOUTH—Temporary mortuary, District Council.

PENTRE—Hall and caretaker's house, Committee of the Workmen's Institute. Mr. Jacob Rees, architect.

PLAISTOW—Extension of St. Mary's Hospital, Trustees.

PONTYPRIDD—New offices, Court House-street, Board of Guardians.

PORTSMOUTH—Additions to Gosport Hospital (£5,320), Governors of hospital.

PURITON — Improvement of elementary school, Somerset County Council.

RADNORSHIRE—Police station (£8,600), County Council.

SACRISTON—Schools, Durham County Council.

SAXMUNDHAM—Enlargement of Council elementary school, Education Committee.

SEATON—Houses, Mr. W. Smithson.

SETTLE—Workshops, Ribble-terrace, Mr. H. Brassington.

SHEFFIELD—Public conveniences, Health Committee.

SHINFIELD—Church at Spencer's Wood, Ecclesiastical Commissioners.

SOUTHAMPTON — Elementary school at Swaythling, Southampton County Council.

SOUTH BANK—Premises for the Unionist Club. Mr. F. Walshaw, architect.

SOUTHEND-ON-SEA—Improvements at the pierhead, shelters, etc., Corporation.

SOUTH NORWOOD—Polytechnic school to accommodate 350 girls upon a site at Selhurst, Croydon Borough Council.

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STEVENAGE—Boys' schools, Hertfordshire Education Committee.
STOCKTON—Elementary school, Bowesfield-lane, Board of Education.
STOPSLEY—Elementary school, Bedfordshire County Council.
STROKESTOWN — Workmen's dwellings (£34,271), Rural District Council.
SURLINGTON—Elementary school (£1,100), Education Committee.
SWANSEA—Asylum, County Asylums Committee.
TENTERDEN—Isolation hospital, Town Council.
TONBRIDGE — Villas, Mabledon-road. Mr. W. Groombridge; five houses, Douglas-road, Mr. C. J. Fowler.
TUNBRIDGE WELLS—Six houses, Whitefield-road, Mr. J. Jarvis; 12 houses, Erskine Park-road, Messrs. Hobbs and Sons.
TYLDESLEY—Artisans' dwellings, Town-lane, Mr. Cross.
WALSOKEN—Enlargement of Norwich-road school (£1,750), Education Committee.
WANDSWORTH—Infirmary (£93,000), Board of Guardians.
WARMLEY—Extension of St. Barnabas's Church. Mr. H. C. M. Hirst, architect.
WEST BROMWICH—Underground conveniences, Dartmouth-square, (£1,200).
WESTON-SUPER-MARE—Masonic Hall, Messrs. Price and Fry.
WINLATON — Congregational church to accommodate 450 people. Messrs. Liddle and Brown, Newcastle, architects.
WORTHING—Additions to Swandean Hospital (£3,000), extensions of electricity works (£4,370), Corporation.
YARMOUTH—Extensions to plant at electricity station, Town Council.
YORK—Swimming baths (£3,000), City Council.

PROVISIONAL PATENTS, 1907.

DEC. 23.

28222. Electric trolley pole improvement and wheel guide for electric tramcars and the like. William Wye, 18, Blackstone-street, Nottingham.

28227. Improvements in the manufacture of electric incandescence lamps. The Edison and Swan United Electric Light Company, Limited, and Edward Alfred Gimingham, Ponder's End, S.O., Middlesex.

28228. Improvements in the manufacture of electric incandescence lamps. The Edison and Swan United Electric Light Company, Limited, and Edward Alfred Gimingham, Ponder's End, S.O., Middlesex.

28255. Improvements in apparatus for electrically igniting miners' safety lamps or the like. Ernest Arthur Hailwood, Gladstone-terrace, Morley, near Leeds.

28277. Improvements in or pertaining to the transmission and reproduction of images by photo-telegraphy. Thomas Thorne Baker and the Pictorial Newspaper Company, Limited, 46, Lincoln's-inn-fields, London.

28281. Collapsible trolley pole for electric vehicles. George Samuel Thomson, 56, Ludgate-hill, London. (Complete specification.)

28289. Improvements in and relating to circuit breakers. Edward Neville Bray and Bray, Markham, and Reiss, Limited, 18, Southampton-buildings, London.

28291. Improvements in connection with incandescence electric lamps. Charles Henry Stearn and Charles Fred. Topham, 47, Lincoln's-inn-fields, London.

28305. Improvements in dynamo-electric machines. Erich Schiktanz, 39, Schiffbauerdamm, Berlin, Germany.

DEC. 24.

26125A. Improvements in electric switches. Arthur Francis Wileman, Kenilworth, Grove-road, Sutton, Surrey. (Date applied for under Rule 5 of the Patents Rules, 1905, Nov. 26, 1907.)

28334. Improvements in or connected with the jointing of metal wires, rods, strips, tubes, and the like. British Insulated and Helsby Cables, Limited, and Douglas Bryce Saunderson, 15, Water-street, Liverpool.

28367. Improvements in electric motor starters. Ernest Schattner, 18, Southampton-buildings, London.

28388. Improvements in or connected with the regulation of electric lamps. The Thames Ironworks, Shipbuilding, and Engineering Company, Limited, and Walter Herbert Flood, 4, South-street, Finsbury, London.

28410. Improvements in and relating to dynamo-electric machines for generating "continuous" current without the use of revolving commutators. Cyril Francis Mackness, "Richardia," Heriot-road, Hendon, Middlesex.

28412. Improvements in signalling by electromagnetic waves. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Patents Act, 1901, Jan. 14, 1907, being date of application in United States.) (Complete specification.)

28425. Improvements in electric measuring instruments. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Patents Act, 1901, Jan. 2, 1907, being date of application in Germany.) (Complete specification.)

28426. Improvements in insulators for overhead systems of electric railways and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

DEC. 27.

28435. Improved electric signalling system for railways. Alec Gardiner, 40, Chancery-lane, London.

28436. Improvements in electric signalling for railways. Alec Gardiner, 40, Chancery-lane, London.

28447. Improvements in means for preventing accidents on electric railways. Joseph Vesey Dickins, 128, Colmore-row, Birmingham.

28451. Method of and apparatus for lengthening the burning life of electric incandescent lamps. Wilhelm Herrmann, 40, Chancery-lane, London. (Complete specification.)

28457. Improvements relating to magnetic clutches, couplings, and the like. Arthur Smith and Christopher Southall, 18, Southampton-buildings, London.

28476. Improved lampholdor and shade carrier for screw cap electric lamps. Charles Maurice Escaré, Paul Fernand Escaré, and Charles Damey, 9, Osborne-road, Thornton Heath, Surrey.

28481. Improvements in or relating to what are commonly known as homopolar electrical generators and motors. Ralph Henry Barbour, 306, High Holborn, London.

28482. Improvements in or relating to electrical brushes or collectors. Ralph Henry Barbour, 306, High Holborn, London.

28483. Improved means of rapid excitation for the dynamos of petrol-electric automobiles and for other purposes. William Arthur Stevens, St. Peter-street, Maidstone.

28487. Improvements in machines for coating wires and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

28494. Jointing system for preventing the falling of the aerial wires of electric tramways. Alfred Ghislain Boon and François Mellaerts, 27, Chancery-lane, London. (Complete specification.)

28507. Improvements in or relating to electrical overload indicators. Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

28516. Improvements in electrical driving gear, more especially intended for motor road vehicles. George William Johnson, 47, Lincoln's-inn-fields, London. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges., Germany. (Complete specification.)

DEC. 28.

28530. Improvements in and relating to dynamo-electric machines. Mather and Platt, Limited, Salford, Ironworks, Manchester. (Emanuel Rosenberg, Germany.) (Complete specification.)

28542. Improved electrical induction furnace. Albert Hiorth, 19, Holborn-viaduct, London. (Date applied for under Patents Act, 1901, Jan. 4, 1907, being date of application in Norway.) (Complete specification.)

DEC. 30.

28592. Improvements in apparatus for testing telephone wires. James Milton Miller and Clinton Jacobs Murray, 18, Fulham-place, Paddington, London.

28603. Electric lashing attachment for jacquard or punching machines. Julius Krüger, 224, Friedrichstrasse, Berlin, Germany. (Complete specification.)

28619. Improvements in secondary batteries. Edward C. Ekstromer and Helcher Ekstromer, 7, Southampton-buildings, London. (Complete specification.)

28634. Improvements in electric locomotives. Benjamin Garver Lamme and Norman Wilson Storer, Westinghouse Building, Norfolk-street, Strand. (Date applied for under Patents Act, 1901, Jan. 5, 1907, being date of application in United States.) (Complete specification.)

28647. Improved method of producing high-frequency electrical oscillations and apparatus therefor. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, London. ((Date applied for under Patents Act, 1901, Feb. 4, 1907, being date of application in United States.) (Complete specification.)

28649. Improved apparatus for magnetic separation of ore. Metallurgiska Patentaktiebolaget, Birkbeck Bank-chambers Southampton-buildings, London. (Date applied for under Patents Act, 1901, April 2, 1907, being date of application in Sweden.) (Complete specification.)

28652. Improvements in and relating to electrical transformers and the like. Henry Metcalfe Hobart and Frank Benedict Cramer, 322, High Holborn, London

28658. Improvements in system of feeding current in electric railways. Luigi de Matteis, 31, Bedford-street, Strand, London. (Complete specification.)

DEC. 31.

28677. Improvement in the method of and means for operating and controlling the electric circuits of lamps of electrically illuminated signs and the like. Harold Copeland Harper, 76, Charlotte-street, Walsall,

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28688. Improved automatic electrical liquid meter and indicator. James Watson, 41, Reform-street, Dundee.

28690. Improvements in cable telegraphy. Isidor Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

28694. Improved method of advertising by an electrically or mechanically controlled machine. George Wallace, 235, High Holborn, London.

28695. Improved galvanic primary battery for motor ignition purposes and the like. George Wallace, 235, High Holborn, London.

28736. Telegraph typewriter. George Alexander Cardwell, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

28738. Improvements in and connected with electrical ignition devices. Carl Ebner, 6, Lord-street, Liverpool. (Complete specification.)

28748. Improvements in and relating to methods of electric train-lighting and apparatus therefor. James Dalziel, 83, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Jan. 16.)

1906.

20928. Systems of operating electric motors for braking purposes. British Thomson-Houston Company. (General Electric Company.)

21504. Manufacture of electric conductors of refractory metal, applicable more especially for use as incandescing bodies in electric lamps. British Thomson-Houston Company. (General Electric Company.)

23894. Electric motor-control systems and apparatus. British Thomson-Houston Company. (General Electric Company.)

23944. Electrical conduit and junction-box fittings. Hirst and Gunner.

26644. Electric supply systems. Leitner.

29174. Electric motors. Leitner.

29320. Electric switch. Lubeck.

29584. Circuit-controlling mechanism. British Thomson-Houston Company. (General Electric Company.)

29618. Sectional poles for telephone, telegraph, and trolley wires. Sciple.

29639. Electric circuit breakers. Scott.

29639A. Retarding devices or dashpots, more especially intended for use with electric circuit breakers. Scott. (Date applied for under Rule 5, Patents Rules, 1905, Dec. 29, 1906.)

29639B. Electric circuit breakers or switches. Scott. (Date applied for under Rule 5, Patents Rules, 1905, Dec. 29, 1906.)

29655. Electrolytic apparatus. Ruthenburg.

29665. Electrical apparatus for transmitting and receiving signals. Dawson and Buckham.

29758. Systems of electric train lighting. Leitner.

1907.

793. Automatic electric motor starter. Kilroy, and Evershed and Vignoles, Limited.

1696. Electric service motors. Couade. (Date applied for under International Convention, Jan. 23, 1906.)

2929. Electrical devices for exhibiting advertisements. Hewett and Foster.

2959. Electrical insulators for telegraph or telephone wires or the like. Purves and Sinnott.

2973. Method and means for actuating electro-mechanical fog signals for railways. Lowthian.

3212. Locks and electrical switches connected therewith. Tiercelin. (Date applied for under International Convention, Sept. 20, 1906.)

3613. Automatic periodically-operated electric switches. Gunning.

3968. Electric cranes, winches, and the like. Sunderland Forge and Engineering Company and Blair.

3997. Dynamo-electric ignition apparatus of internal-combustion engines. Electric Ignition Company and Hall.

6134. Signalling systems for railways and the like. British Thomson-Houston Company. (General Electric Company.)

7665. Coin-freed mechanism for gas, water, and electricity meters. Ullrich. (Date applied for under International Convention, March 22, 1906.)

8482. Apparatus for wireless telegraphy. Marconi and Marconi's Wireless Telegraph Company.

8483. Apparatus for wireless telegraphy. Marconi and Marconi's Wireless Telegraph Company.

8623. Means of propulsion of electrically-driven trains and the like. Stone and Migotti.

10259. Wireless telegraphy. Le Tall. (Hewitt.)

15532. Telegraph or signalling system and apparatus. Justice. (Sub-Target Gun Company.)

17767. Electric switches. Hunter and Warren.

21842. Adjustable electric lamp-shade holder. Kellond.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-⅜
—— Ord., 1,125 000	1 ..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	9/16-11/16
—— Ordinary, Nos. 1 125,000	1 ..	5/32-9/32
British Aluminium Co., Ordinary, 2.001-40 000	5 ..	3½-4½
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4½-5
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	4⅝-5⅛
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3⅞ 4⅛
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 102
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼ 6⅜
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅝-6⅛
—— 4½ per cent. Mortgage Debentures	100 ..	102-103
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85 89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275 001-375 000	3 ..	2-1½
—— 4 per cent. Mortgage Debenture Stock	100 ..	38 48 xd
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2 ..	0-¼
—— Non Cum., 6 per cent., Pref.	2 ..	¼-½
—— 4½ per cent 1st Debenture Stock	100 ..	85 86
—— 4½ per cent. 2nd Debenture Stock	100 ..	65-66 xd
Callender's Cable, Debentures	100 ..	104-105 xd
—— Ordinary	5 ..	9½ 10½
—— 5 per cent. Pref.	5 ..	5¼ 5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1½-1⅝
—— 5 per cent. Debentures	100 ..	94-97 xd
Dick, Kerr and Co., Ordinary, 1 260 000	1 ..	1¼-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	99 102 xd
Edison and Swan United, "A" Shares, 1-9 261	3 ..	⅛-1⅛
—— "A" Shares, 01-017,139	5 ..	1½-2½
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81 xd
Electric Construction, Nos. 1 to 112 100	2 ..	⅛-¼
—— 7 per cent. Cumulative Pref.	2 ..	⅜-½
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	57-62
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅞-8¼ xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	4⅜-4⅝
—— 4½ per cent. Debentures	100 ..	104½-106½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14½-15¼ xd
—— 4 per cent. Debentures	100 ..	96-98
National Electric Construction Co., 1-170,000	1 ..	11/16-13/16
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	28½-30½
—— 5 per cent. Bonds	100 ..	99-102 xd
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9 xd

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅛-5
Bournemouth and Poole, Ordinary	10 ..	9½-10⅛
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	9⅜-10⅛
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	10 10½
—— 4½ per cent. Debenture Stock, Red.	100 ..	98-101 xd
Bromley (Kent) Electric Light and Power Co	5 ..	4⅜-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	96-98
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6½-7
—— Nos. 80,000-100 000	5 ..	5⅞-6⅛ xd
Cambridge Electric Supply Company £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	93-103 xd
Central Electric Supply, 4 per cent. Guar Deb. Stock	100 ..	96-99
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3½-4⅜
—— 4½ per cent. Cum Pref., 1-80 000	5 ..	4-4½
—— 4 per cent. Debenture Stock, Red.	100 ..	95-98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4-4½ xd
—— ditto (905) 40,001-80 000	5 ..	3½-4½
Chelsea Electricity Supply	5 ..	3½-4½
—— 4½ per cent. Debentures	100 ..	100-103 xd
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	9⅜-10⅜
—— 6 per cent. Cumulative Pref.	10 ..	11-12
—— 5 per cent. Debenture Stock	100 ..	120-123 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs (all pd)	100 ..	93-96 xd
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50 ..	50-53
Cordoba Light and Power Co., 1st Mt. stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50 000	5 ..	3½-4½
—— 5 per cent Preference, 1-50,000	5 ..	4⅜-4⅝
County of London Elec. Supply, Ordinary	10 ..	6½-7½
—— 6 per cent. Cum Pref.	10 ..	10½-11
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100 ..	103-106 xd
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	95-98
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅜-½
—— 6 per cent. Cum Pref.	5 ..	⅜-½
—— 4½ per cent. First Mort. Deb	100 ..	79-80
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	— ..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2½-2⅝
—— 5 per cent Debenture Stock, Red.	100 ..	83-87 xd
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	92-94 xd
Folkestone Electric Supply, Ord., Nos. 1-10 000	5 ..	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	4⅞-5⅛
—— 4½ per cent. First Deb Stock, Red.	100 ..	96-99
Hove Electric Lighting, Ord., 1-13 000	5 ..	6⅜-6⅝
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	98-101 xd
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red	100 ..	92-96
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	1/16 3/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3	1½-1⅝
—— 6 per cent Pref.	5	4½-4⅝
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	87-91
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100	92-95
Metropolitan Ordinary, 100 001-200,000	5	5½-6
—— 4½ per cent. First Mortgage Debenture Stock	100	100-103 xd
—— 4½ per cent. Cum. Pref.	5	4⅜-5¼ xd
—— 5½ per cent. Mortgage Debenture, Red.	100	85-90 xd
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1 000)	—	75-77 p.c. xd
Mexican Light and Power Co., Capital Stock	$100	50-52
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500) 4,001-14 000 ($1,000)	—	85½-87½
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb	—	96-97 xd
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57 009	5	6½-6⅝
—— do., 57 010-75 000	5	6½-6⅝
—— do., 75,001-87 500 (issued at £2 prem., 16s. paid)	5	6½-6⅝
—— 5 per cent., Pref., 1-57,009	5	5-5¼
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5-5¼
North Hill Electric Lighting	10	11-12
—— 4 per cent. First Mort. Deb. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5½ 6
—— 4 per cent. Debenture Stock	100	96-97
River Plate Electricity Co., Ord., 1 119 687 & 120 501-120 507	1	9/16 1 16
—— 6 per cent. Non-Cum. Pref. 1-100 000	1	⅞-1
—— 5 per cent. Debenture Stock Red	100	95-96 xd
Rosario Electric Co 6 per cent Cum Pref., 1-20 000	5	4⅜ 5¼
—— 6 per cent Cum 2nd Pref., 1-15 000	5	4⅜-5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	—	96-98 p.c. xd
Smithfield Markets Electric Supply, Ord., 1-12,000	5	½-1½
—— 4 per cent. Debenture Stock	100	71-75
South London Ordinary	5	2½-3
South Metropolitan Electric Light and Power, Ord.	1	½-¾
—— 7 per cent Cum Pref.	1	¾-1½
—— 4½ per cent 1st Mort. Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7½ 8½
—— 7 per cent. Pref.	5	6½-7½
—— 3½ per cent. Deb.	100	85-90 x i
Urban Electric Supply Co., Ordinary, 8-30 007	5	1½ 2½
—— 5 per cent. Cumulative Preference, 50 001-80,000	5	1⅝-2⅝
Westminster, Ordinary	5	8-9
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅜-5½ xd

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260.007	5	5 13/16-6 1 16 xd
—— 10 per cent. Non-Cum 2nd Pref., 260.008-580,007	5	7⅜-8½
—— Permanent 6 per cent Debenture Stock, 1888	100	125-128 xd
Auckland Elec Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	101-104 xd
Barcelona Tramways, Ord., 1-20 000	10	—
—— 5 per cent. Cum. Pref Shares, 1-10,000	10	—
—— 6 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum Pref. Shares, 1-75 000	1	1316/-15/16 x i
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk., Red.	100	92-95 xd
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec Supply and Trams Co., 6 per cent. Cum. Pref.	10	9⅜-9⅝
—— 4½ per cent. Deb. Stock, Red.	100	92-94
Brisbane Tramway Invest., Ord., 1-75 000	5	3 3/16 3 7/16
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	4⅜ 4¾
—— 4½ per cent Deb. Stk., Red., Prov. Certs. all pd	100	95-99 xd
British Columbia Electric Railway Co., Ord Def.	100	104-107
—— Ord Pref.	100	103 104
—— 5 per cent. Cum Perpetual Pref. Stock	100	101 105
—— 4½ per cent 1st Mt. Deb. Nos. 1 6,250, of £240 each	40	98-101
—— 4½ per cent Vancouver Power Deb.	100	100 103
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10	1½ ⅝
—— 6 per cent. Cm Pf. 30 001-60 000	10	5 5½
—— 5 per cent. Perpetual Debenture Stock	100	92-93
—— 4½ per cent 2nd Deb. Stock	100	69-74
Buenos Ayres and Belgrano Trams	5	4 7/16-4 11/16
—— "A" 6 per cent. Cm. Pf., 1-4 000	5	4⅝-5¼
—— "B" 6 per cent Cm. Pf., 1-27 500	5	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100	105-115
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	89-91 xd
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	97-101 xd
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, Ord., Nos 1-137,610	5	6⅜-6⅝
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5	4¼-5⅜ xd
—— 4½ per cent. 1st Deb. Stock. Red.	100	99-103 xd
Cape Electric Tramways, Nos. 1-480,000	1	⅛-¼
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4½-4⅝
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	96-99
City of Buenos Ayres Trams. Co. (1 04), 1-248 000	5	5-5½
—— 4 per cent Deb. Stock, Red 1 985	100	97-101 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red	100	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10	1⅜-1⅝
—— 6 per cent. Cum Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-96
Dublin United Tramways (1896), Ord., Nos 1-60 000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60 000	10	12⅜-13⅜
—— 3½ per cent. Mort Debs., 1-3 000 Red	100	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	82-87
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60 000	5	⅛-⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	58-63 xd
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-⅛
—— 5 per cent "A" Deb. Stock	100	87-91
—— 6 per cent "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10- 0½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	92-95 xd
—— £296 500 2nd Mort Deb. Stock	—	—
—— £83, 30 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-684,188	1	⅛-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425.553	1	13/16-1 1/16 xd
—— 5 per cent. Mort Deb., 1-5,000 Red.	100	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7⅛-8¼ xd
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	80-84
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	94-97 xd
Manila Elec. R.R. and Lightg. Corp., 5 p.c 1st Lien and Coll Tr Sinkg Fund Gold Bonds of 1953, Red., 1-16,635	$1 000	88-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 201-21 635 and 23,436 25 000	—	4½ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100	95-98
Metropolitan Elec Trams., Defd., 1 000 001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref. 500,001 1 000 000	1	13/16-15/16
—— 4½ per cent. Deb. Stock, Red.	100	91-94 xd
Mexico Trams. Co., Gen. Cons. 1st Mort 50-year 5 per cent. Gold Bonds	—	82-84 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 001-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅜-9
Perth Elec. Tramways (W.A.) 5 per cent 1 Mrt. Deb. Stk.	100	97 101
Potteries Electric Traction, Ordinary 1-245 000	1	5/16-9/16
—— 5 per cent Cum Pref., 300 001-545 000	1	⅜-½
—— 4½ per cent Debenture Stock	100	95-96
Provincial Tramways Co., Ordinary 1-24 912	10	4⅜-5¼
—— 6 per cent. Cum. Pref., 1-10 000	10	10-11 xd
Rangoon Elec. Tramway and Supply Co. 6 p.c. Cum Pref., 1-20 000	5	4⅜ 5¼ xd
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	95-97 xd
Sao Paulo Tramway, Light, and Power Co.	$100	115-119 xd
—— 5 per cent. 1st Mort Deb., Red. 1929 1-11,000	$500	91½-93½ p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169.570, Prov. Certs.	1	¾-1⅛
—— 4 per cent. Deb Stock, Red. 1-40	100	78 82 xd
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	73-77 xd
Yorkshire (West Riding) Elec Tram Co., Ord., 70 001-110,000	5	1-1½
—— 6 per cent. Cum Pref., 1-46,261	5	3½ 3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	78-81 xd

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100	66-68
—— 4 per cent. Pref.	100	84-86
—— " " deferred	100	44-47
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	101-104
City and South London, Consolidated Ordinary	100	45-47
—— 4 per cent Debenture Stock	100	101-104
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	113-116
—— " " " '01	100	113 116
—— " " " '05	100	109-112
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50,000	10	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	35-39

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent Debs. Red., within 1-1,069	100	84-87 xd
American Telephone and Telegraph Coll. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000	86-88 xd
Anglo-American Telegraph Co., Ordinary	100	57- 0
—— 6 per cent. Preferred Ordinary	100	100-102
—— Deferred Ordinary	100	16¾-17¼
Anglo-Portuguese Telephone Co., 5 per cent 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44 000	5	6⅜-7½
Commercial Cable Co., Ster., 500-year 4 p.c. Deb. Stk., Red.	100	83-84 xd
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10	6-7
—— 10 per cent Preference, 1-6 000	10	15-16
Direct Spanish Telegraph Co., Ordinary	5	3½-3⅝
—— 10 per cent. Cum. Preference	5	8½-8⅝
—— 4½ per cent. Debs., 1-600	50	97-100 xd
Direct United States Cable Co.	20	13½-14
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	99-101 xd
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	99-101
Eastern Extension, Australasia and China, 1-300 000	10	12⅜-12⅝
—— 4 per cent. Mort. Deb Stock. Perp.	100	98½-102½
Eastern Telegraph Co., Ordinary Stock	100	130-135
—— 3½ per cent. Preference Stock	100	85-86
—— 4 per cent. Mortgage Debenture Stock	100	99-102
Great Northern Telegraph Co. (of Copenhagen)	10	30½-32½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort Debs., within 1-1 200, Red.	100	99-101 xd
Indo-European Telegraph Co.	25	52-55
Marconi's Wireless Telegraph Co., Nos 255,128-284,190	1	⅛-¼
Monte Video Telephone Co., Ordinary 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	¾-1
National Telephone, Preferred	100	110-112
—— Deferred Stock	100	107½-109½
—— 6 per cent Cum. First Pref.	10	10½-12½
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent. Non Cum. Third Pref.	5	5 3/16-5 7/16
—— 3½ per cent. Deb. Stock, Red.	100	96-98 xd
—— 4 per cent Deb. Stock, Red.	100	98-100 xd
Oriental Telephone and Electric Company	1	1 1/16-1 3/16
—— 6 per cent. Cum. Pref	1	1 1/16-1 3 16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	97-100 xd
United River Plate Tels. Co., Ordinary, 1-100.000	5	6½-7 xd
—— 5 per cent. Cum. Pref., 1-40.000	5	4⅜-5¼ xd
—— 5 per cent. Debenture Stock, Red.	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-101 xd
West African Telegraph Co.	10	10-10½
West Coast of America, 1-70 000 and 53 001-53,008	2½	1⅛-1⅜
—— 4 p.c. Debs., 1-1.500, guar. by Western Telegraph	100	95-98 xd
West India and Panama Telegraph Co., Ordinary	10	⅜-½
—— 6 per cent. Cum. 1st Preference	10	7⅛-7⅜
—— 6 per cent. Cum 2nd Preference	10	7⅛-7⅜
—— 5 per cent. Debs., Red., 1-800	100	98-101 xd
Western Telegraph Co., 1-207,930	10	12⅜-13⅛
—— 4 per cent. Debenture Stock, Red.	100	97-100 xd

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Jan. 1	1,497	1,456	+ 40	— h	27½	27½	May 31	72,605	17,676 000	1,529 682	0·98	11·39	4,987	6·34
Ayr Corporation	Nov. 17	1,019	966	+ 53	− 176	8	8	,, 15	15,283	3,603,789	378,834	·57	9·28	1,917	5 35
Baker Street and Waterloo Ry.	Jan. 4	3,230	2,410	+ 790	—	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 5	999	1,059	− 60	+ 30	23·53	23·53	March 31	55,408	11,696,691	1 324 743	—	—	—	6·1
Birmingham Corporation	,, 4	6,079	—	—	—	56½	5 ½	,, 3	18 557	5,752,098	215 345	87	·6·2	9,228	—
Blackburn Corporation	,, 1	1,103	1,0 3	+ 90	+ 3,075	23·80	23·30	,, 25	54,951	10,09?,028	1,002 372	1 25	12 64	2,309	8 02
Blackpool Corporation	,, 2	352	342	+ 10	− 1,210	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	− 1,139	16½	16½	Dec. 31	34,819	2,707,9 8	625,110	3·03	12 803	—	7·796
Bolton Corporation	Jan. 5	2 689	2,538	+ 151	+ 5,783	42	42	March 31	111 294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 1	1,458	1,316	+ 142	+ 1,644	23¼	24¾	,, 31	83,665	13,503,610	1,765,078	1·48	11·37	2,860	7·28
Bradford Corporation	,, 4	4,155	1,109	+ 46	+ 4,333	98	95	,, 31	232 427	46 728,977	5,167,261	1·193	10 73	2,421	—
Brighton Corporation	,, 5	654	787	− 103	− 3,083	17·191	17·131	,, 31	50,652	10,759,310	1 798,305	1·09	10·43	2,844	7·4
Bristol Tramway Company	,, 3	4 538	4 630	− 91	—	53½	51½	,, 31	265,769	46,902,257	6 178,886	—	—	—	—
Burnley Corporation	,, 4	1,227	1,205	+ 22	—	19¾	19¾	,, 31	62,699	11,967,408	1,205,830	1·31	12 48	5,825	8 21
Burton Corporation	,, 5	238	274	− 36	− 58	9¾	8½	,, 31	15,576	3,383,527	421,317	·07	8·87	1,768	6 14
Cardiff Corporation	—	—	—	—	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	,, 4	155	173	− 18	− 18	8·5	8·5	Dec. 31	10 254	2,750 699	350,417	—	—	—	7 96
Central London Railway	,, 4	6 194	6,407	− 207	—	6	6	,, 31	349 298	43,057,897	1,279 698a	1·85	62·29a	55,357	35·22a
Charing X, Euston, & Hamp. Ry.	,, 4	3,170	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 5	3,651	3 286	+ 315	—	9	6¼	h June 30	82,456	10 048,780	—	—	—	—	—
Colchester Corporation	Dec. 25	231	184	+ 37	—	8	8	* March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 26	500	453	+ 47	− 951	15½	15½	Dec 31	25,032	5,966 364	891,9 8	—	6·74	—	4 78
Croydon Corporation	Jan. 3	1 144	1,172	− 28	− 1,546	12 c	12 c	March 3	64,065	13,51?,9 8	1, 02 408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 3	251	259	− 8	− 25	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	− 1,124	4¾	4¾	,, 31	12,468	3 178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Jan 3	97	92	+ 5	+ 2 6n	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 3	4 676	4,455	+ 221	+ 32 0?2	51¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 1	1,336	1,298	+ 38	+ 1,332	22	22	May 15	57 672	15 654 905	1,162 792	878	1·9	4,352	7·3
East Ham Corporation	,, 4	893	8 1	+ 82	+ 384	14	14	March 31	47,140	15,049,240	1,062 151	·74	10 49	3 636	7 14
Glasgow Corporation	,, 4	18 93?	18 977	+ 14	+16,057h	177½	167	May 31	387 381	21,?63,0?8	20,350,367	95	0·47	5,035	5·21
Gloucester Corporation	,, 1	225	232	− 12	—	15	15	March 31	15,?33	3 182,?11	579,996	·06	6 94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 4	5 330	3,455	+1 935	—	9¼	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77 996	18,89?,242	1,624 275	—	?1 52	—	8·65
Huddersfield Corporation	,, 4	1,359	1,430	− 31	—	35½	35	,, 31	81,196	15 2?2,150	1 804 745	1 22	0 79	2,770	5·32
Hull Corporation	,, 4	2 5 0	2,386	+ 124	+ 5,533	26	26	,, 31	121 186	29 ,51,543	2,956,?06	1	9 84	—	—
Ilford Corporation	,, 4	3 4	410	− 36	—	10½	10½	,, 31	26,499	6,?86,754	6 5,1 ?	89	9 58	2,225	6 5
Ilkeston Corporation	,, 1	1·5	1 1	+ 14	+ 3?8	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	13,702	4,640,?18	466 919	6?2	7 55	1 ??3	4·95
Lancashire United Tramways	,, 1	1,?65	728	+ 537	+ 15 054	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	Dec. 28	7,031	6 32?	+ 713	+11,071	96½	96½	March 31	327,794	73,? 24,?53	7,358,185	1 06	10·69	3,352	5 58
Leicester Corporation	Jan. 4	2,0?0	2 158	− 67	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	Dec 28	11,151	10,477	+ 674	+ 8 355	104	104	Dec. 31	563 793	122,094 528	12 115 934	1 108	1 17	5,421	7·75
Liverpool Overhead Railway	Jan. 5	1,345	1,4 4	− 89	− h	9 25	6 65	June 30	77 568	10,937.148	1,102 809	—	—	—	—
London County Council	Dec 21	32,017	27,256	+4,761	+197,170	98	98	Marc? 31	1?78,014	314 227 030	30 130 997	1·05	10 98	—	8·56
Lowestoft Corporation	Jan. 4	153	144	+ 9	+ 107	3½	—	Sept. 30	11 079	2,6 2,922	343,190	1 03	7 9	2,155	6 39
Maidstone Corporation	,, 2	140	76	+ 64	—	4½	2	March 31	5,91?	1 186 5?6	157,050	1 1?	8 6	2,956	6?2
Manchester Corporation	,, 4	13,671	13 288	+ 383	+ 41 135	172	161	,, 31	719,673	143,264,501	15,523,45?	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 4	8,771	8,035	+ 736	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 5	15,974	15,819	+ 155	—	23½	23½	June 30	637,794	97 639,334	—	1·39	—	—	—
Nelson Corporation	,, 4	112	128	− 17	− 26	2⅜	2⅜	March 31	7,?09	2 035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 4	4,077	3,991	+ 86	+ 1,286	59⅛	57¼	,, 31	210,491	45,5?6 468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 4	562	570	− 8	+ 2,019	14½	14½	,, 31	32,421	7 76? 403	772 753	1 03	10 01	1 525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35⅔	35⅔	,, 25	?4 948	18,647,?31	1,818,444	1 19	12·53	2,603	7 2?9
Portsmouth Corporation	May 25	2,330	1,578	+ 752	+ 632	28½	28½	,, 31	98,911	20 668 825	2 199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	553	+ 9	− 788	13½	13½	,, 31	32,651	8,1?0,179	918 825	9?	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1 201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	25,916	5,?45,298	?18,211	1·12	10 45	2,691	7·38
Salford Corporation	Jan. 6	4,628	4,166	+ 462	+ 6.016	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78c	4·78c	Dec 31	7,779	1 537 845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 5	5,491	5,349	+ 142	+10 755	65¼	65¾	March 25	276,907	73 966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7 7
Southend-on-Sea Corporation	,, 1	258	223	+ 35	+ 99	9	9	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248 656	—	9 464	—	4 849
Sunderland Corporation	,, 5	1,297	1,384	− 87	− 1,258	20	20	,, 31	72,396	17 483 132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,?75,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	Dec. 26	237	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	Jan. 4	719	764	− 45	+ 682	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7 5
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,965 296	429 785	—	10 724	1,989	6 95
West Ham Corporation	,, 2	2,095	1,992	+ 103	+ 2,250	14·7	14 7	,, 31	1 2,881	35,?02 836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	Dec. 25	867	769	+ 98	+ 268	20	20	,, 31	43,823	9,276,023	966,133	—	10 886	2,159	6·035

1905-6 figures. † And 88 miles of interlacing track. c Train mile. e Miles of route. h Half-year's figures.

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THE

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DIVERSITY FACTOR.

At the meeting of the Institution of Electrical Engineers last week a most valuable discussion on the "Cost of Electric Power for Industrial Purposes" was commenced. We are pleased that Mr. J. F. C. Snell's paper on the subject is being considered not only in London, but also before the local sections of the Institution. The subject is well worthy of this widespread attention, and the author's treatment of the same leaves nothing to be desired. Of course, his figures and conclusions will be widely criticised, and in some details may be found to be incorrect. This cannot be said of his opening statement, which everyone having the ultimate interests of the industry at heart must endorse. Thus the object of Mr. Snell's paper is "to compare the costs of supply from town installations and power companies, and their relation to the cost of production from plant of various kinds installed in factories. For instance, if a manufacturer can install plant wherewith he can obtain power at a cheaper rate than he can be supplied from an outside source, surely it is in the ultimate real interest of our industry to say so. Or again, if any town can obtain a supply from a power company more cheaply than it can hope to produce from its local station, then, again, it is in the interest of that town that the supply should be taken from without. Or if a number of suppliers can benefit their collective consumers by combination, then the Legislature should remove the present obstacles to such co-operation in the manner contemplated by the Electricity Supply Bill, recently promoted by the Board of Trade, which has, unfortunately, not yet passed into law." Working on these broad lines, the author gives in Tables I. and II. what he terms the ascertained cost of power per unit generated from independent plants of various sizes and with different prime movers. These figures for annual load factors from 10 per cent. up to 80 per cent. seem to us to be low. It is stated that there is no proportionate charge in them for supervision, general establishment charges, or for rating. We should also doubt if, in certain cases with low load factors, a twenty-four hours' supply could be given for the average cost per unit in the tables. The examples from recent practice quoted later on in the paper show that the actual costs are frequently higher than those given in the tables. Still, taking Mr. Snell's figures of cost per unit generated from the private plants as being attainable with careful selection of plant and supervision, it is interesting to compare them with the other figures he gives of the real costs of the Newcastle-on-Tyne Supply Company. It will be found that when the capital charges for machinery and mains required by the power company are considered, that the average cost of production for 1907 was practically the same as that for independent installations of under one hundred horse-power. It is only the diversity factor which enables the power company to give a supply profitably, and this is clearly shown in Table XII. In other words, what the large station gains by using large units of plant it loses in the cost of feeders, so that the capital expenditure per effective kilowatt of plant is of the same order both for the large power company and the independent plant. It would seem, therefore, that when a large corporation area contains industrial undertakings giving a large diversity factor and also a reasonably large load, there can be no chance of an outside power company supplying the corporation at a profit. Thus the diversity factor is of supreme importance, and a large power scheme depends for its success on the linking up of consumers with widely different variations of load. Mr. Snell rightly emphasises the importance of

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low capital expenditure, and we would add to this that cheap capital is of equal importance. For this reason any new power company in this country is now practically doomed from its inception, as the cost of raising capital after the past experience in South Wales and elsewhere must be prohibitive. For the supply in London of power in bulk at cheap rates we must look either to the London County Council after the next elections or to a combination of existing undertakers.

SCHOOLROOM LIGHTING.

Such a matter as the illumination of classrooms may seem, at first glance, to call for but a small proportion of the attention of those who have to do with the administration of the Education Acts. But it is just in the apparent insignificance of the matter that danger lurks, since, on that account, it is apt to escape an adequate amount of attention, and its importance is apt to be completely eclipsed by the broader and more general questions relating to education. Even the most casual reader of the reports of the various education committees must have noticed how certain minor questions habitually escape discussion at committee meetings. In some respects this may not be a disadvantage, for it does not follow that the activities of officious committeemen, who are in no way especially qualified for dealing with matters entrusted to them, are to be preferred to the work carried out on the initiative of capable and qualified officials, who, in many instances, have done more to promote efficiency than when hampered by their committees. As, however, the conditions under which instruction is given in the schools forms a question of great national importance, it is but right that public attention should be directed thereto by various independent organisations. Those who have given any attention to the question of the lighting of school buildings have invariably indicated the necessity for improvements in this direction. Dr. James Kerr, medical officer to the education department of the London County Council, in his report for the year ended March 31, 1907, comments upon the importance of adequate lighting arrangements in school buildings, and draws attention to the fact that inefficient lighting of schoolrooms is in no small measure a cause of various physical defects that develop in children who have to sit in ill-lighted rooms. The artificial lighting of schoolrooms is dealt with in a special section of the report which contains the results of Mr. Bishop Harman's investigation into the matter of positions of the sources of light, and the distribution of light in such places. In our last issue we gave a summarised account of Mr. Harman's comment on electric lighting, from which it will be seen that he describes electric lighting as the most perfect means now available for school use. He has made a close comparison of the various illuminants that are now available, especially of electricity and gas, and his observations are of particular importance. He offers some useful suggestions as to the arrangement of lights, which apply equally to gas and electricity, and which are calculated to secure a satisfactory and uniformly good illumination over schoolroom desks, and at the same time to enable the teachers' portion of the schoolroom to be illuminated in a reasonable degree of efficiency. Mr. Harman points out that with gas, the fewest possible number of burners is desirable, for the more burners the worse the atmosphere, but with electricity the points may, with advantage, be generously disposed. He then goes on to describe his experiments with an incandescent lamp under different shades, and gives the results obtained. He does not consider indirect illumination by reflection (a favourite method in the newer German schools) good where continuous and detailed work at a desk is required. The one drawback to the use of the electric incandescent lamp mentioned by Mr. Harman is its greater cost, which worked out in 1905 at about 1·7 times that of gas. That difference in cost, however, is considerably reduced when, in place of the old incandescent lamp in use in 1905, the high-efficiency metallic lamps are taken into account. Moreover, whatever slight difference there may be in cost between electric lighting by means of the new type of lamps, and gas, this should not be permitted to stand in the way of the wider adoption of electric lighting, which, as has been admitted, is best adapted to giving satisfactory and uniformly good illumination and is free from consumption of air and production of fumes. The results of recent eyesight tests among school children and the prevalence of spinal curvature among them, which may be due to defective eyesight and schoolroom lighting, plead eloquently for greater attention to the question of improved lighting in schoolrooms.

THE INSTITUTION'S NEW PRESIDENT.

It was announced at a meeting of the Institution of Electrical Engineers on the 9th inst, that the Council had unanimously elected Colonel R. E. Crompton (one of their past presidents) president for the remainder of the session. Colonel Crompton, on taking the chair, thanked the Council for the honour they had shown him in calling upon him to succeed the greatest man in the electrical world. They had in Lord Kelvin, he said, a central figure in electrical science, and they did not fully understand what was due to him from the electrical community. Indeed, they only commenced to realise their loss at the impressive ceremony in Westminster Abbey in the closing days of the year, when they felt a great change come over their world. Colonel Crompton said that he had known Lord Kelvin since he began electrical work, and had been associated with him in the corps of Electrical Engineers and in international work, consequently he personally felt the loss very much. Lord Kelvin had given England a great lead in the world of electrical science, which was universally acknowledged by the presidency of the international movement being given to him. He was afraid that we could not maintain that lead for the reason that we had no one to replace Kelvin.

INEFFICIENCY.

The engineer, and especially the electrical engineer, is so keen on having a high efficiency from every item of plant under his charge that a suggestion that he may be wrong is heresy. Still, Mr. C. Turnbull, of Tynemouth, did suggest at one of the meetings of the Municipal Electrical Association that the efficiency of the plant required to provide the peak load on lighting stations might be sacrificed if the capital cost of the same could be considerably reduced. An interesting case in point was described by Mr. W. S. Finlay at a recent meeting of the American Institute of Electrical Engineers. A brief *résumé* of this paper will be found elsewhere in this issue. His proposal is to largely increase the grate area under water-tube boilers, so as to increase the evaporative capacity of the same. Naturally this reduces the efficiency of the boiler, but it largely increases the output of steam obtained for a given capital outlay on the boiler-house. In a station of the Interborough Rapid Transit Company of New York the boilers are provided with a second grate as suggested, and the results should be carefully studied by those engineers

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who have to provide heavy peak loads for a few hours during the winter. We think it will be found that in many cases it would pay to work the boilers economically during medium loads and to reduce the economy by means of a second fire when the short-hour peaks in the load have to be met. The small amount of coal so wasted will cost less than the capital charges on the additional boilers otherwise needed.

COST OF ELECTRICAL POWER FOR INDUSTRIAL PURPOSES.*

BY JOHN F. C. SNELL, MEMBER.

(*Concluded from page 47.*)

It is very unwise of central-station engineers and managers to hoodwink themselves by thinking they are going to supply a small section of power users at a nominal cost, and they forget that the Nemesis must come if those power consumers extend so as to become an important and dominating proportion of the total. In the case of many London boroughs and London companies, it is really quite an impossibility for them to supply power at anything like the cheap rates which will, on the one hand, induce power users to purchase electricity from them, and, on the other, leave their supply undertakings on a sound commercial basis. That there is only one way in which to deal with the London problem must be obvious to all engineers—that is, through some means a large power station must be erected at a minimum cost, which, without prejudicing the present capital involved in the existing undertakings, will enable electricity to be supplied for all purposes at considerably less rates than now obtain. The capital sunk in existing undertakings cannot, of course, be ignored. It constitutes a deadweight upon electrical supply in London, which will remain until this original capital shall have been redeemed. That cannot be for several years yet, and, therefore, the only compromise is to provide this supplementary low-cost station to co-operate with and assist those already in operation.

The effect is apparent even now, for the more successful companies, whose able administration cannot be questioned, find that since they have had to reduce their scales of charges they are not able to declare the same dividends as they were able to do a few years back; and this effect is likely to get worse rather than better. Or take the case of some London municipalities who have so very foolishly contented themselves by merely putting aside a sinking fund on a 42 years' basis, well knowing that their plant could not possibly exist for so long a time. Those municipalities who have wisely added a depreciation fund to this long-period sinking fund are, of course, in a better position, but they are, unfortunately, the exceptions. It will certainly be admitted that 25 years is the maximum period which engineers would be wise to allow as the equated life of their plant. Such municipalities who have allowed depreciation merely at the rate of a 42 years' life have, therefore, a good deal to make up for past years, and they simply cannot put themselves in a sound financial position and at the same time offer power users such a low scale of charges as will promote a large revenue from the sale of electricity for power. They, again, can only carry out the duties imposed upon them by their orders by a wise co-operation with some central scheme.

Turn to the provinces. Table VIII. shows the true cost of production in some of the larger provincial municipal stations. These figures are based upon the official published results for 1906 or 1907. In every case the capital charges have been taken as requiring interest at an average rate of 3½ per cent, and depreciation at 2¾ per cent. In other words, a modest 6¼ per cent. has been taken upon the total capital expenditure. The author thinks that no one will quarrel with him as to this figure, which, if anything, is on the low side.

Table IX. shows the scale of charges which could be adopted for power after allowing the diversity factor. There it will be found that the average rate for, say, a 20 per cent. load factor consumer is 1·16d., whereas a power company ought to be able to supply such a consumer successfully at not more than 0·8d., or a reduction of 30 per cent. This is the result of the larger stations. And if one turns to the smaller provincial stations, which are given in Tables X. and XI., the results are very much the same. It must not be overlooked, however, that the larger districts will almost certainly have a higher diversity factor, and thus the author

* Paper read before the Institution of Electrical Engineers.

TABLE VIII.

True Cost of Production in Larger Municipal Stations for the Year 1907

Annual Load Factor.	Manchester.	Nottingham.	Leeds.	Glasgow.	Average.
Per Cent.	d.	d.	d.	d.	d.
5	5·03	4·93	5·24	4·76	4·97
10	2·71	2·72	2·82	2·59	2·71
15	1·93	1·98	2·02	1·88	1·95
20	1·55	1·61	1·62	1·54	1·58
25	1·32	1·39	1·37	1·32	1·35
30	1·16	1·21	1·21	1·19	1·19
35	1·06	1·14	1·10	1·08	1·09
40	0·98	1·06	1·01	1·01	1·01
50	0·84	0·94	0·89	0·90	0·89
60	0·77	0·86	0·81	0·83	0·82
70	0·73	0·82	0·75	0·78	0·77
80	0·69	0·79	0·70	0·74	0·73
No. of units sold	47,564,903	9,530,096	11,368,956	21,536,425	—
Plant installed ...	33,800 k.w.	10,043 k.w.	10,440 k.w.	18,493 k.w.	—
K.W.D.	25,180	5,765	7,470	16,304	—

TABLE IX.

True Charges for Power Supply, based on Cost of Production and 1·66 Diversity Factor.

Annual Load Factor.	Manchester.	Nottingham.	Leeds	Glasgow.	Mean.
Per cent.	d.	d.	d.	d.	d.
5	3·19	3·16	3·32	3·02	3·17
10	1·79	1·83	1·86	1·75	1·81
15	1·32	1·39	1·38	1·33	1·35
20	1·09	1·17	1·09	1·11	1·16
25	0·95	1·04	0·99	0·99	0·99
30	0·86	0·95	0·89	0·90	0·90
35	0·79	0·89	0·82	0·84	0·83
40	0·74	0·85	0·77	0·80	0·79
50	0·67	0·81	0·70	0·73	0·73
60	0·62	0·73	0·65	0·69	0·67
70	0·59	0·70	0·62	0·66	0·64
80	0·56	0·68	0·59	0·64	0·62

TABLE X.

True Cost of Production from Smaller Municipal Stations for the Year 1907, at Different Load Factors.

Annual Load Factor	Aberdeen	Dundee	Cheltenham	Coventry	Darlington	Oldham	Average
Per cent.	d.	d.	d.	d.	d.	d.	d.
5	5·66	4·43	6·20	4·90	4·25	6·07	5·25
10	3·04	2·40	3·42	2·67	2·79	3·32	2·94
15	2·17	1·72	2·50	1·93	1·71	2·40	2·07
20	1·74	1·39	2·03	1·57	1·39	1·94	1·67
25	1·46	1·18	1·75	1·34	1·19	1·67	1·43
30	1·30	1·05	1·58	1·19	1·06	1·49	1·28
35	1·17	0·95	1·43	1·08	0·98	1·36	1·16
40	1·08	0·88	1·34	1·01	0·91	1·25	1·09
50	0·93	0·78	1·19	0·90	0·81	1·12	0·95
60	0·86	0·71	1·11	0·82	0·74	1·04	0·88
70	0·80	0·66	1·04	0·77	0·70	0·97	0·82
80	0·75	0·63	0·99	0·73	0·67	0·90	0·77
No. of units sold	4,280,248	3,439,231	1,701,370	2,522,110	1,095,287	4,133,615	—
Plant installed ...	1,810 k.w.	3,010 k.w.	1,980 k.w.	2,400 k.w	749 k.w.	5,232 k.w	—
K.W.D.	2,633 k.w.	2,367 k.w.	1,316 k.w.	1,533 k.w.	740 k.w	2,400 k.w	—

TABLE XI.

True Charges for Power Supply based on Cost of Production and 1·66 Diversity Factor.

Annual Load Factor	Aberdeen.	Dundee.	Cheltenham	Coventry.	Darlington.	Oldham.	Mean
Per cent	d.	d	d.	d	d.	d.	d
5	3·58	2·82	3·90	2·53	2·73	3·87	3·25
10	2·00	1·59	2·32	1·49	1·58	2·22	1·86
15	1·47	1·10	1·76	1·14	1·16	1·67	1·56
20	1·21	0·98	1·48	0·97	1·09	1·30	1·17
25	1·05	0·86	1·31	0·86	0·89	1·23	1·03
30	0·95	0·78	1·20	0·80	0·81	1·12	0·94
35	0·87	0·72	1·12	0·75	0·74	1·04	0·87
40	0·82	0·68	1·06	0·71	0·70	0·98	0·82
50	0·74	0·61	0·98	0·65	0·66	0·90	0·76
60	0·69	0·57	0·92	0·63	0·62	0·85	0·71
70	0·65	0·55	0·88	0·60	0·58	0·81	0·68
80	0·62	0·52	0·85	0·58	0·56	0·77	0·65

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is quite probably wrong to assume the same coefficient in both tables. These figures, of course, will improve as years go on—or at least it is hoped so—because with extensions of the stations, as has been said before, the capital cost per kilowatt should be reduced. This will apply with more force to the larger systems. But a warning should be noted by station engineers that the future will bring in all probability a very large proportionate increase of low-price power units, and with improvements in lamps and their reduced energy consumption the proportionate lighting units may even fall below their present figure. This all means that the average revenue per unit will be considerably lessened. The only possible way, therefore, to meet this is to watch every penny of capital spent, and not to waste money on ornate buildings and expensive land, or to install too much spare plant. It is only by these means that electrical supply will be able to hold its own. The author may be criticised for taking only 6¼ per cent. in the case of the large undertakings, while he has taken 10 per cent. in Tables I. and II. for the smaller local works plant; but he is perfectly justified in so doing, and for this reason. In the supply stations the plant has been built to careful specifications, is under expert supervision, and there is a reasonable proportion of stand-by plant with consequent relief in the running hours per unit of plant. Whereas in the case of a local factory plant, not only is there considerably less supervision, but the installation includes no stand-by plant. Therefore a depreciation of 5 per cent is taken instead of 2¾ per cent., and interest is allowed at 5 per cent., this being the figure which manufacturers generally require as against the 3½ per cent., the average value of municipal stocks. Take the case of the Newcastle Power Company—which at present is the only one operating over a large area—and on the scale on which it is expected power companies will work. Table XII. gives the real cost of production based on the 1907 figures. Side by side is the power scale of charges based on 1·66 diversity factor.

TABLE XII.

Load Factor.	Newcastle Power Company.	
	Average Cost of Production, 1907.	Real Cost for Power Supply, 1·66 D.F.
Per cent.	d.	d.
10	2·31	1·49
15	1·62	1·07
20	1·28	0·86
25	1·07	0·74
30	0·98	0·65
35	0·83	0·60
40	0·76	0·55
50	0·65	0·49
60	0·58	0·44
70	0·53	0·42
80	0·50	0·39

This company has an expenditure of £59·6 per kilowatt installed, of which the cost of the stations has been about £33 per kilowatt; mains and sub-stations, etc., £26. It is interesting to note that the plant installed in sub-stations amounts to about 35,000 kw. supplied by generating plant installed at the station with a total capacity of 20,000 kw. Now it cannot be said that even this company, having so large a capital expenditure involved, and operating on such a big scale, is entirely satisfactory in its finances with a depreciation and reserve account amounting to only 1·07 per cent. for the year. The question arises on such an undertaking whether undue expenditure has not been made upon the transmission system.

The author read a paper in 1904 which dealt with the question of transmission distances in this country, and then showed that at a pressure of 10,000 volts the economical distance for transmitting a load of 1,500 kw. was only 11 miles, where the displaced local station cost £20 per kilowatt. A new diagram (Fig. 1) is now given which shows the effective radii of distribution for different loads, and different costs per kilowatt. An explanation is necessary to make this curve perfectly clear. It has been assumed that every 100 kw. installed at the power station will supply 166 kw. outside; and the cost of the power station is taken at £12 per kilowatt, or £7·2 per effective kilowatt supplied. Each curve represents a consumer, or group of consumers situated at the respective distances and supplied through high-tension cables laid in duplicate and static transformer sub-stations. The horizontal lines show the costs of alternative local stations per kilowatt. The point at which the two curves cross is that at which both systems are equal in cost. It shows, therefore, that so far as capital is concerned the effective radii of transmission in miles are as follows, shown in Table XIII.

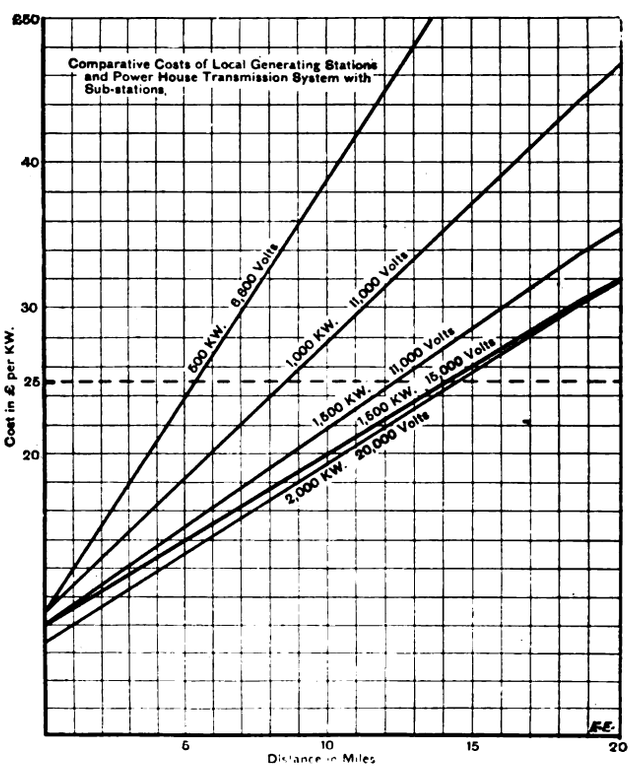

FIG. 1.

These distances, of course, only refer to a comparison between a supply from a central source and local plants installed within factories which usually cost from £20 to £25 per kilowatt. Transmission by overhead lines would still further increase these radii, of course, but there is still much difficulty and great expense in obtaining the necessary easements for high-tension lines in this country.

TABLE XIII.

Kilowatt	Voltage	Local Station Costing per Kilowatt.				
		£20	£25	£30	£40.	£50.
		Miles	Miles	Miles	Miles	Miles.
500	6,600	3·7	5·3	7·0	10·3	13·8
1,000	11,000	5·8	8·5	11·2	16·5	22·0
1,500	11,000	7·8	11·5	15·0	22·0	—
1,500	15,000	8·5	12·4	16·2	—	—
2,000	20,000	9·7	14·2	18·5	—	—

Table XIV. sets out the estimated charges of various power companies. In the first column are given the estimated average charges which were proposed in the London County Council (1907) Bill, column I.*a* being for extra high-tension untransformed energy at the consumer's terminals, column I.*b* for transformed alternating current at any pressure, and column I.*c* for transformed and converted direct current at any pressure. In the next column are set forth the maximum prices under this Bill; in column III. the maximum price proposed by the Administrative Company of 1906; and in column IV. the real tariff which could be charged by the Newcastle Power Company, based on their 1907 results and with an estimated diversity factor of 1·66, is set out again for convenience.

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SUMMARY.

The costs of various prime movers installed in factories of various kinds have been given, and examples from different works. The present inability of most undertakings to meet a large demand for power at such rates as to hold their own with local plants has been discussed. What, then, is the remedy to remove this somewhat precarious state of things? It must be admitted that the indictment is true, generally speaking. If Table XIV. is

TABLE XIV.

Estimated Charges from Bulk Supply Undertakings.

Annual Load Factor	I. London County Council, 1907. Estimated Average Charges			II. London County Council, 1907. Maximum Prices.		III. Administrative Co., 1906. Maximum Prices.	IV. Newcastle. Real Cost based on 1907 Figures and 1·66 D.F.
	(a) E.H.T.	(b) T.Alt.	(c) D.C.	(a) T.Alt.	(b) D.C.		
Per cent	d.	d.	d.	d.	d.	d.	d.
10	1·002	1·159	1·453	1·738	2·179	1·50	1·49
15	0·728	0·839	1·042	1·258	1·562	1·16	1·07
20	0·591	0·679	0·836	1·019	1·254	1·02	0·86
25	0·508	0·583	0·713	0·875	1·069	0·94	0·74
30	0·454	0·519	0·631	0·779	0·946	—	0·65
35	0·414	0·474	0·572	0·710	0·858	0·81	0·60
40	0·385	0·439	0·528	0·659	0·792	0·75	0·55
50	0·344	0·391	0·466	0·587	0·699	0·72	0·49
60	0·317	0·359	0·425	0·539	0·638	—	0·44
70	0·297	0·337	0·396	0·505	0·594	—	0·42
80	0·282	0·319	0·374	0·479	0·561	0·64	0·39

compared with Tables I. and II., it will be seen that a power company can compete successfully with any of these other prime movers if the power company supply transformed alternating current, but if the power company is constrained to supply direct current then it is only with smaller plants—*i.e.*, 100 h.p. or less—with which it can hold its own. It is not suggested that the figures in this table are the ultimate minimum charges for power which power companies can afford to make, but they cannot be reduced materially. The influence of additional capital cost per kilowatt is shown in Fig. 2, in which successive

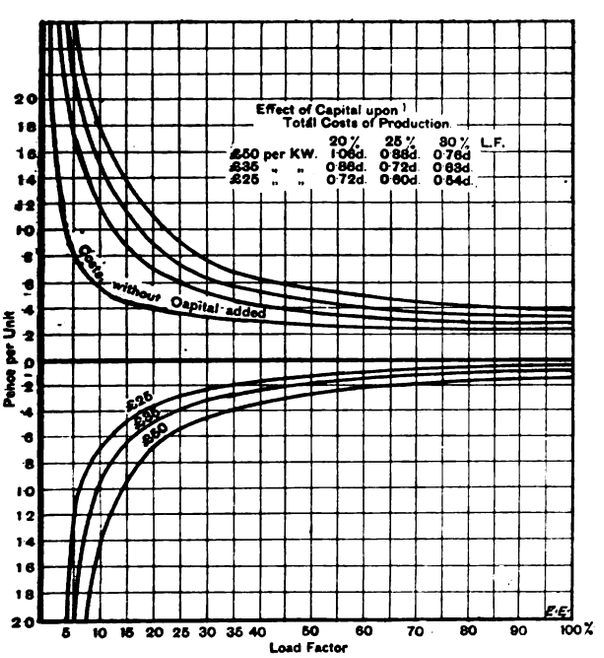

FIG. 2.

curves are shown adding to each the capital charges due to the increased expenditure. It will be seen that the difference in cost of production, at 20 and 25 per cent. load factors, between a system costing £25 per kilowatt and one costing £50 per kilowatt is 32 per cent.—and at 30 per cent. load factor, 29 per cent. This demonstrates very clearly how important it is to minimise the capital involved.

The author believes he has made out a case for showing that in all the larger power stations where the capital expenditure is reduced to a minimum and the supply is produced on a sufficiently large scale but within a reasonable distributing radius, a sound scale of charges for power can be made which (apart from all the incidental advantages resulting from a supply from an outside source available at any hour of the day or night) can hold its own with any independent local power plant, whether supplied from steam, oil, or gas. But, as has been known for a long time now, the capital expenditure must be minimised and distribution must not be attempted over too great a radius. It has been shown that the London companies and municipalities, having been the pioneers of supply, are unfortunately crippled by a large expenditure, and cannot conceivably—except in a few isolated cases—so reduce their cost per kilowatt nor increase their production as to economically meet this demand for low-priced power. This problem in London can only be dealt with by centralisation, and all further expenditure on existing individual systems is prolonging an evil which must ultimately be reflected upon the undertakers, and is, in fact, already so doing.

In the provinces a different problem is presented. Many of the smaller boroughs cannot hope to attain such dimensions, and many of them are already saddled with a high capital expenditure per kilowatt, such as to prevent them from offering the low scale needed. This remark does not apply to the smaller boroughs, where power supply cannot become a dominating part of the output, for in such cases among smaller users a larger diversity factor exists, and it may be expedient to sacrifice the principle of a uniform tariff to all classes by offering a special rate to such sparse power consumers. But if this principle—or rather want of principle—be applied in a small industrial town where the power supply may become quite the dominating output, then such a policy can only produce disaster. In such a case there appears to the author to be only one alternative—viz., that all extensions of the local generating plant should be stopped, and that supply should be taken from a power company, if there be one reliably constituted in the neighbourhood, as has been arranged by the Middlesbrough and Tynemouth municipalities, for instance; or a joint Board of local towns could co-operate at a very considerable saving to the respective partners if sufficiently proximate to one another. If this be too Utopian, then possibly the county council of the district could take the matter up, or by the aid of legislation the principal borough of the group could undertake this responsibility.

It will be found economically more sound to concentrate plant in the larger town and transmit to sub-stations in the surrounding towns than to go on increasing each station. That station offering the better facilities for circulating water, coaling, and cheap land and assessment would naturally be selected. Electricity supply differs materially from gas supply in the want of economical accumulation, and to attempt to store electrical energy at the present time on too large a scale would necessitate too great a capital cost. Where separate gas undertakings in small boroughs—having operated for so many years without opposition, and having either paid off their debt or saved a very large reserve fund—are able to score is in this storage and consequent higher works load factor, representing, of course, a minimum cost of producing plant. By the multiplication, however, of small electricity stations, the initial charges of starting the undertakings, the smaller units of plant, the unnecessary amount of stand-by, neither of which would be so accentuated in one common station, all tell against the successful competition of the electricity undertaking, opposed, as it probably is, by the already established gasworks. For small local boroughs, therefore, to go on adding to this cost, and therefore increasing their difficulties, is to the author's mind a grave mistake. It is of no use arguing that the small gas undertakings paid their way and have now become successful even on the small scale referred to. The conditions are so utterly different, for the gasworks had an open field.

Looking back, it would have been much wiser if the controlling authorities—viz, the Local Government Board and the Board of Trade—had prevented some of the smaller local boroughs from adopting their separate electricity stations. The only remedy the author can suggest, after an extensive study of this problem, is the co-operation of neighbouring boroughs who already have plant; the supply of neighbouring townships from a central borough,

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which must be effected despite municipal jealousy; and, in the case of new boroughs requiring—as they will require—an electrical supply, an arrangement with a neighbouring borough or with a power company for this supply. This does not apply to municipal boroughs only, but to companies as well. The author hopes that the results of discussing this paper will not only establish in the minds of factory owners that electricity supply from outside with all its advantages can be made successfully and in competition with local power installations of any kind in the majority of cases, but also awaken engineers responsible for town installations to the advisability of co-operation rather than extending small stations individually at greater cost.

DISCUSSION AT LONDON, JAN. 9.

Mr. J. H. RIDER (London County Council) was called upon to open the discussion, and, in doing so, stated that he was about to support Mr. Snell. It was impossible to discuss the paper in its entirety within the few minutes available for the purpose, therefore he proposed to confine himself to a few points only. Mr. Snell, he said, opened out into the old discussion as to whether or no a supply of power should be taken on by a station originally equipped for lighting. It was a common habit with those who had a lighting station with a poor load factor to offer a power supply at a cheap price, and to make up by charging a high price for street and private lighting, especially when the undertaking was owned by a municipality. If the demand for power were to become preponderatingly great at such stations it would result in losses, and he believed that in many instances the losses resulting from a supply of power charged at a too low rate were made up by higher charges to lighting consumers. The only true basis on which to charge was the load factor basis tempered by the diversity factor. He thought the difficulty could be got over by treating consumers as a class, and applying the maximum demand principle in the fixing of a price. In this way any increase or decrease in either class of consumer would make no difference to the stability of the undertaking. The author gave statistics concerning the diversity factor in various works, and mentioned a diversity factor of 1·25 for Sunderland. The speaker had found a diversity factor of 1·25 among the various London County Council tramway sub-stations. If it were possible to get a street-lighting as well as a power load, as he supposed they had at Sunderland, the diversity factor should be much better than 1·25. With regard to static transformers, he had checked Mr. Snell's figures showing relative cost of static transformer sub-stations and rotary sub-stations, and he was able to corroborate the prices given by Mr. Snell. He advised all those who wanted to supply power cheaply to go in for alternating-current motors. With regard to the London power question, Mr. Snell's figures showed that the basis of the curve adopted by the London County Council for their Power Bills was a true one, and he agreed that the only way to get at a scale of charges was to fix maximum prices on a uniform diversity factor. It was his honest conviction that it would be fatal to the interests of electrical supply to perpetuate individual systems in London, as such individual stations could not possibly give a cheap power supply.

Mr. A. H. SEABROOK (West Ham) said: I appreciate the enormous amount of time which Mr. Snell must have given to the preparation of this paper, but there are one or two statements in it which I cannot reconcile, but which I have no doubt the author will be able to reply to at the close of the discussion. Turning first of all to the tables in Section 1 of the paper which give the ascertained cost of power per unit generated for independent plants of small and large size, it appears to me that the last column, the average costs, are too low. Even allowing for the difference in the cost of coal between the North and South of England, it is contrary to the experience we have been obtaining recently; but supposing they are correct, I do not quite see how any power company will undertake to do much in the way of taking them over, because there is not much margin between the average cost of ·696 with a load factor of 20 per cent. given in that table and the figures given in Table XIV., sub-table (*b*), of ·679. It seems to me there is something wrong there. If a big power station of 12,000 kw. or 15,000 kw. cannot get a bigger margin or difference than ·02, there must surely be some explanation for it. I have no doubt it is a matter that can be easily explained. With regard to the details of the individual tests, they also do not support the figures in Tables I. and II., but they are nearer to the experience that we have had, correcting, of course, the cost of the fuel as between North and South. In Section III. we have our old friend—I am afraid he is rather an elusive friend—the £12 per kilowatt station. A good many of us have heard a good deal about him in a room not very far from this. I would like to know whether it is possible to build a station at that figure, or even double the figure. The Newcastle Power Company have been credited with cutting these things about as finely as possible, but, as the author admits himself, the cost of their station is £33 per kilowatt, and as they do not appear to be extending their main power station, but extending it on another site on the Tyne, one would assume that they have found the limit of economical power stations. We have had no explanation of that. Of course, that is an assumption. Then the figures for the cost of sub-stations appear to me to be high. Comparing a great many that we have constructed recently, the cost given of a static sub-station is quite double the cost of those as it actually came out, and the same thing applies to the cost of rotary sub-stations. With regard to the rotary sub-stations, you will notice that the cost per kilowatt is a very big percentage of the cost per kilowatt for the main power station, which seems excessive. With regard to the space taken up by the static chambers, which is given as ·8ft. per kilowatt, that seems very high indeed, because the best place for the static transformers is out of doors, where they can get plenty of ventilation, or in the roof of some building out of the way entirely.

The PRESIDENT: May I say on behalf of the author that you have not made it quite clear whether your prices for static transformers and rotary transformer stations were half or twice the author's cost.

Mr. SEABROOK: Half the cost per kilowatt. With regard to Section IV. of the paper, which contains some criticism of the present London suppliers, I have no doubt, with regard to the author's opinion as to what is to be done for London, that later on some engineers will join in the discussion who have had a great deal of experience in this matter, who will put their views clearly before the meeting. Personally I do not believe that a large power station will solve the difficulty. The problem is quite a different one from that in the provinces, where you are taking over power stations supplying half a million to a million units per annum. But here we are dealing with power stations selling from 12 million to 20 million units per annum, and operating over small compact areas. For instance, the City Company has an area of one square mile. With regard to these tables giving the true cost of production for the various power stations in London and the provinces, one table is rather striking to me—Table VIII.—which, in its last column, gives the average costs of some of the largest power stations in the country at various load factors. I have been very interested in comparing the figures in that table with the figures in Table II., which gives the average cost per unit for private installations. Apparently Manchester, Nottingham, Leeds, and Glasgow have a cost of production double that of a private installation of from 100 kw. to 500 kw. Newcastle also in Table XII. shows a considerably higher cost per unit than the small manufacturer's private installations. On p. 26 the author gives a warning to station engineers, "That the future will bring, in all probability, a very large proportionate increase of low-price power units, and with improvements in lamps and their reduced energy consumption the proportionate lighting units may even fall below their present figure. This all means that the average revenue per unit will be considerably lessened." I should like to ask, What does it matter if it is? If I sell a million units for lighting at 3d., and the next year I sell an additional million units for power on an improved load factor for 1d., my average revenue is brought down from 3d. to 2d. If I have calculated my charge for power correctly, there is no earthly reason why because I have a lower average receipt per unit I should have a lower net profit. Of course, it is quite obvious that if the power units are incorrectly calculated it is disastrous. It would be disastrous in the station for which I am responsible, as I suppose for this year four-fifths or five-sixths of our output will consist of low-priced units. But I do not anticipate anything like the result the author warns us against, because I am convinced that the cost at which we have put the production of these low-price power units is correct. Anyway, time will tell. It may be said that our present balance-sheet is not a very brilliant affair, but that was due to other causes, not to reductions to power consumers, but mainly in reductions to lighting consumers, based on an estimated increase of consumption which was not obtained in the year during which reductions were given, but it is being obtained during the current year. Then there appears to me to be a bigger difference between the three sub-columns of the first main column in Table XIV. than there should be. I cannot quite reconcile, for instance, on the 25 per cent. load factor why an extra high-tension price of ·508 rises to ·583 with transformers. The very high efficiency of the modern transformers, and the small cost at which they are obtainable, surely cannot cause such a difference as that. The author says on p. 30, "If Table XIV. is compared with Tables I. and II., it will be seen that a power company can compete successfully with any of these other prime movers i the power company supply transformed alternating current, but if the power company is constrained to supply direct current, then it is only with smaller plants—*i.e.*, 100 h.p. or less—with which it can hold its own. Considering that the bulk of the small boroughs and the small installations consist of direc current, it does not seem to me that if the power companie

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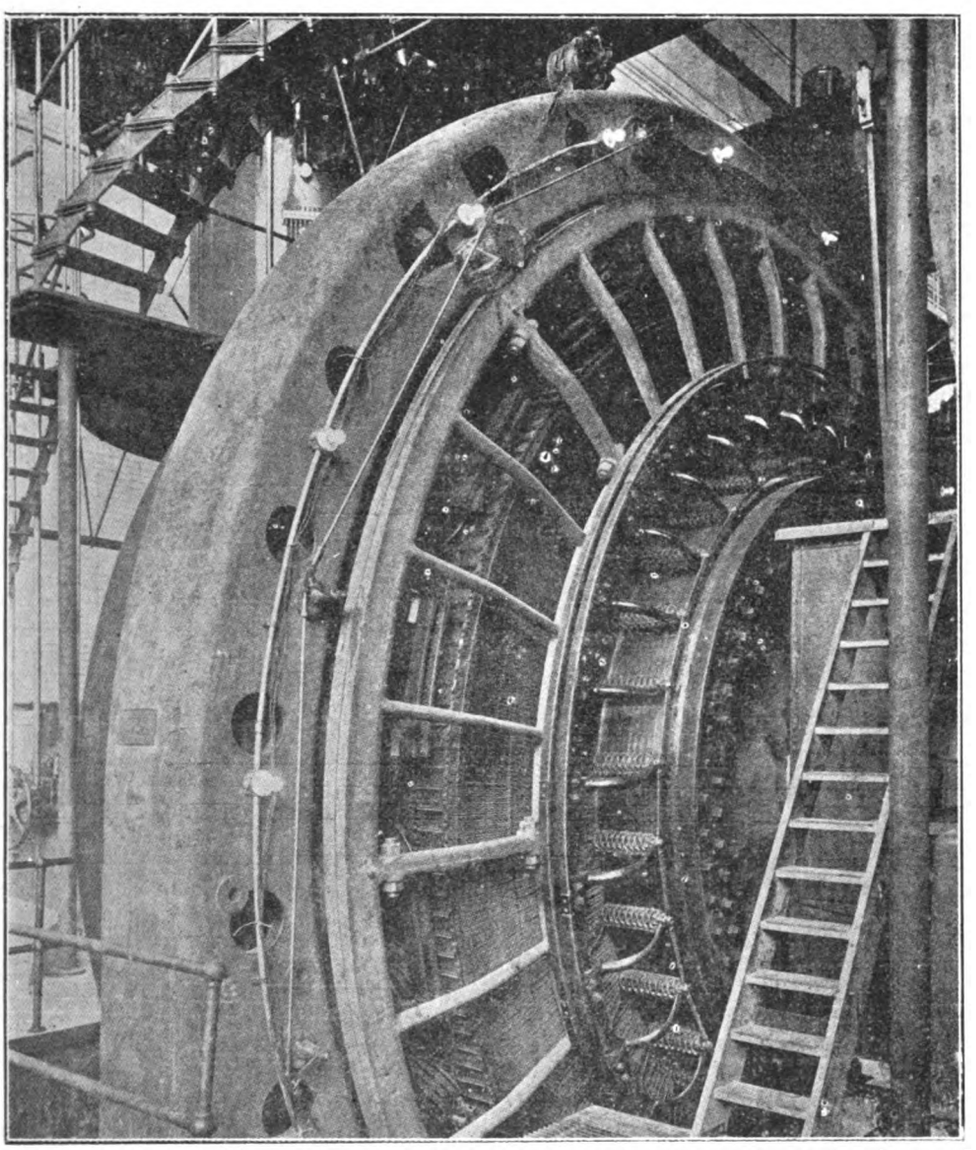
can only take 100 h.p. and under that the small boroughs with their direct-current power stations are going to receive much benefit. I am quite certain that Mr. Snell can explain all these points, but I think it is right to mention the difficulties one had come across in reading the paper.

Mr. J. A. JECKELL (Coventry) thought that Mr. Snell's curves offered very little opportunity for station engineers to induce consumers to take a supply from them. The author gave the charges that were made to power consumers in several large towns taking a load factor of 25 per cent., which showed a mean charge of ·99d. That might be all right in the case of a consumer who took only about 100 h.p., but the consumer who required from 500 h.p. to 5,000 h.p. would not pay that price, because he could manufacture for himself just as cheaply. They at Coventry six years ago were producing current for lighting at over 6d. per unit. If that was so, there was very little chance of them getting any steam or gas user to turn out his plant and go in for electrical plant. At Coventry they had a lighting station, and had put down next to it a power station, but they did not propose to charge the power consumer for the capital expenses, etc., on the lighting plant, as was done by many stations originally laid out for lighting but where improvements had been made in order that a supply of current for power could be given. Their lighting station cost them £75,000, and the cost of providing current was 6d. per unit. Another £75,000 was spent on the power station, where the current generated cost ·89d. per unit, and was sold at 1½d. The result was a balance-sheet which showed a true cost of production of 1·63d. With regard to capital charges, however desirable, he said, it was to reduce capital charges on a station, it was equally necessary to reduce manufacturing or station costs, which they could do without a single penny of expenditure. As regard static sub-stations, Mr. Snell showed that a station of 100 kw. to 250 kw. capacity worked out at a cost of £3·33 per kilowatt. At Coventry they proposed to give a supply to the outside area through kiosks fitted with two transformers at a cost of £2 per kilowatt.

Mr. W. H. PATCHELL agreed with the author as to the necessity of awakening engineers to the importance of centralisation. In 1905 Mr. Fladgate, the chairman of the supply company with which the speaker was then connected, endeavoured to bring this about among the London power companies, and if the latter had supported him loyally the question would have been settled long ago. The speaker criticised some of the figures given in the paper, and mentioned that the small amount of energy taken to run some works was a disappointment to the power companies. In a wagon shop where there were seven motors totalling 150 h.p. the consumption amounted to 17 units per horse-power month, in a brewery 28 units per horse-power per month, and in a colliery 36 units per horse-power month were used. In all cases the small amount of energy used in proportion to horse-power was noticeable. Incidentally the speaker said that some of the mains which now gave a poor supply where carbon-filament lamps were used would give improved results with metal-filament lamps.

The CHAIRMAN (Colonel Crompton) here announced that as there was a long list of speakers yet, the meeting would stand adjourned until the 16th inst. (last night).



The New 4,000-kw. 575-Volt Direct-Current Generator at the Lincoln Wharf Station of the Boston Elevated Railway Company, Boston, Mass.

2,700-KW. DIRECT-CURRENT DYNAMOS AT THE LINCOLN WHARF STATION OF THE BOSTON ELEVATED RAILWAY.

In the electric railway field one of the most interesting of recent installations is that made by the Boston Elevated Railway at its Lincoln Wharf station, where two Allis-Chalmers direct current generators of 5,400 kw. combined capacity at normal load are now in operation, after one of the quickest deliveries on record for machines of this size.

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We are indebted to the *Electrical Review* of New York for the following description of these machines:

The first of the generators, as shown in the accompanying illustration, was put in regular service Oct. 23, which was eight days in advance of the date specified for delivery, notwithstanding the fact that there were unavoidable delays, aggregating more than 30 days, during the period of erection, as a result of other work in progress at the station. The second machine was placed in regular operation Nov. 13, 18 days prior to the time specified in the contract for the delivery of that unit.

On the second day following complete erection both machines were subjected to exhaustive tests under the direction of Messrs. Stone and Webster, consulting engineers for the Boston Elevated Railway Company. These tests consisted of thorough full-load and overload heat runs, as well as commutation tests under which the circuit breaker was tripped at 50 per cent. overload. These tests proved the machines to be well within the temperature guarantees, and the commutating conditions were equally satisfactory. Each machine is capable of carrying over 4,000 kw., or, both together, over 8,000 kw., with the same setting of brushes as at no load, which is evidence of their excellent commutating characteristics. It is also worthy of mention that the second machine was operated under a 50 per cent. overload the second day after it was put into service, the first machine having been carrying its required load regularly from the time it was first put on the line until these tests were made.

These machines are so built as to satisfactorily meet the severe conditions of street railway service, which at certain periods of the day imposes large overloads; consequently they have been designed to endure sudden fluctuations in load of any degree from zero to the extreme limit of capacity, or *vice versâ*, without shifting the brushes.

These generators, direct-connected to vertical cross-compound engines, are of the multiple compound-wound type, designed for 575 volts at a speed of 75 r.p.m. The armature core of each is formed of punched steel laminations mounted on a cast-iron spider. The rings are composed of segments which are built up on the spider in such a way as to obtain the greatest possible strength. The armature construction is very open, and ample air passages are provided throughout the core to insure thorough ventilation. The armature coils are made of drawn copper strip bent into shape in such a way as to be interchangeable on the same armature. The several conductors that are to go into the same slot, after being insulated individually with linen tape, are placed together, and the necessary slot insulation is pressed on the coils by means of steam-heated presses.

The armature coils are held on the core by wooden wedges and the end connection held down by specially-designed clamps, thus avoiding entirely the necessity of band wires. A brush oscillating device is provided, by means of which the brushes travel back and forth on the commutator in a direction parallel with the engine shaft, keeping the commutator in perfect condition and avoiding the usual wearing of grooves.

With additions made at the Lincoln Wharf, Harvard, and Charlestown power stations of the Boston Elevated Railway, the total normal capacity of the system will reach approximately 50,000 kw. with ample provision for overloads. The Lincoln Wharf power station, where the new generators are installed, is the largest modern steam plant operated by the company, supplying current for surface and subway cars operated in the heart of the Boston business district as well as a large proportion of the power for the elevated system. As reconstructed, it will undoubtedly be one of the best plants of its kind to be found in any large city of the country.

SOME NOTES ON THE ELECTRICAL PURIFICATION OF FEED WATER.

BY A STATION ENGINEER.

Although the supply of boiler feed water is not frequently one of the main problems which the central-station engineer has to solve, it still remains a consideration of importance to be taken into account for the obtaining of efficient results in the production of electrical energy. In this connection the two principal objects to be attained are a sufficient quantity of water at as low a cost as possible, and the quality or composition of the same to be suitable for use in boilers—*i.e.*, there must be in solution no acid which corrodes the boiler plates, and a minimum of the salts of lime and magnesia which form scale and reduce the efficiency of heat transference to the water. The first object is well attained usually by the use of surface-condensing plant in conjunction with the engines, the air-pump discharge being collected in the hot-well and returned from thence to the boilers, only a small proportion of fresh water having to be added to make up for what has been lost by leakage, blowing down of boilers, etc. Now, the water during its passage through the engines as steam becomes intimately mixed with the lubricating oil, forming an emulsion, so that it is no longer fit to be pumped into the boilers, for a film of oil or grease inside a boiler is equivalent as a heat insulator to scale about 100 times as thick; therefore, the presence of a comparatively small quantity of oil in the feed water will give rise to serious risk of the burning of the boiler tubes or plates. It is of the first importance, then, that all trace of oil should be eliminated from the water before it enters the boilers, but though many methods have been tried to effect the purpose by mechanical means, employing various filtering media—such as sawdust, sand, etc., settling tanks, baffle plates, etc.—none of these methods have been found satisfactory in any but a very limited degree, and it has been found necessary to treat the emulsion of oil and water by some chemical or electrical process, in order to separate the oily particles from the water in such a way that, by passing the fluid through an ordinary filter, containing, say, wood, wool, or sand, the former will be retained whilst the latter passes on in a quite clean state, fit for use.

These present notes refer to the working of a purifying plant on the Davis-Perrett electrical system, capable of dealing with 8,000 gallons of water per hour. The process is a simple one, as will be seen by reference to the accompanying diagram and description following. The air-pump discharge is pumped into the top of the treating tanks, A A, made in duplicate for convenience in dealing with the quantity of water involved. These tanks are of wood, standing on porcelain insulators; each has a long narrow trough, into which the water is delivered, and the remainder is divided by wood partitions into six sections. In each section are fitted 10 iron plates (27in. by 21in. by $\frac{1}{8}$in) placed alternately, touching the bottom, and an inch or two clear of it, so that the water flows up one side and down the other towards the outlet, consisting of an iron standpipe. The plates are coupled together alternately, thus forming rows of five each, which are connected in parallel with all the other corresponding rows. The two groups of plates are then connected to a 500-volt direct-current supply through a double-pole change-over switch, by means of which the two groups are made positive and negative in turn as required. This provision is made in order to equalise the deposit of the iron plates and lengthen their life, for it is evident that if the current were kept flowing in one direction day after day the positive electrodes would very soon be conspicuous by their absence. On putting the 500 volts pressure on to the electrode terminals, the current flowing through the water was found to be about five amperes, and the current which was required to produce the proper effect on some 6,000 gallons per hour which was to be treated was 10 amperes, or 0·9 unit per 1,000 gallons treated. In order to increase the current a small proportion of the make-up feed of fresh water is added to the air-pump discharge previous to its being pumped to the treating tanks, and by adjusting this fresh-water addition a very fine regulation of the electric current flowing can be obtained, given an easy means of varying the current according to the amount of water with which the apparatus is dealing at any time. It may here be mentioned that no alteration of the current is required within fairly wide ranges of load, provided that sufficient is kept on to deal with the maximum flow of water. Overflowing from the treating tanks, in which the oil separates out and remains floating on the surface, the water falls into a

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shallow iron tank, B, which forms a small reservoir from which the two filters, C C, are supplied. The filters (of the Wilson self-cleansing type) are in duplicate, in order that during the five or six minutes which elapse whilst one filter is undergoing flushing the other filter may be dealing with the whole of the water supply; ordinarily the flow of water is divided nearly equally between them.

It happens, though rarely, that both filters commence flushing about the same time; for this reason there is a small stand-by reservoir to keep the feed pumps supplied for a few minutes. The automatic cleansing of the filters is effected by an ingenious system of siphons. Each filter has its own flushing tank, D, just above it. As the quantity of dirt in the filter increases, the flow of the water becomes more and more restricted, resulting in the level of the surface of the water rising. At a certain height the small siphon, E, is set to work, and the water overflowing through its discharge pipe fills the bucket, F, which in turn causes the attached lever to turn about its fulcrum, G, and pull down the chain, H. This closes the outlet valve, I, of the filter and the inlet valve, J, simultaneously opening the valve, K, in the auxiliary section of the flushing tank. The water in the auxiliary section now flows into the flushing tank, standing nearly full, and by raising its level brings the siphon, L, into action, and this

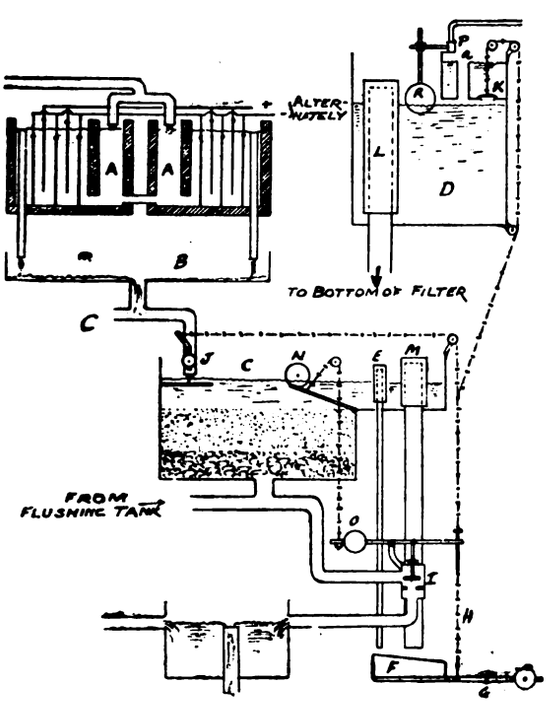

Diagram of Davis-Perrett Feed-Water Purifying Plant.

suddenly empties the entire contents of the tank, D, into the filter from below. First the air in the connecting pipes is forced up through the filtering medium, thoroughly disintegrating and aerating it, rendering the next process very thorough; then the flush of clean water comes, and rushing upward carries with it the lighter particles of dirt. The filter fills and the water-level rapidly rises above the small siphon, E, until it actuates the large siphon, M, which then empties the filter into a large drain tank below as rapidly as the filling took place. The action of the float, N, and the board to which it attached, reaching across the whole width of the filter, is such that all the rush of water from the filter to its discharge, M, must rise over the top of it, so that only the dirt and a comparatively small portion of the filtering medium are carried away, and when the discharge is completed at the breaking of the siphon action, the filter-bed settles down ready for another period of work. At this stage the float-board lies in a horizontal position, and by means of a chain holds up the weight, O, keeping shut the valve, I, allowing it to open gradually, to resume supply, as the filter fills. Other actions which take place when the discharge is completed are the lifting of the bucket, F, when it drains empty by a small aperture in the bottom; this releases the valve I, now under the control of the float, as mentioned above, and at the same time allows the inlet, J, to resume supply to the filter and the valve K to shut. The ball-cock, P, in the auxiliary tank opens and fills it, and continues open until the overflow by the stand-pipe, Q, fills the flushing tank to its standing level, at which height the ball, R, shuts the ball-cock, and the tank is ready for the next flush. In ordinary service, at about three-quarters full capacity, the filters flush every eight or nine hours, so that the loss of fresh water from this cause is quite diminutive compared to the total quantity of water dealt with, and is hardly an appreciable additional cost to that of the ordinary make-up supply. The capital cost of the entire installation is little more than the water charges for six months in some cases. The working costs consist of charge for current at the rate of about one unit per 1,000 gallons of water treated, and labour in cleaning the oil and scum off the surface of the treating tanks once a week. As this can be done by one man in about an hour it is not a heavy item. The filtering medium, gravel and sand, will only require changing after long periods of service, not more frequently than once a year. The results obtained from the use of this method have been quite satisfactory. The loss of water temperature in the process is quite small, although the apparatus is outside the building and not under cover. As the tanks and filters act as reservoirs to a certain extent, a fair comparison of inlet and outlet temperatures is not obtainable by taking simultaneous readings at these places. Sometimes a higher temperature is obtained at the outlet than at the inlet. To get an accurate estimate of the temperature difference which obtains on the average, a series of readings would require to be taken at frequent intervals for an hour or two at outlet and inlet respectively, and temperature curves plotted. From approximate readings the temperature loss appears to be 4 or 5 degrees F. only.

THE CONDUIT SYSTEM OF ELECTRIC TRAMWAY CONSTRUCTION AND RECENT IMPROVEMENTS.*

BY FITZ ROY ROOSE, A.M.I.MECH.E., A.M.I.E.E., F.C.S.
(L.C.C. ENGINEER'S DEPARTMENT).

Since the paper on the reconstruction of the London County Council tramways by Mr. Alexander Millar, A.M.I.C.E., was read before the Institution of Civil Engineers in 1904, many new lines have been constructed and reconstructions carried out. Improvements and modifications have been made which from experience have been found possible and advantageous, having regard to firmer construction, longer life, and cheaper maintenance. It is the author's intention to avoid, as far as possible, repetition of the details contained in Mr. Millar's paper, and to confine himself to a comparison of the original method of construction of the conduit system with that at present in vogue.

In the year 1903 there were in South London 16·4 miles (single) of tramways on the conduit system, and since then about 88 miles have been constructed and reconstructed, making a total of 104 miles (single) to date, while on the north side of the Thames about 50 miles have been constructed and reconstructed. The work of reconstruction is still proceeding. The electrified lines have been extended over Vauxhall Bridge to Victoria, and over Westminster Bridge along the Embankment to Blackfriars, and an important subway has been formed between Holborn and Aldwych, under Kingsway. An extension to the latter is now in progress to connect with the Embankment under Waterloo Bridge, passing under the Strand, which, when completed, will link the southern and northern systems.

ORIGINAL METHOD OF CONSTRUCTION.

The first line constructed from Westminster to Tooting, *vid* Clapham, and opened in 1903, consisted of a concrete tube in which were embedded iron yokes, 3ft. 9in. apart, supporting two central rails ½in. apart, and level with the road, thus forming an opening in the road surface through which access to the tube for the electrical connection was obtained. These two rails, known as "slot rails," were held in position on the yokes by bolts, and kept to uniform gauge by tie-rods, extending between a shoulder on the

* Paper read before the Junior Institution of Engineers.

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yoke and the rail itself. The slot rails, yokes, and conduit were all combined in one operation. The slot rails and yokes having been assembled and brought to the required line and level, a centering, formed of laths of wood, and shaped to fit the inside contour of the yokes, was inserted and wedged in position. Wooden or sheet-iron frames were hung from each slot rail at intervals of 15ft., to form pockets known as insulator pits. The whole structure was then surrounded by a mixture of 5 to 1 concrete. When the concrete was thoroughly set the wooden centering and box frames were drawn. A concrete conduit was thus formed with a pocket on either side every 15ft., surmounted by the slot rails. The track rails were then laid to accurate gauge, on either side of the conduit, and packed up on 9in. of 7 to 1 concrete, tie-rods being inserted between each track rail and yoke to maintain the gauge. Under every joint between the track rails a soleplate or anchor was riveted and embedded in 3 to 1 concrete. (These were not actually used on the Tooting lines, but on the Camberwell lines, which were laid about the same time.) Dicker joints were adopted on the Tooting lines. Later lines, however, had ordinary fishplates and anchors. Cast-iron frames and covers were bedded against the slot rails over each pocket formed in the conduit. Paving was then laid. The conductor bars (tee rails) were next put into the conduits through a gap, a 7ft. 6in. length of slot rail being left out temporarily for the purpose. Insulators were bolted to the flange of the slot rail in each pocket, and the conductor bars were fixed by clips to the insulator, and thus presented two rubbing surfaces, which, when brought to gauge, were 6in. apart. At each joint between the conductor bars two copper bonds were riveted, bridging the joints, ensuring a continuous conductor (Figs. 3 and 4).

At intervals of half a mile a gap of 2ft. was left in the conductor bars, forming a section insulator, at which point current was supplied to the line. The ends of the conductor bars were flared back $1\frac{1}{2}$in., the distance between the extremities of the bars thus being increased to 9in. This was done to ensure that the plough, after leaving one section, should slide between the bars of the next without catching. For greater stability, and to withstand the shock caused by the plough entering between the flared ends, two insulators, contained in a larger pocket, supported the flared ends. From each bar on each side of the break thus formed, a cable in an earthenware duct was taken to a feeder pillar erected on the footpath, and from which current was obtained, the feeder pillar being in turn fed from a sub-station supplied with power from a generating station. Switches were placed in these feeder pillars so that current could be cut off the conductor bars when necessary. At each of these section insulators, covers, known as "plough hatches," were fixed, which, when removed, formed a gap large enough to permit of a plough being withdrawn from the conduit. The plough, a collecting device (connected by cable to the car motors), was suspended from each car. It passed through the slot and terminated in two rubbing contacts called shoes, which, by means of springs, were pressed out against the conductor bars, and thus completed the circuit between the conductor bars and the motors in the cars.

At intervals of about 60 yards, the ordinary insulator pits in each track were deepened and connected by means of a 12in. pipe, with sumps or catchpits, built in the margin of the tramway. These sumps formed settling chambers for the mud, the water flowing to the sewer through a 12in. pipe, which was trapped at the sump end to prevent sewer gas escaping to the road. A manhole cover in the road gave access to the sumps for cleaning purposes. The track rails were drained by means of holes drilled in the floor of the groove of the rail, into cast-iron boxes, bolted against the web of the rail, which in turn were drained into the tube itself through 3in. pipes. The frames of the catchpits were the same as the ordinary insulator pit frames, but had special covers, which allowed of the insulator being placed to one side of the pit, instead of centrally, thus facilitating cleaning operations.

Fig. 1. Sectional Elevation of Conduit.

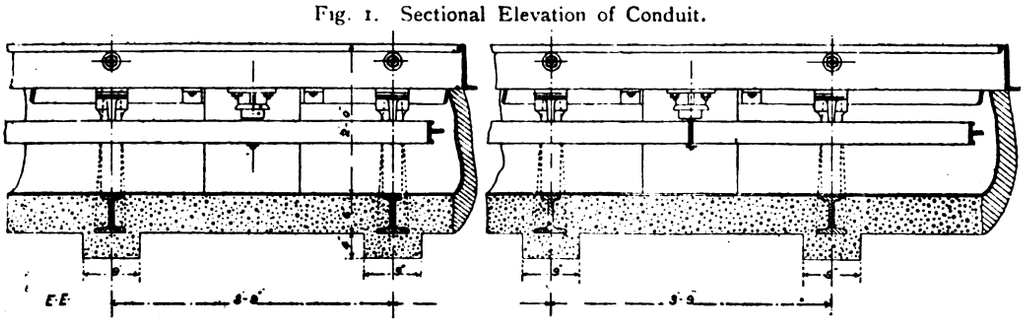


Fig. 2. Sectional Plan of Conduit.

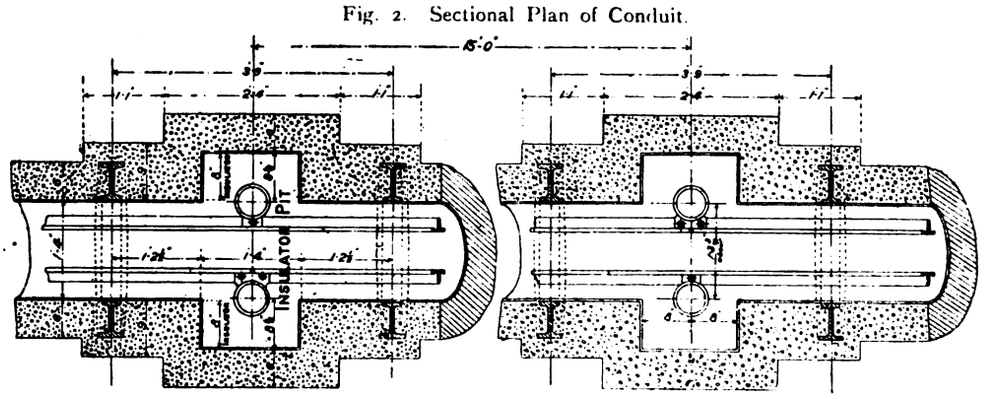
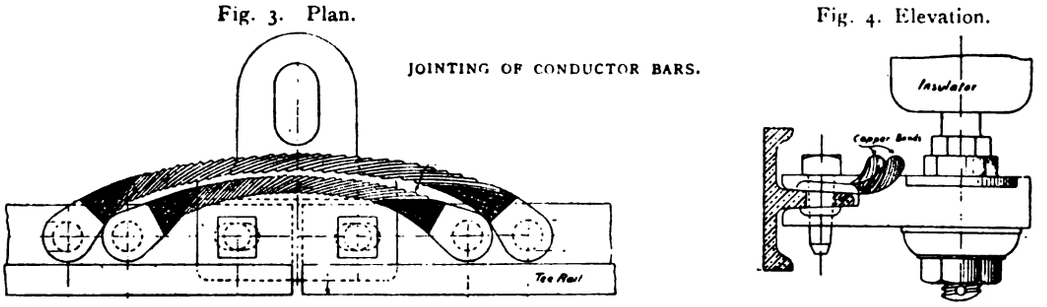


Fig. 3. Plan.

Fig. 4. Elevation.

JOINTING OF CONDUCTOR BARS.



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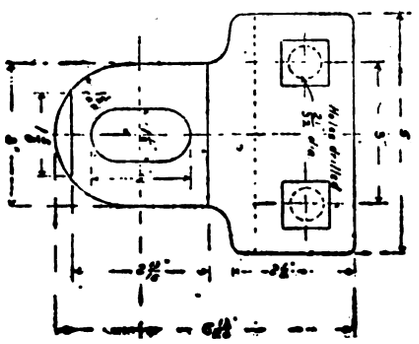
Crossovers and junctions were constructed with special castings, special yokes being supplied, enabling one conduit to diverge from the other, and thus follow the track branching off from the main line.

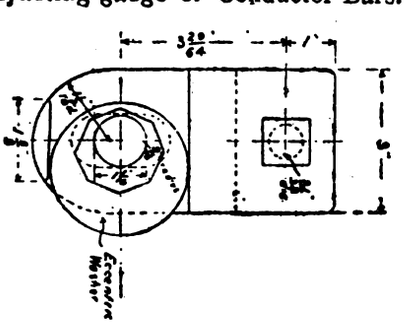
At all facing and trailing points a chamber, termed a mechanism pit, was built under the whole width of the track, in which all connecting rods and necessary mechanism for actuating the points, both slot and track, were installed.

Fig. 5. Plan of Double Clip used at Joints (see Fig. 3).



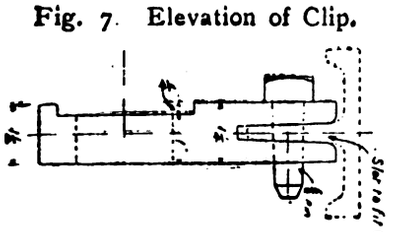
These pits extended 3ft. outside the outer rail, and were drained into the nearest sump or direct into the sewer. At facing points of junctions, the rod in the mechanism pit actuating the track and slot points was extended through a pipe to a lever box in the footpath, from which it could be operated. Adjacent to the mechanism box, a small pit was built of concrete, containing a tap and length of hose terminating in a nozzle, which was used for cleansing the points, being connected through a meter

Fig. 6. Plan of Intermediate Single Clip and Eccentric Washer for adjusting gauge of Conductor Bars.



to a convenient water-main. The conductor bar work for crossovers and junctions was necessarily somewhat complicated, as provision had to be made for the plough branching from one conduit into another. This was done by having gaps in the bars, the ends of which were flared wherever the slots intersected or converged. To continue the current across these gaps, "jumper" cables were drawn through earthenware pipes and bolted on to each conductor bar, ensuring continuity of current.

Fig. 7. Elevation of Clip.



The insulators which suspended the conductor bars consisted of three separate parts—an iron hood, corrugated on the inside surface, with a projecting bolting-up face containing two holes for bolting up to the slot rail; a porcelain cup, also corrugated; and a corrugated spindle or pin. The three parts were assembled by first placing the porcelain cup in the cast-iron hood and packing round with neat cement. When the cement had set, the pin was placed in a central upright position in the porcelain cup, and was in turn surrounded with neat cement. Thus was formed, when placed in position, an insulated bolt at right angles to the slot rail, on which a clip was secured. This clip (Figs. 5 to 7), made of cast iron, clasped the stalk of the conductor bar, the bar being held in position by a cottar pin driven through convenient holes in the clip.

(To be continued.)

ELECTRICAL POWER IN RAILWAY GOODS WAREHOUSES.*

BY H. HENDERSON, ASSOCIATE MEMBER.

The introduction of electrical power into railway working has been of very great assistance, especially in dealing with goods traffic in warehouses. The advantage of electric

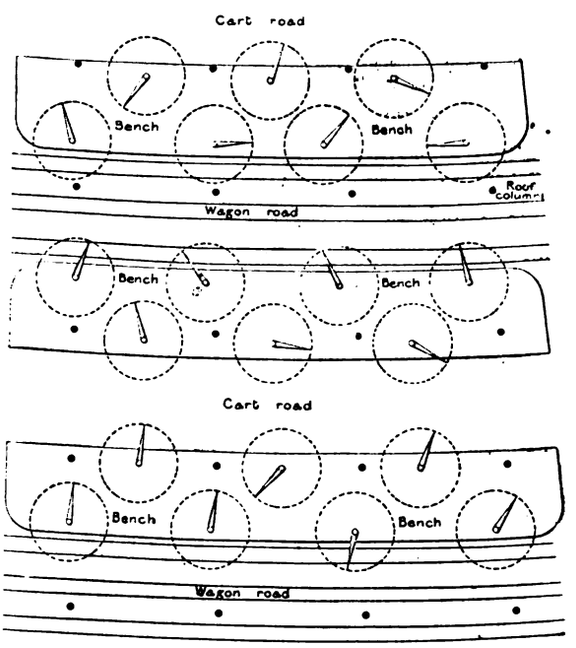


FIG. 1.—Showing Hydraulic Cranes, Forth Warehouse.

lighting was proved years ago, and the late Mr. W. E. Langdon claimed that the work done in a given time was increased 30 per cent. by the installation of arc lamps in one of the Midland Company's warehouses. It is obvious that good lighting is essential where goods are being loaded

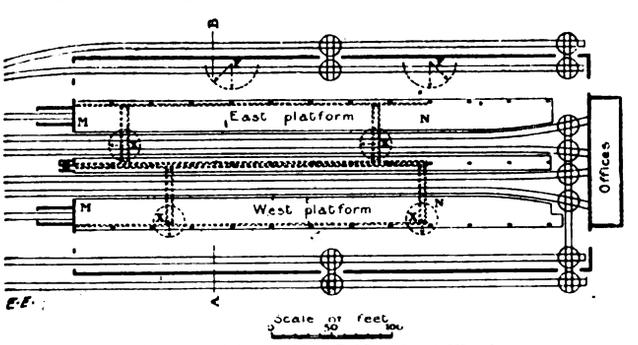


FIG. 2.—Ground Floor, New Bridge-street Warehouse.

and unloaded, and time is saved if the addresses can be distinctly read by means of the light provided. In the North-Eastern Railway Company's goods warehouse in Forth Banks, Newcastle, hand lamps had to be employed on the benches when gas was in use. When arc lamps were introduced, the hand lamps were dispensed with, which was a considerable gain in the speed of handling goods, and also from the point of view of safety. The good lighting provided by the arc lamps also allows of better supervision of the material by watchmen, which saves a considerable amount in the way of claims. The use of electricity for power purposes is, however, of more recent date, and it is with the question of power that this paper deals. Amongst the chief advantages to be gained are: (1) more floor space avail-

* Paper read before the Institution of Electrical Engineers

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able by making use of overhead travelling cranes; (2) less aggregate power to perform the same work as hydraulic; (3) less cost for power; (4) after the machinery is in running order, less maintenance is required.

Nos. 1 and 2 are very clearly seen by examining Fig. 1 and 2. Fig. 1 is a plan of part only of the Forth goods

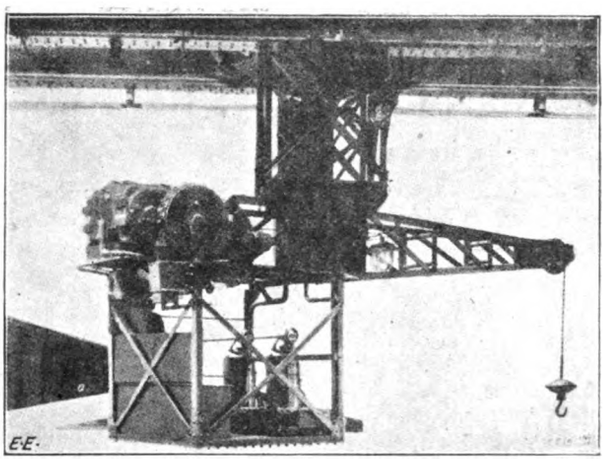

FIG. 3.—Overhead Travelling Crane with Revolving Jib.

warehouse. This shows the warehouse as orginally designed for hydraulic power. The total number of hydraulic cranes per row of benches was 18, in three rows, making a total of 54. These cranes served benches with an approximate length of 1,500ft. and an area of about 48,000 square feet, which gives 30·3 h.p. per 1,000 square feet of bench area and a lifting capacity of 1·4 tons for the same area.

working, four electric overhead travelling cranes, described later, serve two benches of a total length of 580ft. and an

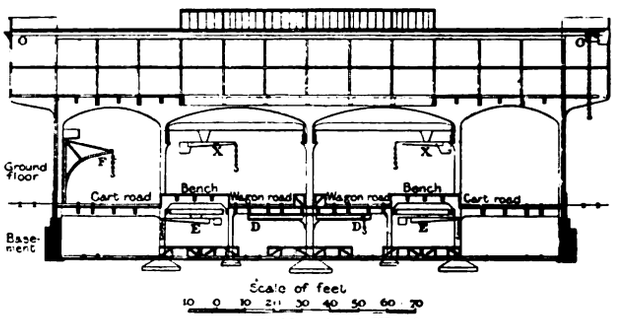

FIG. 4.—New Bridge-street Warehouse.

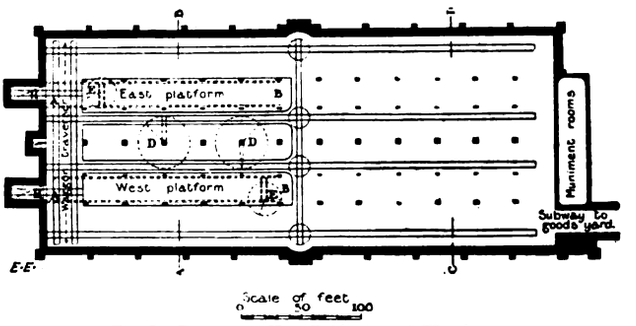

FIG. 5.—Basement, New Bridge-street Warehouse.

area of about 15,000 square feet. These cranes give 6·13 h.p. per 1,000 square feet of bench area, and a lifting capacity of 0·27 ton for the same area. These figures show what a great saving can be made by adopting such cranes, and

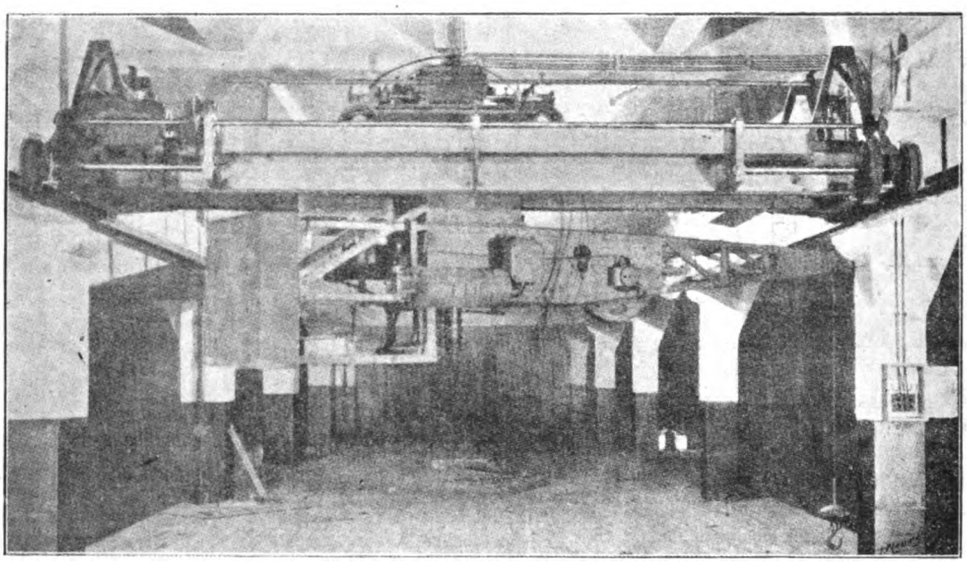

FIG. 6.—Overhead Travelling Jib Crane.

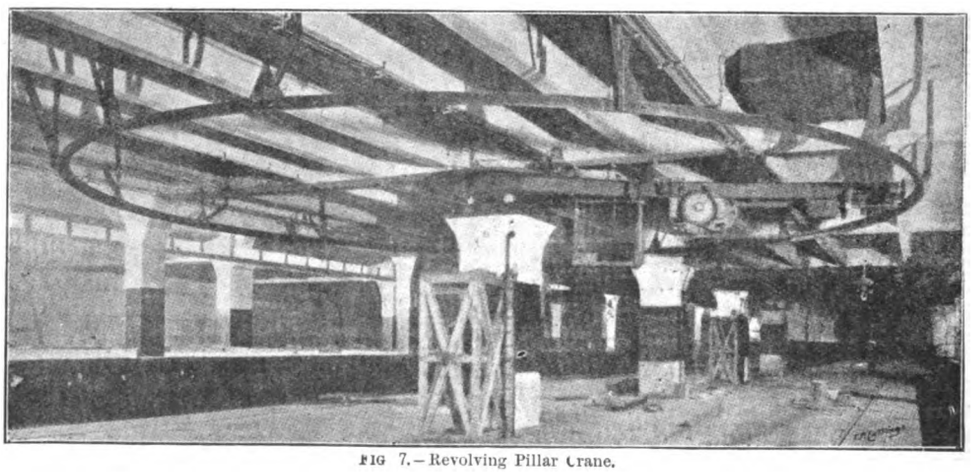

FIG 7.—Revolving Pillar Crane.

In the company's new warehouse (Fig. 2) at New Bridge-street, Newcastle, which is designed for electrical that nine similar electric cranes could have replaced the 54 hydraulic cranes at the Forth goods warehouse, where

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head room is ample for the use of overhead travellers. The figures cover all motions in each case.

The types of machinery used in a goods warehouse are (1) machinery for dealing with goods—namely, cranes, hoists, etc.; (2) machinery for dealing with traffic—namely, capstans, hoists, and traversers. In describing the different types, the new goods warehouse of the North-Eastern Railway at New Bridge-street will be taken as an example because it has been designed for electrical working, and the whole of the machinery is electrically driven. Under heading No. 1, a type of crane has been adopted which seems to be most suitable for this class of work. It consists of an ordinary overhead travelling crane, but instead of being fitted with the usual crab the hoisting gear is attached to a revolving jib carried on a lattice framework fixed to the crab. The crane has thus four motions, controlled by two universal controllers fixed to a platform on the revolving jib. The jib, controllers, and hoisting gear are clearly shown in Fig. 3, which also shows the method of suspension from the crab. The lifting capacity is one ton, and the sizes of the four motors are: lifting motor, 15 b.h.p. at 150ft. per minute; revolving motor, 1½ b.h.p. at 250ft. per minute; cross traversing motor, 1½ b.h.p. at 150ft. per minute; travelling motor, 5 b.h.p. at 350ft. per minute. The span is 48ft. 6in and the jib radius 11ft. From the cross-section of the building shown on Fig. 4, upon which these cranes are marked X, it will be seen that a jib can reach material outside the

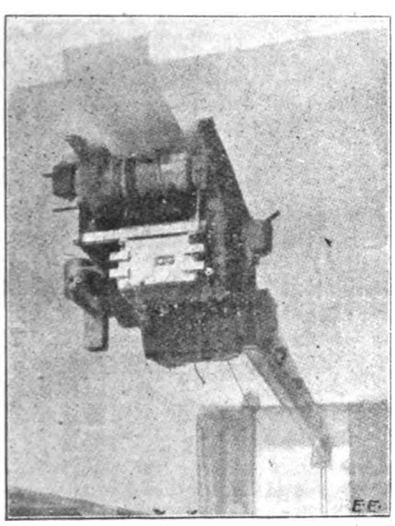

FIG. 8.—Travelling Crab.

span of the main girders and do lifting work in three spans of the main building. This is a great advantage, as material can be taken from any wagon and deposited on a cart irrespective of the position of either vehicle. Such work cannot be accomplished by any other type of crane, and at the same time the full command of the whole of the bench is obtained without in any way taking up valuable storage space. Other cranes on the same floor include two wall cranes shown at F on Fig. 4. These are ordinary revolving jib cranes with stationary machinery and a fixed driving platform. The machinery, consisting of lifting and revolving gear, with a separate motor for each motion, is fixed on brackets above the top support of the crane, and the jib is revolved by a vertical shaft carrying a pinion, driving a spur wheel fixed to the top of the crane post. These cranes are capable of lifting one ton at a speed of 60ft. per minute with 6 b.h.p., and of slewing at a speed of 150ft. per minute with 1½ b.h.p. The motors are driven by a double controller with a single handle, as in use on the travelling cranes.

In the basement four cranes have been erected, and, owing to the smallness of the head room, special types have been used. Two of the cranes are travelling jib cranes, similar to the ground floor. These are shown at E on Fig. 5, and in further detail on Fig. 6. In these cranes the revolving jibs are 12ft. radius, and the span is 20ft. They can thus cover a width of nearly 40ft., and have a track 200ft. long. The capacity is one ton, and the sizes of the motors are: lifting motor, 6 b.h.p. at 60ft. per minute; revolving motor, 1½ b.h.p. at 150ft. per minute; cross traversing motor, 1½ b.h.p. at 100ft. per minute; travelling motor, 2¼ b.h.p. at 100ft. per minute. It will be seen that the hoisting gear is forward on the jib in this case, and a heavy balance weight attached at the back. This is done to keep the controlling platform up, on account of the small amount of head room available. The remaining two cranes in the basement are of a special type, and are named revolving pillar cranes.

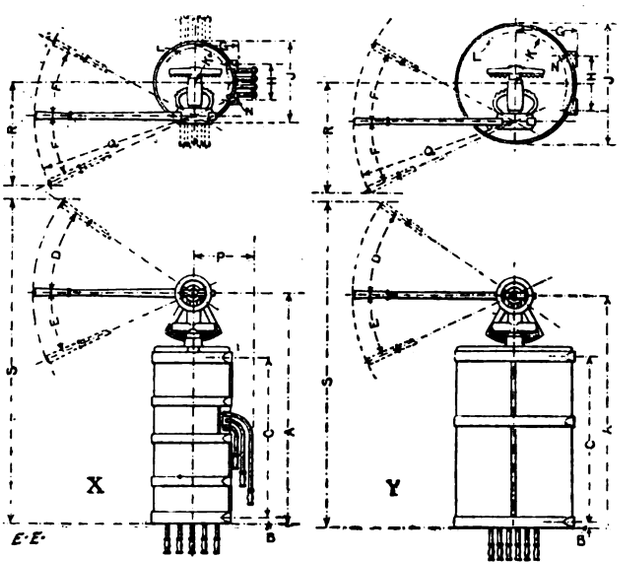

FIG. 9.—Universal Controller.

They are shown at D in Fig. 5, and a full view of the crane and circular track is shown on Fig. 7. Each crane consists of a revolving framework, one end of which is constructed to encircle one of the main pillars of the building, whilst the other is fitted with wheels which run on a circular track attached to the roof. The cage and hoisting gear are fixed near the pillar to the revolving frame, and the travelling motor is at the outer end near the wheels, the two motions being driven from one controller. The pillar end of the frame runs on a heavy casting which, when bolted up, forms a vertical circular support carrying a square horizontal flange on the bottom

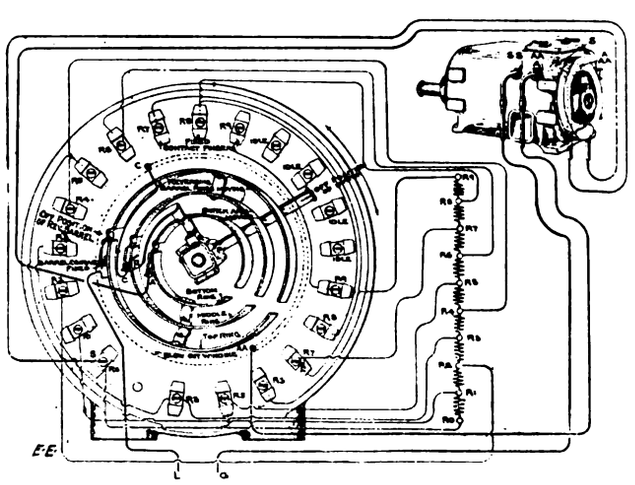

FIG. 10.—Connections of Controllers.

The end of the frame surrounds this support and carries two rollers which bear on the vertical surface, thus keeping the motion circular. These cranes are capable of lifting one ton at 60ft. per minute with 6 b.h p. and revolving at 150ft. per minute with 1½ b.h.p.

For hoisting material to the top floors, which are used for storage of grain, flour, and similar materials, there are in use two transporters and six jiggers. The transporters travel the full width of the building at about 70ft. from the ground-floor rail level, the track being extended 16ft. on each side of the building to permit the hoisting of material from wagons outside the warehouse. These machines are shown at O in Fig. 4. The hoisting gear is contained in a travelling crab, which also carries the cage.

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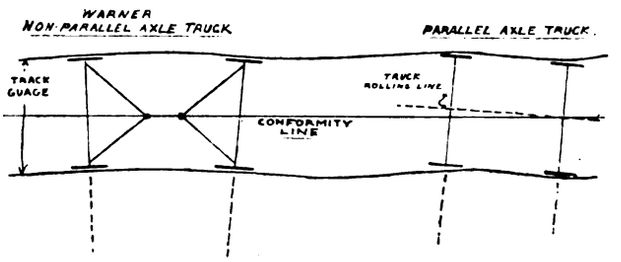
The track is formed of heavy channel irons bolted to the roof girders and to the concrete roof, the running rails being bolted to the bottom flange. The lifting is done with a 15-b.h.p. motor at 150ft. per minute, and the travelling with 1½-b.h.p. at 350ft. per minute, both motors being driven from one controller. The lifting capacity is one ton. These hoists can pick up material from any part of the ground floor directly beneath them, and can deposit it on either of the upper floors, the wire passing through a slot in the floor when travelling from the well to the first floor. In the jiggers the machinery is fixed. A heavy H-iron is bolted to the roof, and along this travels a small framework for bringing in the load from outside either to the first or to the second floor, and in two cases to a third floor also. These hoists are shown in Fig. 8. The hoisting rope is permanently fixed at one end, to the outer end of the girder, and passes through the travelling frame over two pulleys to the fall block, and thence to the winding drum. The travelling motor drives an endless rope attached to the frame, running it in or out as required. A large pulley is fixed at the outer end of the girder to take this rope. The capacity is 15cwt., and the lifting is done with 10 b.h.p. at 100ft. per minute, and the travelling with 1½ b.h.p. at 120ft. per minute. These jiggers are made to be controlled from each floor, and also from two places on each floor—namely, one inside and one on a platform outside. The various points of working are interlocked in such a manner that the controllers can only be worked from one point at once. This is done mechanically by gear wheels and clutches, the various points being coupled by wire ropes driving small shafts with bevel wheels, and finally driving two controllers. All these machines, with the exception of the jiggers, are driven by universal controllers, the general arrangement of which is shown in Fig. 9, and a diagram of connections for one motion is shown in Fig. 10. The resistances are all enclosed in special iron cases with radiating ribs, forming a compact arrangement easily fixed.

(To be continued.)

THE WARNER TRUCK.

On Friday last we had an opportunity of witnessing a demonstration of the Warner patent steering control applied to one of the West Ham tramcars, which was given through the courtesy of the chairman and of Mr. H. E. Blain, the general manager of the West Ham Corporation tramways. In our issue of Aug. 9, 1907, we gave details of a series of tests carried out with this truck on one of the cars of the Metropolitan Electric Tramways, Limited. Mr. J. Sutherland Warner, who is the inventor of the Warner patented steering control, which is owned by the Warner Engineering Company, claims that, in order to avoid the excessive flange friction and the excessive wear of wheel and rail treads, which is giving so much concern to electric traction engineers at the present time, the planes of the wheels must change in conformity with the irregularities in the rails. The car, instead of having two pairs of wheels rigidly fixed in a frame, has two pairs of wheels which swing independently of each other, the car body being slung over the wheels by suspension links. So delicate is the suspension of a car that, when standing still, the whole vehicle may be swayed horizontally with an amplitude of 3in or 4in. with one hand. Last Friday's demonstration served to show how smooth a vehicle fitted with the Warner control can run; during the journey a minimum of shock and vibration being experienced. A vehicle in motion will naturally tend to move in a mathematically straight line. Since no length of rail can be mathematically straight, it follows that mathematical correctness is unobtainable with several lengths placed end to end, or in parallel lines forming the gauge of bi-rail tracks. Mr. Warner has conceived the "conformity line," which is a representation of a straight line "bent" only to conform with changes in track direction, as apart from the rails' irregularities, and this, together with the relative irregularity of the two rails, is shown in the sketch. The latter also illustrates a common position for a set of wheels and axles both with the trucks at present universally employed (parallel axle trucks) and with the Warner steering control (non-parallel axle truck). It will be seen from the sketch how flange friction may be minimised and rail wear reduced by means of the non-parallel axle truck, the wheels of which are being continually steered round



the inequalities in the track. This method of control is applicable not only to tramcars, but to railway vehicle and mining trucks, the latter lending itself particularly to the method of control invented by Mr. Warner.

PROMOTION.

(. . . "There has been far too much promotion . . . See last week's leading article.)

Whene'er on night shift I awake,
To think upon the world's affairs,
And incidentally to fa/ke take (*sic*)
The previous readings, all the cares
Of life seem due
To those of you,
Not one of whom with me compares.

If I were not so modest, or
Afraid of talking through my hat,
I should I'm sure be director,
And chief of more than one firm that
Would quickly grow,
And profits show,
If only on its board I sat.

So many manufacturers
Are working at a loss you see,
Because undoubtedly each errs
In not appointing me to be
His chieftain great
With regal state
To seek and gain economy.

* * * * *

Good gracious me! The volts have been
Right off the scale, and now they're back
To zero, where they seem to mean
To stay awhile and make things black
As impish night.
What's that? A light!
Yes! 'Tis the chief . . . I've got the sack.

SIDNEY DENHAM.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, Jan. 25.

MONDAY, JAN. 20.—"A" Coy.—Technical drill, 6.30 p.m.

TUESDAY, JAN. 21.—"B" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

WEDNESDAY, JAN. 22.—"A" Badge examination for "C" and "D" companies.

THURSDAY, JAN. 23.—"C" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

FRIDAY, JAN. 24.—"D" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

SATURDAY, JAN. 25.—Week-end run for Cambridge det. at headquarters.

(Signed) J. H. S. PHILLIPS, Captain.
Acting Adjutant.

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NOTES.

Electrical Engineers' Ball.—This event, which has been held with increasing success during the last few years, is to be repeated at the Hotel Cecil on Friday, Jan. 31. Tickets may be obtained from any member of the committee, a list of whom appears below: H Alabaster, A. K. Baylor, J. H. Bowden, H. W. Bowden, G. Burney, J. Carlton, T. O. Callender, E. A. Carolan, A. Clift, E. C. De Segundo, R. S. Erskine, A. L. C. Fell, G. Flett, E. J. Fox, T. E. Gatehouse, Sir J. Gavey, W. Geipel, Dr. R. T. Glazebrook, J. Gray, R. K. Gray, A. E. Hadley, R. Hammond, H. E. Harrison, H. Hirst, J. S. Highfield, H. R. Kempe, J. E. Kingsbury, E. M. Lacey, W. E. Lane, H. M. Leaf, G. C. Lloyd, W. L. Madgen, W. L. Matthews, W. H. Massey, W. M. Mordey, H. T. S. McKay, P. V. McMahon, F. H. Nalder, Major W. A. O'Meara, G. W. Partridge, J. Petersen, J. S. Raworth, J. H. Rider, M. F. Roberts, W. Rutherford, J. H. Rosenthal, A. Siemens, A. M. Sillar, F. A. Smith, J. Spagnoletti, T. E. P. Stretche, G. Sutton, E. M. Sawtelle, C. P. Sparks, C. D. Taite, J. Taylor, R. J. Wallis-Jones. Executive Committee—J. E. Kinsbury, P. V. McMahon, G. C. Lloyd, M. F. Roberts, R. J Wallis-Jones. Hon. treasurer—R. Hammond. Hon. secretaries—A. M. Sillar and H. Alabaster.

Shrinkage of Wood When Dried.—Interesting experiments on the shrinkage of wood due to the loss of moisture have recently been completed by the Forest Service at its timber-testing station at Yale University in the United States. These experiments show that green wood does not shrink at all in drying until the amount of moisture in it has been reduced to about one-third of the dry weight of the wood. From this point on to the absolutely dry condition, the shrinkage in the area of cross-section of the wood is directly proportional to the amount of moisture removed. The shrinkage of wood in a direction parallel to the grain is very small; so small in comparison with the shrinkage at right angles to the grain that, in computing the total shrinkage in volume, the longitudinal shrinkage may be neglected entirely. The volumetric shrinkage varies with different woods, being about 26 per cent. of the dry volume for the species of eucalyptus known as bluegum, and only about 7 per cent. for red cedar. For hickory the shrinkage is about 20 per cent. of the dry volume, and for long-leaf pine about 15 per cent. In the usual air-dry condition from 12 to 15 per cent. of moisture still remains in the wood, so that the shrinkage from the green condition to the air-dry condition is only a trifle over half of that from the green to the absolutely dry state.

Colonial Trade Expansion.—An important step has just been taken by the Manufacturers' Association of Great Britain in regard to the development of trade with the Colonies. In view of the altered condition of the markets in Australia, New Zealand, and Canada through the adoption by these colonies of new customs tariffs and the passing of local measures for the encouragement of industry, the association have decided to dispatch a commercial mission to inquire into and report upon the trade position and prospects in those colonies. The commissioner appointed to undertake the inquiry is Mr. Ben. H. Morgan (secretary of the association), who reported in a similar capacity on the trade of South Africa some time ago. The commissioner has been authorised to report on the extent and possibilities of the market with a view to (*a*) increasing export trade; (*b*) establishing branch factories behind the tariffs, the extent and condition of local industries, the nature and extent of foreign competition, transport services (with special reference to shipping "rings" and "conferences"), the operation of local tariffs, and probable effects of preferences. It is understood that Mr. Morgan will also make representations direct to the Australian Government with a view to securing further reductions on various items of the tariff and increased preferences in favour of British manufacture before the Bill receives the approval of the Senate, and he will also discuss with representatives of the various Governments a number of questions, such as methods of assessing and collecting customs duties, the fiscal treatment of catalogues of British manufacturers, the extent of encouragement that will be given to British manufacturers establishing branch factories, and many other matters a clear understanding of which will greatly facilitate trade within the Empire.

Notes on New Publications.—"Iron and Steel," by J. H. Stansbie, B.Sc. (London: Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. 6s. net) is the latest publication in the well-known "Westminster Series." Mr. Stansbie gives us a comprehensive view of the modern aspects of iron and steel manufacture, together with an account of its history, which should enable readers to follow its march of progress. The methods of producing varieties of the metals suitable to the requirements of the engineer, foundryman, and mechanician are described sufficiently to enable the user to follow the producer in his work, and thus learn the history of the material he is handling. The various processes are described, and the descriptions are made easier to follow by numerous diagrams. The chapter on "Electric Smeltings" opens with description of the action of electric generators, and explains the meaning of electrical units. It then unfolds the principles of the electric furnace, and goes on to describe the various processes of steelmaking in the electric furnace—the processes of Hèroult, Kjellin, Stassano, and Keller being clearly explained. Mr. Stansbie has added a useful glossary to his book. — *Science Abstracts* for December (in two sections — A, Physics; B, Electrical Engineering) have now been issued by the Institution of Electrical Engineers.—The December issue of the *Proceedings* of the American Institute of Electrical Engineers gives a report of the discussion on "The Grounded Neutral," which centred round the papers read by Messrs. Paul M. Lincoln, G. J. Rhodes, and others.—Dr. J. W. Richards contributes the concluding portion of his article on "The Electrothermic Production of Iron and Steel" to the December issue of the *Journal* of the Franklin Institute. In the same issue Mr. F. H. von Keller describes a new form of Cooper Hewitt mercury-vapour lamp.

The Milan Exhibition.—What the Lord Mayor of London described as the "finishing touches" of the Milan Exhibition, 1906, were given last week in the distribution of awards made in the British section of the exhibition at the Mansion House. Whatever the Milan Exhibition may have done, it has certainly proved to the world that British manufactures are still second to none in high character and quality, and the number and value of the awards bestowed by the international jury (quoted in a report by Mr. Arthur Serena, the commissioner of the British section) fully confirms this. The British exhibitors formed only 2·63 per cent. of the total, but they carried away 3·34 per cent. of the awards, principally in the higher degrees. In all, Great Britain obtained 9 Hors Concours awards, 99 Grands Prix, 50 diplomas of honour, 96 gold medals, 53 silver medals, and 19 bronze medals, and 8 exhibits received honourable mention. This was a highly satisfactory record. In addition, 96 complimentary diplomas were offered to Government departments, public institutions,

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members of the British Commission and of the jury, and 105 awards of varying degrees were made to what were known as "collaborateurs," whilst a special gold medal was given to the Hon. C. A. Parsons for his development of the steam-turbine. The total revenue of the British Commission was about £13,800, and the expenditure about £9,000. An allowance of 25 per cent. on the amounts severally paid by the exhibitors for space was returned to them, and a surplus of £4,700 had been returned to the Treasury. Among the principal commercial awards, in addition Hors Concours award to Mr. C. A. Parsons, we notice the names of the following well-known firms: Babcock and Wilcox, Limited, the Cambridge Scientific Instrument Company, Limited, Alfred Herbert, Limited, Willans and Robinson, Limited, and the Worthington Pump Company, Limited.

Boiler Efficiency.—In a paper read before a recent meeting of the American Institute of Electrical Engineers, entitled "The Ratio of Heating Surface to Grate Surface as a Factor in Power-Plant Design," Mr. W. S. Finlay discussed at length the effect of varying the area of the grate. A number of curves were presented, showing how the various factors entering the problem are affected by the load factor. Mr. Finlay described an interesting boiler setting adopted for 18 boilers in one of the stations of the Interborough Rapid Transit Company of New York. A second furnace was added to each boiler, under the ash-pit, the new stoker having an area about 80 per cent. of that of the old. He gave the results of firing with both of these furnaces, and compared the performances of the boiler when thus operated with its original performance with a single furnace. The output of the boiler was considerably increased, while its efficiency remained practically constant. This arrangement should effect a considerable saving in boiler-room area, and hence reduce a number of factors entering into the cost of the installation. Mr. Finlay estimates that the cost of the boiler-house itself may be reduced about 40 per cent., the cost of the boilers reduced 50 per cent., and the piping 40 per cent. He also estimates economies in the coal-handling apparatus, although the remaining factors of the boiler-house would not be changed. This had resulted, in the case referred to, in a total cost of the boiler-house of nearly £21 per kilowatt of station output. The cost for a single-grate equipment for an equivalent output was estimated to be £25 per kilowatt output of the station, showing that altogether a saving of 19 per cent of the first cost of the plant was made by the double-furnace arrangement. From this it was calculated that for a plant costing with a single-boiler equipment about £30 per kilowatt output, a saving of 20 8 per cent. would be possible by using the double-furnace arrangement.

Telephony.—The method of selecting and operating apparatus, either mechanically or electrically, by means of bodies tuned to different frequencies of vibrations is applied by the Felten und Guilleaume-Lahmeyerwerke A.-G. (according to a recent patent) to various systems of telegraphy and telephony, and is also stated to be applicable for recording melodies in musical notation or speech in ordinary letters. In party-line telephone systems each station is provided with a simple generator, in which a pole-wheel revolves between the coils on the pole-pieces of a permanent magnet, and also with a series of tuned springs mounted on a common base exposed to the action of an electromagnet through which the generator currents pass. To send a current of the frequency necessary to call a certain station, the speed of rotation of the generator crank is increased until the spring corresponding to the station to be called is vibrated, and at this moment the line circuit is closed by a separate key. This method of selective calling and operation may also be used in divided-board exchange systems, in automatic exchange systems, and in multiplex harmonic telegraphy. Several generators of different frequencies may be arranged at different points in a single circuit, as in a fire-alarm system, the calling station being indicated at the central station by its corresponding spring. In the application of the invention to printing telegraphs the transmitting generator has several pole-wheels with different numbers of poles, so that, on depressing one or several keys, one or several currents of different frequencies are sent to line. One or more receivers of the electro-mechanical typewriter type may be connected with a single line. An intermittent direct current may be used instead of alternating current. At the receiving station the tuned bodies may be vibrating tongues, strings, wires, etc., or hollow bodies filled with liquid or air or other gas. The current impulses may also be generated by means of microphones, which may be set in action in any suitable manner—*e.g.*, by sirens or tuned whistles. By using a suitable typewriter, melodies may be printed in musical notation or speech in ordinary letters.

Pumping Plant in Floating Docks.—In a floating dock there is generally little scope for the application of electricity, but, as Mr. Harry R. Jarvis showed in a valuable paper which he read last week before the North-East Coast Institution of Engineers and Shipbuilders, when cheap electric power is available it is undoubtedly the best that can be adopted, especially for "off-shore" docks, thereby dispensing with the weight of boilers, etc., on the dock, and also reducing the number of permanent staff required for the dock. The pumping plant generally used in floating docks does not require any elaborate description, but we may abstract the following remarks made by Mr. Jarvis as showing a direction in which electricity may be applied. The amount of work done when lifting a ship is, said Mr. Jarvis, in direct proportion to the weight of vessel lifted; the larger and heavier the ship, the more water has to be removed from the dock within the limits of its lifting power. In most of the different types of floating dock, a main pipe of varying diameter runs from end to end of the dock at the bottom of the side walls. On this pipe the sea connections for the inlet valves and the branches for the distributing pipes are placed as may be required. To give the dock the requisite stability when working, the pontoons and walls are subdivided into a number of separate watertight divisions, each having its own flooding and draining pipe and air-pipe. Flooding or draining goes on through the same pipe in each compartment, so that one set of pipes only is required for this purpose. The pumps are usually of the centrifugal vertical spindle type, and are seated directly on to the main drain, taking water from the under side and discharging it at their own level into the sea. The motors for driving the pumps may be either steam or electric, and are generally placed on the top deck of the side wall. The connection between the pump and motor is by vertical shafting, supported at intervals by plummer blocks attached to the internal framing of the dock's wall. The weight of the shafting and pump impeller is carried by a ball thrust bearing in the motor bed-plate. The engaging clutch between the motor and shafting is made flexible, to deaden noise and shock.

Weaknesses in Measuring Instruments.—Mr. Kenelm Edgcumbe read a useful paper before the Association of Engineers-in Charge last week on electrical measuring instruments. It would appear that engineers have a lot to learn yet concerning meters, so that in explaining the weak points inherent in such instruments, and in giving

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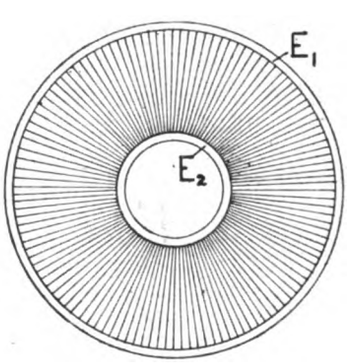
some useful hints for their handling, Mr. Edgcumbe should have succeeded in securing a fuller measure of recognition for their importance from engineers-in-charge. A mistake is often made from the very outset in selecting the most suitable range when ordering the instrument. This is a question which becomes of supreme importance in ampere-hour or watt-hour meters, since with very light loads it is not simply a case of the indications being inaccurate, but the meters will not start at below a certain minimum, owing to the initial friction which has to be overcome. An ampere-hour meter should start with from 1 to 1½ per cent. of its full load, and a watt-hour meter with from ¾ to 1 per cent. After being installed for some time, however, it will be found that these figures have been doubled. Mr. Edgcumbe suggests that the range of the meter should be selected so that its maximum reading is about fifty times the smallest load which it is wished to register—even if this entails overloading it to the extent of, perhaps, 20 or 30 per cent. for short periods. In the case of alternating-current wattmeters the question is complicated by the fact that the power divided by the voltage does not necessarily give the amperes flowing. Mr. Edgcumbe suggests that, whenever possible, in ordering a wattmeter, not only the maximum reading in watts, kilowatts, or horse-power should be given, but also the corresponding current, or, failing this, the approximate power factor to be expected. With voltmeters the requirements are different. But in this case Mr. Edgcumbe believes that a set-up corresponding to a scale of 400-500 volts is about the greatest which can be regarded as satisfactory. Such an instrument was described as "set-up 80 per cent.," meaning that the lower reading is 80 per cent. of the upper. For a moving-coil instrument such a definition would be quite sufficient, but in the case of a moving-iron scale, in which the divisions vary somewhat in length, it is useless. A much better criterion is to determine what fraction of the maximum reading lies in the upper half of the scale. For example, a moving-iron voltmeter scale reading up to 250 volts might contain 100-250 volts in the upper half—that is, roughly, 25 per cent. of the top reading. With an evenly divided moving-coil scale this would correspond to a total range of 125-250 volts. Mr. Edgcumbe referred to the question of accuracy to be aimed at in specifying an instrument, and laid down a table which may serve as some guide. The accuracies of the indicating instruments were expressed as a percentage of the maximum scale reading. Thus, if a 100-ampere ammeter is said to be correct within 1 per cent., it means that the indications can be relied on to within one ampere throughout the scale. The question of accuracy was dealt with at some length, as well as were several other features that have to be taken into account.

Central-Station Publicity.—If the good people of Ipswich have not placed in the forefront of their New Year resolutions the determination to become consumers of the Corporation electric supply department, they will have only themselves to blame if, at the end of the year, they find themselves to be the sufferers through their own neglect. Mr. Frank Ayton, the enterprising chief electrical engineer, has come to the fore with some good advice which should help perplexed citizens to decide upon which of the many resolutions secretly made at this time of the year are worthy of being carried out. The means which he has taken to attract the attention of the public of Ipswich to the Corporation electric supply department are certainly effective, and cannot fail to produce some beneficial result. Large posters are displayed on tramcar windows and on jointers' tents containing three "good resolutions." The first is "For residents," and is as follows: "Resolve to safeguard your health by using electric light. With the new lamps, the cost compares favourably with any other system of lighting." The next resolution is addressed to tradesmen: "Resolve to attract more business by brilliant and efficient lighting. Electric light is the mark of the up-to-date shop, and it does not spoil the goods." Finally, manufacturers are advised to "Resolve to reduce expenses and inflate profits by using electric power." Two pamphlets have been issued explaining that the electric supply department is now prepared to install wires, apparatus, and fittings for electric lighting, heating, or power, and accept payment by instalments spread over one or two years at the option of the consumer. If the consumer desires to take advantage of the "easy-payment" system, the department will add 5 per cent. on to the amount of the estimate if the payments are to be spread over one year, or 10 per cent. if over two years. Another pamphlet calls attention to the advantages of electric heating. A telling advertisement has also been inserted in the local railway time-table. Mr. Ayton is to be congratulated on taking such energetic steps to make the advantages of his department known. The methods which he has adopted are not, perhaps, those which engineers usually look upon with favour, but there can be no gainsaying their suitability in the town in which they are used.

Nitric Acid from Air.—The commercial success of the Birkeland-Eyde process for the fixation of atmospheric nitrogen by electric discharges, has demonstrated the preference for the arc over the spark method. Formerly



sparks were considered to be more efficient than the arc for bringing about a combination of atmospheric oxygen and nitrogen, but the necessity of using a great many sparks led to mechanical complications and difficulties, which, while possible of being overcome, were, nevertheless, a great hindrance on account of the extremely high cost of the apparatus required. Those of our readers who remember the extremely interesting paper on the subject read by Dr. Birkeland at a meeting of the Faraday Society in London some months ago (and subsequently reprinted in our columns), will know that in the process with which his name is associated the "flaming disc" is employed, and its success has gone a long way towards emphasising the superiority of the arc over the spark method. It is interesting to know, however, that independent workers in the same field have obtained results which confirm the results obtained by Dr. Birkeland. From a lengthy summary of the work of Mr. I. Moscicki and of Mr. I. von Kowalsky in Fribourg, in Switzerland, which appears in our New York contemporary, *Electrochemical and Metallurgical Industry*, we gather that the "flaming disc" of Moscicki (and others) provides a simple method. In the new system of Moscicki the magnetic deflection of an arc is used. This is also employed in the well-known system of Birkeland and Eyde, but the method is a different one. The method employed by Moscicki is based on the use of two concentric ring electrodes (as illustrated). The arc passes from one ring, E_1, to the other, E_2, in radial direction. A magnetic

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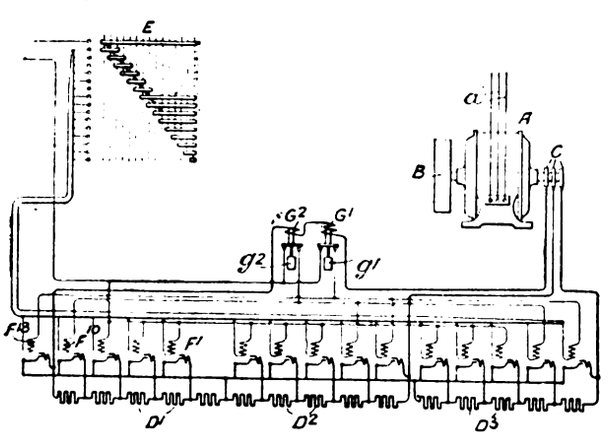
flux is provided perpendicular to the plane of the drawing. The arc is thereby deflected, and revolves continuously around in the annular space between the two rings. The revolving arc gives the appearance of a luminous ring between the two ring electrodes. In a later issue we hope to describe the application of this principle, and to deal with the results of some German investigations, which to a large extent confirm the results obtained by Messrs. Moscicki and Von Kowalsky, and show the "flaming disc" to be an improved modification of the Birkeland-Eyde method. In the meantime we might add, on the assurance of our contemporary, that the results so far obtained are quite satisfactory, and are to be continued on a larger scale.

Motor-Control Systems.—A patent granted to the British Thomson-Houston Company relating to the control of motors driving varying loads, such as mine hoists and rolling mills, may be summarised as follows: The motor is fitted with a flywheel or other reservoir of energy, and automatic means is provided, dependent upon increase of load, for putting resistance in the motor circuit. The invention is shown in the diagram as applied to an induction motor, A, but is applicable also to motors of other types. The motor, A, is supplied from three-phase mains, *a*. For starting, a hand controller, E, is used to cut out resistances, D^1 D^2 D^3, progressively from the secondary circuit leading to slip-rings, C, the cutting out being performed by sets of coils, F^1 . . . F^{10} F^{18}, which actuate



separate switches. To provide for the automatic control, the return wires from the coils F^{10} F^{13} and the corresponding coils of the other sets pass through switches adapted to be opened by coils G^1 G^2 in the event of the load increasing sufficiently. The coil G^2 is designed to act before the coil G^1. Further coils may be added to control a greater number of the switch coils, F^1 . . . F^{10} F^{13}. When the coils G^1 G^2 open their switches, some of the starting resistance is reinserted in the secondary circuit, and the flywheel, B, gives up some of its surplus energy. To prevent the automatic switches from reclosing immediately consequent upon the diminished secondary current, dash-pots, g^1 g^2, are added. In a modified form, the automatic switch coils, G^1 G^2, are in the secondary circuit of a small auxiliary motor coupled to the main motor, the primaries of the two being in parallel, and the dash-pots are not used.

Illuminated Advertisements.—The popular success of the exhibition of illuminated advertisements by means of electric signs on shop fronts and in public places is attested to by the agitation which it is now attempted to raise with a view to confining that method of advertising within certain limits. The National Society for Checking the Abuses of Public Advertising have petitioned the London County Council with respect to the illuminated advertisement which has recently been installed on one of the shot towers near Waterloo Bridge. Ostensibly, their protest is levelled against the advertisement mentioned, but it is not difficult to see that behind the protest lurks the desire to put an end to a method of advertising which promises to become exceedingly popular on account of its effectiveness. Unhappily for the society, no legal power of prohibition exists, for by-laws under the Advertisements Regulations Act, 1907, if framed, could not for five years apply to notices already in existence, consequently their aims are at present limited to getting the County Council to frame a by-law which will keep the display within its present dimensions. The electric sign advertisement near Waterloo Bridge, then, is made the centre from which to oppose that method of advertising in general. And the ground on which the petitioners base their protest is somewhat novel. They state in their petition that their protest "is purely on the ground of injury occasioned to a great municipal interest by this class of advertisement," but the "municipal interest" is not specified. We should imagine, however, that it is the possible spoliation of the Thames Embankment scenery, with a consequent depreciation of property in the neighbourhood, which the petitioners have in mind. One may not be disposed to dispute the claim that the Thames Embankment was constructed as a pleasure promenade, but, one may ask, did it not cease to fulfil such a purpose before the objectionable illuminated advertisement came upon the scene? The Embankment is a highway over which there is a busy stream of traffic of all descriptions; electric tramway routes are laid along it, and it is now one of the main arteries of traffic between the North and South of London. For some considerable time past electric signs have shone conspicuously from the hotels overlooking the pleasure gardens by the side of the Embankment, and we are not sure that the public have experienced any great loss of pleasure on that account. Nor does it seem at all likely that the particular sign objected to will seriously outrage the feelings of those who make use of the Embankment, or that it will lead to any great deprivation of the pleasure which they enjoyed prior to its erection. Of course, it is impossible not to feel a certain measure of sympathy with those who put themselves to such considerable expense in striving to preserve intact places of natural beauty for free enjoyment by the public, and neither the purity nor the patriotism of their motives is for one moment in question. Too much may be claimed, and, we fear, sometimes is claimed on the grounds of utility, and on some occasions the spoliation of scenery and the destruction of traces of the great and historic past have amounted to sheer wantonness. But certain utilitarian practices cannot now be stayed, and one of these is advertising. Trading concerns find in electric light advertisements a valuable selling medium, and it is upon the confidence of manufacturers and tradesmen that an important business in electric signs has been built up. We have seen innumerable types of these signs, and have frequently presented illustrations of various types in these columns, and our readers will doubtless agree with the opinion that, on the whole, electric signs as now made are of an artistic design, which is not at all displeasing. The sign near Waterloo Bridge is no more calculated to interfere with the intelligent enjoyment by the public of the beauty of the Embankment than are any of the other of the so-called disfigurements; and we would remind those who seek to arrest the development of electric signs on the ground of any "great municipal interest," that electric sign advertising is regarded as an important and lucrative business for electricity supply undertakings, many of which are owned by municipalities, to whose interest it is, therefore, that the business should increase.

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FORTHCOMING EVENTS.

FRIDAY, JAN. 17.

Royal Institution of Great Britain.—At 9 p.m., at Albemarle-street, Piccadilly, W., "The Centenary of Davy's Discovery of the Metals of the Alkalis," by Prof. T. E. Thorpe.

Institution of Civil Engineers (Students' Section).—At 8 p.m., "The Principles of Engineering Geology," by Dr. Herbert Lapworth (Lecture II.).

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate, St. James's Park, S.W., "Third Report to the Gas-Engine Research Committee," Prof. T. W. Burstall.

SATURDAY, JAN. 18.

Royal Institution of Great Britain.—At 3 p.m., "The Electrification of Railways," by Prof. Gisbert Kapp (Lecture I.).

Birmingham and District Electric Club.—At 7 p.m., at Colonnade Hotel, New-street, presidential address by Mr. E. C. R. Marks.

Institution of Electrical Engineers (Students' Section).—At 10 a.m., visit to Elliot Bros.' works.

MONDAY, JAN. 20.

Society of Arts.—At 8 p.m., "The Theory and Practice of Clock-Making" (Cantor Lecture I.), by Mr. H. H. Cunningham, C.B.

TUESDAY, JAN. 21.

Institution of Civil Engineers.—At 8 p.m., "Experimental Investigations of the Stresses in Masonry Dams subjected to Water Pressure," by Sir J. W. Ottley and Dr. A. W. Brightmore; "Stresses in Dams: an Experimental Investigation by Means of Indiarubber Models," by Messrs. J. S. Wilson and W. Gore; "Stresses in Masonry Dams," by Mr. E. P. Hill.

WEDNESDAY, JAN. 22.

Institution of Civil Engineers.—Students' visit to the buildings of the Franco-British Exhibition, Shepherd's Bush, W.

THURSDAY, JAN. 23.

Institution of Electrical Engineers.—At 8 p.m., at the Institution of Civil Engineers, "Standard Performances of Electrical Machinery," by Dr. Rudolf Goldschmidt.

Institution of Electrical Engineers (Leeds Local Section).—At 7.15 p.m., at the university, "Notes on the Development of Turbo-Alternators," by Dr. R. Pohl.

FRIDAY, JAN. 24.

Physical Society.—At 5 p.m., at the physics laboratory of the Royal College of Science, Imperial Institute-road, South Kensington. "Recalescence Curves," by Mr. W. Rosenhain; "An Experimental Examination of Gibbs's Theory of Surface Concentration regarded as the Basis of Adsorption, and an Application to the Theory of Dyeing," by Mr. W. C. M. Lewis.

SATURDAY, JAN. 25.

Royal Institution of Great Britain.—At 3 p.m., "The Electrification of Railways" (Lecture II.), by Prof. Gisbert Kapp.

APPOINTMENTS VACANT.

Shift Engineer, Elland Urban District Council. Applications to Mr. J. Clarkson, clerk, by Jan. 20.

Switchboard Attendant, Middlesbrough Corporation. Applications to Mr. H. M. Taylor, borough electrical engineer, by Jan. 20.

Engineer and Manager, Neath Rural District Council electric lighting station. Commencing salary, £200 per annum. Applications to the Chairman of the Council by Feb. 1. See advertisement.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MAXIMUM DEMAND AND SHOP CONSUMERS.

SIR,—You will have gained the thanks of many electric light users who pay on the maximum demand system for your leaderette in last week's issue under the above heading. Your suggestion that there should be no objection to a shopkeeper having his demand indicator cut out for 12 consecutive nights at Christmas, while he indulges in a special lighting display, is one that will appeal to any wide-awake tradesman.

But think of the station engineer! In many towns half the lamp connections are in shops, and to have all these doubled or trebled for 12 nights at a season when the demands for traction, heating, and domestic lighting are all at a peak would be disastrous. Such an excessive load could only be met by a large increase of plant, which would lie idle all the rest of the year.

I hope a time is coming when the increase of motor connections and domestic lighting will make even a 100 per cent. increase of the shop consumers' demand a negligible quantity in comparison with the total load; but so long as shops bear the present large proportion, I fear that your suggestion, when carried to its logical conclusion, forms an excellent argument for the maximum demand system.—Yours, etc.,

A. L. RAWLINGS.

Taunton, Jan. 14, 1908.

RE QUESTION 1,019—SINGLE-PHASE CURRENTS FROM THREE-PHASE CIRCUITS.

SIR,—Referring to "Q.'s" letter in your issue of the 3rd inst., it would be interesting to see oscillograms proving his statement that in the case of ordinary direct-current to single-phase rotary converters the fluctuations on the direct-current side are almost obliterated, though this question is not sufficiently akin to ours to allow conclusions to be made from the one to the other.

Mr. T. S. Messent, in his letter published in the same issue, is right in his contention that, by suitable design, the internal voltage drop in the three phases of the single-armature rotary can be reduced to almost any desired value, but he overlooks the fact that the ratio between the voltage drop in the different phases is not altered thereby, and thus the distribution of the currents remains unaffected.

The suggestions of making the number of turns in the three phases unequal, or of unbalancing the voltage supplied to the rotary, are not practicable, as heavy currents would flow between the three phases at no load. These currents would under condition of load only add (geometrically) to the currents due to the single-phase load, but not alter them.

By such means it may be possible to obtain equal currents in the three phases for one given single-phase load, but that is surely no practical solution of the question. The same result can be obtained by static transformers, using artificial load of condensers and choking coils.

Regarding the tests I referred to in my previous letter, they have been made on standard six-phase direct-current rotaries supplying three-phase current to three slip-rings being 120deg. (electrical) distant from each other, and taking single-phase current from two slip-rings having 180deg. (electrical) distance. The load on the three-phase circuit corresponds (within the difference due to the higher no-load current) to the load which would be obtained if transformers were similarly connected and loaded.

If these tests are not considered sufficiently conclusive, I may point out that no tests or plants are known proving that it is practicable to obtain balanced load on a three-phase circuit by means of single-armature rotaries when only single-phase power is used. Until such tests are forthcoming I maintain my previous conclusion that the only possible way, commercially, of taking single-phase current from a three-phase supply and obtaining balanced load is by means of motor-generator sets.—Yours, etc,

K. FAYE-HANSEN.

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RE QUESTION 1,023.

SIR,—Seeing that neither "T. Y. P." nor his critics have succeeded in answering the above question very satisfactorily, will you kindly allow me to make the following suggestion, which, I think, will fulfil the requirements stated, including that of *remote control*.

The power required to propel the truck is given by the formula,

$$\text{H.P.} = S\,W\left(\frac{K}{375} \pm \frac{6}{n}\right),$$

where S = speed of truck in miles per hour;
W = rolling weight in tons;
K = resistance to motion on level (tractive effort in pounds per ton);
n = number of feet "go" to each foot rise or fall.

In the absence of further information, we will assume the following values to be convenient: S = 6; K = 30; n = 100; then

$$\text{H.P.} = 6 \times 11\left(\frac{30}{375} + \frac{6}{100}\right) = 66 \times (\cdot08 + \cdot06) = 9\cdot24.$$

Allowing the gearing to have an efficiency of 70 per cent., the

$$\text{B.H.P. of motor} = \frac{9\,24 \times 100}{70} = 13\cdot2 \text{ (say 15 b.h.p.)}$$

The value of n, however, must be carefully considered, as any change in that factor will considerably alter the size required for the motor.

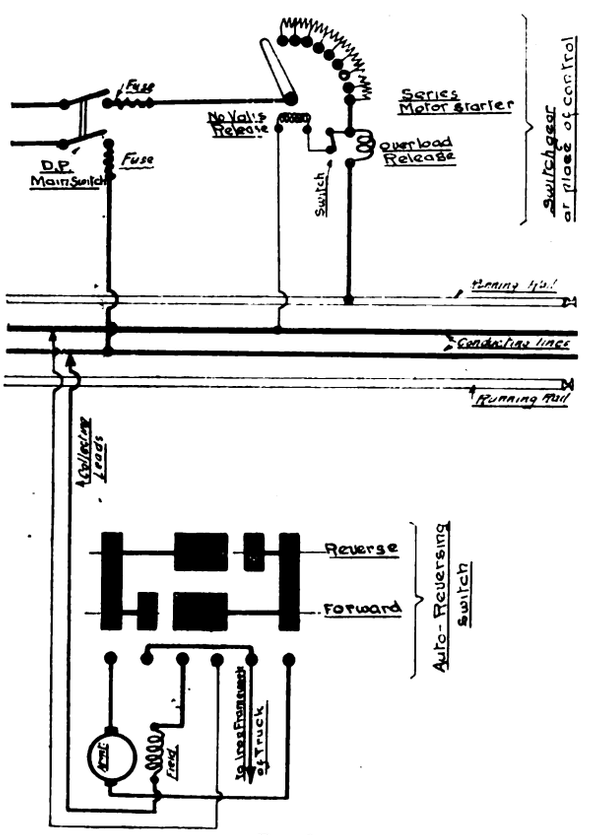

FIG. 1.

By using a series-wound motor the following apparatus will be required and to be connected up as shown in Fig. 1:

1. Double-pole main switch and fuses.
2. Motor starter with no-volts and overhead release (Nos. 1 and 2 would be mounted as an ordinary motor panel, and situated at the convenient place for control).
3. Series-wound motor.
4. Automatic reversing switch with levers (to be fitted on the underside of truck and near the motor).
5. Collector.
6. Two line conductors (arranged either by the side or in between the two running rails).

The type of motor starter to be used depends upon the experience of the man who will have to operate it. In a *really* fool-proof starter the brush arm (which is independent of the hand lever) will switch off immediately an attempt is made to cut out the resistance too quickly. The majority of overload release mechanisms on the market are arranged to *short-circuit* the hold-on (or no-voltage release) coil immediately a predetermined maximum of current is exceeded. This is not good practice, especially where damp may corrode or dust collect on to the short-circuiting contacts, and fail to make the hold-on coil release the switch-arm to protect the motor from burning up. The overload release should be arranged to *brake* the hold-on coil circuit when an overload comes on. If the contacts, through dust or damp, become defective, the motor cannot be started up, and no damage is done to it.

The reversing switch shown in the diagram is of the drum type. This is chosen because it can be made as cheaply to stand rougher usage than the flat type. The drum contacts should be long so as to allow an ample angular movement of the operating levers. There are only two positions for the drum—*i.e.*, "forward" and "reverse."

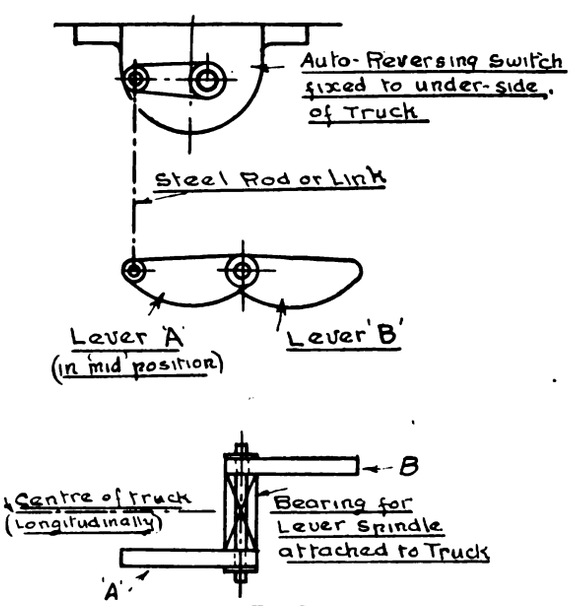

FIG. 2.

Fig. 2 shows an arrangement of levers for operating the switch. The two levers, A and B, are both keyed to the same spindle, but in plan are in different planes. A roller or block is fixed near each end of the track. When the truck has nearly reached the end of its travel, the lever A (at one end) or B (at the other end) is pushed upward as it rides over the block, and in held up by means of another small lever, which, by the action of a spring, engages with one of the two notches in a disc which is keyed to the drum spindle inside the case After the truck has been returned the other operating lever is pushed up at the end of the journey, and the drum moved round to "reverse" again.

Space will not allow me to enter upon the detail of the line conductors or the collector, both of which can be arranged very simply and easily.

If making use of the "running" rail as a line conductor is objected to, a third line conductor must be resorted to, but this would not entail much extra expense.

The advantages I claim for my scheme are: (1) a minimum of electrical apparatus is carried under the truck, which is not so accessible nor suitable for electrical reasons as a motor panel; (2) the apparatus is less costly, less complicated, less liable to get out of order; (3) there is less apparatus to be attended to, and it can be operated by less expensive labour; (4) the whole plant can be readily isolated from the mains by a switch which is *at hand*.—Yours, etc.,

E. R. WOOD.

SIR,—It appears as if in the first answer to the question No. 1,023 a printer's error has occurred in the statement that "30 h.p. will be required to work the truck"; this should be more like 3 h.p. If a 30-h.p. motor was put on the truck, the result would be, when the motor was switched on, that it would run away on account of having so small a load of, say, 1½ h.p. on it, and simply smash up the

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gearing to atoms. The system of working any truck by means of electrically-operating switches in which there is a certain time element does not prove satisfactory for jobs of the nature as stated in the question.

The firm with which the writer is engaged had considerable trouble some time ago with some quick-travelling hoists, which travelled at 200ft. per minute. These were operated by means of a hand rope which went on to the rope wheel of the starting switch, the motor being fitted with a brake electrically operated by means of two shunt coils in series with the shunt winding of the motor. To stop the hoists the main circuit was first broken, and then the shunt and brake circuit were broken, across which a non-inductive resistance was placed so as to take up the kick. After the shunt circuit was broken it took some two or three seconds for the brake to drop, due to the residual magnetism in the motor fields and the brake coils. In this time the hoist had travelled some 6ft. to 8ft., and with a varying load it was impossible to get the hoist to pull up within 2ft. to 3ft. of the same spot each time, and it was found necessary to substitute for the electrically-operated brake one operating directly by mechanical means from the actuating rope, in such a manner that when the starting switch was moved to the "off" position the brake came on instantaneously. Therefore, if a truck has to travel 10ft. at a fairly quick speed, the margin in which the same has to be pulled up to rest will be so small that it will be impossible to allow a margin of some 3ft. or 4ft. at each end, so that the electrically-operated switches will not have sufficient time to work in, thus compelling one to use mechanical means instead of electrical means for operating switches and brake.—Yours, etc., C. G.

CHEAPENED METHODS OF ELECTRICAL DISTRIBUTION.

SIR,—With reference to a leading article in your current issue on "Electricity Supply to Small Towns," you draw attention to Mr. Snell's remarks about the great cost of distributing electrical energy in small towns, which means small consumers scattered over a large area. The writer being manager of and largely interested in an electric supply company supplying a small town, is day by day made to realise the great advantage the gas company have in supplying small consumers. Once inside the doors of a consumer's premises electric light can safely hold its own, but with small consumers the interest and depreciation on the capital cost of getting there absorbs a large percentage of the subsequent profit, so with a view to reducing this handicap the recognised methods of distribution have been departed from in several towns, some particulars of which were given in a paper on "Cheapened Methods of Electrical Distribution" by Mr. J. H. C. Brooking (Institution of Electrical Engineers, Manchester Section, Dec. 18, 1906).

It is generally difficult to foresee how economy can be effected, but when the time arrives to do the work and one is on the scene of operations the local surroundings lend themselves to suggesting short cuts. The work is done and then forgotten, so it would serve a very useful purpose if you followed the plan adopted in above paper and asked engineers of different towns for particulars of means they adopted to reduce the cost of distribution, and thus procure for publication much useful information that now exists buried in some out-of-the-way districts.—Yours, etc.,

£. S. D.

[We shall be pleased to receive any further correspondence on this important subject.—ED., *E. E.*]

LIVE-STEAM FEED-WATER HEATING.

SIR,—As a member of the firm which has been primarily responsible for the "resurrection of appliances for live-steam heating," I would ask for space to add a few words to Mr. Wilkinson's letter which appears in your issue of the 10th inst.

Live-steam heating in itself has never been dead. External live-steam heaters have been in constant use for many years, and have proved their efficiency. External heaters being comparatively costly and cumbersome, engineers have devoted considerable attention to internal heaters, which, besides being cheaper, are also more efficient.

For many years different internal heaters were tried and failed, but the failure was always mechanical. The heaters broke down owing to their designers not appreciating the fact that the feed water must be pumped into a solid body of water, not into a vessel or pipes filled with steam or air. All attempts to pump or spray the feed water directly into the steam space failed through the pumps and check valves refusing to act under these conditions. Also internal heaters consisting of closed vessels placed in the steam space failed. Having a pipe leading up to them from the check valve and discharge pipe leading down below the water-level in the boiler, they naturally collected all the air which is always released from the feed water as it is heated. This air, having no possible escape, accumulated until it filled the heater; then the impossibility of pumping into air and steam asserted itself, and the heavy hammering action which resulted soon burst the pipes or the heater, or both.

Mr. Patterson's "resurrection" began in 1900, when we patented and put upon the market an internal heater which did not fail mechanically. We got over all the difficulties by supplying a vessel holding a sufficient body of water to ensure the satisfactory working of the pumps, and we made this vessel open at the top so that it is quite impossible for air to gather in it. This is our original patent, and it is owing to its thorough success that there has been the "resurrection," accompanied by the usual imitations which always surround a successful invention.

I do not quite understand Mr. Wilkinson's remark about its being possible for a live-steam heater to "entail a heavier consumption of fuel than would be required were the boilers minus the live-steam heater." This has never occurred in my experience, and I can only conceive its happening where the feed water is violently ejected from the top of an apparatus which has not a chamber large enough to receive and steady the feed water before it overflows into the heating trays.—Yours, etc.,

A. W. HAMILTON,
Hon. President, Belfast Association of Engineers.
Prince's Dock, Belfast.

THE RAILWAY CRISIS.

"Lancastrian" is quibbling, which is not argument. I will again take his own example. He says "I said wages were not paid out of capital," and his original example was in the building of a dock wall, when he thought that value put into the wall during the week equivalent to wages paid meant that wages were not advanced by capital. He now imports the term "credit," and lays the fault to "credit system." A dock wall, broadly, consists of materials + labour, and as the dock wall is to last for years, and the return on materials + labour is by driblets, I fail to see how any man can deny that capital advances—that is vulgarly speaking, pays wages—thereby using the term pays = advances. I never argued finality of payment, only absolute necessity for "advancing." Both "Staffordian" and "Lancastrian" are permeated with one ineradicable idea—collectivism—the "community"—in my mind, an idea which has not a single element of right or justice in its purview. Mill says—and in this I emphatically agree with him—that "the foundation of the whole *is the right of the producers to what they themselves produce.*" Granted the correctness of that view there is an end to polite confiscation by a community Jones saves £1 out of his month's salary; he buys a share in a company, and because of his abstinence he becomes a capitalist, therefore a pariah whose capital is to belong to and to be controlled by a community. This view, in my humble opinion, is pure unadulterated rubbish. If Jones goes on saving up his pounds and investing them, ultimately handing the total over to his son or to Jack Robinson, has he not right to do so? Why is Jones or Robinson, careful saving man or men, to divide with Brown and Smith, who neither work well nor save? Jones

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worked for the £1 he saved last month; he uses it productively as capital. He had no immediate return for the work equivalent to that pound; he deferred his return till the products of the investment came to hand. And it is so with all capital. We began this controversy upon the point "identity of interests." I intentionally enlarged it on my side to show that capital = labour of a right took its share of the return from the combination capital + visible labour. My friendly opponents have diverged much further, and in order to combat their extraordinary views I should have to write a volume per week. I am a mere unit among workers, and anonymous contributions carry little weight, but let my opponents read Rogers's "Political Economy," Chapter VI, p. 58, *et seq.*, and get his opinion as to "identity of interests," and he says: "It is idle, then, for labourers to talk of the tyranny of capitalists in the mass." Later on in another chapter he has one of the most weighty sentences ever penned by mortal man, *vide* p. 117, Chap. X: "An educated people works less and earns more than one which is untaught can." The question whether capital is held by 100,000 or by 100,000,000 is altogether outside the general question. The holder of capital is the holder of unrewarded work till the capital is used productively and gets its return, and the work of yesterday has as much right to its reward as the work of to-day. As it seem impossible to agree upon even a fundamental point, it is useless to continue this controversy. Unless there can be points of absolute agreement as a jumping-off ground there can be no real argument. THE WRITER ON THE CRISIS.

THE BRITISH CORRESPONDENCE SCHOOL OF ELECTRICAL ENGINEERING.

This new organisation for giving instruction in electrical engineering by correspondence has been organised by Mr. Frank Broadbent, M.I.E.E., and Mr. Andrew Stewart, A.M.I.E.E. The offices are at 36, Maiden-lane, Strand, W.C. After giving the two names above as technical directors of the undertaking, it is hardly worth while saying any more about it, as these two gentlemen are so well known throughout the electrical engineering industry in this country. Still, from the information they have placed before us, we can see that the scheme of instruction is good and the arrangements for ensuring a close touch between students and instructors excellent.

So far the following courses have been arranged: elementary electrical engineering; practical electrical engineering, dealing with the apparatus for the generation and distribution of electricity; electric power distribution over large areas; the management of electric light and power installations; electric wiring; the general design of direct-current electrical machinery; and, finally, the design and construction of polyphase machinery. The number of lessons in each course varies from eight to twelve, and the fees from £1. 1s. to £2. 10s. These charges are reasonable, and the new school will bring instruction by correspondence within the reach of numbers who from their inability to attend good technical classes are handicapped in their endeavour to improve their status in the profession.

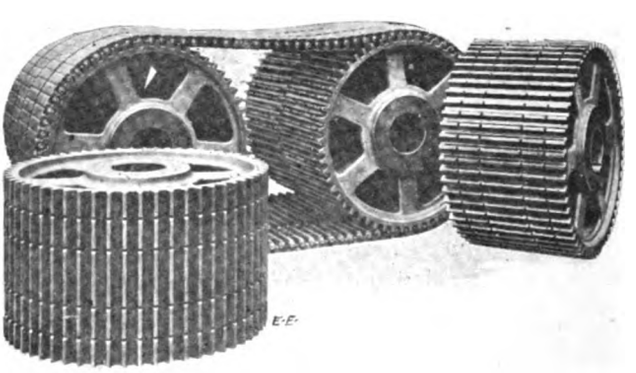
TRADE NOTES AND NOVELTIES.

Ammonia Recovery Gas Plants.

Messrs. Crossley Bros., Limited, Openshaw, Manchester, have just issued a pamphlet in which attention is called to their recent improvements in producer-gas plants, and especially to those designed with a view to the recovery of ammonia. Their work in connection with power-gas plants is too well known to need emphasis here, but the design of their plants for the recovery of ammonia is of sufficient interest to warrant a description of the system. In designing plants for ammonia recovery it has long been well known that when bituminous fuel is subjected to superheated air and steam, with excess of steam, at a low temperature, a considerable proportion of the original nitrogen contained in all coals is present in the gas produced in the form of ammonia. To make this process an economic success, it has been found necessary in practice to cool the gases leaving the gas producer to such a degree of temperature that a great proportion of the latent heat of the steam present in the gas is recovered. A portion of this heat is recovered by superheating the air and steam on its way to the gas producers. To recover the remainder of the heat, together with the latent heat of the water vapour present in the gases, it is usual to cool the gases and condense the water vapour present in them by means of circulating water, which heat is afterwards recovered in an air saturating tower. Messrs. Crossley Bros. by their improved arrangement have reduced the cost of the process very considerably. In the main, the essence of their system consists in washing and cooling the gases, condensing the water vapour, and absorbing the ammonia in one and the same apparatus. The sulphate liquor circulated is used for the purpose of simultaneously saturating the air with water vapour and causing the liquor to be cooled for further circulation. In addition to a simple system of regeneration and ammonia extraction, a form of gas producer is used in which a rotary cone firegrate, having a large grate area, and distributing the air blast evenly throughout the fuel bed. A typical sample of the gas made in one of the producers showed the following analysis: CO_2, 16·0; CO, 12·0; H, 29·5; CH_4, 1·0; N, etc., by remainder 42·5 per cent. combustible. The new ammonia recovery plant shows great improvements on the previous form in use, judged from the main points described in the pamphlet, which our readers are advised to procure for themselves.

Large Morse Chain Drives.

The Westinghouse Brake Company, of 82, York-road, King's Cross, London, inform us that they have recently executed an order for what is probably the biggest chain power transmission yet attempted—that is to say, three Morse silent high-speed rocker-joint drives complete, each to transmit 500 h.p. These



Morse Silent Chain Drive (Westinghouse Brake Co.)

drives were ordered by an engine works in Russia, Government of Moscow, which already had a 280-h.p. Morse drive in satisfactory operation. The accompanying illustration gives a good idea of the appearance of these large drives, of which the following are further particulars: diameter of wheels, 37·78in.; face width, 22in.; chain, 2in. pitch, 10in. wide. Two chains running side by side over one set of wheels.

"Wilkinson" Feed-Water Heater.

We are glad to note from the testimonials from engineers which Mr. G. Wilkinson, Beech Mount, Harrogate, has reprinted and circulated with the latest issue of his pamphlet, that the "Wilkinson" feed-water heater continues to give the satisfactory results that were predicted for it. The fact that during the past few months orders for over 80 heaters have been received (including many repeat orders) shows that its advantages are appreciated. At the Wakefield electricity works, where this apparatus is in operation, the increase in steam output amounts to about 35 per cent., and the increase in evaporation per pound of fuel from and at 212deg. F. to about 6 per cent. Tests were recently made, under the personal supervision of four independent experts, upon a 30ft. by 8ft. 6in. Lancashire boiler, fitted with two check-feed valves, one giving economiser feed direct, and the other connected through the Wilkinson steam temperature feed-water heater. The results showed an increased evaporation per pound of coal, deducting 1 per cent. for the difference in temperature of feed water from economiser, amounting to 12·5 per cent., and a saving in coal, making no extra allowance for a continuously clean and efficient boiler, of 11 per cent. A full description of the apparatus has already appeared in these columns.

Controllable Superheaters.

The Cruse Controllable Superheater Company, 5, Blackfriars-street, Manchester, have given in a neat little pamphlet an illustrated description of their novel method of control. It is claimed that controllable superheaters, worked with induced or forced draught, give high-temperature gases in the downtake,

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The steam-tubes are protected by internal water controller tubes, and do not burn. Controllable superheaters supply the link hitherto missing in Lancashire boiler plants—viz., that between the economisers and the boiler. The feed from the economisers is passed through the internal or controller tubes of the superheater, and is raised therein from the economiser temperature of about 250deg. F. to the temperature of the steam in the boiler, which, at a working pressure of 160lb. on the square inch, would be 370deg. F., and enters the boiler at full temperature ready to be transformed into steam. The apparatus is usually made equal to a minimum working pressure of 200lb. on the square inch, and is usually designed to give a maximum total steam temperature of steam of 575deg. F.

Hopkinson Gas Plants.

The Hopkinson Gas Plant Company, Standard Works, Huddersfield, have sent us a copy of their new list of suction, suction pressure, and pressure gas plants for non-bituminous fuels.

B.T.H. Lamps.

An artistic card, depicting "Sunset in the Fens," is the latest of the B.T.H. publicity productions. The text on the card is as follows: "When the sun sets use B.T.H. Edison electric lamps, which give maximum light at minimum cost."

Vulcanised Insulated Cables.

Messrs. Johnson and Phillips, Limited, Charlton, Kent, have handed us a copy of their new list dealing with Paterson's vulcanised bitumen cables, of which they are the manufacturers. Single, twin, and three cored cables are priced in the list, and particulars are also given of Paterson's jointing material. A copy of this list will be sent to anyone interested.

PERSONAL.

Mr. C. A. L. Prusmann, borough electrical engineer at Swansea, has been granted leave of absence for two months owing to ill-health. Mr. G. H. Thompson, assistant engineer, will act for him during his absence.

The Carlisle Electricity Committee have decided to offer the appointment of electrical engineer to Mr. Allen, the chief assistant engineer of Plymouth. Mr. Allen was the second on the list of selected applicants.

Mr. D. E. Bell, who has been for several years in the employ of the Sunderland Corporation electrical department, has been presented with a gold watch and a cigarette case on leaving to take up a position under the Cleveland and Durham Electric Supply at Middlesbrough.

There was an interesting gathering at the head offices of the Blackburn electric tramway department last week-end, when Mr. Wm. Thomas, one of the senior car drivers, who is leaving the country for New Zealand, was presented with a silver-mounted umbrella and letter case as a token of esteem by his fellow employés.

With reference to our note in last week's issue that Mr. O. F. Francis, of Kirkcaldy, had been appointed electrical engineer for Carlisle, it is now stated that the Kirkcaldy Burgh Council have offered Mr. Francis a substantial increase in salary to remain in Kirkcaldy, and he had decided to accept it. The salary offered by Carlisle was £300 a year, with increments of £20 a year until it reached £400; but the Kirkcaldy Town Council have made the salary £350 a year, with increments of £25 a year until the salary reached £400.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Whitehaven.—The Harbour Commissioners have decided to have tantalum lamps installed on the Lime Tongue.

Watford.—A proposal is on foot to apply for a loan for the remodelling of the electricity works and plant.

Bradford.—Six houses were wrecked as the result of a gas explosion in Legrams-terrace, Listerhills, the damage being estimated at about £5,000.

Wallsend.—The Town Council are making a strong protest to the gas company owing to the increase of 3d. per 1,000ft. levied by them in the district.

Carlisle.—The Council are seeking sanction to the borrowing of £5 000, the estimated cost of prospective mains extensions during the next three years.

Leicester.—On Monday evening last a serious gas explosion took place in a house owing to the existence of a leakage between the meter and the street main.

Leeds.—Owing to fumes produced by the imperfect combustion of coal gas a lad was poisoned in bed last Sunday morning. "Accidental death" was the verdict.

Beckenham.—The Urban District Council have decided to apply to the Local Government Board for sanction to loans for electricity purposes totalling £19,023.

Bolton.—No fewer than 18 leading cotton spinning and weaving firms and textile machinists, and one or two bleaching concerns, are now using electricity for driving purposes.

Liverpool.—"Death from gas poisoning, caused by faulty gas-fittings," was the finding of a jury holding an inquest on the body of John Quinn, a master carter, on Monday last.

Dundee.—In connection with the new generating station the contractors for the foundations have now commenced operations, and the work is being carried out as rapidly as possible.

Broughty Ferry.—The amount of electric current generated at the Corporation electricity works for December was 20,789 units, an increase of 1,732 units as compared with last year.

Winchcombe.—A statement of accounts for the year was submitted to the gas company recently, when another deficit was shown. No dividend has been paid by the company for some years.

Clapton.—At an inquest held upon a victim from suffocation by gas, Dr. Wynn Westcott, the coroner, stated that cases of gas poisoning were far more common now than they were 10 years ago.

St. Marylebone.—The Electricity Committee of the Council have adopted a wall plug meter for registering supplies for radiators, power, etc., and have decided to rent the 100-unit size at 2s. 6d. per quarter.

Manchester.—Rumours have been current to the effect that another American electrical engineering firm are about to build works in Trafford Park, but no official confirmation of the report can be obtained.

St. Pancras.—The Electricity Committee are recommending the painting of the arc lamp-posts at an estimated cost of £50; also an extension of mains to Grafton-mews in order to meet the demands for electric lighting of premises situated there.

Release of Trustee.—The *London Gazette* states that Mr. A. S. Cully, of Ruskin-chambers, 191, Corporation-street, Birmingham, has been released from trusteeship in the estate of Mr. F. E. Williams, electrical engineer, 328, Coventry-road, Birmingham.

Southend.—An alarming gas explosion occurred at 7, Ambleside-drive on the 12th inst. The bay window was blown out, the casement door landed in the garden, and the glass and ceiling were wrecked. The premises caught fire, but the flames were soon subdued.

Lowestoft.—At the last Council meeting the Electric Lighting Committee reported that there were connected to the mains 850 consumers, representing 42,294 8-c.p. lamps, also that during the past month 18 new consumers, representing 511 8-c.p. lamps, had been connected.

Devonport.—At the last meeting of the Town Council strong complaints were made of the poor quality of the gas, and it was reported that there had been received no less a number than 282 complaints received at the office during January, and 361 during December.

Liquidation.—According to the *London Gazette*, the creditors of the City of Wellington Electric Light and Power Co. are required to send particulars of their debts and claims to Mr. H. E. Salt, the liquidator, 251, Winchester House, Old Broad-street, London, E.C., by Jan. 24.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 22 a special settling day in the Great Fitzroy Gold and Copper Mines' 50,000 shares of £1 each, fully paid, Nos. 1 to 25,000 and 350,001 to 375,000; and the Java Rubber Plantations' 19,500 shares of £1 each, 15s. paid, Nos. 6,001 to 25,500.

Paddington.—The Borough Council have been compelled to vote £700 of the ratepayers' money to meet the increased charges of the Gaslight and Coke Co. for public lighting in the borough. The Council have decided to support the Islington Council in an appeal to the Board of Trade for an inquiry into the administration of the company.

Margate.—The Town Council have passed the following resolution to be forwarded to the President of the Board of Trade: "That this Council urges upon the President of the Board of Trade the desirability of installing a system of wireless telegraphy between the Long Sand lightship and the shore, at an early date, for the purpose of assisting in saving lives at sea."

Flint.—No less a price than 4s. per 1,000 cubic feet is charged for gas by the company to the Corporation. In addition 10s. 9d. is added per lamp for lighting and cleaning. The Council have tried unsuccessfully to get the price lowered, and have now resolved to obtain information from engineering firms as to the cost of establishing an electric plant in the borough.

Oakworth.—Joshua Moore, a retired overlooker, was last week found dead in bed. The room was full of gas, and evidently this was the cause of the death. The deceased is said to have been without sense of smell, so would not have detected the escape of gas. If electricity had been the illuminant, no sense of smell would have been necessary to have prevented this death.

West Bromwich.—On the night of the 9th inst. an alarming explosion, caused by an escape of gas, occurred on the premises of Thomas D. Beddard, the Pheasant Inn, Albert-street, West Bromwich. A fire was being lighted under a boiler in the brewhouse at the time, and the force of the explosion was so great that part of the roof of the brewhouse was wrecked and the roof of an outhouse was completely blown off.

Buxton Congress.—An exhibition of the latest examples of medical and sanitary equipments, gas, water, and electrical apparatus, etc., will be held at the Buxton Pavilion from July 18 to 24, 1908, under the auspices of the Royal Institute of Public Health, the president being the Right Hon. Victor Cavendish, M.P. The exhibition will be open to the public, and an opening reception will also be held in the same building.

Barrow.—The Local Government Board have held an inquiry into the application of the Town Council for sanction to the borrowing of £5,000 for purposes of the electricity undertaking. The town

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clerk stated that the application was made to meet future capital expenditure to carry on the work on businesslike lines. There being no questions the inquiry was closed, and the inspector subsequently visited the different works.

Poplar.—The Borough Council have, on the recommendation of the Electricity Committee, decided that a rate of 2d. per unit for lighting shall be offered to tradesmen entering into agreements, for not less than 12 months, for inside and outside lighting, with a minimum charge of 50 per cent. of the maximum current consumable, on an average of six hours' lighting per day; or for inside lighting only, on similar conditions, at 2½d. per unit.

Newport.—The town clerk has waited on the Board of Trade and the Local Government Board with regard to the sum of £2,819 required in connection with the Corporation-road power station. The Board of Trade will grant the loan, but it is suggested that the Corporation should go in for a provisional order to amend the Newport Corporation Acts, 1900-2-6, so that the loan could be arranged. This has been agreed to by the Town Council.

Therapeutic Radium Baths.—The Austrian Minister of Agriculture has decided to create a radium-bathing institution at Joachimsthal in order to utilise radium water for therapeutic purposes. Proposals have already been made to the Government by the Karlsbad Municipality, and, says the *Morning Post*, by an English syndicate for the organisation of radium baths, but the Minister of Agriculture has determined to retain control of the undertaking.

Windsor.—The Council are asking the Windsor Royal Gaslight Co. and the Windsor Electrical Installation Co. to tender for the lighting of the town from March, 1909, the tenders to be delivered by March 31, 1908. The period of lighting to be for five years, and the lighting power to be not less than at present. Also that each company be asked to also tender on the basis that at the end of the term the standards shall be the property of the Corporation.

Cottingham.—Strong complaints have been received by the Urban District Council from residents as to the bad lighting of some of the lamps in the village. The Council in turn have complained to the British Gas Co., who have asked that if there was cause for further complaints they should be sent to the company and not to members of the Council. The chairman very properly considered that the Council was the authority to whom complaints should be made.

Morley.—The Council having received prices for the lighting of Satcherd-lane, have resolved to install electricity as against gas, the cost of the former proving to be cheaper. The output from the electricity works for the month of November was 26,93) units, as compared with 23,006 the corresponding month of the previous year, being an increase of 3.924 units. There were 20,602 units sold to consumers by meter, against 18,151 the previous November, showing an increase of 2,451 units.

The Westinghouse Companies.—The United States judge has issued an order permitting the receivers of the Westinghouse Electric and Manufacturing Co. to exchange a claim of £174,976 against the British Westinghouse Electric and Manufacturing Co. for shares in the Traction and Power Securities Co. of Great Britain, equal at par to the same amount and interest, provided that the British Westinghouse Electric and Manufacturing Co. secures *bona fide* subscriptions for a bond issue of £250,000.

Fareham.—The electrical engineer having advised the Urban District Council that it was necessary to increase the high tension from Harrison-road to Trinity-street, the Council have decided to lay a main underground from Harrison-road by way of the back path to Trinity-street instead of increasing the overhead wires. This will secure a sufficient supply for the new Price's School. The Council have also decided to place telephone instruments at the electrical engineer's house and the electric light station.

Accrington.—At a meeting of the Electricity Committee last week-end the chairman reported having, with other councillors, met representatives of Messrs. Belliss and Morcom at the electricity works in relation to the recent breakdown of one of the engines, and the firm undertook to make the defect good free of cost. They had also offered to allow their engineer to remain at the works for a period of some six weeks to carefully watch the engine at work, provided the Corporation would pay half his wages during that time. This course was agreed to.

Middlesbrough.—The Corporation electrical engineer (Mr. H. M. Taylor) reports that during December the units sold numbered 188,783, an increase of 40,000 units on the corresponding month of December last year. The revenue amounted to £2,196, against £1,840 last year, and the estimated profit was £1,201, against £1,145 last year, the total works cost being £994, or 1·26d. per unit, compared with 1·12d. last year, an increase of ·14d. per unit. During the month 615 lamps were connected, making 85,884 lamps connected up to date.

Bredbury and Romiley.—A letter from the secretary to the General Post Office applying for the consent of the Council to the fixing of an overground telegraphic line along Stockport-road, between Stockport and Hyde borough boundaries, was read at the last meeting of the Council, upon which it was agreed that the application be postponed for further consideration, and that in the meantime the Stockport Corporation be informed of the application, and that they be requested to submit their observations in respect thereof, especially in regard to the tramway system.

Erith.—The sub-committee of the Council, which had been appointed to consider the question of the insurance of the boilers, superheaters, and economiser at the electricity works, reported at the last committee meeting that they had considered the quotations of the National Boiler and General Insurance Co. and the Manchester Steam Users' Association for an insurance of £6,000 upon the group of boilers, superheaters, and economiser, and accepted the quotation of the National Boiler and General Insurance Co. for such insurance at a premium of £20. 10s. 6d. This was approved by the committee.

Edinburgh.—The end of the dispute between the Postmaster-General and the Corporation of Edinburgh over the laying of the underground wires is not within sight. The Postmaster-General, against the wishes of the Corporation, wants to open up part of Princes-street, and he declines to accept the alternative routes proposed by the committee. Pointed correspondence has taken place between parties, and the town clerk of Edinburgh, commenting on the necessity for bringing matters to a definite point, suggests a direct reference to the appeal tribunal.

Oldham.—A Local Government Board inquiry will be held on the 22nd inst. into an application by the Corporation for sanction to the borrowing of £1,500 for extensions to the electricity undertaking. At the last Council meeting regret was expressed that applications for the supply of electricity to cotton mills could not be entertained owing to the insufficiency of plant. The total units sold during the fortnight ended Jan. 1 were 223,653, compared with 196,238 units in corresponding fortnight last year. The units used for lighting and power were 69,497, and 154,156 for traction purposes. The number of arc lamps connected is 646, incandescent 23,706, and motors 365.

Farnham.—It was reported at the last meeting of the Urban District Council that Mr. Roumieu, J.P., of the Farnham Electric Lighting Co., had interviewed the Public Works Committee in regard to the company's desire to provide electric lighting by means of overhead wires. Mr. Roumieu wrote that it was only by overhead wires that current could be produced at a price that would be readily paid by the consumers. He said the Board of Trade had decided to postpone the revocation of the company's order until the Council came to a decision on the matter. Mr. Patterson said the Council ought to have had more information from the company, and the chairman agreed. The clerk was instructed to write for fuller information.

Bournemouth.—At the last meeting of the Town Council the borough engineer reported a correspondence with the National Telephone Co., who wished to make use, for underground telephones, of certain of the ducts, the property of the Corporation. The company asked the terms upon which the Corporation would lease the ducts to the company. It was decided to inform the company that the Council would be prepared to let the ducts for a term expiring on the date of the company's licence in 1911, at a rental at the annual rate of £70 per mile, this to be subject to the company paying all expenses in connection with any alterations required to be made to the ducts or otherwise in connection with the matter, and to the execution of an approved agreement

Shetland.—Orkney and Shetland have not been in telegraphic communication with the mainland since Dec. 27, and it is announced that until the cable is repaired wireless telegraphy will be installed. The mainland station, which is now almost completed, has been erected on an out-of-the-way spot at the nearest point to the Shetland station. A qualified staff of telegraphists will be sent to the stations from the Aberdeen Post Office, and it is expected that within a week wireless messages will be transmitted to Shetland and the other islands. Thus through communication will be established between the mainland and Iceland and the Faroes. At present, messages to Shetland and the Orkneys are dispatched from the mainland by mail steamer. It is expected that some considerable time will elapse before the cable can be repaired.

Shoreham.—The Works Committee of the Shoreham Harbour Trustees have called the attention of the Corporation of Brighton to the weakening of the east beach in front of the electricity works, which, in the opinion of the Trustees, has become a source of danger to the works and the harbour generally, and have asked the Corporation to immediately deal with the matter. It appears that the weakening of the east beach in front of the electricity works is of such importance, the interests at stake being so large both with regard to the electricity works and the harbour itself, that something should be done without delay. There has been a great loss of shingle in front of the works, and there is also a danger arising to the harbour from the possible breakage on the west side of the electricity works, in which case the south channel would be seriously involved.

Northfleet.—At the District Council meeting the clerk reported upon the London and District Electricity Supply Bill. Although Northfleet and Gravesend were mentioned in the Bill, it did not mean that the promoters would necessarily come so far down. The works would be situated in Essex. If the promoters did extend to Northfleet, they would be able to supply electric energy for power purposes, and 20 per cent. of that supply could be utilised for lighting purposes. Subject to Gravesend's consent they could also supply the trams. But in the event of the promoters buying the undertaking of the Gravesend Corporation, it was stipulated that the conditions under which Gravesend had to supply would no longer be in force. It was agreed that the clerk should confer with the town clerk of Gravesend with further reference to the matter.

Carmarthen.—A special meeting of the Town Council was held on the 10th inst. to consider the draft arrangement with Messrs. J. B. Saunders and Co., of Cardiff, for the electric lighting of the town. Several objections were made on the ground that the electricians had not adhered strictly to the terms contained in the agreement entered into with the Council some time ago. Chief objection was laid to Clause 12 in regard to overhead wires, the clerk being instructed to lodge an objection with the Board of Trade by the 15th inst. in case Messrs. Saunders and Co. did not acquiesce in the Council's demands. It was also agreed to insist upon Messrs. Saunders and Co. including the following streets in their main cable area: Blue-street, John-street, Waterloo-terrace, and Water-street, to the junction with St. Catherine-street. Failing refusal of consent objections will be lodged.

Haywards Heath.—The Urban Council and the officials of the Post Office Telephone Department held a meeting on the 10th inst., when the telephone officials requested permission to erect wooden poles

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in place of the fallen iron standards to carry the Post Office telephone wires through the town. The Haywards Heath Council have received a strongly supported petition from owners and residents along the route of the demolished poles not to allow the erection of poles. but that the wires should be carried underground. The telephone officials urged reasons against the underground system, and held out little prospect of the request being acceded to, but the Council resolved not to grant permission for wooden poles, and decided to send a petition to the Postmaster-General asking that the underground system should be adopted in carrying the trunk telephone lines through Haywards Heath.

King's Lynn.—At the Council meeting the engineer reported that since the previous meeting one application for a supply of current had been received, making a total of 614 private connections; that five electric radiators had been fixed for existing consumers. The question of the lighting of St. John's Church was considered, and the matter was left in the hands of the chairman and engineer to deal with. The engineer reported that the number of units generated during November, 1907, was 69,780, against a total of 65,251 for November, 1906; total units sold to private consumers (light and power), 41,166, against 31,793; units sold at lighting rates, 25,965, against 21,323; units sold at power rates, 15,291, against 10,470; cost of fuel, stores, repairs, and wages at station in November, 1907, was £181. 6s., against £159. 10s. for November, 1906; cost per unit generated, 0·6236d., against 0·5866d.; wages of lamplighters and repairs to lamps, mains, and meters, £25. 7s. 11d. against £26. 4s. 9d.

Airdrie.—At the last meeting of the Council a letter was read from the Board of Trade intimating that application had been made under the Airdrie and Coatbridge electricity order for power to the company to lay cables for the supply of extra high-pressure energy. A report on the matter was read from the burgh surveyor, who stated that the company had already a high pressure of 6,600 volts to their sub-station in Craig-street, where it was distributed, and they had laid a high-pressure cable to the Rivet Works in Hogg-street. They now proposed to lay the high-pressure mains in troughs, the nature of which was not specified, but he suggested that they be of earthenware. It was also proposed to allow connections to earth, and he pointed out that this might affect gas or water pipes that were close to the cables, and he suggested that the gas and water managers should be consulted in their respective departments. The matter was remitted to the Gasworks Committee with powers, if necessary, to consult an expert, and to keep in touch with what was being done in the same matter by the Coatbridge Council.

Luton.—The Council have decided to urge the Board of Trade to reintroduce the Electricity Supply Bill during the coming session, and exercise every means to have the same passed into law. The electrical engineer has reported that since Dec. 2 last 91,109 units had been generated, an equivalent of 480 8-c.p. lamps and eight motors of 41 h.p. connected, making a total of 456 consumers, with 24,941 lamps and 218 motors of 1,361 h.p. The number of units generated showed an increase of 48 per cent. over the number generated during the corresponding period of last year. At the present time applications were in for over 1,000 additional lamps and 41 h.p. in motors The main in Park street will be extended in order to supply light to the tramway car shed, at an estimated cost of £74. The electrical engineer reported that he had invited tenders for replating and renovating the present storage battery and increasing its capacity. The tender of the Chloride Electrical Storage Co., of Clifton Junction. Manchester, has been accepted at the price of £559, and the expenditure will be met by three annual payments out of revenue.

Westminster Engineering Co.—The Westminster Engineering Co. report that in order to devote their attention particularly to the manufacture of dynamos, motors, switchboards, arc lamps, and other specialities they have disposed of the wiring, fittings, and installation branch of their business carried on since 1890 and up to this date at 16, Davies-street, Berkeley-square, W. Mr. Walter Riggs, who managed the branch for them for seven years, retains his position with the new proprietors, who will continue the business under the name of "Girdlestone and Co.," but neither the Westminster Engineering Co. or Mr. J. O. Girdlestone, the managing director of the company, have any interest in, or are in any way connected with, the business after the date of this notice. The offices and sales department will remain at Victoria-road, Willesden Junction, as before, but customers who find it more convenient may still deal with Messrs. Girdlestone and Co, who are agents for the sale of the company's manufactures. The company are busy at their works in all departments, and business prospects look very bright.

Electrical Fittings.—An important Admiralty order has been received relative to the nature of balancing and other tests which the electrical fittings and circuits of vessels must in future undergo at the conclusion of refits, or when new machinery is installed, and fixing the responsibility for the carrying out of these tests. The tests will be governed by the nature of the refits, which will be classified under two heads: (1) long refits; (2) ordinary refits. In the case of "long refits" the whole of the circuits and fittings are to be tested by the dockyard officers prior to the final inspection by Admiralty officials. In the case of "ordinary refits" only new circuits and fittings are to be tested, and this will be done by the dockyard officers in conjunction with the ship's officers. In every instance, dynamos, motors, fire-control fittings, dynamo firing instruments, etc., will be tested and balanced. The final inspection and trials will be performed by Admiralty officers, but in their absence the duties will be undertaken by dockyard officers, reports being forwarded to the Admiralty.

Kendal.—A conference on telephone charges, convened by the Westmorland County Council, was held in the Kendal Town Hall on the 11th inst., when representatives were present from the County Council, Chamber of Commerce, Urban and District Councils, the Corporations of Kendal and Appleby, and other authorities in the county. All the speakers protested strongly against the proposed measured-rate system of the National Telephone Co., and it was unanimously decided to send delegates to represent all bodies in Westmorland at the interview with the Postmaster-General next month. The local question was also broached. When the Kendal exchange was established there was an agreement between the Kendal Chamber of Commerce and the National Telephone Co. that the area formed, which was practically the whole of the county of Westmorland, should be a free area, and it was shown that this agreement was being broken. It was unanimously decided to appoint an executive committee with full powers to meet the Telephone Co. and try to come to terms as to the local area previous to the interview with the Postmaster General in London.

Islington.—The Lighting Committee are recommending the Council to borrow £23,304 for the provision of additional plant at the electric light station. This sum is made up of the following items: one 1,500 kw. steam-turbine and alternator with exciter complete condenser, air and circulating pumps and accessories, foundations, brickwork, etc., steam and exhaust pipes, valves, cable for connecting, switches, lagging, etc.—total, £9,642; one cooling tower, including power-driven fans capable of cooling water for condenser, foundations, building work for pond, pipes, valves, alteration to existing buildings, and sundries—total, £2,380; three water-tube boilers, each capable of evaporating 20,000 gallons of water per hour, complete with chain-grate stokers and all accessories, with foundation brickwork complete, steam pipes, valves, blow-down pipes and accessories, water-meter, with pipe connections and valves, cable connection for motors, etc., one feed pump, feeding capacity 10,000 gallons per hour, with pipe connections, valves, and accessories—total, £9,470; steel coal bunkers, including hoppers, chutes, coal conveyor, foundations, and all accessories complete, £1,412; contingencies, £400—grand total, £23,304.

Lewisham.—The Lighting Committee of the Borough Council have received notice from the South Metropolitan Electric Light and Power Co. of their intention at the expiration of one month to lay one 19/09 low-tension concentric lead-covered cable from the existing joint-box on the east side of High-street, Lewisham, in a northerly direction to a joint-box some distance up the street. The cable will be placed in earthenware troughs filled with refined pitch and laid under the footway and roadway where possible, and junction boxes fixed. The committee have approved the proposal so far as the authority of the Council extends, subject to the reinstatement being carried out by the Council, at the cost of the company, in accordance with the scale of charges adopted by the Council for such works, and to the trenches, where they are in tar paving, being broken up either to the forecourt line or to the kerb, whichever is the nearer, and to no part of the footways being kept open for more than one week, the Council reserving to themselves the right to fill in the ground and charge the company with the cost of the trenches if allowed to remain open for a longer period, and also subject to the cables being laid at a depth of at least 2½ft. where crossing a roadway. The committee have directed that the London County Council be informed of the action taken.

Thomson-Houston Harriers (Rugby).—On Saturday last over 80 runners, representing Sparkhill, Leamington, Hinckley, Coventry, Willans and Robinsons, Thomson-Houston, Thrapston, and Walsall, turned out for the second annual seven miles cross-country race promoted by the Thomson-Houston Harriers. Although only the second "annual" it now ranks as the largest and most interesting competition of its kind in the Midlands, excepting only the junior and senior championships. Saturday's race proved a big attraction for the Rugby people, and many hundreds lined the Station-road to see the start and finish. W. Coales, of Thrapston, was first man home, followed by Noakes and Hart, of Sparkhill. The following were the placings of the clubs engaged: (1) Thrapston; (2) Sparkhill; (3) Thomson Houston; (4) Coventry Godiva; (5) Leamington; (6) Willans and Robinson; (7) Hinckley; (8) Walsall. Arthur Russell, captain of the Thomson-Houston Harriers, and ex-champion steeplechaser of England, was out with a view to putting in some training for the Olympic Games at London next summer, when he will represent his club in the steeplechase championship of the world. Mr. T. N. Martin, the hon. secretary of the Thomson-Houston Harriers, is anxious to hear from the hon. secretaries of works clubs with a view to arranging some interworks athletic contests, and any letters addressed to him at 31, Paradise-street, Rugby, will receive prompt attention.

Pontypridd.—Considerable interest was taken in engineering and commercial circles in the annual dinner of the staff of the tramway and electric lighting department of the Pontypridd Urban District Council, which took place at the New Inn Hotel, Pontypridd, under the presidency of Mr. Hugh Bramwell, M.E. (general manager of the Great Western Colliery), the chairman of the Electricity and Tramway Committee. Responding to the toast of "The Council," the Chairman remarked that the electrical undertaking was as yet in its infancy, and, being in this state, it had to be supported out of the rates. The Council had undertaken considerable responsibility, and the repayment of the loans as required by law took up the profits, but he predicted its being brought to a successful issue by Mr. Teasdel, the capable manager of the department, and his staff in the near future. Mr. J. E. Teasdel (the Council's engineer and manager), responding to the toast of "The Staff," said that with the linking of the town route with that of the Rhondda he hoped there would be an increased revenue of £30 a week. The progress of the tramway undertaking had already been most gratifying, as there was now an increase of between £30 and £40 per week in the Treforest and Cilfynydd routes as compared with the receipts 12 months ago, while in regard to the electric lighting department good progress had also been made there, there having been an increase of between 30 and 40 per cent. during the past 12 months. The balance sheet showed a deficit, but that was due to

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the fact that the capital expenditure was not now bringing in the revenue which it eventually would, and he maintained that the progress of the undertaking would compare favourably with that of any other similar one. Another gratifying fact was that, although a difficult and dangerous route had to be traversed by the tramcars, especially when the streets were overcrowded, such as they were on Saturday nights, there had not been a single serious mishap.

Dudley.—An electrical exhibition is now available to Dudley ratepayers and friends. The Corporation have thrown open for public inspection the electrical generating station at Springsmire, and the manager (Mr. C. E. Savage) has secured a number of exhibits so as to constitute the whole a most interesting and instructive exhibition of electricity and some of its applications. The plant in work at the station for the supply of electric light and power on the tramways and in the town is on a large and important scale. The boiler-house contains six Babcock and Wilcox boilers, with one Boby heater and mechanical stoking apparatus. In the engine-house are four Westinghouse engines and dynamos (400 kw. size), one Ferranti engine with a 500-kw. Electrical Construction Co.'s dynamo, and one with a similar 400-kw. dynamo. In the condenser house are a Worthington condenser capable of dealing with 3,000lb. of steam per hour, Worthington feed pumps, and a Green's economiser. Amongst the independent exhibits are a variety of cable accessories, telephonic apparatus, and an electrical welding apparatus, which can be seen at work. Grinders driven by motors are shown by Messrs. Harper, Sons, and Bean; working motors by Messrs. Whittaker Bros.; a working electric drill by Mr. E. C. Theedam; and two large arc flame lamps by the Westinghouse Co. There are numerous other exhibits of electrical accessories. At a meeting of the Streets, Tramway, and Lighting Committee of the Town Council the engineer laid before the meeting the following particulars of the working of the electrical undertaking for the four weeks ended Nov. 23, 1907: units generated—trams, 81,891 (corresponding period last year, 69,831); private lights, 51,566 (44,606); private motors, 46,000 (32,232); public lights, 13,726 (13,760); station use, 3,353 (3,101)—totals, 196,536 and 163,530. There were connected to the mains the equivalent of 48,060 8-c.p. lamps. Total consumers, 336. Motors, 105, amounting to 746 h.p.

Swindon.—The Town Council, with a view to extending the street-lighting by electricity, recently appointed a committee to go into details, and as a result they have now reported that they have considered a report of the electrical engineer with regard to improving the incandescent electric street-lighting, and also as to the reduced terms upon which electricity could be supplied for electric street lighting if the whole of the existing reflector electric lamps were converted to tantalum or Osram lamps, and the whole of the gas lamps in the streets where the electric mains have been laid, and also the whole of the gas lamps in the streets where the electric mains may hereafter be extended, were converted to electric lamps. The sub-committee recommended that the incandescent electric lamps and the gas lamps as mentioned be converted to tantalum or Osram electric lamps at an estimated cost of £301. 4s. 6d., that the gas lamps in the streets where the electric mains are hereafter extended be converted to electric lamps, and that it be an instruction to the electrical engineer accordingly. Also that they had considered a report of the electrical engineer with regard to extending the arc lighting, and recommended that arc lamps be substituted for the existing electric incandescent lamps and gas lamps in Manchester-road, Milford-street, Fleet-street, Faringdon-street, Commercial-road, and Victoria-road, to all of which the Council have agreed. When both the above schemes have been carried out the results, as set out in the reports of the electrical engineer, will be as follows: Lighting and cleaning—increased cost per annum, £104. 8s. 9d.; less wages of four lamp cleaners at 13s. per week each per annum, £135. 4s.; net decreased cost per annum, £30. 15s. 3d.; capital expenditure, £301. 4s. 6d., say £300; interest and sinking fund on £300 at 4 per cent. (term 10 years) would be about (per annum) £37; increase in candle-power from 1,064 to 11,958. Arc lighting—increased cost per annum, £88. 13s. The capital expenditure for carrying out the arc lighting scheme, amounting to about £1,800, will be incurred by the Electricity Committee, and the charges made per arc lamp include the necessary annual instalments for interest and sinking fund, etc., on this sum; increase in candle-power from 3,480 to 36,000.

Hanley.—The third annual supper of the staff of the Hanley electricity works was held at the Three Tuns Inn on the 9th inst., when a large number of the staff, supported by local contractors and electrical friends, were present. The chair was taken by Mr. Councillor Schofield, vice-chairman of the Electric Lighting Committee. The first toast of the evening, "The King and Royal Family," was heartily responded to, and the following toasts were also proposed: "Electric Lighting Committee," proposed by Mr. Adams, deputy engineer; responded to by the chairman, Mr. Councillor Schofield; "Success to the Hanley Electricity Supply," proposed by Mr. Charles Osborne (Blackburn, Starling, and Co.), who mentioned that he remembered the Hanley electricity works from the very first, and had always taken a great interest in the welfare and progress of the undertaking, which had made great strides since supply was first given. This toast was responded to by Mr. C. H. Yeaman, chief engineer, with much applause. Mr. Yeaman stated that the working cost for the last four years had varied but little, notwithstanding a large increase in output. For 1903 it was £5,160, 1904 £5,685, 1905 £5,125, and for 1906 £5,131. The gross working expenditure since the start had been £55,438, and including management, etc., £74,024. Added to this were interest payments of £25,528 and repayments of loans aggregating £22,680, while the total receipts during the 12 years of operation came to over an eighth of a million pounds. This sum represented a sale of 8,000,000 units, and a quarter more than that were generated in addition. The aggregate profits were, roughly, £8,600, and losses £3,600, having a surplus balance of about £5,000, earned by trading during the period of supply. Wages amounted to £11,378 and salaries £8,748, so that labour received nearly £20,000 benefit by the establishment of the works. Mr. Yeaman also stated that he had never had a better staff, nor one which showed more enthusiasm; and now that the competition fight between gas and electricity was keen, and likely to become more keen, there was plenty of scope for the strenuous life, and he believed that pulling together with courage in the prow, prudence on the bridge, and well ballasted with a substantial reserve fund, and backed by a governing body entirely at one with the management, the good ship would weather the storm and come gaily sailing into the port of success. In any case, the town as a whole got the benefit. Electric lighting to-day only cost one-third of what it did three years ago in Hanley, owing to new lamps and reductions in the price of current, so that the craving for cheapness could be met while giving a decidedly good article. All they wanted was a whole-hearted support and co-operation from their friends and fellow ratepayers to show what they could do. They would strive to gain this, and certainly would—one and all—deserve it. "Contractors and Experts," proposed by Mr. Marston (mains superintendent), was very aptly responded to by Mr. Hulse (representing the British Westinghouse Co.), and Mr. Barkham (representing the Union Electric Co.). "Local Engineering Visitors" was proposed by Mr. Paddy, and responded to by Mr. C. Osborne "Our Latest Arrival" (Mr. C. W. Charlesworth), proposed by Mr C. H. Yeaman, was responded to by Mr. C. W. Charlesworth (latest arrival). "Success to Howden's No. 1 Engine," lately installed at the Hanley works, was proposed by Mr. Horobin, and heartily responded to by Mr. Walker (Howdens, Limited). Songs and pianoforte and gramaphone solos were rendered by members of the staff and visitors. The evening was a most enjoyable one, and the excellent catering of Mr. and Mrs. Evans appreciated by all.

TRACTION.

Burnley.—The tramway system at Burnley is to be extended at a cost of £70,000.

East Ham.—The Council Tramways Committee have decided to procure top covers for five additional cars in response to the application of residents in the borough,

Cardiff.—Owing to the defective state of the tramway track in several parts of the city, the Corporation have appointed a committee to inspect and report with a view to carrying out the necessary repairs.

Leven.—During the five holidays the passengers carried between Gallatown and Leven totalled 41,200—an increase of 700 on the previous year. Wemyss cars alone carried 19,506 in the first four days of the year—an increase of 12,000; Kirkcaldy cars conveying the balance.

Belfast.—A meeting of ratepayers has been held to consider the advisability of confirming the Corporation's decision to promote a Bill for acquiring the Cavehill and Whitewell tramway at a cost of £60,000. The meeting carried a resolution against the proposal, and a plebiscite will now be taken.

Glasgow.—The Council have received a deputation from the Trades' Council urging the Council to proceed with the construction of the alternative car route from Pollokshaws terminus to Rouken Glen *via* Thornliebank. The Council have remitted the matter to the Tramways Committee for consideration.

Lowestoft.—A statement has been submitted to the Corporation Tramways Committee showing the earnings of each conductor for the year ended Sept. 30, 1907, and the committee have resolved that the sum of £6 (the same amount as last year) be awarded at the discretion of the general manager to motormen and conductors for good conduct bonuses.

Islington.—A joint conference between the Works Committees of the Islington and Hackney Borough Councils will suggest to the London County Council that Ball's Pond-road should be widened, so as to accommodate a double line of electric tramways. It is proposed that the widening should be carried out as a metropolitan improvement.

Rochdale.—A special meeting of the Rochdale Town Council has been held to consider the propriety of the promotion by the Council in the ensuing session of Parliament to confer further powers upon the Council with reference to their water, tramway, electrical tramways and construction of new streets. The total cost of the undertaking will be £55,000.

Perth.—The Town Council at their monthly meeting received a deputation of about 20 persons in favour of the inclusion in the proposed provisional order of the extension of the tramways in the direction of Dovecotland and Jeanfield. A motion was carried that the extension of the tramways be carried from High-street to the cemetery gate and on to the burgh boundary.

Chiswick.—The Works Committee of the Council have decided to support Ealing's application for an injunction against the London United Tramways Co. on account of the noise occasioned by tramcars, and contribute £60 towards the cost. A resolution was also carried to call the attention of the Commissioner of Police to the noise of the trams, and request him to withdraw his licence in respect of those cars found to be unsuitable.

Somersetshire.—At a meeting of the Drainage Commissioners the engineer reported that, as instructed, he had inspected the plans and line of route of the proposed Crewkerne, South Petherton, and Martock light railway, and he suggested that a clause be inserted in the company's order providing for culverts and bridges of a certain specified size to facilitate the removal of flood water. It was decided that the report be adopted and the necessary steps taken.

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Accrington.—At a meeting of the Town Council last week-end, on the minutes of the Electricity Committee being considered, Mr. Crawford said he was pleased to learn that already 50 out of 80 of the whole staff on the old tramway company had been engaged for service on the Corporation's tramways, and he hoped before long they would all be taken on. The manager stated that the remainder of the employés would be required on the Haslingden and Rawtenstall sections.

West Ham.—A somewhat serious tram accident happened on Sunday afternoon to two cars belonging to the Corporation in Grange-road, Plaistow. It was foggy at the time, and whilst a car travelling from Stratford to Canning Town was going down the hill towards the gates of the East London Cemetery it was dashed into by another car coming in the opposite direction. The two cars met on the single line, and each suffered severely from the impact. There was no personal injury.

Liverpool.—At mid-day on the 10th inst. a boy jumped on the footboard of an electric tramcar passing along Crown-street to steal a ride while the conductor was collecting fares on the top. As the conductor was descending the boy jumped off, and ran across the street. Unfortunately, another electric tramcar coming the opposite way knocked down the boy and ran over him. He was crushed underneath the plough-guard, and, when extricated after some difficulty, he died.

Hornsey.—At a special meeting of the Hornsey Borough Council for the purpose of considering a Bill which is to be introduced in Parliament to electrify the Highgate-hill steep-grade cable tramway, it was stated that the line was the first cable tramway laid in Europe, the system being introduced from San Francisco. Every possible engineering difficulty that could occur was met with in its short length and surmounted. The Council adopted a recommendation of their Parliamentary Committee to oppose the Bill.

Aberdeen.—As a Bay View tramcar was proceeding from the send-off in Castle-street westward about 11 o'clock on the 9th inst. a seaman named Harkins, of H.M.S. "Ringdove," whilst crossing Union-street from Broad-street, ran in front of the car and was knocked down, but was caught by the cow-catcher. He was carried into the offices of the tramway department in an unconscious condition, and was afterwards removed to the Royal Infirmary. Harkins sustained some injuries to the head, but it is not thought that he is seriously hurt.

Croydon.—A deputation of inhabitants attended the last Council meeting to present a memorial bearing 2,989 signatures, asking the Council to proceed at once with the extension of the trams from the junction of the existing line at Lower Addiscombe-road, Cherry Orchard-road, through Morland-road and Woodside up the Portland-road, so connecting these districts with the services to Croydon, Thornton Heath, Purley, the Crystal Palace, and Penge. The Council referred the matter to the Tramways Committee for report.

Royton.—When the fog prevailed on Sunday last an accident happened at Royton, but luckily it was not attended with personal injuries. A Rochdale tramcar was going to Oldham, and an Oldham car proceeding in the opposite direction. When near the loop at Longsight the fog was so dense that the drivers were unable to see many yards in front of them. Both drivers applied the brakes, but were unable to prevent the collision. The Oldham car dashed into the Rochdale one, the front of which was badly damaged. Luckily no one was injured.

Barnes.—A meeting of ratepayers of the Barnes and Mortlake districts, held on the 13th inst., strongly protested against the proposed introduction of a tramway service in its midst. Mr. E. C. Morley, who presided, declared carried a resolution which called upon the District Council to vote against the parliamentary Bill sanctioning the construction of tramways from Hammersmith and Putney, through Barnes, to Mortlake and Richmond. There was considerable opposition among occupants of the gallery, and the meeting eventually broke up in disorder.

Blackpool.—Benjamin Rushworth, a tram driver in the employ of the Blackpool Corporation, was on Saturday night returning from the cemetery along the New-road route about 11.30 p.m. with the last car, and when crossing the points opposite Cookson-street the car left the rails, colliding with an electric standard, smashing the base, and completely demolishing the railings and wall of an adjoining garden. There were no passengers in the car at the time, and although the front of the tram was badly smashed the driver escaped with a few scratches from broken glass.

Yarmouth.—On the suggestion of the Rollesby Guardians the standards on Caister-road are to be banded with white to make them more conspicuous to drivers at night. An agreement has been entered into with the Great Eastern Railway for a site for a shelter at the Gorleston terminus, and the Electricity Committee have ordered materials for it at a cost of £19. The roof of the shelter at Yarmouth bridge is to be continued over the footway. Receipts on the Yarmouth and Gorleston sections since April 1 have totalled £17,800, a decrease of £870 On the Caister route £3,075 has been taken.

South Norwood.—A deputation of South Norwood residents, of whom Mr. W. F. Stanley, J.P., was spokesman, waited upon the Borough Council at their last meeting to urge the extension of the tramways to the district from Croydon, *viâ* Addiscombe and Woodside. He mentioned that a public meeting had unanimously adopted a resolution in favour of the scheme, of which the Council already possessed parliamentary powers. He concluded by presenting a petition in its support signed by nearly 3,000 residents of the neighbourhood concerned. The matter was referred to the Tramways Committee.

Huddersfield.—At the Council meeting a report from the Tramways Committee contained a financial return for the nine months ending Dec. 31, from which it appeared that the receipts amount to £65,006, and that the total working expenditure amounted to £32,054, leaving a gross surplus of £32 952. From that should be deducted £10,050 for interest on capital, £7,402 for redemption of debt and other charges, making £18,356, leaving a balance of £14,596. From this, again, £9,290 is deducted for depreciation, reckoned at 3 per cent., leaving the net surplus £5,305, as against £2,900 for the corresponding period last year. The committee intend to spend £12,573 on widening of lines, and to charge the cost to the depreciation fund.

Rio de Janeiro Tramway, Light, and Power Co.—The company announces that, owing to increasing business in Europe, it has opened offices at 46, Threadneedle-street, E.C., and that the registers, etc., will be transferred on Feb. 14 to the above address from the offices of the British Empire Trust Co., which has hitherto acted as secretaries and registrars in Europe. The company also announces that, owing to the pressure of other engagements, Mr. William Mackenzie, of Toronto, has resigned the presidency, but will remain chairman of the Board. Dr. F. S. Pearson has been elected president, and Mr. R. M. Horne-Payne and Mr. E. R. Wood additional vice-presidents. Mr. George Flett, managing director of Dick, Kerr, and Co., has also been elected an additional director.

Leith.—The Leith Tramways Committee have had under consideration a letter from the Edinburgh Corporation with regard to the proposed extension of the Leith electric tramway system to Granton. The town clerk was instructed to reply to the effect that the Leith Corporation do not see their way to depart from the proposal they had already made with regard to the joint interest in the extension on the part of the two corporations. Members of the committee point out that to accept the Edinburgh proposal Leith would have to pay the city at the rate of 6½ per cent. upon the city's capital of £12 000, and at the same time be liable for any deficiency for the working. It would be better for Leith to borrow the money required, which they could do at 3½ per cent. It is still thought possible, however, that some understanding may be arrived at between the Edinburgh and Leith Town Councils.

Vienna.—In order to facilitate the collection and delivery of letters and packages in Vienna, the Ministry of Commerce is engaged upon a plan for an underground electric railway which would link together the chief and various district post offices of the city, which number about 64. According to the plans which are now under discussion, the line would be built 25ft. below the surface of the ground, and the tunnel would have a height of 5ft. and a breadth of 4ft. 4in. The stations would be built underneath the post offices. The trains would run at 20 miles an hour, and would consist of a motor and three cars, each carrying as much as the ordinary post van. It is estimated that it would take seven years to construct that line, whilst its cost would be enormous. It is stated that the line could be operated for much less than the present method of horse and van delivery, whilst the mails could be handled in less than half the time now required for the purpose.

Keighley.—The report of the Corporation tramways for the period from July 1 to Dec. 26, five days short of the half-year, shows that progress has been made though the advance has not been rapid. During the half-year the number of car miles run has been 110,145 08, and the number of passengers carried has been 1,034,935, or 9·39 per car mile. The receipts have amounted to £4,295. 12s. 10d., or 9·29d. per car mile, as compared with £3,997. 0s. 7d. in the corresponding period of last year. The expenses have amounted to £2,663. 18s. 2d., equalling 5·80d. per car mile, as compared with £2,580. 8s. 5d. in the corresponding period of the previous year. This shows that whereas the increase in receipts has been £268. 12s. 3d., the increase in expenditure has been £83. 8s. 9d. Various changes have been effected during the half-year, including the institution of the system of cars making a complete circuit. Another innovation has been the issuing of 1d. return fares on certain specified stages.

Walsall.—At the last meeting of the Town Council Alderman J. Cope, in submitting the report of the Tramways Committee, remarked that some time ago the committee were given permission to undertake the work of reconstruction in connection with the tramways system, and were empowered to spend £38,100. He was pleased to say, however, that instead of spending that amount they had carried out the work in an efficient manner for £31,422, a saving of £6,678 having thus been effected. One of the factors which had been most conducive of success was that the Tramways Committee had consisted of practical men, and to the fact that the officials had helped very much in the work. The town clerk helped them greatly in the negotiations of their contracts; the surveyor also had assisted them by saving on streets improvements, and the tramways manager had excelled himself in the commercial ability he had brought to bear upon the undertaking, and to his constant care and attention was due in a great measure the fact that the committee had such a balance to the good.

Bolton.—The question of whether a Bill should be promoted to Parliament by the Bolton Corporation for powers to make street improvements, and to revive the powers and extend the time for the construction of a tramway, was emphatically answered in the negative by a town's meeting on Tuesday night. The gathering was held in the town hall, and the mayor presided over a crowded attendance, which early manifested its opposition to the scheme. The town clerk reported that in order to obviate the opposition of the late Sir William Hulton to the Bolton Improvement Act of 1898, by which the boundaries of the borough were extended, the Corporation entered into an agreement to construct a tramway along Hulton-lane, Bolton, and to widen it at their own cost. The period of the power to construct that tramway expired in 1908, and they now sought to revive the powers originally obtained in 1898. The Mayor moved the resolution in favour of the Bill, and Mr. Alderman Miles seconded. The first speaker in opposition was Mr. S. Partington, and he was followed by Mr. Tootill, who had been deputed to speak on behalf of the Bolton and District

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Trades' Council. Opposition was also expressed by the Bolton and District Property Owners' Association and the Tradesmen's Association. The Bill was supported by Colonel Hesketh, who urged that, as the agreement had been entered into by the Corporation, they ought in honour to carry it out. Only 30, however, voted in favour of the Bill out of an attendance numbering close on 2,000.

Kennington. — In connection with the St. Mark's Tramway Brotherhood of the United Kingdom a commodious new hall was opened by the Duchess of Marlborough on Saturday near St. Mark's Vicarage, opposite Kennington Oval. The brotherhood, which now numbers a thousand members, and has branches in many parts of the country, originated in this district. The dedicatory prayers having been read by Canon Allen Edwards, rural dean, the Rev. John Darlington (vicar, and president of the brotherhood) said the hall put in a practical shape a very long-cherished dream. He had had many teachers in life, but for practical patience he had learnt from no one more than he had from the tramway men, who did not complain, and put up with the many rubs and difficulties which came in the course of their exhausting and long labours. He hoped the hall and brotherhood would call attention to them. Mr. Darlington added that in the brotherhood they had every shade of Church view, and members of all sects and persuasions and of all political creeds. The Duchess, to whom a bouquet was presented by Master John Darlington, declared the hall opened amid applause. She said she sincerely hoped that every member of the brotherhood might derive benefit from it, and spend many happy, pleasant, and profitable hours there. She trusted that those walls might shelter nothing but kindly feeling and goodwill, and that all the resolutions and friendships made might be a help and comfort to every member as he went out to a hard day's work. She expressed admiration for the brotherhood and the principles underlying its constitution, and wished them every success, hoping they would have an ever-increasing membership in the years to come.

London, E.—Good progress is being made with the work of reconstructing the electric tramways in East London. Considerably more than half the work has been accomplished already, and it is hoped that the new trams will be running by March. But much depends upon the weather, which has lately been interrupting the work. Special interest attaches to the line from Aldgate to Bow Bridge, inasmuch as an experiment is being tried with the G.B. surface-contact system. The London County Council were forced into the experiment by reason of the Stepney Borough Council objecting to the overhead system being adopted along the Mile End-road. The Stepney Council's opposition was raised on the ground of the unsightliness of the electrical standards. On the other hand, the London authority asserted that they were unable to lay conduit cables because of the nearness of the Underground Railway tunnel to the surface of the road. Eventually the County Council made a compromise by undertaking the G.B. surface-contact system. It was originally intended to construct the tramways from Aldgate to Cambridge-road on the underground conduit system, and from Cambridge-road to Bow Bridge on the overhead trolley system. The cost of the track work and overhead equipment would on the mixed system have amounted to about £92,000, as compared with £66.000 for the G.B. surface-contact system. There is thus a saving of £26,000. This relates to the three miles of double track. The relative cost per mile of single track work is £11,000 for the G.B. system and £19,000 for the alternative system. A new car-shed is also being constructed in Fairfield-road at a cost of £50,000, the cars require special equipment at a cost of £3,360, and the cables and cable ducts account for £15,850. Altogether, the line from Bow to Aldgate will cost £122,210, the cost of rails at £11,000 having already being provided for.

Manchester.—At a meeting on the 14th inst. of the Manchester Tramways Committee it was stated that the result of the work of the parcels department during a period of nine months had been that an income of £3,670 had been earned and the expenditure had amounted to £2,586, making a profit of £1,084. A few months ago the committee adopted an experiment on the Middleton route in the long-distance fares, and the general manager (Mr. M'Elroy) presented a report showing the receipts per car mile since the reduction was made in comparison with the corresponding previous period. This showed that while the receipts per passenger had decreased by from 1·25 to 1·21 the increase of earnings per car mile had increased in the proportion of from 10·40 to 10·57. It was decided to refer the report to a sub-committee to consider the whole question of long-distance fares. A fact which has been ascertained by the experience of the tramways authority is that on an average the earning per car mile is about 30 per cent. more from the 2d. and 3d. passengers than from the 1d. passengers. The arrangements to be made for the trolley boys was discussed in a report furnished by the general manager. He suggested that appointments should begin at 15 years of age, with the wages at 7s. a week, with uniform and free conveyance on the cars to and from duty. They should receive an annual increase of 2s. a week for four years till they were 19 years old, and at that age, if found suitable, should be permitted to act as guards and paid at the rate of 4½d. per hour, with an annual increase of ½d. an hour for two years, thus reaching the minimum rate of wages for guards (5½d. an hour) by the time they attain 21. It was stated that workmen's return tickets, which are issued before seven o'clock in a morning, were estimated to be costing the department £5,000 a year.

Great Northern, Piccadilly, and Brompton Railway.—A Bill "to confer on the Great Northern, Piccadilly, and Brompton Railway Co. further powers with reference to capital" has been deposited for introduction into Parliament next session. Under this Bill it is proposed to cancel the agreement of Jan. 30, 1903, between the Underground Electric Railways Co. of London and Messrs. Speyer Bros. with reference to the profits of the Brompton Co. available for dividend on the 482,500 ordinary shares of £10 each, which at the date of that agreement constituted the capital of the Brompton Co. In lieu of the division of profits arranged under that agreement it is now proposed to convert 33,540 of these shares, the numbers of which are set out in the first schedule to this Bill, into preference shares "as on and from July 1, 1908," and the company may from time to time resolve, with the assent of the Underground Co., to convert all or any of a further 286,460 shares, the numbers of which are given in the second schedule to this Bill, into preference shares. The whole of the preference shares, irrespective of the dates at which the shares were converted, are to rank equally and to be entitled to a non-cumulative dividend at the rate of 4 per cent. per annum, except that the dividend to which the 33,540 shares will become entitled "shall be guaranteed by the Underground Co." The above shares represent the 320,000 which under the agreement proposed to be cancelled were to be entitled to a cumulative 4 per cent. dividend. The Bill further enacts that the Underground Co. shall within 10 days after the expiration of each half-year pay such a sum as with the revenue of the company for that half-year shall be sufficient to enable the company to pay the interest which has accrued in that half-year on the debenture stock of the company. It is further proposed to give permissive power to the Underground Co. to guarantee the dividend on all or any of the 286,460 shares, which may with their assent be converted into preference shares.

Fife.—A good start has been made with tramways in Fife. Kirkcaldy Corporation has the credit of introducing the first system of electric cars in the county. The original tramway extended from Linktown to Gallatown, or from end to end of the "Lang Toon." This line, a single one, was not very long completed when a double line from Junction-road, *via* Victoria Bridge, the railway station, and thence to High-street, *via* Whitescauseway, was constructed, thus connecting with the original through line, and in addition a branch line to the Beveridge Park. While vastly increasing the public convenience, the rapid extension of the system was not likely to secure immediate financial success, but there was wisdom in the decision to enlarge the scheme, as, apart from the greater convenience secured, it would seem, as regards the financial side of the question, that the turning of the corner is now within sight. The Kirkcaldy system had not been long in operation when Mr. R. E. Wemyss, of Wemyss Castle, commenced to lay a line of tramway from Leven to Gallatown, the northern terminus of the Kirkcaldy system, and coming in direct touch with all the populous places on the route. This was a bold stroke on the part of the laird of Wemyss, but he was very hopeful from the first as to the issue, which has already fulfilled his highest expectations, the Leven-to-Kirkcaldy tramway proving a noted success. While the Wemyss enterprise has brought Kirkcaldy into closer touch with the growing population on the east as far as Leven, it has also been the means of giving a much-needed fillip to the Kirkcaldy system, which is now carrying at the rate of 4½ million passengers a year, or equal to the whole population of the burgh 2¼ times each week. But, after all, little more than a start has yet been made to tramways in Fife. It is quite reasonable to expect that the Wemyss tramway will be pushed nearer the "East Neuk" before very long; that Kirkcaldy Corporation will send its cars on to Dysart, which it can do at comparatively small expense, and for which it has powers; and that the prosperous communities in West Fife will also in the near future be linked together.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Brussels.—The Belgian State Railways invite tenders for telegraph construction material. Tenders by Feb. 5.

Fury.—Tenders are invited for the erection of a chimney shaft at the electricity works. Tenders by Jan. 27.

Bourges.—Tenders are invited by the Military Authorities for one five-ton electrical crane. Tenders by Feb. 14.

Campina (Bucharest).—The Municipality invite tenders for the electric lighting of the town. Tenders by Feb. 9.

Czernowitz (Austria).—Tenders are invited for the installation of electrical and water-power plant. Tenders by Jan. 20.

Melbourne.—Tenders are invited by the Postmaster-General for switchboards and telephone sets. Tenders by May 26.

Sydney.—The Postmaster-General invites tenders for 33 switchboards for common-battery working. Tenders by March 4.

Madrid.—The Public Works Department invite tenders for the construction of a tramway at Santander. Tenders by Jan. 30.

Oporto.—The Municipality invite tenders for the construction, maintenance, and working of tramways. Tenders by March 11.

Madrid.—The Public Works Department invite tenders for the construction of electric tramways in Cadiz. Tenders by Jan. 22.

Paris.—The Post and Telegraph Department invite tenders for indiarubber-insulated cotton-covered copper wire. Tenders by Jan. 25.

Innsbruck.—The Austrian Government Railways invite tenders for the necessary plant for electrically lighting Bishofshofen Station. Tenders by Jan. 30.

Salford.—The Tramways Committee invite tenders for the supply of tramrails. Particulars from the General Manager, Tramways Office, 32, Blackfriars-street, Salford.

Great Yarmouth.—The Corporation invite tenders for the supply, delivery, and erection of one 400-kw. continuous-current traction steam generator. Tenders by Feb. 1.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Ghent.—Tenders are invited for 30 electric cranes for the new dock. Particulars from the Public Works Department, 15, Rue des Augustins, Brussels. Tenders by Feb. 1.

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Kilkenny.—The District Lunatic Asylum Committee invite tenders for electric generators, accumulators, switchboard, underground mains, wiring, and fittings. Tenders by Jan. 18.

Hanover.—The Prussian Government Railways invite tenders for iron wire, steel wire, wire rope, insulators, cotton wire, insulated wire, and telegraph construction material. Tenders by Jan. 29.

Finchley.—The Urban District Council invite tenders for the supply and erection of one 350-kw. high-speed engine and dynamo combined, together with spare parts. Tenders by Jan. 20.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1.

Camberwell.—The Borough Council invite tenders for the annual supply of various stores and materials, including maintenance of private telephones and electric bells, and rubber goods. Tenders to the Town Clerk by Jan. 20.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1.

Tunbridge Wells.—The Corporation invite tenders for the supply of high and low tension cables for 12 months. Specifications, etc., from Mr. Horace Boot, consulting engineer, at the Electricity Works. Tenders to the Town Clerk by Feb. 1. See advertisement.

Bristol.—Tenders are invited for the supply of cables and appliances for conveying electrical energy to the Avonmouth Docks, and for construction and maintenance for 12 months. Tenders to the Secretary of the Docks Committee, 19, Queen-square, Bristol, by Feb. 17.

Cardiff. - The Corporation invite tenders for extra high-tension three-phase feeder cable and one 500-kw. motor-generator. General conditions, specification, and form of tender may be obtained from Mr. Arthur Ellis, city electrical engineer and manager, Central Offices, The Hayes, Cardiff. Tenders by Jan. 23.

Wimbledon.—The Corporation invite tenders for one 1,000-kw. steam-driven turbo-alternator, with condensing plant, two water-tube boilers, economisers, pipe work and feed pump, high-tension main switchboard, and switchboard gallery. Particulars from the Borough Electrical Engineer. Tenders by Feb. 18.

Adelaide.—Tenders are invited for the supply and delivery, c.i.f. Port Adelaide, of special work, points, and crossings for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C. Tenders to the Chairman, Municipal Tramways Trust, Adelaide, by Feb. 11.

West Hartlepool.—Tenders are invited for the erection of an electrical sub-station at West Hartlepool, for the North-Eastern Railway Co. Plans and specification may be seen and quantities and further information obtained upon application to Mr. William Bell, the company's architect, at York. Tenders to the secretary, Mr. R. F. Dunnell, York, by Jan. 27.

Samara (Russia).—According to the decision of the Town Council of Samara, Russia, the Chairman invites tenders from contractors for the construction and the working of a central electric station, and also to take charge of the organisation of the tramways at Samara. The above undertaking to be given in a concession. For particulars and conditions write to l'Administration de la Ville de Samara.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 500 tons of steel slot rails and about 190 tons of conductor rails required for the reconstruction on the underground conduit system of electric traction of certain sections of the Council's tramways. Particulars from the chief engineer, Mr. Maurice Fitzmaurice, C.M.G., County Hall, Spring-gardens, S.W. Tenders to the Clerk by Jan. 21.

Plymouth.—The Corporation Electricity and Street Lighting Department invite tenders for the supply of the following stores during 12 months ending March 31, 1909: (1) arc lamp carbons; (2) electricity meters; (3) transformers; (4) cables (paper-insulated); (5) lubricating oils, etc.; (6) engine waste, etc.; (7) gas mantles, etc. Specifications may be obtained on application to Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by Jan. 23.

London, N.—The London County Council invite tenders for the road work and platelaying required for the reconstruction for electric traction on the conduit system of the Council's existing tramways in Caledonian-road and Seven Sisters-road. The total length of the above-mentioned lines is about 5¼ miles, single track. Particulars from the chief engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W. Tenders to the Clerk by Jan. 28.

Catanzaro (Italy).—The Italian *Gazzetta Ufficiale* of Jan. 2 announces that tenders are invited for works in connection with the maintenance of the lights and lighthouses in the province of Catanzaro, and for the provision of lighting apparatus and accessories, at the estimated cost of 149,727 lire (about £5,989). The works and provision of materials are to extend over a period from Jan. 1, 1908, to Jan. 30, 1913. Tenders must be sent in before Jan. 22 to the Ministero dei Lavori Pubblici, Rome.

RESULTS OF TENDERS.

Southampton.—The Town Council have accepted the tender of Willans and Robinson, at £7,851, for the supply of a steam generator.

Chatham.—The Town Council have decided to accept the tender of the British Thomson-Houston Co. for the supply of electric lamps at £4. 4s. per gross.

Manchester.—The Corporation have placed an order with Bruce Peebles and Co. for eight Peebles-La Cour motor-converters in sizes ranging from 250 kw. to 600 kw

Victoria (N.S.W.).—The Postmaster-General has accepted the tender of J. Bartram and Son, of Melbourne, for the supply of eleven sections of branching system magneto-telephone switchboard.

Luton.—The tender of the Chloride Electrical Storage Co., Clifton Junction, Manchester, has been accepted, at £559, for replating and renovating the present storage battery and increasing its capacity.

Islington.—The Borough Council have accepted the tender of Daniel Adamson and Co. for the repair of No. 10 engine at the electricity works for £548, and repairs to steam-pipes and foundations for £152.

Keighley.—The tender of the Electrical and Ordnance Accessories Co., Stellite Works, Aston, Birmingham, at £48. 16s. 6d., has been accepted by the Electricity Committee for the supply of one motor-generator.

Lowestoft.—The tender of the Electrical Co., Charing Cross-road, W.C., for the annual supply of meters has been accepted; also the tender of Siemens Bros. and Co, at £472, for the supply of a 45-h.p. locomotive.

Electric Lighting for the War Office.—We understand that a second contract for electric lighting work in connection with a large number of lights has just been placed by the War Office with Messrs. J. B. Saunders and Co.

Cardiff.—The tender of the British Westinghouse Co. for two transformers for supplying the Great Western Railway Co.'s passenger stations with electric light—one of 50 kw. at £53. 10s., and one of 40 kw. at £47—has been accepted.

Weymouth.—The Town Council have received the following tenders for wiring No. 1, Bank-buildings for the purpose of electric lighting: Orchard and Co., £22. 7s. 6d.; Rendell and Sons, £19. 5s.; O. Tett, £18. 12s.; J. H. Rankin, £13. 8s. (accepted).

Portsmouth.—The Corporation have accepted the tender of Dick, Kerr, and Co. for 100 tons of tramway rails at £7. 10s. per ton and 100 pairs of fishplates at 5s. per pair; also the tender of Walter Scott for 50 tons of tramway rails at £8. 5s. per ton

Grimsby.—The following tenders have been accepted for the extension of the plant at the electricity works: Messrs. Johnson and Phillips, two years' cable supply, £1,358. 4s. 3d.; Phœnix Dynamo Co., engine and dynamo, £2,383; and Messrs. Bertram Thomas, switchboard and wiring, £299. 5s.

Stockport.—The Corporation have accepted the following tenders for the electricity department: Stockport Engineering Co., exhaust piping for 500-kw. set, £61; Worthington Pump Co., London, atmospheric valve, £34. 10s.; Lancashire Dynamo and Motor Co., 35-h.p. motor £119, spare armature for 60-h.p. motor £80.

Swindon.—The Electricity and Tramways Committee recommend the acceptance of the tender of T. Parker, of Wolverhampton, at £45. 10s., to supply a variable-speed motor and regulator for fixing in the boiler-house at the electricity works; and that of W. and T. Avery, of Birmingham, at £30, to supply and deliver a weighing machine, with automatic tape register.

Stepney.—The Electricity Supply Committee have received the following tenders for the lighting of Broad-street, Horseferry Branch-road, Medland-street, and Wapping High-street by means of electric arc lamps:

R. A. Bradshaw and Son*	£361	10	0
W. Lucy and Co.	392	5	0
W. Macfarlane and Co.	533	10	6

* Recommended for acceptance.

OPENINGS FOR CONTRACTORS.

AINSDALE—Passenger station, Lancashire and Yorkshire Railway Co.

ALVERDISCOTT—Chapel (£700), Wesleyan Trustees.

ARBROATH—Electric power station, South Grimsby-street, Arbroath Electric Lighting Co.

ASHBURTON—Conversion of existing mixed school into girls' school; new boys' school (£2,000), Devon Education Committee.

ASHTON-UNDER-LYNE—Salvation Army hall, Old-street and William-street, Salvation Army; shop and garage, Old-street and Cavendish-street, Messrs. Wood and Co.; rebuilding warehouse, Wood-street, Manchester and County Bank; conversion of eight houses into storeroom, etc., Mr. Priestley.

ATHERTON—Mill (£70,000), Atherton Spinning Co.

BACUP—Elementary school, Town Council.

BALLYMENA—Public abattoir (£395), Urban District Council.

BALLYMONEY — Workmen's dwellings (£30,998), Rural District Council.

BARNOLDSWICK—Alterations to school (£250), West Riding County Council.

BARNSLEY—Young Men's Christian Association hall, Eldon-street, Mr. E. W. Dyson.

BARROW—Laundry at workhouse, Guardians; extensions to electricity undertaking (£5,000), Town Council.

BATH—Mansion (£1,674). Mr. W. H. Watkins, architect.

BATH—Extensions to hospital (£3,000), Town Council.

BEESTON—Alterations and additions to Council school, Education Committee.

BELFAST—Pumping station, Park-avenue, Improvement Committee.

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BERWICK — Higher-grade school for girls (£8,000), Education Committee.

BEXHILL—Extensions to electricity undertaking (£5,855), Town Council.

BICESTER—Market offices and buildings, Urban District Council.

BICESTER—Dairy at Mixbury, Mr. C. E. Kayler.

BIRKENHEAD—Tapestry manufactory, Norman-street, Messrs. A. H. Lee and Sons.

BIRMINGHAM—Sanatorium, Cotswold Hills, Town Council.

BIRTLE EDGE—Children's homes, Mr. W. E. Gill, Bury.

BLACKPOOL—Police station (£2,800), Town Council.

BLAENAVON — Additions to Council school, Monmouth Education Committee.

BOCKING—Enlargement to school (£1,965), Essex County Council.

BOLTON—Alterations and extensions to cotton mills, Messrs. Barlow and Jones.

BOLTON—Sanatorium, Town Council.

BOSTON—Schoolroom, Carlton-road, Mr. Groom; two houses, Carlton-road, Town Council.

BOUGHTON—Elementary school (£2,220), Chester Education Committee.

BOURNEMOUTH—Two houses, Bournemouth-road, Mr. J. J. Shepherd; house, Highwood-road, Mr. J. J. Shepherd; additions to factory (old R.N. Reserve buildings), Hamworthy, Mr. J. E. Mundell; house, Cliff-road, Mr. S. Tugwell; three pair houses and one detached house, Balston-road, Mr. T. Heath; house and stabling, Alington-road, Mr. S. Tugwell.

BRACEWELL—Elementary school (£900), West Riding County Council.

BRAINTREE—Pumping station (£3,500), Urban District Council.

BRAMALL—Church, Ecclesiastical Commissioners.

BREDBURY—Additions to factory, Green-lane, Niell-Elder Mill Co.

BRISTOL—Extensions to warehouse. Mr. W. H. Watkins, architect.

BROADSTAIRS—Additions and alterations to the Rumfields pumping station, Urban District Council; pair of villas (£925), Mr. W. L. Downton, City Bank-chambers, W.C.

BULVERHYTHE—School hall at the Congregational mission church. Mr. T. W. Elworthy, architect.

BURSLEM—Alterations at public library, Town Council.

CARDIFF—Additions to workhouse, Guardians.

CARROG—Elementary school, Welsh Education Committee.

CHATHAM—Pair of villas, Maidstone-road (£925). Mr. W. L. Downton, Theobald's-road, W.C., architect.

CHELMSFORD—Public conveniences, corn exchange, Town Council.

CHESTERFIELD—High school (£16,000), Derbyshire County Council.

CHINGFORD—Elementary school (£5,612), Essex County Council.

CLIFTON—Additions to North Riding Asylum, Mr. G. H. Fowler Jones, architect; Wesleyan chapel, Mr. Taylor, architect.

COLCHESTER—County asylum (£289,276), Essex County Council.

COLDSTREAM—Young Men's Christian Association hall.

CONNACHT—County sanatorium, Galway County Council.

CONNONLEY—Elementary school, West Riding County Council.

CONSETT—Houses, West-parade, Mr. Coates.

CORK—Seventy-seven houses, Rural District Council.

DARTMOUTH—Residence, Mayor's-avenue, Mr. E. H. Back.

DIPTON—Police station, Commissioner of Public Works.

DOWLAIS—Elementary school, Education Authority.

DOWNPATRICK—Public library (£2,000), Town Commissioners.

DUNKELD—Restoration interior of cathedral, Sir Donald Currie.

EALING—Elementary school (£20,000), Education Committee.

EARLSWOOD—Twenty-three houses, Great Western Railway Co.

EASTBOURNE—Additional accommodation at the workhouse, Board of Guardians.

EASTBOURNE—Houses, Furness-road, Mr. W. H. Cornwell; additions to Devonshire Park Theatre, Messrs. W. L. Wallis and Co.; four houses, Victoria-drive, Mr. A. Oakden; houses, Prentice-road, Messrs. Miller and Selmes; three shops, Church-street, Mr. W. Llewellyn; nine houses, Bexhill-road, Mr. W. Hookham.

ECCLES—Council school, Clarendon-road, Town Council.

EDINBURGH—Villas, Mildmar-drive, Mr. W. Gavine; three houses, Smithfield-street, Mr. G. A. Wood; tramcar shelter, Musselburgh Electric Light and Traction Co.

EVESHAM—Public hall and institute (£6,000), Town Council.

FAREHAM—Parochial building for St. Peter's parish (£350), Churchwardens.

FARNWORTH—Mortuary, Mr. J. Royley.

FELIXSTOWE—Construction of a shelter, etc., Hamilton-terrace Cliffs (£4,100), Urban District Council.

FISHGUARD—Council school, Pembrokeshire Education Committee.

GILFACH-BARGOED—New station, Rhymney Railway Co.

GLASGOW—Thirty houses, Campsie-street, Springburn, Messrs. Walker and Nisbet.

GORT—Workmen's dwellings (£21,134), Rural District Council.

GRAVESEND—Six houses, Northcote-road, Town Council.

GRAYS—Improvements to school (£301), Essex County Council.

GRAYS THURROCK—Refreshment kiosk, Urban District Council.

GRIMSBY—School for defective children (£950), Town Council.

GRIMSBY—Public lavatory (£800), Town Council.

GUILDFORD—Technical institute, Surrey County Council.

GULLANE—Enlargement of public school. Mr. J. A. Carfrae, Edinburgh, architect.

HAMMERSMITH, W.—Electricity sub-stations, King street and Hythe-road (£9,209), Borough Council.

HANLEY—Conversion of old post office, Percy-street, into premises for the Hanley Liberal Club.

HAWICK—Public abattoir (£2,800), Town Council.

HERNE—Parish hall. Mr. R. Messenger, architect.

HONLEY—Nurses' home. Mr. W. Cooper, Huddersfield.

HULL—Special school, Education Committee.

JARROW—Parish hall, Trustees Christ Church.

KENNETHMONT—Public hall to accommodate 300 persons.

KESWICK—Houses, Messrs. R. and F. Hall.

KING'S NORTON—Public offices, District Council.

KIRKBURTON—Elementary school (£3,250), West Riding County Council.

KIRKBY—Two houses, Oxford-street, Mr. J. Stow; six houses, Diamond-avenue, Mr. A. G. Limb.

LARNE—Houses and stables, Victoria-street, Mr. H. Girvin; five houses, Waterloo-road, Mr. W. M'Neill.

LEATHERHEAD—Mortuary, Urban District Council.

LEICESTER—Extension of the fire brigade station, Town Council.

LEMINGTON—Shop, warehouse, etc., for the Blaydon Co-operative Society.

LEWISHAM, S.E.—Additions to the Park Fever Hospital, Metropolitan Asylums Board.

LINCOLN—Extension to city hospital (£1,300), Town Council.

LINTHWAITE—Houses, New-road, Mr. J. Ainley.

LITTLEHAMPTON—Shelter and hall (£1,500), Urban District Council.

LITTLE HORTON—Wesleyan Reform school-chapel. Messrs. Walker and Collinson, architects.

LONDON—Elementary school to accommodate 192 scholars, Crispen-street. Mr. W. P. Ryan, architect.

LONDON, E.—Congregational hall, Whitechapel-road. Messrs. G. Baines and Son, Strand, architects.

LONDON, E.C.—Bank premises, Great Eastern-street (£1,679), London and Provincial Bank.

LONDON, S.W.—Erection of Westminster New County Court, H.M. Office of Works.

LONDON, W.—New factory for the Wolfram (Tungsten) Metal-Filament Lamps. Mr. R. J. Lovell, Queen Victoria-street, architect.

LONDON, W.—Police section house, Upper Rathbone-place. Mr. J. Dixon Butler, architect.

LONG EATON—Elementary school (£8,500), Education Committee.

LOWER BENTHAM—Elementary school (£1,400), West Riding County Council.

LOWESTOFT—Secondary school, Education Committee.

LUTON—Two houses and premises, Clarendon-road, Mr. Geo. Kingham; four houses, Wimborne-road, Mr. A. Turner; two houses, Ashburnham road, Mr. Geo. W. Pryer; 10 houses, Hitchin-road, Messrs. Iron and Oakley.

MAIDSTONE—Two houses, Bower Mount-road, Messrs. Clarke and Epps; house and shop, Tovil-hill, Mr. W. T. Burrows; 10 houses, Tovil-road, Messrs. Clarke and Epps; two houses, Pope street, Mr. T. Large.

MANCHESTER—Forty houses, Barrack-street, Hulme, Sanitary Committee.

MANCHESTER Dental hospital, Oxford-road, Hospital Committee.

MERRYMEET—Wesleyan chapel, Mr. J. Sansom.

MIDDLETON—Alterations and enlargement of the public elementary school, East Suffolk Education Committee.

MILNSBRIDGE—Houses at Cowlersley, Messrs. Lunn and Kaye.

MULBEN—Two blocks of houses at Glentauchers Distillery.

NAAS—Workmen's dwellings, Rural District Council.

NEWARK—Secondary school to accommodate 150 boys, Governors of the Newark Grammar School.

NEWBURN-ON-TYNE — Conversion of old Wesleyan chapel into a cottage hospital. Mr. H. C. McBeath, architect.

NORTHALLERTON—Passenger station (£17,000), North Eastern Railway Co.

NORTH WINGFIELD Out-offices, infirmary, Guardians.

NORWICH—Extension to isolation hospital (£4,050), Town Council.

NOTTINGHAM Bleaching factory, etc. Mr. F. Ball, architect.

NUNEATON—Public conveniences (£360), Town Council.

OLDBURY—Elementary schools, Urban District Council.

OLDHAM—Extensions to electricity undertaking (£1,500), Town Council

OLDHAM—Strong room, treasurer's office, Corporation.

OSWESTRY—Warehouse, Willow-street, Messrs. Dales.

PENISTONE—Elementary school, West Riding Education Committee.

PETERBOROUGH—Shops, Broad Bridge-street, City Council.

PILSLEY—Out-offices, infirmary (£175), Guardians.

PLYMOUTH—Public abattoir, Prince Rock (£650), Town Council.

PORTSMOUTH—Sailors' home, Wesleyan Trustees.

PONTYPRIDD — Twenty-two villas, The Avenue, Mackintosh-road Building Club.

PRESTOBE—Elementary school, Bolton Education Committee.

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PRESTON—Weaving shed, Tardy Gate Co.
RAYLEIGH—Elementary school (£3,528) Essex County Council.
REIGATE—Extensions to parish church (£3,000), Churchwardens.
RHYL—Assembly rooms, Urban District Council.
RICHMOND—Public conveniences (£350), Town Council.
RUGBY—Houses, Benn-street, Mr. A. J. Shillitoe; fire-engine station, Governors of Rugby School.
SALFORD — Extensions to electricity undertaking (£4,220), Town Council.
SAWBRIDGEWORTH—Four houses, Sayesbury-avenue, Mr. E. Read.
SELLY OAK—Council school, Raddle Barn-lane, King's Norton Urban District Council.
SILSDEN—Houses, Bolton-road, Mr. Brear; two shops, Clog Bridge, Mr. W. Mitchell.
SKELMERSDALE—Two houses, Witham-road, Co-operative Society.
SKELMANTHORPE—Houses, Commercial-road. Mr. J. Berry, Huddersfield.
SLAITHWAITE—Engine-house, Messrs. Pogson and Co.
SLOUGH—Roman Catholic church on a site in Curzon-street. Mr. Benedict Williamson, architect.
STANFREE—Elementary school (£500), Education Committee.
SALTERFORTH—Elementary school, West Riding County Council.
SKIPTON—Elementary school (£6,055), West Riding County Council,
STALYBRIDGE—Electrical equipment, Ray Mills Co.
STEETON—Elementary school, West Riding County Council.
STIRLING—Municipal buildings, Corporation.
STOCKPORT—High school, Corporation.
STOKE—Post office (£6,000), N.S. Railway Co.
STRETFORD—Extensions to electricity undertaking (£42,718), Town Council.
STROKESTOWN — Workmen's dwellings (£34,279), Rural District Council.
SWANSEA—Extensions to technical college (£8,000), County Council.
SWINDON—Cottage homes (£4,500), Board of Guardians.
SWINDON—Eighteen houses, Portsmouth-street. Mr. F. George; house, Mr. Tyler; stores, Cricklade-road, Co-operative Society of Swindon; house and shop, Exmouth-street, Mr. J. Arkell; additions to Great Western Hotel, Station-road, Messrs. T. and J. Arkell.
TAMWORTH—Addition to Wilnecote School, Warwickshire County Council; houses, Sheldon-street, Mr. H. Shelton.
TAUNTON—Corporation institution, Town Council,
TERRINGTON ST. CLEMENT—Residence, Alma Lodge Estate. Messrs. Walker and Walker, architects.
THORNTON HEATH—Pavilion, recreation ground, Croydon Town Council.
TIVERTON—Extensions at the isolation hospital, Tiverton and District Hospital Board.
TUPTON—Out-offices, infirmary, Board of Guardians.
TYSELEY—Elementary school (£14,000), Worcester County Council.
WADEBRIDGE—Alterations to Council school, Cornwall Education Committee.
WALTHAMSTOW—Elementary schools, Education Committee.
WANDSWORTH, S.W.—Fittings for relief station, Battersea Park-road, Board of Guardians.
WARLEY—Administrative offices, Court House-street, Pontypridd, Board of Guardians.
WATERFOOT—Secondary school and technical institute (£26,000).
WEST BROMWICH—Public conveniences (£1,200), Town Council.
WEST HARTLEPOOL—Electrical sub-station, North-Eastern Railway Co.
WILMCOTE—Four villa residences, Messrs. Knight and Hebery.
WIGAN—Artisans' dwellings, Chequerbent, Mr. W. T. Fletcher.
WORSLEY—Technical schools, County Council.
WOLVERHAMPTON—Manufacturing works, Messrs. Chubb and Son.
WORTHING—Police station and houses, East Worthing, West Sussex County Council.
YARDLEY—Elementary school (£15,000), Worcester County Council.

FOREIGN.

ALLAHABAD (INDIA)—Police station (32,000 rupees), Government of United Provinces.
BRANTFORD (CANADA)—Electric railway, Hamilton Radial Electric Railway Co.
EPERNAY (FRANCE)—Enlargement of railway terminus (500,000fr.), Government.
HONFLEUR (FRANCE) — Theatre and school buildings (891,000fr.), Municipal Council.
KYOUPYAW (BURMA) — Court and circuit house (40,000 rupees), Government of Burma.
LONDON (CANADA) — Distributing plant for Niagara power (235,000dol.), Municipality.
MEXICO—Asylum (£153,000), college (£102,000), City Council.
MILAN (ITALY)—Establishing tramways at Lucca, and electric railways at Milan.
MONTREAL (CANADA)—Custom house (2,000,000dol.), Government.
MULAKAND (INDIA)—Hydro-electric scheme, India Office.
ORLEANS (FRANCE)—Large public hall, cattle market, etc. (300,000fr.), Municipality.
OUZAIN (FRANCE) — Enlargement of goods station (550,000fr.), Orleans Railway Co.
PARIS (FRANCE)—Enlargement of Hospital Laënne. Rue de Sèvres, Municipal Council.
RANGOON (BURMA)—General hospital (10,000 rupees), Municipal Council.
REGINA (CANADA)—Legislative buildings (1,250,000dol.), Municipal Council.
ST. GALL (SWITZERLAND)—Columbarium at municipal crematorium (49,000fr.)
ST. PAUL (CANADA)—Presbyterian church (165,000dol.).
SAMARA (RUSSIA)—Construction and working electricity station and organising tramways.
SHERBROKE (CANADA)—Electric light and power plant, Municipality.
SOPHIA (BULGARIA)—University building, Municipal Council.
TORONTO (CANADA) — Four-storey edifice (100,000dol.), Canadian Birkbeck Investment Co.
VANCOUVER (B.C.)—Electric railway, B.C. Electric Railway Co.
VIENNA (AUSTRIA)—Municipal lighting scheme (30,750,000fr.).
WINGHAM (CANADA)—Repair to hydro-electric plant (25,000dol.), City Council.
WINNIPEG (CANADA)—Giant plant for St. Louis Car Co.

COMPANIES' MEETINGS AND REPORTS.

GENEVA TRAMWAYS.

The first annual general meeting of the Geneva Tramways Co. (1906) was held on Monday in London, the Hon. A. G. Brand presiding.

In moving the adoption of the first report of the newly-reconstructed company, the CHAIRMAN stated that the result of the working of the tramway company for the period under review showed a gradual but steady increase on the year 1905, amounting to 82,815fr. For a part of the year under review, although the increase in the gross takings were quite satisfactory, the expenditure had increased to a still greater extent, the receipts thus showing an approximate decrease in actual profits, as compared with the corresponding period of 1906, of about 22,000fr. This difference was principally due to the increased cost of labour and material. The increased demand of the operatives for higher wages in their case would amount to something like 60,000fr. per annum. As the average wages in Geneva were well below those paid in most of the Swiss companies, they were obliged to enter into negotiation with their employés, which resulted in a substantial rise in the rate of wages being carried out. The new scale came into operation on July 1 last, which would hold good for five years, and had given satisfaction to all concerned.

Mr. OTTO BEIT seconded the motion, which was unanimously agreed to.

BRITISH WESTINGHOUSE.

A circular has been issued by the directors of the British Westinghouse Electric and Manufacturing Co., which states: "The directors had prepared and were about to issue a communication to the shareholders when the conditions in the United States made it necessary to temporarily place the American companies under the protection of the Courts. It thereupon became desirable to await the outcome of important proceedings which the directors believed necessary for the best interests of the property before issuing the communication in question. The American company had heretofore either itself furnished the financial assistance needed by this Company, or acted as its guarantor, and as that company was unable, under the circumstances, to contribute to the British company's requirements, it became necessary for the directors to make other arrangements for meeting present needs. Under the existing conditions of the money market it would have been impossible to raise money by the issue either of shares or debenture stock ranking *pari passu* with the existing debenture stock, and it was, therefore, found necessary to make an issue of prior lien debentures. At a meeting of the debenture stockholders held on Dec. 18 an issue of £300,000 of such debentures was authorised. In order that the whole of this amount might be available for present and future needs, the American companies agreed to accept, in liquidation of the £186,374 owed to them, Traction and Power Securities Co. shares (an asset of the company) at par. The £300,000 of prior lien debentures is required as follows: to repay advances from bankers expected to be reduced by February and March to £100,000; to meet accounts payable, now due, £110,000; to meet additional requirements on account of expansion of business, £90,000. The directors have had under consideration for some time the changing from July 31 to Dec. 31 of the termination of the financial year, as experience has shown July 31 to be an inconvenient date for closing the books and taking the necessary inventories, and they have decided to make the change now. The proceedings at the close of 1906 connected with the reduction of capital have rendered this change additionally desirable, as that reduction was based upon figures established on Dec. 31 of that year. The next accounts to be presented to the shareholders under the new arrangement will cover two periods — one of five months from Aug. 1, 1906, to Dec. 31, 1906, and another from Jan. 1, 1907, to Dec. 31, 1907. The annual general meeting for the consideration of these accounts will be held as soon after the close of the financial year as possible. The Company's assets amount to £3,629,521, and the total liabilities to £1,736,741. The 11 months of the present year show a trading profit

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of £76,000, and a net profit of £17,780, after providing for interest on loans and debenture interest. The accounts and business of the Company will be dealt with in detail at the annual meeting, but it will be seen that there has been a considerable improvement in the affairs of the Company, and the directors believe that if there be no unfavourable development in industrial conditions the position of the Company will continue to improve. In the meantime the arrangements made have enabled the Company's business to be protected and the interest to be punctually paid to the debenture stockholders."

LEGAL INTELLIGENCE.

HAMPSTEAD RAILWAY ACCIDENT.

At the Central Criminal Court on Friday last, before Mr. Justice Bigham, William John Hollis, a signalman employed by the Metropolitan Railway Co., was indicted for manslaughter in connection with the deaths of three men who were killed in a collision between two electric trains at West Hampstead Station on Oct. 26.

Mr. R. D. Muir, who appeared for the Public Prosecutor, related the details of the accident (a full account of which has already appeared in the *Electrical Engineer*). He submitted that people were not safe when travelling on railways if signalmen were permitted to make a clean sweep of the regulations, as Hollis admitted he had done Therefore, apart from any question as to the working of the electrical apparatus, there was, on the admission of the prisoner himself, such gross negligence on his part as to make it the duty of the jury to return a verdict of guilty. Witnesses repeated the evidence given by them at the police court and elsewhere; Mr. Phillips, engineer to the Metropolitan Railway Co., saying there was nothing in the disc instrument to account for any failure. He considered that the release-box must have been used. His theory was that the prisoner had forgotten the train. He (prisoner) thought he had started it off, and because the disc still showed "train on line," he thought he must have pulled back the lever prematurely. Then by some means he got to the release-box and released the instrument. In answer to the judge, Mr. Phillips thought the negligence of which Hollis was guilty was in not ascertaining whether the line was clear by personal investigation.

Mr. Justice Bigham, in summing up, said his own opinion was that Hollis was careless, and that the story he had told in the witness-box was a story of made-up excuses. An occasional act of negligence, even though it resulted in death, ought not to bring upon a man the terrible consequences of a conviction for manslaughter, however. The jury found the prisoner not guilty, and he was discharged.

CLAIM AGAINST AN ELECTRICAL COMPANY.

In the City of London Court on Tuesday a claim was made by Mr. Frank Sanderson, member of the London Stock Exchange, 17, Bishopsgate-street Without, who sued Mr. George Pearson, 154, Abbott-road, Poplar, electrical engineer, for £20, money lent. The defence was that the money was advanced to the London Electrical Syndicate, of which defendant was the managing director. Plaintiff said that in 1902 defendant persuaded him to take up 120 £1 shares in the London Electrical Syndicate, for which he paid in full. His partner, Mr. Levy, also took 160 shares. Later on defendant borrowed £20 of him privately. Defendant offered him 50 more shares for the £20, but that was declined by him. The cheque for the £20 was made out to the defendant, while the cheques for the shares were paid to the company. The company had since gone into liquidation, but the witness received no notice of it although the defendant was the liquidator. Defendant recently told him he was running a company which was paying 75 per cent. dividends, and he, therefore, thought the defendant ought to pay the £20. The share certificates of the London Electrical Syndicate were not issued for two years. Defendant said that the loan was to the company with which to pay wages, and it was quite as much in the interests of the plaintiff that the company should go on as in his (defendant's) favour. Plaintiff was sent notice of the liquidation Witness had a fourth share in the company, but he paid nothing for his share originally he admitted in cross-examination. Plaintiff agreed to take 20 shares for the £20 loan, and if they were not allotted to him it was an oversight. He found the inventor of the patents, which were regarded as valuable. The company had since been reconstructed.

Judge Rentoul, K.C., found for the plaintiff, but without costs.

BROKEN OVERHEAD TROLLEY WIRE.

At the Blackpool County Court last week a claim by Mr. Neil Neilson against the Blackpool, Lytham, and St. Annes Tramway Co. of £30 for injuries alleged to have been caused by his coming in contact with an overhead wire on Aug. 5 was heard.

On that date plaintiff was cycling, with a friend, along Lytham-road, into Blackpool, when he received a blow, he alleged, from a broken overhead wire, which was said to have thrown him from his machine. He stated that he was afterwards three weeks in recovering from the injuries received. The injuries were said to consist of a burn behind the right ear and bruises on one arm. Evidence on behalf of plaintiff was given by Mr. B. L. Myer, a Liverpool electrician.

For the defence, it was urged that the plaintiff was riding along, and not keeping a proper look-out and not heeding any warnings, and thus came into contact with a wire. He was thrown from his cycle, receiving injuries. An electrician in the employ of the defendants said he was assisting to clear the highway, and he saw the plaintiff riding up and told him to ride round to the right or dismount, as there were wires down. He found the switches out in the box, and one of the tramcars was in darkness. He was certain the current was off at the time of the accident. The wires, he added, belonged to the Blackpool Corporation, who were responsible for their repair. Mr. H. S. May, the Blackpool Corporation's residential electrician, explained that the wires were so placed that if any wire dropped on the trolley wire it would be fused right through in two seconds. It also caused the automatic switches to drop, and as long as these were down there could be no current.

His Honour, after hearing further evidence, gave a verdict for the defendants.

BOURNEMOUTH TRAMWAY ASSESSMENT.

At the Poole Quarter Sessions last week the Recorder (Mr. A. Clavell Salter, K.C., M.P.) delivered judgment in the appeal of the Bournemouth Corporation against the assessment of their tramways in the borough of Poole, which was heard in London some time ago.

In delivering judgment, the Recorder said the appeal was against a rate made on May 13, 1907, wherein the appellants were rated as occupiers of certain land, buildings, car-sheds, tramway lines, and appurtenances in the parish of Poole. The assessment published in the supplemental valuation list was reduced by the Assessment Committee, and the appeal was against the reduced figures—namely, gross estimated rental, £5 659 and rateable value £1.850. The hereditament in question was the electric tramway which runs from Poole to the County Gates, and there connects with the Bournemouth tramways. The Poole undertaking was the property of the Corporation of that borough, but was occupied by the appellants as tenants under an agreement for a lease, and was worked by them as an integral part of the system of tramways owned and controlled by them. He had to consider what rent might fairly be expected to be got, in the conditions laid down by the statute, for the Poole undertaking The first and main consideration of an intending tenant would be the profit which he could make by working the Poole undertaking as a tramway. He had, therefore, first to ascertain the profits in the parish—that was to say, the gross receipts and expenses. Various methods were adopted for obtaining these. Two valuations had been placed before him on two alternative methods. One method proceeded upon an estimate of the gross receipts and expenses per car mile in the parish of Poole, without regard to the rest of the system; the other method valued the whole system, and then apportioned a car mileage to the parish of Poole. He thought the former was the better and more correct method, and, therefore, turned to the valuation on that method. The appellants showed no rateable value and a loss on working of about £2,000 a year, the respondents showed a rateable value of about £2,000 a year. There was more difficulty in ascertaining profits in the case of a tramway as compared with a railway, where passengers and goods were always carried between fixed points, and for that reason the valuations put before him were alike unsatisfactory. It was, therefore, plain that the real matter which must mainly determine the result was the estimate of the gross receipts. Having commented at some length on the evidence placed before him, the learned recorder said that where the evidence on both sides, as in this case, was so largely estimate and conjecture, he thought he should be wrong to ignore the rent actually paid by the Bournemouth Corporation under a recent agreement. It was sufficient to say that an arrangement was come to in 1903, under which the Poole undertaking should be purchased by the Corporation of Poole and then leased by them to the appellants, who should pay a rent equal to the interest and sinking fund on the sum raised by the Corporation of Poole to make the purchase. The purchase price was to be the fair market value of the undertaking as a going concern, and this was fixed by the arbitrator at £100,000. The lower line at Parkstone was afterwards constructed at a cost exceeding £25,000, and the appellants were paying as rent for the hereditaments to be rated at 4 per cent. per annum on a sum exceeding £126,000, and were liable to pay sinking fund as well. This rent was admittedly largely in excess of the rateable value, but in the arbitration in 1904 Mr. Lacey stated that the fair value of the undertaking was £55,379, and this included certain cars for which the arbitrator had awarded £8,000, so that Mr. Lacey's real figure was about £47,000. He could not think that the subsequent addition of the lower road, at a cost exceeding £25,000, could have reduced the rateable value of the undertaking, but assuming that it did not add to such value, and leaving out the sinking fund, 4 per cent. on £47,000 was more than the rateable value appealed from. He thought he must include the appellants among the possible tenants of this undertaking, and if it were to let to-morrow he had no doubt that the appellants would be among those ready to take it on terms. In considering what rent they could afford to pay, he thought they would have regard not only to the profits to be made in Poole, but also to the contributive value of this undertaking to the rest of their tramways, and to the advantage of maintaining their control over the entire system from Poole to Christchurch. He was satisfied that they would be willing to give now, for the whole undertaking, at least as much rent as they were willing to give in 1904 for the upper line only. After giving the matter the best consideration he could, he had come to the conclusion that this property might fairly be expected to let for a rent which would justify the rating appealed from. He, therefore, thought this appeal must fail.

In reporting the recorder's decision to the Bournemouth Town Council the Town Clerk said he was very dissatisfied with it, because it meant that there was practically thrown over the whole of their carefully-prepared evidence as to earning power and the expense involved in the showing of net profit. The recorder had taken the basis of rent arrived at in a bargain entered into almost by compulsion—a bargain relating to an undertaking which an unfettered individual would have thought involved considerations quite outside the Poole undertaking, such as getting rid of running powers through Bournemouth,

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INQUESTS.

In the Westminster Court on Monday Mr. Troutbeck held an inquiry with reference to the death of C. H. de Benam, who was run over and fatally injured by an electric brougham belonging to the Electromobile Co.

It appears that deceased had just alighted from a van in which he had been riding, and was in the act of crossing the road when he was knocked down by the electric brougham. Captain Wilson, who was being driven in the brougham, stated that when in Knightsbridge he saw a man stop in front of the motor, having come from the near-side The vehicle was only two or three yards from him when witness first saw him, and his impression was that the driver's bell drew his attention to the man. The brakes were at once applied, but witness felt one of the wheels go over the man's body. The brougham was pulled up in a few yards. He did not think the driver could have avoided knocking the man down. The driver of the car gave evidence to the same effect, adding that when he first saw the man he was going at from 7 to 10 miles an hour, and was on his third speed. He had his foot on the brake, and was gradually slowing up, but he could not apply his electric brake. He thought deceased was 15 or 20 yards from him when he rang his bell. The effect of putting the controller to neutral was to let the engines run free. There were five speeds, and he was doing 9 or 10 miles on the third. On the fourth he could do 12 or 13 miles an hour. The electric brake would not act if applied when going at a slow speed. He was keeping a good look-out. The witness subsequently admitted that he might have applied the electric brake with advantage.

The Coroner pointed out that it was a very serious thing for a man to drive an electric car with an impression on his mind that it was no use applying the electric brake. He added that these noiseless cars formed a new danger in the London streets.

The jury returned a verdict of accidental death, adding that there was negligence on the part of the driver, especially having regard to the fact that an electric brougham was a noiseless motorcar.

It was subsequently stated on behalf of the Electromobile Co. that their electric broughams travelled 500,000 miles a year, and this was the only fatal accident they had had in five years.

The sudden death of a driver while in charge of an electric tramcar was the subject of a coroner's inquiry at South Shields on Tuesday. It was stated that the deceased driver was one of the most active men in the service, and that he had been apparently in the best of health. A few minutes before his death he was chatting cheerfully with the conductor. After the car had pulled up at one of the usual halting places, the conductor rang for the vehicle to proceed again on its journey, but there was no response. The driver was found leaning over the side rail. He moaned, then died. The car was set in motion, with the dead body on the platform, without the passengers being made aware of the tragic cause of the stoppage, and pulled up at a doctor's residence. The medical man said that in spite of the driver's apparent good health he had no doubt suffered from heart disease, and death had been accelerated by exposure to the cold. The jury returned a verdict to this effect. It was suggested that a glass screen might be placed on the front of the cars to protect the drivers from the cold, and a member of the Tramway Committee said this suggestion should receive due consideration. The doctor also suggested that there should be a periodical medical examination of all motormen and all persons having the safety of the public in their hands.

PROVISIONAL PATENTS, 1908.

JAN. 1.

5564A. **Concatenated control of alternating-current motors.** Ralph Davenport Mershon, 65, Chancery-lane, London. (Date applied for under Rule 13, March 7, 1907.) (Complete specification.)

2. **Improved electric portable lamp.** Timothy Shepherd, 20, Martineau-street, Birmingham.

12. **Resistance for controlling electric current.** Norman Russell Booth, 7, Hanison-road, Halifax.

16. **Improvements in telephones.** Nathaniel David Phillips, 322, High Holborn, London.

57. **Improvements relating to electric motors.** Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

66. **Improvements in arc lamp electrodes.** George Milo Little, Westinghouse Patent Bureau, Norfolk street, Strand, London. (Date applied for under Section 91 of the Act, Jan. 5, 1907, being date of application in United States.) (Complete specification.)

72. **Improved apparatus for the production of undamped electrical vibrations.** Simon Eisenstein, 7, Southampton-buildings, London. (Complete specification.)

79. **Electromagnetic apparatus for determining the hardness of para-magnetic metals.** Jwan Kryloff and Paul Schimunek, trading as Paul Grosch Succs. Schimunek und Co., 4, South-street, Finsbury, London. (Complete specification.)

93. **Improvements in and relating to automatic electric switches or cut-outs.** George Frederick Mansbridge, 1, Imperial-buildings, East Croydon, Surrey.

JAN. 2.

106. **Improved secondary battery.** Paul Schreiber, 35, Grosvenor-mews, New Bond-street, London.

104. **Improvements in electric lamp fitting.** Charles Maurice Escaré, Paul Fernand Escaré, and Charles Damey, 9, Osborne-road, Thornton Heath, Surrey.

112. **Improvements in or relating to magneto-electric machines.** Hermanus Willem van Raden, High-street-chambers, Coventry.

136. **Improvements relating to electric lamp and shade holders for oil-lamp reservoirs.** Albert Henry Entwistle, 8, Quality-court, Chancery-lane, London.

153. **Improvements in trolley poles.** John Shepherd and Frank B. Ullery, 40, Chancery-lane, London. (Complete specification.)

155. **Improvements in electromagnetically operated regulating or switching apparatus.** Otto Rennert, 31, Bedford-street, Strand, London. (Complete specification.)

156. **Improvements relating to recording meters of electromotive force and current strength.** John Seabrook, 102, Knollys-road, Streatham Hill, London.

157. **Improvements in or connected with apparatus for the transmission and reception of electrical or electromagnetic oscillations or vibrations.** Edward O'Toole, Thanet House, Temple Bar, London.

JAN. 3.

174. **Apparatus for the automatic control of engines, trains, or trams, both steam, electric, or any other description, to be worked in connection with special apparatus for the purpose of working the automatic control.** William Fenton Bladon, East End House, Roose, Barrow-in-Furness.

177. **Improvements in apparatus for controlling electric motors.** John Henry Hindle, Silver-grove, Utley, Keighley, Yorks.

197. **Improvements in switching apparatus for interconnecting the lines of a telephone exchange system.** John Edward Kingsbury, 24, Southampton-buildings, London. (The Western Electric Company, United States.)

201. **Improvements in electric lamps for use by divers.** Robert Henry Davis, 4, South-street, Finsbury, London.

220. **Improvements in selective electric signalling.** Arthur Harold Nicholson, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

JAN. 4.

268. **Improved method of strengthening electric vibrations.** Simon Eisenstein, 7, Southampton-buildings, London. (Complete specification.)

286. **Improved sender connections for wireless telegraphy or telephony.** Simon Eisenstein, 7, Southampton-buildings, London. (Complete specification.)

290. **Improvement relating to multiple switches particularly applicable to automatic telephone exchange selectors.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

JAN. 6.

308. **Seal lock for electric incandescent lamps and the like.** Ernest Eglington, "Pentire," Elm Park-road, Winchmore Hill, London.

312. **Automatic polarised reversing switch for electromotors.** George Winteringham and John Austin Cole, 46, Bruce-grove, Watford, Herts.

324. **Improvements in electrically-heated hot-water bottles.** Herbert W. Christian, 6, Breams-buildings, Chancery-lane, London. (Date applied for under Section 91 of the Act, Jan. 8, 1907, being date of application in United States.) (Complete specification.)

325. **Improvements in or relating to induction ignition coils.** Richard William Sanders and Morris Greenberg, 165, Queen Victoria-street, London. (Complete specification.)

327. **Improvements in or relating to electric speed indicators.** Eugène Louis Amedée Lertourné, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Jan. 9, 1907, being date of application in France. (Complete specification.)

328. **Improvements in and connected with electric motors.** Eugéne Louis Amedée Letourné, Birkbeck Bank-chambers, Southampton-buildings, London. ((Date applied for under Section 91 of the Act, Jan. 10, 1907, being date of application in France.) (Complete specification.)

333. **Improvements in and connected with electric accumulators.** Chaimsonovitz Prosper Elieson, 18, Southampton-buildings, London.

345. **Improvements in or relating to electrical distribution.** Alfred Julius Boult, 111, Hatton-garden, London. Joseph Lester Woodbridge, United States.) (Complete specification.)

346. **Improvements in or relating to electrical distribution.** Alfred Julius Boult, 111, Hatton-garden, London. Joseph Lester Woodbridge, United States.) (Complete specification.)

358. **Improvements in and relating to heat accumulaters.** The British Thomson-Houston Company, Limited, and Frederick Samuelson, 83, Cannon-street, London.

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JAN. 7.

372. **Improvements in composite telegraph - telephone circuits.** Charles Mark Jacobs, St. Cuthbert's, Alexandra-road, Reading.

373. **Improved multi-conductor cable.** Alfred Whalley, 15, Water-street, Liverpool.

399. **Improvements in telegraphic switches and repeating apparatus and circuits in connection therewith.** William Leivesley, 65, Chancery-lane, London. (Complete specification.)

401. **Electrolytes for alkaline storage batteries.** Thomas Alva Edison, 23, Southampton-buildings, London. (Date applied for under Section 91 of the Act, May 10, 1907, being date of application in United States.) (Complete specification.)

425. **Improvements in telegraphene apparatus.** Einar Alexander Hytten, 6, Lord-street, Liverpool. (Complete specification.)

434. **Improvements in electric measuring instruments.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JAN. 8.

440. **Improvements in the manufacture of incandescent electric lamps.** The Edison and Swan United Electric Light Company, Limited, and Edward Alfred Gimmingham, the Edison and Swan Company Works, Ponder's End, Middlesex.

445. **Improvements in or relating to electrical storage batteries.** Alfred Wood Somers and Richard Joseph Crowley, Spring Bank, Bradford, Yorks.

461. **Improvements in connection with incandescence electric lamps.** Charles Henry Stearn and Charles Fred Topham, 47, Lincoln's-inn-fields, London.

468. **Improvements in or relating to electrical meters.** Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

479. **Improvements in and relating to electric switches.** Frederick Hugh Smith, 18, Southampton - buildings, London.

484. **Improvements in electrical measuring instruments.** Owen David Lucas, 49, Linden-gardens, Bayswater, London.

496. **Improvements relating to multiple and harmonic telegraphy with undamped oscillations.** Simon Eisenstein, 7, Southampton-buildings, London. (Complete specification.)

505. **Improved electric alarm apparatus.** Walter Blut, 67, York-strasse, Berlin, Germany.

JAN. 9.

549. **Improved electrical heating apparatus.** Wilhelm Ernst Trümper, 37, Chancery-lane, London. (Date applied for under Section 91 of the Act, Feb. 1, 1907, being date of application in Switzerland.) (Complete specification.)

559. **Improvements in electric lamps for miners' helmets and the like.** Johann Heinrich Dräger and Alexander Bernhard Dräger, 7, Southampton-buildings, London. (Complete specification.)

560. **Improvements relating to radio-telegraphy.** The Amalgamated Radio-Telegraph Company, Limited, 7, Southampton-buildings, London. (Valdemar Poulsen, Denmark.) (Complete specification.)

634A. **Improvements in and relating to electric switches.** The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London. (Date applied for under Rule 13, Jan. 9, 1907.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Jan. 23.)

1906.

24448. **Electric motor-control apparatus.** British Thomson-Houston Company. (General Electric Company.)

27358. **Automatic electrical circuit breakers of the loose-handle type.** Hamlyn.

1907.

98. **Electric transmission systems.** British Thomson-Houston Company. (General Electric Company.)

155. **Incandescent electric lamps.** British Thomson-Houston Company. (General Electric Company.)

1278. **Operating mechanism for electric switches and other purposes.** British Thomson-Houston Company. (General Electric Company.)

1301. **Electrical ignition devices for internal-combustion engines.** Clift.

4363. **Processes of insulating electric conductors.** British Thomson-Houston Company. (General Electric Company.)

4392. **Signalling in wireless telegraphy.** Poulsen.

8286. **Rotating members of dynamo-electric machines.** British Thomson-Houston Company and Dawson.

24792. **Magnetic compass.** Lawrence.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price.
	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
—— Ord., 1,125,000	1 ..	¼-½
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	9/16-11/16
—— Ordinary, Nos. 1 125,000	1 ..	5/32 9/32
British Aluminium Co., Ordinary, 2,001-40,000	5 ..	3¾-4¼
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4⅞-5⅛
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	4⅞-5⅛
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100-102
—— 5½ per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-6⅝
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	101-103 xd
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85 89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 276,001-375 000	3 ..	¾-1
—— 4 per cent. Mortgage Debenture Stock	100 ..	49 50 xd
Brush Electrical Engineering, Ordinary, Nos. 1-105 781	2 ..	0-½
—— Non Cum., 6 per cent., Pref.	2 ..	¼-¾
—— 4½ per cent. 1st Debenture Stock	100 ..	85-86
—— 4½ per cent. 2nd Debenture Stock	100 ..	63-66 xd
Callender's Cable, Debentures	100 ..	104-106
—— Ordinary	5 ..	9¼-10¼
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1 9/16-1 13/16
—— 5 per cent. Debentures	100 ..	94-97 xd
Dick, Kerr and Co., Ordinary, 1 250 000	1 ..	1¼-1⅝
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102 xd
Edison and Swan United, "A" Shares, 1-39 261	5 ..	⅝-1⅛
—— "A" Shares, 01-017,153	5 ..	1¼-2⅛
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81 xd
Electric Construction, Nos. 1 to 112 100	2 ..	¼-½
—— 7 per cent. Cumulative Pref.	2 ..	¼-1⅛
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	59-64
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅞-8½ xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	4⅞-5⅛
—— 4½ per cent. Debentures	100 ..	104½-106½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14½-15⅝ xd
—— 4 per cent. Debentures	100 ..	96-98
National Electric Construction Co., 1-170,000	1 ..	11/16-13/16
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	28½-30½
—— 5 per cent. Bonds	100 ..	98-102 xd
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9 xd

Electric Lighting and Supply.—

Name.	Amount paid.	Last price
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅝-5⅛
Bournemouth and Poole, Ordinary	10 ..	9½-10½
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	9½-10½
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	10-10½
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102 xd
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅜-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	96-98
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6¾-7½
—— Nos. 80,000-100,000	5 ..	5¾-6¾ xd
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	105-109 xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	4¼-4⅝
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	4¼-5
—— 4 per cent. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	4⅜-4¾ xd
—— ditto ('903) 40,001-80,000	5 ..	3¼-4¼
Chelsea Electricity Supply	5 ..	3⅜-4⅛
—— 4½ per cent. Debentures	100 ..	100-103 xd
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	10-11
—— 6 per cent. Cumulative Pref.	10 ..	11½-12½
—— 5 per cent. Debenture Stock	100 ..	120-123 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	97-100 x 1
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0 ..	50-53
Corinth Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3¼-4¼
—— 5 per cent Preference, 1-50,000	5 ..	4⅜-4⅝
County of London Elec. Supply, Ordinary	10 ..	6½-7½
—— 6 per cent. Cum Pref.	10 ..	10¼-11
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	103-106 xd
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	96-98
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅜-⅞
—— 6 per cent. Cum Pref.	5 ..	¾-1⅛
—— 4½ per cent. First Mort. Deb.	100 ..	70-80
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2½-2¾
—— 5 per cent Debenture Stock, Red.	100 ..	83-87 xd
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	91-93 xd
Folkestone Electric Supply, Ord., Nos. 1-10 000	5 ..	4½-5
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5 ..	5-5½
—— 4½ per cent. First Deb Stock, Red.	100 ..	96-99
Hove Electric Lighting, Ord., 1-13,000	5 ..	6⅜-6⅞
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	98-101 xd
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	⅛-¼
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10¼

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4⅜-4⅝
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	89-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	92-95
Metropolitan Ordinary, 100,001-200,000	5 ..	5⅜-6⅛
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	100-104 xd
—— 4½ per cent. Cum. Pref.	5 ..	4⅜ 5¼ xd
—— 3½ per cent. Mortgage Debenture, Red	100 ..	£5 90 xd
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1 000)	—	75½-77½ p.c. xd
Mexican Light and Power Co., Capital Stock	$100 ..	51-53
—— 5 per cent. 1st Mort. Gold Bonds, Rec., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	86½-88½
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb	— ..	96-98 xd
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57 009	5 ..	6¼-6⅜
—— do., 57,010-75,000	5 ..	6¼-6⅜
—— do., 75,001-87,500 (issued at £22 prem., 16s. paid	5 ..	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5-5¼
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5 ..	5-5¼
Notting Hill Electric Lighting	10 ..	11-12
—— 4 per cent. First Mort. Deb. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5¼ 6
—— 4 per cent. Debenture Stock	100 ..	96-97
River Plate Electricity Co, Ord., 1-119 687 & 120 501-120 507	1 ..	9/16-11 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	⅞-1
—— 5 per cent. Debenture Stock, Red.	100 ..	94-97 xd
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5 ..	4⅜ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15 000	5 ..	4⅞ 5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	—	98-100 p.c. xd
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	¼-1½
—— 4 per cent. Debenture Stock	100 ..	71-75
South London, Ordinary	5 ..	2½-3
South Metropolitan Electric Light and Power, Ord.	1 ..	½-¾
—— 7 per cent Cum Pref.	1 ..	1-1¼
—— 4½ per cent 1st Mort. Deb.	100 ..	100-105
St. James's and Pall Mall, Ordinary, 101-20,000	5 ..	7⅛ 8½
—— 7 per cent. Pref.	5 ..	6½-7¼
—— 3½ per cent. Deb.	100 ..	85-90 x d
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1½-2¼
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	2-2½
Westminster, Ordinary	5 ..	8½-9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	5-5½ xd

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260.007	5 ..	5⅞-6⅛ xd
—— 10 per cent. Non-Cum 2nd Pref., 260,008-280,007	5 ..	7⅛-8⅛
—— Permanent 6 per cent Debenture stock, 1888	100 ..	125-128 xd
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb Stk, Red.	100 ..	102-105 xd
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref Shares, 1 10 000	10 ..	—
—— 5 per cent Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares. 75,001-150,006	1 ..	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1 ..	13/16-15/16 x d
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk, Red.	100 ..	93-96 xd
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Bombay Elec. Supply and Trams Co, 6 per cent. Cum. Pref.	10 ..	9⅛-9⅜
—— 4½ per cent. Deb. Stock, Red.	100 ..	92-94
Brisbane Tramway Invest., Ord., 1-75 000	5 ..	3 3/16-3 7/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅝ 4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	97-101 xd
British Columbia Electric Railway Co., Ord Def.	100 ..	125-128
—— Ord. Pref.	100 ..	105-109
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	101-105
—— 4½ per cent 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	99-102
—— 4½ per cent. Vancouver Power Deb.	100 ..	100-103
British Electric Traction, Ord. 1-300 000 & 60 001-90,000	10 ..	1⅜-1⅞
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	5 5⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	97-98
—— 4½ per cent 2nd Deb. Stock	100 ..	69-74
Buenos Ayres and Belgrano Trams.	5 ..	4¼-4⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5¼
—— "B" 6 per cent Cm. Pf., 1-27 500	5 ..	4⅜ 5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	105-115
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	89-91 xd
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	98-102 xd
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	98-103
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-94
Calcutta Tramways, Ord., Nos 1-137,610	5 ..	6¼-6⅜
—— 5 per cent. Cum. Pref., Nos. 1 20 000	5 ..	4¼-5⅜ xd
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	99-103 xd
Cape Electric Tramways, Nos. 1-480,000	1 ..	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	96-99
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5¼-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	99-103 xd
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10 ..	13-14
—— 6 per cent. Pref., Nos. within 1-60 000	10 ..	12⅜-13⅜
—— 5½ per cent. Mort. Debs., 1-3,000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p c. Deb. Stk, Red.	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	82-87
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	⅜-1⅜
—— 4 per cent. 1st. Mt. Db Stock, Red.	100 ..	58-63 xd
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	92 95 xd
—— £296 500 2nd Mort. Deb. Stock	— ..	—
—— £283,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	⅛-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	13/16-1 2/16 xd
—— 5 per cent. Mort Deb., 1-5,000 Red	100 ..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7⅛-8⅛ xd
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	80-84

Name.	Amount paid.	Last price.
	£	£
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98 xd
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Stukg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 ..	88-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436 25 000	5 ..	4½ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100 ..	96-98
Metropolitan Elec Trams., Defd., 1 000.001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref., 500,001-1 000 000	1 ..	13/16- 5/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	91-94 xd
Mexico Trams. Co, Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	£3-85 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 20-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 001-2,000	100 ..	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5 ..	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	£8 102 xd
Potteries Electric Traction, Ordinary, 1-245.000	1 ..	5/16-9/16
—— 5 per cent Cum Pref., 300 001-545 000	1 ..	⅛-⅜
—— 4½ per cent Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary, 1-24 912	10 ..	4½-5
—— 6 per cent. Cum. Pref., 1-10,000	10 ..	9½-10½ xd
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-20,000	5 ..	5-5½ xd
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	96-97 xd
Sao Paulo Tramway, Light, and Power Co.	$100 ..	121-125 xd
—— 5 per cent. 1st Mort Deb., Red. 1929. 1-11,000	$500 ..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169 570, Prov. Certs.	1 ..	⅞-1⅛
—— 4 per cent. Deb Stock, Red. 1-40	100 ..	78 82 xd
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100 ..	60-70 xd
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5 ..	1-1½
—— 6 per cent. Cum Pref., 1-46,261	5 ..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	81-84 xd

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	66-68
—— 4 per cent. Pref.	100 ..	84-86
—— " " deferred	100 ..	44-47
—— 4 p c Deb. Stock (Prov. Script Certs, fully paid)	100 ..	101-104
City and South London, Consolidated Ordinary	100 ..	44-46
—— 4 per cent Debenture Stock	100 ..	101-104
—— 5 per cent. Pref Stock '91	100 ..	116-119
—— " " " '96	100 ..	113-116
—— " " " '01	100 ..	113-116
—— " " " '05	100 ..	109-112
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10½
—— Ordinary, 1-50,000	10 ..	3⅜-4⅜
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	35-39

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	84-87 xd
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53 001-78 000	$1 000 ..	86-88 xd
Anglo-American Telegraph Co., Ordinary	100 ..	57-60
—— 6 per cent. Preferred Ordinary	100 ..	100-102
—— Deferred Ordinary	100 ..	16-16½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co., 1-44,000	5 ..	6⅜ 7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	80-84 xd
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10 ..	6¼-7½
—— 10 per cent Preference, 1-6 000	10 ..	15¼-16½
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-3⅞
—— 10 per cent. Cum. Preference	5 ..	8⅛-8⅜
—— 4½ per cent. Debs., 1-600	50 ..	97-100 xd
Direct United States Cable Co.	20 ..	13¼-14¼
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	99-101 xd
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	99-101
Eastern Extension, Australasia and China, 1-300,000	10 ..	12⅛-13
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	99½-100¼
Eastern Telegraph Co., Ordinary Stock	100 ..	131-136
—— 3½ per cent. Preference Stock	100 ..	83-86
—— 4 per cent. Mortgage Debenture Stock	100 ..	99-102
Great Northern Telegraph Co. (of Copenhagen)	10 ..	30-32
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100 ..	99-101 xd
Indo-European Telegraph Co.	25 ..	52-55
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1 ..	⅜-⅝
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	⅞-1
National Telephone, Preferred	100 ..	110-112
—— Deferred Stock	100 ..	107½-109½
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent Cum. Second Pref.	10 ..	10-12
—— 5 per cent. Non Cum. Third Pref.	5 ..	5¼-5½
—— 3½ per cent. Deb. Stock, Red.	100 ..	96-98 xd
—— 4 per cent. Deb. Stock, Red.	100 ..	99-101 xd
Oriental Telephone and Electric Company	1 ..	1 1/16-1 3/16
—— 6 per cent. Cum. Pref	1 ..	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	97-100 xd
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6¼-7 xd
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅜-5¼ xd
—— 5 per cent. Debenture Stock, Red.	100 ..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	98-101 xd
West African Telegraph Co.	10 ..	10-10½
West Coast of America, 1-30 000 and 53 001-53,008	2½ ..	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	96-99 xd
West India and Panama Telegraph Co., Ordinary	10 ..	⅜-½
—— 6 per cent. Cum. 1st Preference	10 ..	7¼-7⅞
—— 6 per cent. Cum 2nd Preference	10 ..	7¼-7⅝
—— 5 per cent. Debs., Red., 1-800	100 ..	98-101 xd
Western Telegraph Co., 1-207,930	10 ..	12⅜-13⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	97-100 xd

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Jan. 8	1,356	1,282	+ 74	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	Nov. 17	1,019	966	+ 53	— 176	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	Jan. 11	3,280	2,290	+ 990	+ 1,780	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 12	964	995	- 31	—	23·53	24·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 4	6,079	—	—	—	56¼	54½	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 1	1,103	1,013	+ 90	+ 3,075	23·80	23·80	,, 25	54,951	10,094,028	1,004,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 9	339	341	- 2	- 1,224	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 603	—	7·796
Bolton Corporation	Jan. 13	1 990	1,985	+ 5	+ 5,789	42	42	March 31	111 294	23,410,690	2,411,969	1·14	1·03	2,649	6·12
Bournemouth Corporation	,, 8	1,279	1,330	- 51	+ 1,693	23¼	24½	,, 31	83,665	13,503,610	1,765,058	1·48	11·37	2,850	7·28
Bradford Corporation	,, 4	4,155	1,109	+ 46	+ 4,313	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 12	648	737	- 89	- 3,173	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 10	4,503	4,754	- 251	—	53½	51½	,, 31	265,769	46,902,257	6 178,886	—	—	—	—
Burnley Corporation	,, 11	1,155	1,184	- 28	—	19½	19½	,, 31	62,699	11,967,458	1,205,830	1·31	12 48	5,825	8·21
Burton Corporation	,, 5	238	274	- 36	- 58	9⅝	8½	,, 31	15,576	3,383,527	421,317	1·07	8 87	1,768	6·14
Cardiff Corporation	—	—	—	—	—	32·62	†32·26	,, 31	106,560	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	,, 11	144	146	- 2	- 20	8·5	8·5	Dec. 31	10,254	2,780 699	350,417	—	—	—	7·96
Central London Railway	,, 11	6,318	6,456	- 138	- 345	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	52·29a	55,357	35·22a
Charing X, Euston, & Hamp. Ry.	,, 11	3,190	—	—	—	7⅔	6½	—	—	—	—	—	—	—	—
City and South London Railway.	,, 12	3,560	2,998	+ 562	+ 907	9	6½	h June 30	82,456	10 048,780	—	—	—	—	—
Colchester Corporation	Dec. 25	231	184	+ 37	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Jan. 9	374	424	- 50	- 120	15½	15½	Dec 31	25,032	5,966 364	891,9·8	—	6·74	—	4·78
Croydon Corporation	,, 10	1,147	—	—	—	12 c	12 c	March 31	64,065	13,514,9 8	1,·02,408	1 08	9·76	3,123	6 67
Darwen Corporation	,, 10	207	225	- 19	- 43	7 23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1,124	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Jan. 10	86	88	- 2	- 19a	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 10	4,753	5,008	- 255	- 237	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 8	1,316	1,083	+ 233	+ 1,566	22	22	May 15	57,672	15 554 905	1,162,792	·878	11·9	4,362	7·3
East Ham Corporation	,, 11	824	828	- 4	+ 379	14	14	March 31	47,140	15,049,240	1,062,151	·74	10·49	3 636	7·14
Glasgow Corporation	,, 11	16,013	16,054	- 41	+16,015h	177½	169	May 31	887,381	221,063,058	20,350,367	·95	10·47	5,035	5 21
Gloucester Corporation	,, 8	210	227	- 17	—	15	15	March 31	15,033	3,182,111	579,986	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 11	5,445	3,535	+1,910	+ 3,215	9¼	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,986	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	,, 11	1,440	1,410	+ 30	+ 2 988	35½	35	,, 31	81,196	15 252,150	1,804,745	1·32	10 79	2,770	5 92
Hull Corporation	,, 11	2,466	2,310	+ 155	+ 5,744	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 4	374	410	- 36	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 8	114	113	+ 1	+ 370	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	13,702	4,640,618	466,919	·672	7 55	1 723	4 95
Lancashire United Tramways	,, 8	1,037	974	+ 63	+ 92	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 4	6,022	5,847	+ 175	+11,434	96½	96½	March 31	337,794	73,024,853	7,358,185	1·06	10·69	3,352	5 58
Leicester Corporation	,, 11	1,986	2,015	- 29	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 4	10,124	10,804	- 680	—	104	104	Dec. 31	563,793	122,094,528	12,115 934	1 108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 12	1,326	1,412	- 86	- h	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	Dec 28	31,615	23,540	+8,075	+205,216	98	98	March 31	1378,014	314,227 090	30,130 297	1·05	10 98	—	8 56
Lowestoft Corporation	Jan. 11	144	150	- 6	+ 101	3½	—	Sept. 30	11,079	2,672,922	343,190	1·03	7 9	2,156	6·39
Maidstone Corporation	,, 2	140	76	+ 64	—	4¼	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2 956	6 2
Manchester Corporation	,, 11	13,120	13,175	- 55	+ 40,918	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 11	8,873	7,995	+ 878	+ 1,614	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 12	15,593	15,682	- 89	+ 66	23½	23½	June 30	637,794	87,639,334	—	1·39	—	—	—
Nelson Corporation	,, 11	121	132	- 11	- 37	2⅔	2⅔	March 31	7,309	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 11	3,745	3,758	- 12	+ 1,204	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1 11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 11	560	545	+ 15	+ 2,034	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10 01	1,525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35½	35½	,, 25	94,948	18,647,731	1,818,444	1 19	12 53	2,603	7·209
Portsmouth Corporation	May 25	2,330	1,578	+ 752	+ 632	28½	28½	,, 31	98,911	20,668 825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,661	8,130,179	918 825	·95	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	25,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	Jan. 6	4,628	4,166	+ 462	+ 6,016	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 12	5,223	5,256	- 33	+10,722	65½	65½	March 25	276,907	73 966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 8	230	245	- 15	+ 84	9	9	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4 349
Sunderland Corporation	,, 12	1,129	1,239	- 110	- 1,378	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	Jan. 9	168	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 11	706	742	- 36	+ 645	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965 296	429 785	—	10 724	1,989	6·95
West Ham Corporation	,, 2	2,095	1,992	+ 103	+ 2,250	14·7	14 7	,, 31	1·2,881	35,002,836	2,556,854	789	10·96	4,407	6·79
Wolverhampton Corporation	,, 8	738	788	- 50	+ 487	20	20	,, 31	43,823	9,276,023	966,133	—	10 886	2,159	6·086

1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE

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RAILWAY ELECTRIFICATION.

The first lecture of the two to be delivered by Prof. Gisbert Kapp before the Royal Institution of Great Britain on the electrification of railways is as interesting reading as the first edition of the historic book "Electric Transmission of Energy," by the same author, published in 1886. This book laid the foundation of practical dynamo design, because it put the facts and formulæ in such a clear way as to be readily understood by an engineer. Earlier work in the same direction, while equally clear to the mathematician, did not appeal to the practical man. The lecture delivered on Saturday last on the "Electrification of Railways" shows that Prof. Kapp has lost nothing of his old power of dissolving difficulties when writing on engineering subjects. This consoles us for the shortcomings of the "Encyclopædia Britannica," although we see no reason why these Royal Institution lectures should not appear in the 1950 edition of this standard publication. Prof. Kapp starts with the practical question, "Why should we electrify main lines?" The answer as given in the first lecture is that "we want to travel more frequently, more quickly, more safely, in greater comfort, and, if possible, more cheaply than by steam. As regards greater comfort and more frequent opportunity of travel, the superiority of electric traction has been demonstrated by the lines already electrified. As regards greater economy, the proof is as yet doubtful, but it would obviously be premature to deny greater economy merely on the ground that it has not yet been attained in the few isolated—and I might almost say tentative—installations started up to the present. When the electric light was first introduced into our homes we had to pay eightpence a unit, but now, with its more general application, the average price has come down to about half that sum. So it will be with electric travel. A few dozen miles electrified here and there can hardly be expected to result in great economies, but let the whole system be electrified and any inherent advantage in an economical sense must make itself felt. The economy will naturally be greatest in the countries where coal is dearest, and it is for this reason that we see the Swedish, Italian, and Swiss Governments considering the introduction of electric working on a large scale." We would add to this the statement that in those countries where an industry is at the highest state of development it is most difficult to introduce a radical change. Thus in England the receipts per mile of railway and the traffic carried are higher than in any other country. The attempts to introduce foreign locomotives on English lines have not been successful due to the superiority of the English engines. These considerations and our cheap coal make it more difficult to change over English main-line railways to electrical working than to equip new lines in countries where the railway systems are growing. It is useless to repeat here the success of the electrification of railways in Italy and elsewhere, as the figures proving this are published by us in the report of Prof. Kapp's lecture. The value of the information thus brought before the institution is enhanced by the fact that the author has been working on the subject for years, and gives freely his opinions both as to the advantages of electrification and as to the improvements yet to be sought for in such work. It will be remembered that when the District and Metropolitan Railways were being electrified there was a dispute between the two companies as to what system should be used. At this inquiry before Mr. Alfred Lyttelton, K.C., as arbitrator, Prof. Kapp was the strongest technical witness in favour of the high-tension alternating-current system as developed by Ganz and Co. That his side did

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not secure the award was due to the predominance of the American evidence, but the correctness of the opinions he then expressed is conclusively shown by the success obtained in Italy, Switzerland, and Sweden with the system he recommended. We do not propose to discuss the details of railway electrification as given in the paper, but would recommend this to all our readers as a sound basis on which to build up a more intimate knowledge of the subject. We trust that the English railway companies will themselves recognise this, and call on Prof. Kapp for his professional aid when the electrification of their line is being considered.

ELECTRIC CLOCKS.

The London County Council agenda for this week's meeting contained notice of the following resolution intended to be moved by Captain Swinton: "That it be an instruction to the General Purposes Committee to consider and report as to whether it would be possible to arrange that all clocks publicly exhibited in the streets of London should be synchronised from Greenwich." During the past few days an interesting controversy has been carried on in the columns of the *Times* with reference to the synchronising of clocks. That such a reform is necessary we are all ready to admit, for there are possibly few who have not suffered disappointment through confiding trust in successive clocks of any great London route. Electrical synchronising seems to offer a solution to horological chaos, but this, unfortunately, has made practically no headway in the United Kingdom. A method has been tried at Glasgow, but its success does not seem to have been sufficiently marked to inspire its adoption elsewhere. On the Continent, however, great progress has been made in this direction, not only in the apparatus required for the purpose, but in its adoption. Electric clock installations do already exist in numerous large premises in London and elsewhere, and their successful working may be taken as evidence that some of the most important difficulties have been overcome, and that the principle is suitable for application to public-service clocks on a much larger scale than hitherto. We fear that the matter has not received adequate attention from electrical engineers in this country, and, apart from a communication to the Institution of Electrical Engineers by Mr. Hope-Jones some years ago, and the labours of that gentleman and two or three others, this most promising branch of the industry has been quite neglected. To those who have so ably been doing pioneering work the thanks of the electrical community are due. But the time has now arrived when the value of such work should receive fuller recognition, and the attempt be made to secure a wider adoption of a system of electrically-synchronised public-service clocks in this country.

FIRES ON LONDON UNDERGROUND ELECTRIC RAILWAYS.

Complaints of fires have recently been numerous by passengers on the underground railways of London, and the Board of Trade have been led to order an inquiry into the matter. The particular case inquired into was the explosion and electric flashing which took place in a car at Sloane-square Station on the District Railway on the 8th of the present month. Major Pringle, inspecting officer of railways, and Mr. A. P. Trotter, electrical adviser of the Board of Trade, together conducted an inquiry into the occurrence, and the report which they have made, and is published in another column, is altogether of an assuring character, and sufficient to allay the fears of passengers. Many alarmist letters were written to the Press shortly after the occurrence, but it is clear that the apprehensions of danger expressed in those letters were in no way justified by the facts. The report states that the probability of the occurrence was the failure of the electric lighting wires owing to damp. The heating of the wires resulted in the liquefaction of a small plug of bitumen. An explosion of bitumen followed, causing smoke and fumes. Subsequently electric flashing took place along the pipe and at the junction box under the car. The inspectors also point out that arrangements exist on all underground as well as on tube railways to allow passengers, in case of need, to descend from a train at either end, and that the main danger in case of fire would be from panic. This salutary warning should have the effect of deterring the writing of alarmist letters to the Press, thus causing needless apprehensions among the travelling public.

ELECTRICAL POWER IN RAILWAY GOODS WAREHOUSES.*

BY H. HENDERSON, ASSOCIATE MEMBER.

(Concluded from page 86.)

Machinery for Dealing with Traffic.—The capstans, which number 42, are designed for a pull of one ton, or six loaded wagons averaging a total weight of about 90 tons, at a speed of 250ft. per minute. The motors are 26 b.h.p., and are compound wound, the series winding being on two poles and the shunt on the remaining two. The starting switches are operated directly by the treadle, a strong dashpot preventing too rapid movement of the switch. The switch also contains an overload release, which brings the switch to starting position and necessitates the treadle being released before the motor can be started again. This works very promptly, and prevents rough usage of the capstan. Whether this type of starting switch is the most desirable one for electric capstans is a debatable points. Electric capstans cannot be roughly treated as hydraulic capstans can. In the latter, if the capstan is overloaded (a very frequent occurrence) no harm is done to the capstan, and the load must be reduced until the power of the capstan is sufficient for the load before any movement will take place. Such methods of working cannot occur with an electric capstan, and unless a protective device is provided damage will occur to the apparatus. Provided the overload release is kept in order, the operator, however careless, will soon learn that the capstan must be treated with respect if any work is to be got out of it. Another serious objection to the direct operation of the starting switch by the treadle is that the necessity of gradually depressing the treadle tends to take the man's mind off his work, which is by no means without danger; also, owing to his having to work against the dashpot and balance weight attached to the treadle, he may not cut out all the resistance, which will burn out after a few such operations. The preferable method is for the treadle to operate a main switch only, the starting switch being automatically worked either by a magnetic coil or by gearing from the motor spindle. The movement of the treadle then becomes a single one, as in hydraulic capstans Another point which seems to be overlooked in capstans is the space allowed in the cast-iron tank. Capstans are often designed so small that it is impossible to get into them, and any work on repairs or alterations necessitates working in most awkward positions, where sight of what is being done is almost impossible. This is a great mistake. If the capstan is inside there is no reason why it should not be covered in by light plates, which can be easily removed and the whole of the mechanism exposed. With outside capstans this would not apply, but the difficulty can be got over in a different manner. The author recently had the privilege of seeing several capstans in

* Paper read before the Institution of Electrical Engineers

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a goods yard in Lancashire which were excellently arranged. The tank was of a double pattern, fixed end to end, these ends being cut out to form a communication between the two. The tanks were very deep, and one of them was covered with a heavy lid in one piece, which carried the motor and the capstan head. The switchgear was also fixed in the same tank, and consisted of a double-pole switch worked from the treadle, a starting switch from the motor spindle, and a switch which short-circuited the armature when the treadle was off, thus acting as a brake. The second tank was covered with light plates, and simply contained the outlet to the drain, and a ladder for descent. Thus access was easily gained to the capstan proper, and it was possible to pass in underneath the motor and capstan head and do any work required in comfort. All the apparatus was thus under a cover, which did not require to be removed, was easily got at, and there was room to deposit any parts which required to be taken down. Objection may be taken to the expense of having to dig a deeper hole for the tanks, but the advantages gained easily outweigh such objection. If all electric capstans were designed upon this principle, it would do much to remove a number of the troubles which occur with electric capstans in practical working. In the 42 capstans at New Bridge-street the head is driven by bevel gearing, and the shaft of the armature is fitted with an electromagnetic strap brake in series with the motor operated for braking by a heavy balance weight when the current is cut off. A view of the capstan is shown in Fig. 11, and a diagram of the connections of the controller in Fig. 12.

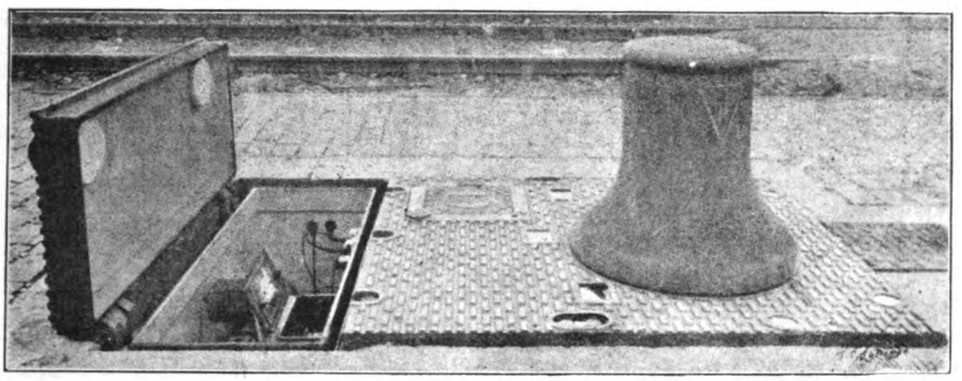

FIG. 11.—Electric Capstan.

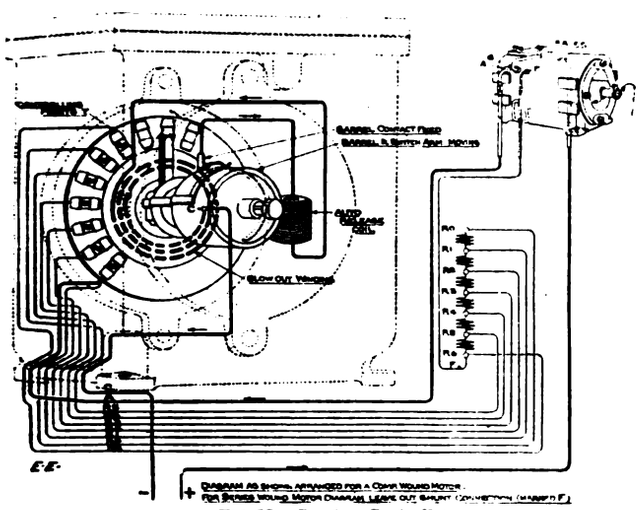

FIG. 12.—Capstan Controller.

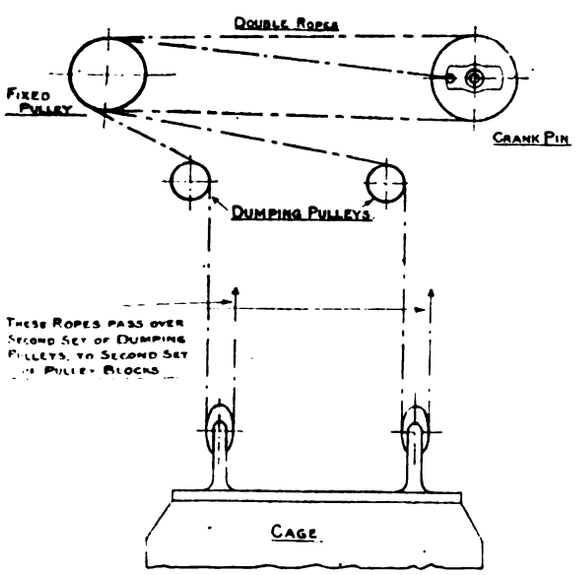
DOUBLE ROPES
FIXED PULLEY
CRANK PIN
DUMPING PULLEYS
THESE ROPES PASS OVER SECOND SET OF DUMPING PULLEYS, TO SECOND SET OF PULLEY BLOCKS
CAGE

FIG. 14.—Diagram of Rope Attachments for Wagon Hoist.

Wagon Hoists.—As will be seen from Fig. 5, the only access to the basement for railway wagons is by way of the wagon hoists. These are worked electrically, and are capable of lowering 30 tons and lifting 20 tons. They are controlled on the push-button principle, and are probably the largest hoists of that type ever made. The hoisting arrangement is very simple, being, in reality, two sets of huge pulley blocks. The usual method of operation is, however, reversed, and that block which is generally fixed is in this case the movable set, and the load is raised by means of the tail end rope. Its use in connection with a hoist, especially of such a size, is, indeed, very novel. The machinery, which is at the top of the hoist, is composed of two exactly similar parts, each driven by a 50-h.p. 240-volt compound motor, the motors being connected in series. Each motor is coupled to its gearing by means of a shaft carry a magnetic strap brake and also a high-speed centri-

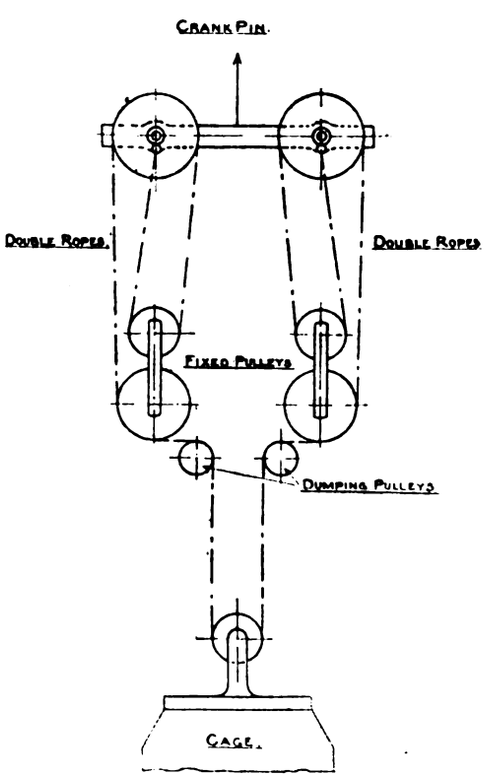

FIG. 15.—Diagram of Rope Attachments for Wagon Hoist.

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fugal brake, to check too rapid motion. The gearing finally drives a large toothed wheel, which has teeth over about three-eighths of its rim, the remaining part being simply flat. The two parts of the machinery are coupled together by means of a heavy crank-pin, forming a complete engine, and leaving a space of about 3ft. 7in. return from the pulleys attached to the cage to the second set of blocks, finally being made off at the opposite end of the crank-pin to which they started. This arrangement is shown in Fig. 14. The switchgear is of Messrs. Smith and Stevens pattern, operated from push buttons on the ground floor and from a set of push buttons in the cage

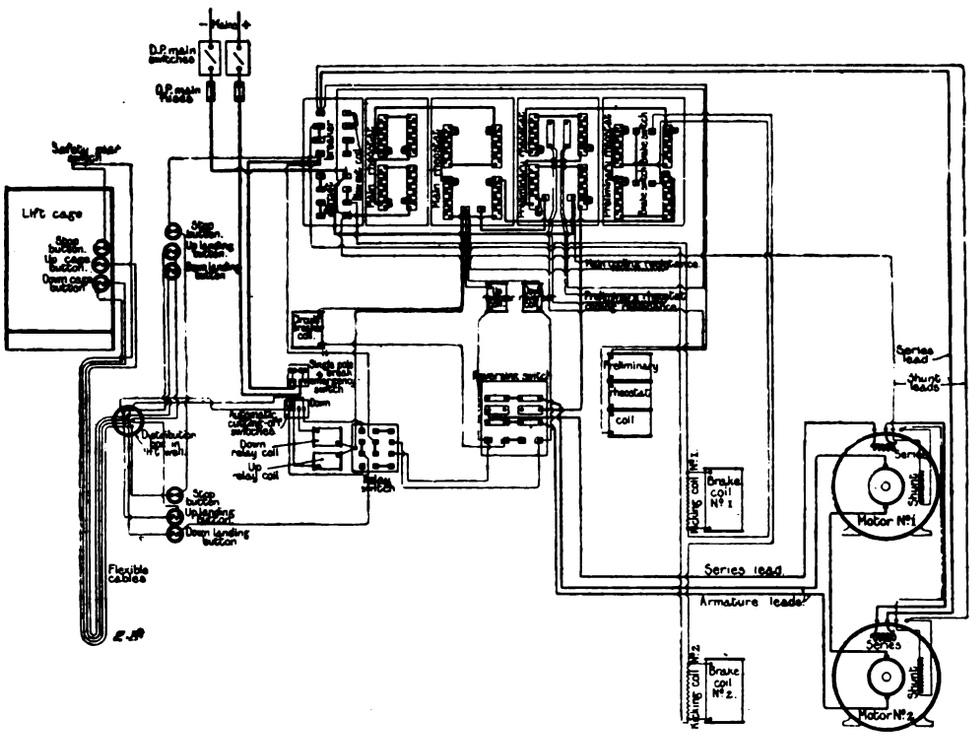

FIG 15.—Starting Gear Connections for Wagon Hoist.

between the large toothed wheels, in which the ropes are operated. To this crank-pin are attached the ends of the four ropes which hoist the cage, and also the ends of the ropes connected with the balance weights which balance the load. Fig. 13 is a diagrammatic development of the method of attaching the ropes. Starting with the ends, the two Fig. 15 shows the connections and the various coils connected with the starting gear, which is of the makers' usual pattern, enlarged to suit the size of the hoist. The speed of the hoists is 60ft. per minute and the lift 18ft. After the wagons are lowered to the basement floor they are received by a large traverser. This machine runs in a

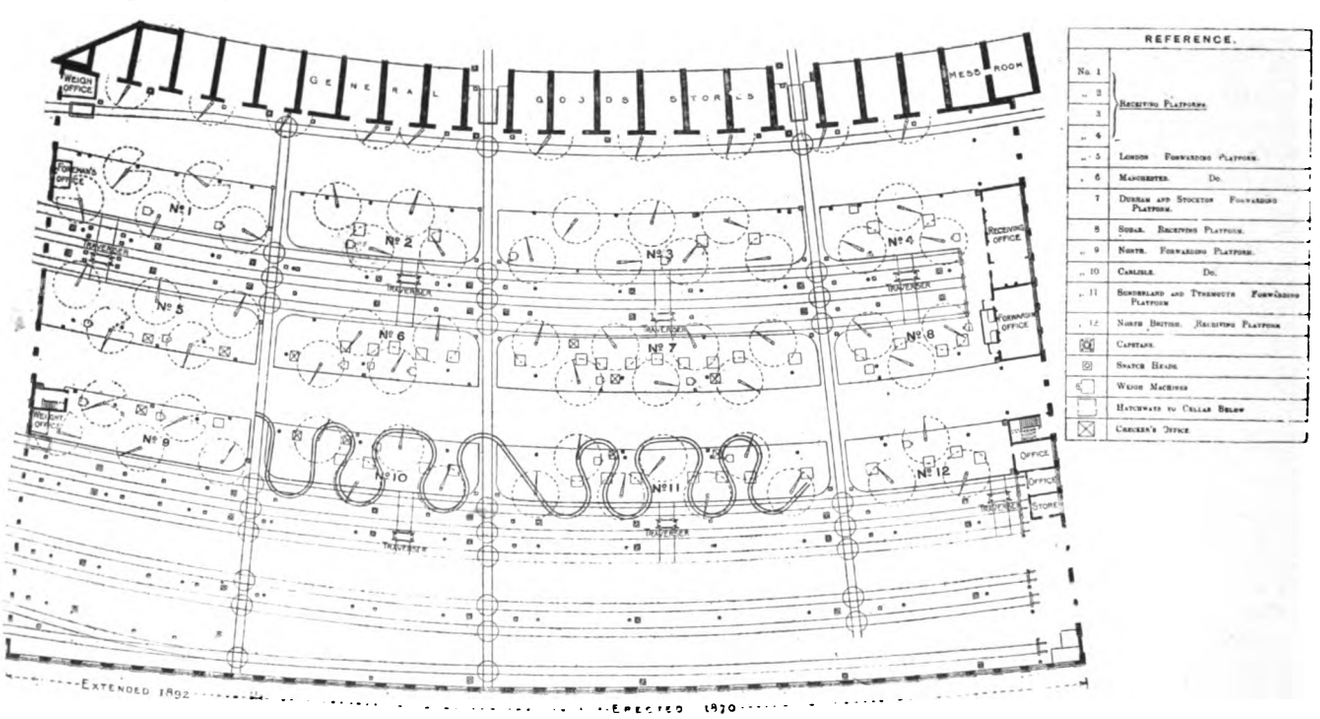

FIG. 16.—Plan of Forth Bank Goods Warehouse.

ropes are attached to the crank-pin. From thence they pass over a fixed pulley at the side (both ropes running in one groove). From this pulley they pass over the pulley on the crank-pin and back to a second fixed pulley, after which they pass over "dumping" pulleys to the top of the cage, the double rope opening out so that they may be attached to each side of the top beam. The ropes then special pit 30ft. wide and the full width of the building, as shown on Fig. 5. The traverser consists of a large platform 27ft. long and 18ft. wide, running on eight large grooved wheels on four sets of rails. There are also two sets of roller wheels running on the same rails to take the centre weight and that of the driving platform. Upon one side, which is extended and fitted with a handrail, is fixed the

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motor which drives the traverser, and also a capstan head for drawing wagons on to the traverser from the hoists. The motor is 26 b.h.p., driven by a simple reversing controller. The motor drives a shaft fitted with a double-clutch gear. One clutch drives the nearest shaft which carries the running wheels, and the other clutch drives the capstan head. The clutches are operated by one hand-wheel, so that both motions cannot be used together. The clutch connecting the capstan head is arranged to drive the head in one direction, the reversal of the motor driving the shaft only, the arrangement being similar to that of a free wheel. Current is carried to the motor through collectors fixed underneath the floor of the traverser and running in a conduit carrying the bare wires. The speed of the traverser is 300ft. per minute, and the capstan speed 200ft. per minute.

The power is taken from the Newcastle Electric Supply Company's Pandon Dene sub-station at a pressure of 580 volts between the outers. All the power is supplied at this pressure and the lighting at 240 volts. The whole building is controlled from two switchboards, one for power and the other for lighting, a separate account being kept of the energy used for each.

SCHEDULE OF POWER INSTALLED.

	No. of machines.	No of motors.	Power of machine, B.H.P.	Total power, B.H.P.
Basement—				
Overhead travellers	2	8	11¼	22·5
Revolving pillar cranes	2	4	7½	15 0
Wagon traverser	1	1	26	26·0
Wagon hoists	2	4	100	200·0
Capstans	16	16	26	416·0
Ground floor—				
Travelling cranes	4	16	23	92·0
Radial wall cranes	2	4	7½	15·0
Capstans	26	26	26	676·0
Second floor—				
Transporters	2	4	16½	33·0
Jiggers	4	8	11½	46·0
Third floor—				
Jiggers	2	4	11½	23·0
Total	—	—	—	1,564·5

With regard to the cost of electrical working, the New Bridge-street warehouse has not yet been in use to any large extent, so that no figures can be given. Some interesting figures are, however, given below with respect to a goods warehouse in the South-West of England. This warehouse originally contained 50 hydraulic cranes and six hydraulic capstans. Before deciding to electrify the cranes, etc., experiments were made to ascertain which cranes and capstans used most of the water. It was found that three of the cranes and the six capstans used 90 per cent. of the water. It was then decided to electrify these and drive the remaining cranes with electrically-driven pumps. The cranes were electrified by fixing a lifting and slewing gear on a fixed framework underneath the bench, utilising the old crane posts and jibs. In one case the old hydraulic controllers were used to work liquid starters, in the second crane special liquid starters were fixed, and in the third crane (which was used most frequently) ordinary controllers with wire resistances were used. The two pumps were fitted with 15-b.h.p. motors and worked automatically from float switches on the accumulators. By means of change-over switches in the float circuits, the pumps and accumulators could be grouped as desired. These alterations were carried out at a cost of £1,157, and the cost of working fell from £600 to £150 per annum. The saving of labour in such cases is very great, especially if the power is taken from a public supply, as is done in the case mentioned, the rate being 1d. per unit. This shows what a great saving can be made by means of electric driving, even by converting steam or gas driven hydraulic pumps to electrically-driven pumps, and working these by automatic switches. Under the heading of conversion of plant may be added a change which was made at the Forth goods warehouse, Newcastle. Referring to Fig. 16, it will be seen that upon the benches are a number of plain squares. These are hatchways for the cellars, and the hydraulic cranes are arranged so that most of them can lower material into the cellars. It was decided to experiment on one row of benches with electric cranes. A crane of the transporter type was designed, and the track laid out in such a manner as to pass over the roadway, benches, and railroad, and, at the same time, to pass vertically above the principal hatchways. This necessitated the specially-shaped track shown on Fig. 16. The track is made of channel iron, and carried on a series of lattice girders attached to the roof columns. Current is conveyed to the motors on the transporter through the track rails, which necessitates the insulating of each support. Some difficulty was experienced with this at the commencement, due to the vibration breaking down the insulated bolts. This trouble was easily got over by using hard red fibre plates, and bushing the holes with two fibre tubes and washers, one tube sliding within the other. This made an excellent joint, and no trouble was experienced afterwards. The transporter consists of a small bogie running on four wheels, and driven by a vertical motor fixed on top of the framework. To the underside of this framework are attached the cage and lifting gear. As there is a difference of 480 volts between the rails, the wheels have to be insulated from the axles. Brushes press on each wheel and carry the current to the motors and the controller, which is of the universal type previously described. The lifting capacity is one ton, and the lifting is done with a 15-b.h.p. motor, the travelling motor being 3-b.h.p. There are two transporters on the track, and these displaced 11 hydraulic cranes. They work very well, and can easily perform the duties which were previously done by the hydraulic cranes. The number of units registered against these cranes averages 350 per month, which is very small, and if the wages of the boys who drive the cranes are added, the total cost taken at the power rate of most supply companies would be insignificant compared with that of the number of hydraulic cranes displaced.

ELECTRIFICATION OF RAILWAYS.—I.*

BY DR. GISBERT KAPP.

Before beginning to write out these lectures I did what specialists generally do—namely, looked in the "Encyclopædia Britannica" in the hope of finding a comprehensive article about the early history of the subject which might be utilised. In this I was, however, disappointed; the "Britannica" mentions only one case of the early history of electric propulsion on a railway, and gives no details. It says merely that a certain R. Davidson had constructed an electric locomotive which weighed five tons and was run at a speed of four miles per hour over the Edinburgh-Glasgow Railway. The date given is September, 1842. As in those days the trolley was unknown, we must conclude that this locomotive, like the well-known boat of Prof. Jacoby, was propelled by current derived from primary batteries.

The first electric railway in the modern sense of the term (that is, with current supplied to the motor by a conductor from a source fixed outside the vehicle) was undoubtedly that shown at an exhibition in Berlin in 1879 by Werner von Siemens. Although more like an interesting toy in appearance (Fig. 1), it had most of the characteristics of later work. A 3-h.p. motor was mounted on wheels and connected by spur gear with the axles. This was the locomotive, and it drew a few small carriages with seating accommodation for a few passengers after it. The speed was four miles per hour. The current had a pressure of 150 volts, and was brought to the motor by a "third rail" laid between the track rails, and a sliding contact was used as a connecting link between the conductor and the motor. The return current was taken back to the generating dynamo by the track rails. We have here some of the essential elements of the modern electric railway, and it is rather surprising to find that Werner Siemens in his next application of electricity to the propulsion of a vehicle on rails abandoned the principle of the "third rail," and used the track rails both as lead and return conductors. This was in the electric tramline (Fig. 2) at Lichterfelde, near Berlin, joining the railway station with

* Lecture delivered before the Royal Institution of Great Britain, Saturday, Jan. 18.

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the military academy. The voltage was 180 volts, and the maximum speed attained 22 miles per hour. The gauge was 1m., and the car, of which I throw a picture on the screen, weighed, with its full complement of 26 persons, 4·8 tons. Very soon after—namely, in 1883—the well-known Portrush-Bushmills line in Ireland was opened. This is a line with 3ft. gauge six miles long, and containing gradients up to 28 per 1,000. Here the third rail (91lb. per yard) is again used with return through track rails, and the speed on the level is 12 miles per hour. In America the first electric line was opened for traffic one year later, and from 1884 onwards there has been a steady development of electric traction, first for tramways and then for main lines of railway. I do not propose to sketch the history of this development in detail, as that would leave me no time for the treatment of the technical side, but I may draw attention to one landmark in this history—namely, the work done by a group of technical and financial men who formed a committee for the "study of high speed electric railways." By the close of the last century there had already been electrified various main lines, both in Europe and America, but the speeds were moderate, and the experience thus far obtained was hardly of the nature to enable engineers to predict what would happen if electrification were attempted at speeds equalling or exceeding the fastest runs of steam locomotives. It was to collect data on the various points affected by speed that the famous Zossen trials were made with two cars built by rival firms. With an expenditure of 1,000 h.p. the car (Fig 3) attained a speed of 125 miles per hour. It was fitted with four three-phase motors of nominally 250 h.p. each, but on starting the motors could be heavily overloaded, the total intake of power by the car amounting for short periods to as much as 3,000 h.p. The car weighed 94·5 tons. The working pressure was 10,000 volts three-phase current supplied by three lines erected vertically above each other by the side of the track. This method of arranging the trolley wires requires so much head room as to render the system inapplicable to existing lines on account of bridges and tunnels. The value of the Zossen trials lies, therefore, not in proving that high-speed electric traction is possible with the particular arrangement chosen, but in providing data on which to calculate the power required at high speeds and in the demonstration that it is possible to take off as much as 1,000 h.p. at so high a speed as 125 miles per hour. It should be noted that before the highest speed could be attempted the permanent way had to be strengthened.

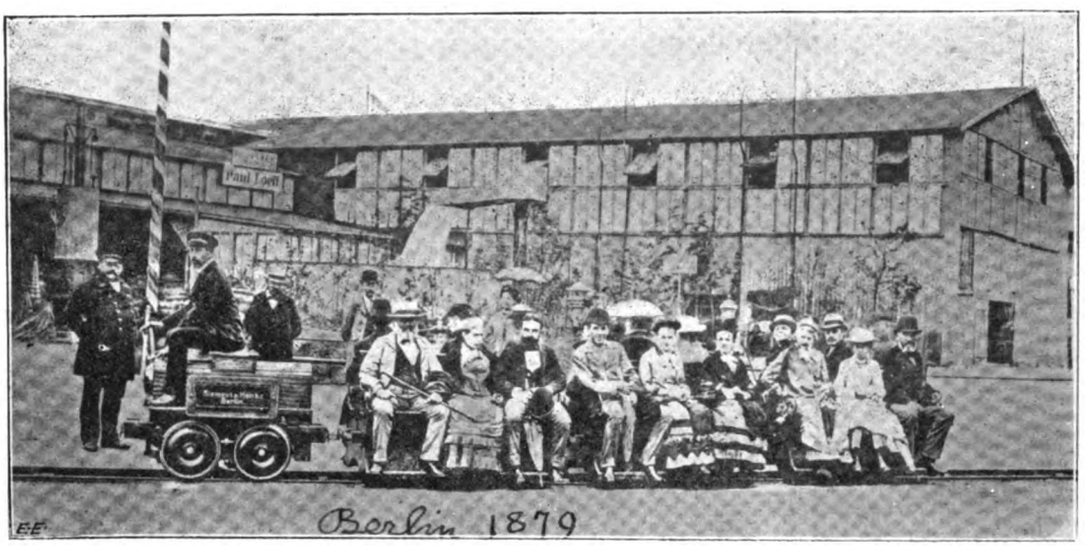

FIG. 1.—View of First Electric Railway in Berlin.

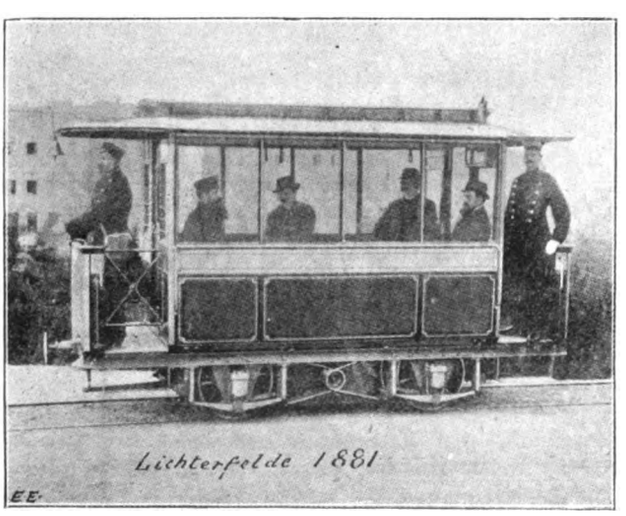

FIG. 2.—Electric Car at Lichterfelde.

ADVANTAGES OF ELECTRIFICATION.

It might be asked, Why should we electrify main lines? The answer is that we want to travel more frequently, more quickly, more safely, in greater comfort, and, if possible, more cheaply than by steam. As regards greater comfort and more frequent opportunity of travel, the superiority of electric traction has been demonstrated by the lines already electrified. As regards greater economy, the proof is as yet doubtful, but it would obviously be premature to deny greater economy merely on the ground that it has not yet been attained in the few isolated—and I might almost say tentative—installations started up to the present. When the electric light was first introduced into our homes we had to pay 8d. a unit, but now, with its more general application, the average price has come down to about half that sum. So it will be with electric travel. A few dozen miles electrified here and there can hardly be expected to result in great economies, but let the whole system be electrified and any inherent advantage in an economical sense must make itself felt. The economy will

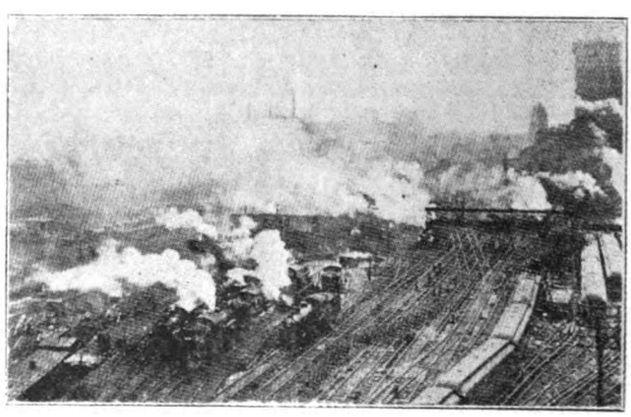

FIG. 5.—View showing the Interference of Steam with Signalling on the New York Central Railway.

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naturally be greatest in the countries where coal is dearest, and it is for this reason that we see the Swedish, Italian, and Swiss Governments considering the introduction of electric working on a large scale.

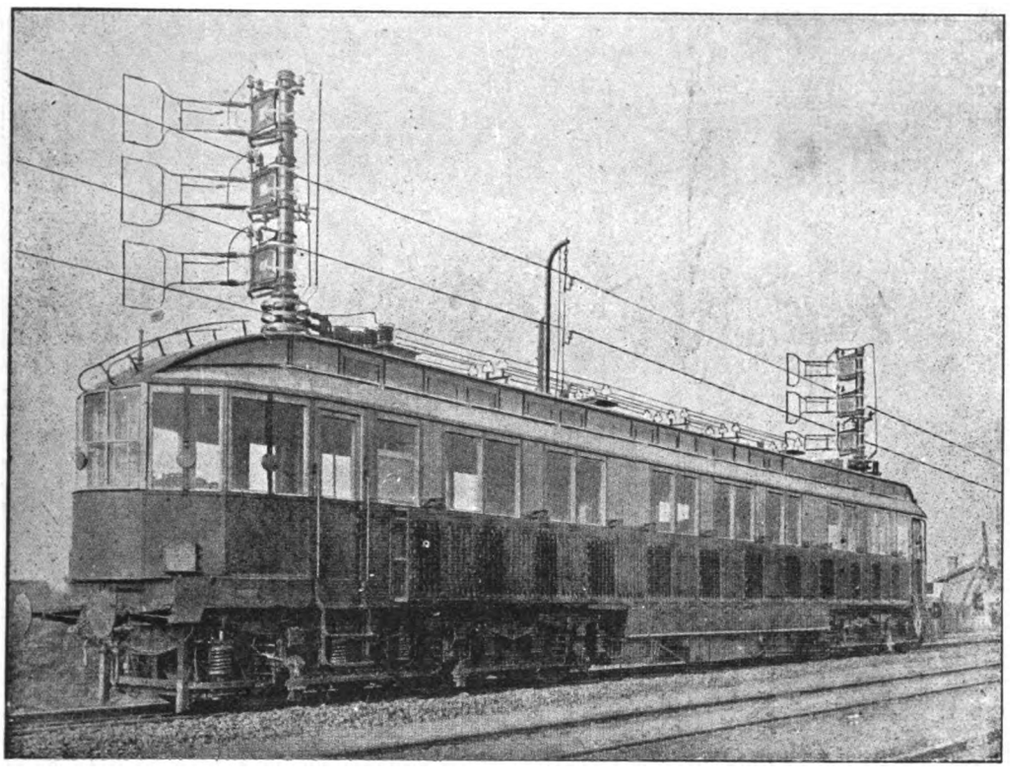

FIG. 3.—The Siemens 10,000-Volt Car which ran at 125 miles per hour on the Zossen line

The increase in traffic capacity, and especially the ability of the electric locomotive to handle heavier trains at higher speed, is due to the circumstance that, unlike the steam locomotive, it has not to carry the part that generates the power with it, but only the part that utilises the power.

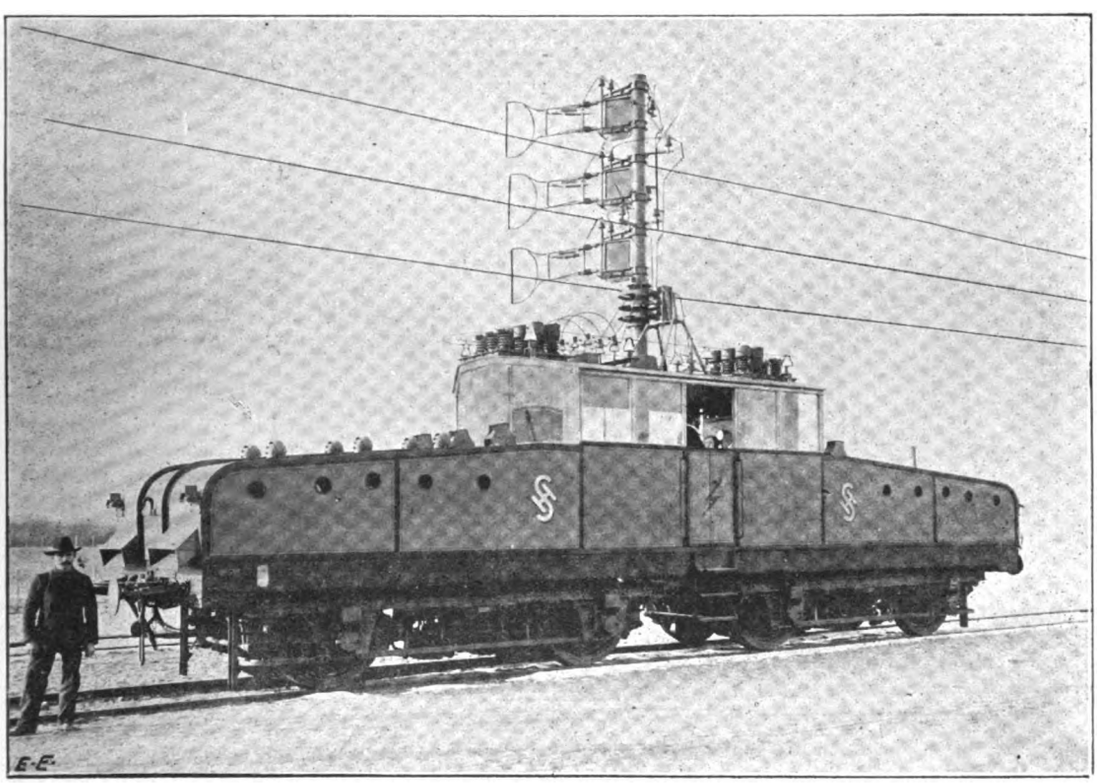

FIG. 4.—Electric High-Tension Locomotive on the Berlin-Zossen line.

In a steam locomotive the power is limited by the capacity of the boiler to generate steam. There is no such limitation in the electric locomotive, for the boiler (in the case that water power is not used) may be of any required size; there may be any number of boilers, and they may be arranged to burn any kind of fuel. There is no limitation to the power generated, but only to the power the motors on the locomotive can take up. Thus with equal total weight the capacity for dealing with heavy traffic is far greater in the case of the electric locomotive than in that of the steam locomotive. In this comparison I do not only mean drawbar pull, but the sustained effort of a strong pull exerted at high speed—in short, the horse-power. A modern electric express locomotive will develop about 30 h.p. for every ton of its own weight, and if built for slow passenger or fast goods service the power is about 22 h.p., whilst even for slow goods service on heavy grades the power developed per ton of its own weight is still 10 h.p. to 12 h.p. These figures are based on the gene-

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rally accepted rating of a temperature rise of 75deg. C. after one hour's run. For shorter runs the power will, of course, exceed the limits here given.

Another advantage of electric driving is the ability of exerting a greater drawbar pull at starting and on heavy grades, not only when by reason of motor coaches the adhesive weight is increased, but even in the case of locomotive traction for the same adhesive weight. In a steam locomotive the crank effort is not uniform. The skidding point is determined by its maximum and the drawbar pull by its mean value. In the electric locomotive the crank effort is uniform, and it will, therefore, with the same adhesive weight and the same safe margin against skidding, have a 30 to 40 per cent. greater drawbar pull than the steam locomotive. There is also greater safety against toppling over when going round curves. The modern steam locomotive with its enormous boiler has a high centre of gravity, in some cases 5ft. to 6ft. above rail level; the centre of gravity of an electric locomotive is only 3ft. 6in. to 4ft. above rail level. Owing to the absence of reciprocating masses, the working is smoother and the wear on rails less; and, finally, as more of the total weight may be utilised for adhesion, and as the adhesive weight itself is more effective, the traffic capacity of a given line can by electrification be increased, without those alterations in the permanent way which would be necessary if the same increase of traffic capacity were attempted by the use of heavier steam locomotives.

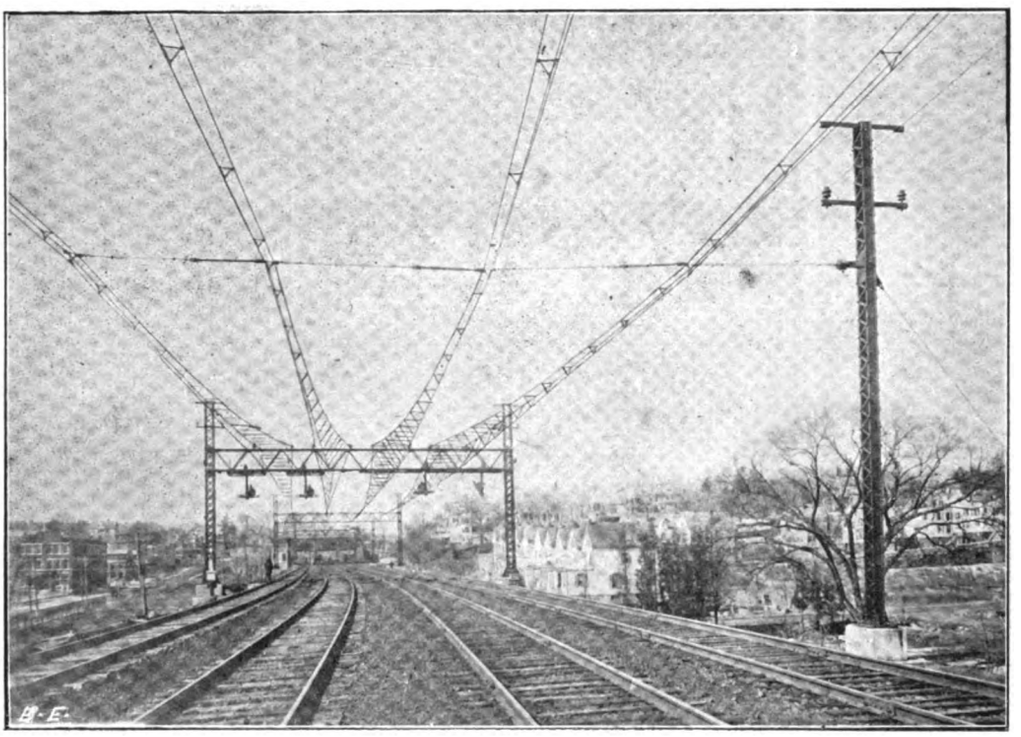

FIG. 6.—The Double Catenary System as used by the Westinghouse Co.

Then there is the question of economy in fuel and labour. By the latter I do not mean the labour actually required in driving a train. Although a fireman is not required, it would not be prudent to have only one man on the footplate on long express runs, although on short-stop runs this is perfectly safe. The saving of labour will come in consequence of the simplified service generally. There are no trips to the round house for cleaning tubes, and the

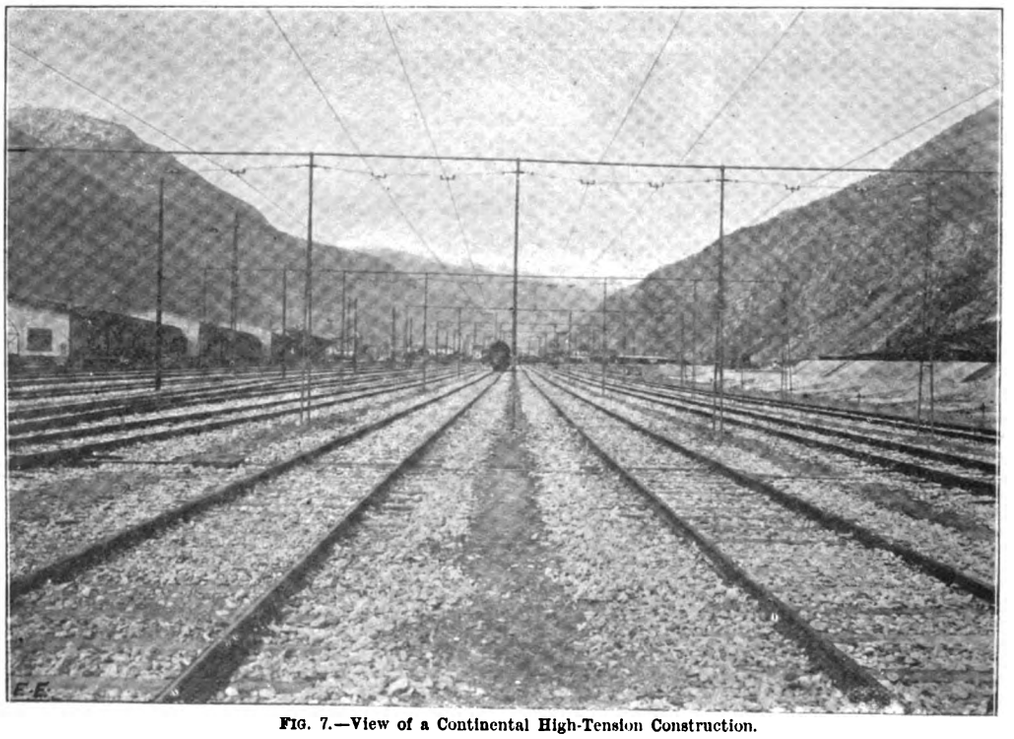

FIG. 7.—View of a Continental High-Tension Construction.

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labour in taking up brasses and generally keeping the gear in order will be much less than with the highly complicated

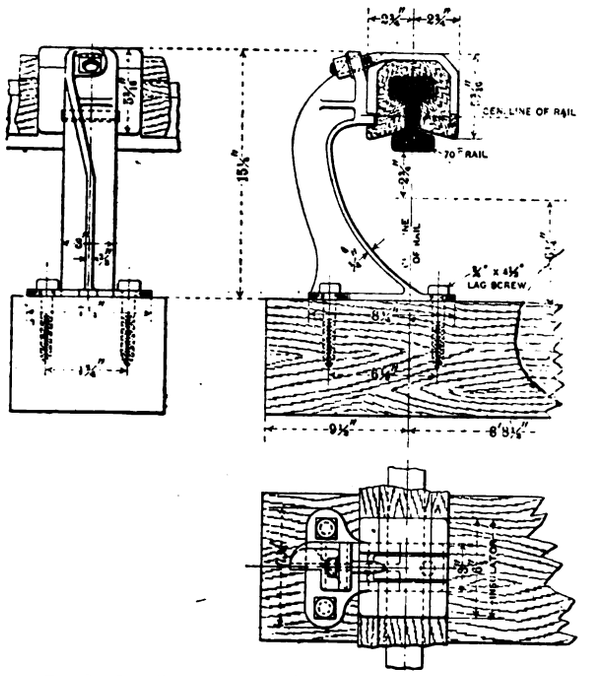

FIG. 8.—Details of Wilgus and Sprague Protected Third-Rail.

mechanism of a steam locomotive. The ability to run in either direction makes the turntable superfluous, whilst

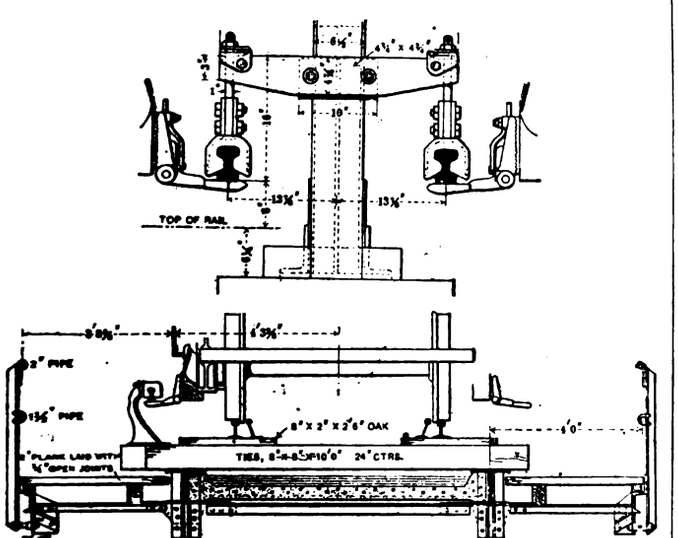

FIG. 9.—Details of Wilgus and Sprague Protected Third-Rail on the Philadelphia Rapid Transit Railway.

multiple control applied to motor coaches at both ends of the train greatly simplifies the make-up of trains. As regards the fuel consumption whilst the train is actually running, there is probably no other economy than can be obtained by the possibility of using a cheaper kind of fuel in the fixed boilers, since the better efficiency of fixed boilers and engines is offset by the losses in transmission and conversion; but we must remember that a locomotive is much longer under steam than in actual service, and

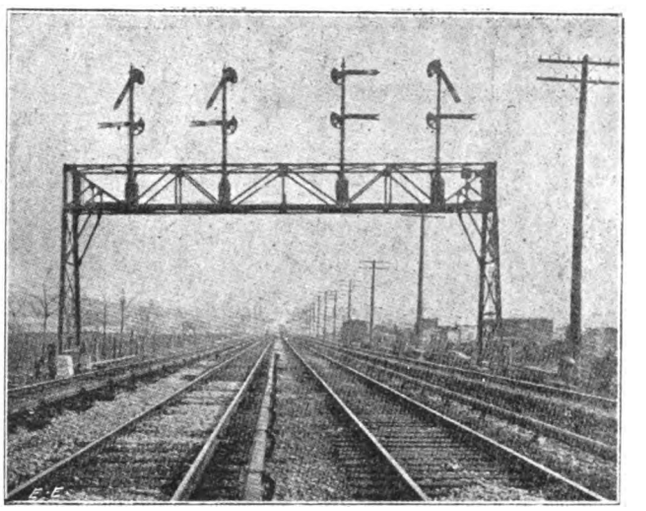

FIG. 10.—Protected Third-Rail on Four-Track Division, New York Central Railway.

that during the time it stands waiting or makes trips necessary in putting trains together (what railwaymen call shifting) fuel is also consumed. The electric locomotive consumes no fuel at the power-house except when actually at work.

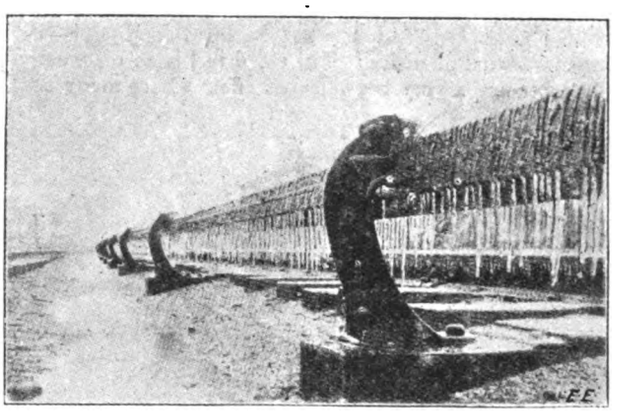

FIG. 11.—Protected Third-Rail after Sleet Storm.

All these are undoubted advantages, but what are the *objections to electric propulsion*. There can be no question that the electrical equipment of a train is as reliable as any mechanical apparatus can be, perhaps more so, because it is easy to fit safety appliances which will prevent overloading any part. Even under such trying conditions as the Simplon Tunnel, with its moisture and heat,

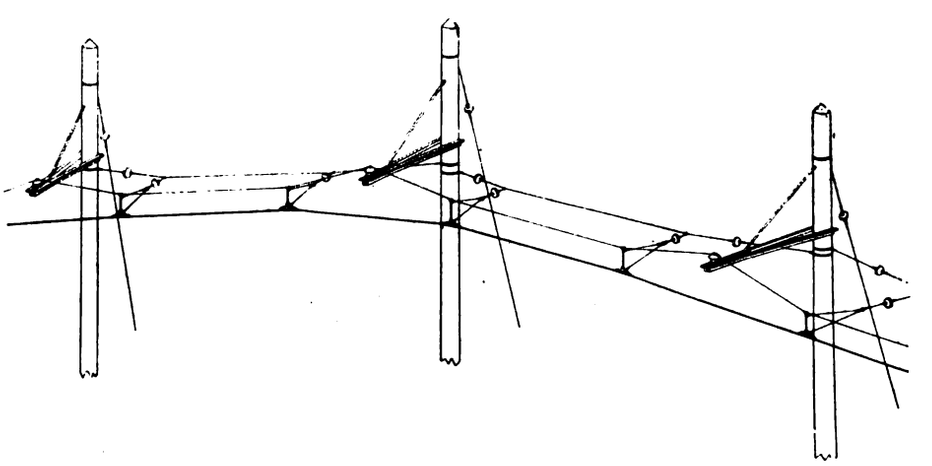

FIG. 12.—Curve Construction—Two Points of Pull-off designed by the General Electric Co. of America.

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means have been found of rendering electric working perfectly reliable. If electric traction has a weak part, it is certainly not in the train itself, but in the link between power-house and train—that is to say, in the conductor with its sliding contact. That this weakness is not a serious matter is shown by the fact that many

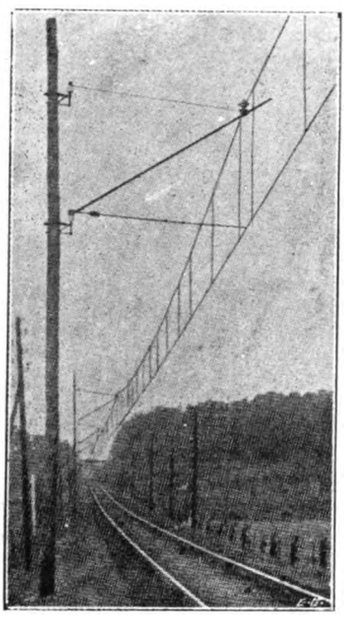

FIG. 13.—Single Catenary System.

hundreds of miles of electrified main line are now in successful operation, but still there are difficulties, and it is interesting to briefly glance at them and at the means applied to overcome them. Of the two systems—viz., a third rail on the ground and by overhead conductor—each brings its own difficulties. The third rail is an obstruction. It may become a very complicated affair where many roads meet and cross. It may be a source of danger to persons walking or working on the line, and it may fail to act if its working surface is covered with ice. The overhead conductor has the advantage of leaving the permanent way perfectly free from encumbrance, and there is less difficulty at points and crossings, but it may obstruct the view of signals. That steam locomotives are sometimes also offenders in this respect may be gathered from Fig. 5 which represents the terminus of the New York Central Railway before that line was electrified. Here smoke and steam render the signals invisible, and as the obstructing body is continually shifting there is no remedy. A network of overhead wires may also obstruct the view, but this kind of obstruction does not change its position, and it is,

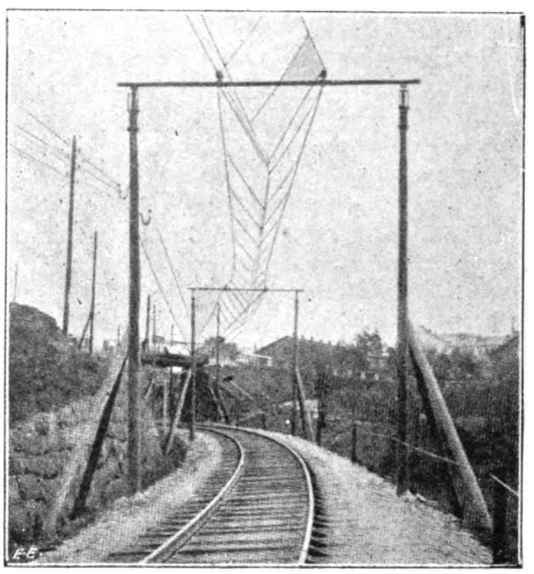

FIG. 14.

therefore, possible to so place the signals that they are permanently visible. The single-phase line erected by the Westinghouse Company (Fig. 6) and a part of the three-phase line leading to the Simplon Tunnel (Fig. 7) shows this. In both cases the signals are perfectly visible.

In most of the third-rail equipment used at present the working face of the conductor is on the top. This has certain disadvantages. The lower edge is only about 4in above the sleepers, so that the danger of earthing from accumulation of wet snow and ashes or from even a slight flooding of the line is present; it is difficult to guard the conductor from contact without at the same time interfering with the contact surface, and the latter cannot be completely protected from snow and ice. To overcome these defects, Messrs. Sprague and Wilgus have introduced a

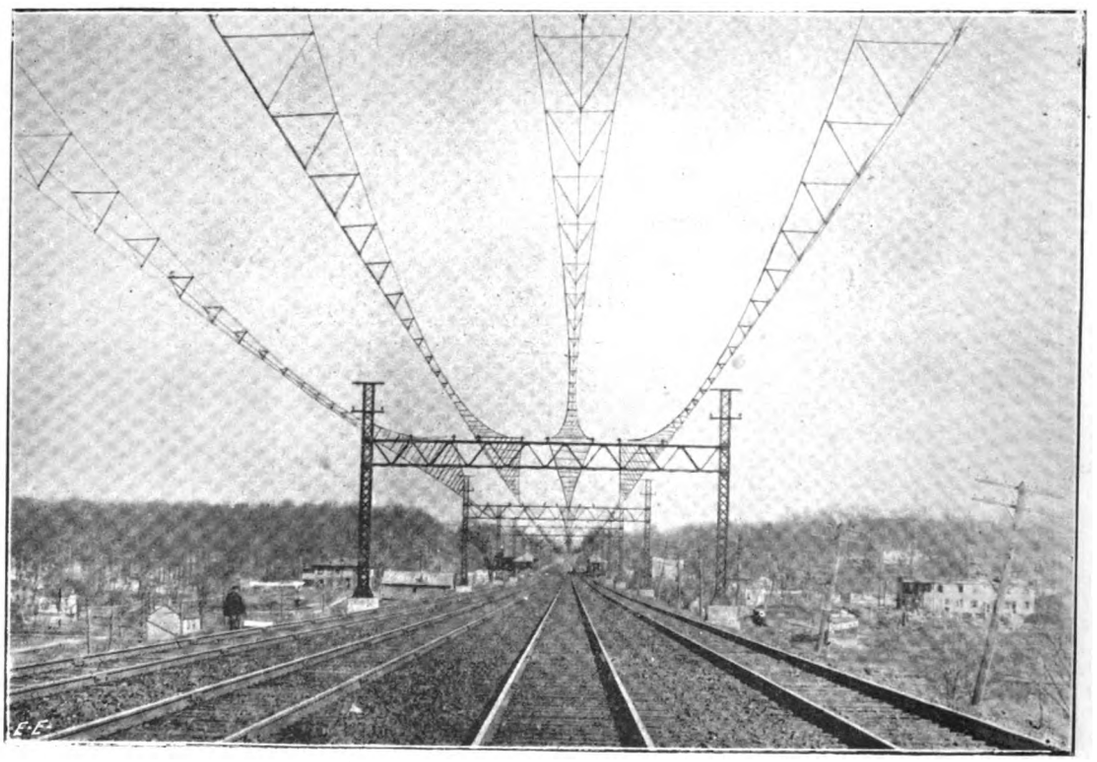

FIG. 15.—The Double Catenary System.

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type of third rail with "under-running contact shoe." (Figs. 8 and 9). The lower edge of the third rail, which is also the working face, is 9in. above the sleeper and nearly 3in. above the top of rail. The exposed part is sheathed with a fibre trough, leaving only the underside free for the contact, and although

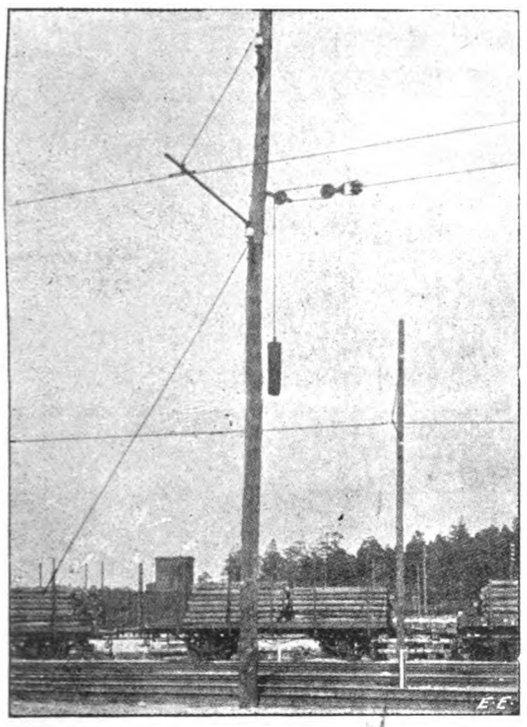

FIG. 16.

sleet may accumulate on the top and side of the rail it does not adhere to the contact face. On the New York Central system 285 miles of track are now being equipped with the Sprague-Wilgus third rail (Figs. 10 and 11), and some other American lines have also adopted it.

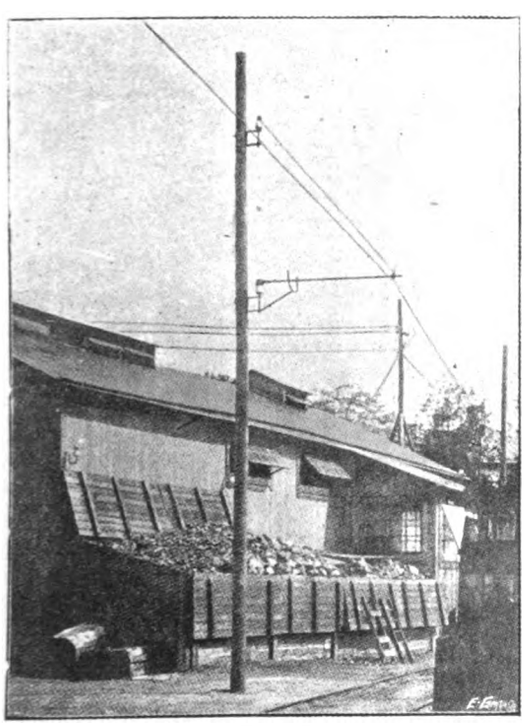

FIG. 17.

In overhead construction for high speeds care must be taken to keep the conductor as straight as possible, as any sharp bends will cause the contact piece to jump and by drawing an arc to damage the wire. This was the reason why in the Zossen experimental line a side contact was provided. It was thought that with such an arrangement the sag of the wire could not affect the relative position of wire and contact piece, and this reasoning has proved perfectly correct. As, however, the head room necessary for the Zossen arrangement renders its adoption on existing lines impossible, another solution had to be found. This is the suspension by catenary. The catenary itself may have any sag required to render the system almost independent of temperature variation, and the suspension of the contact wire is effected by hangers of varying length, so that all the suspending points are exactly on the same level. Since the hangers can be placed fairly close to each other (three to ten yards), the sag of the contact wire can be made imperceptible. There is the further advantage that in the event of the contact wire breaking it will dangle free and not reach the ground. This is shown in Figs. 12 and 13 illustrating the arrangements of the "single catenary system" used by the General Electric Company of America, and the double "catenary system" (Figs. 14 and 15) used by the Westinghouse Company and on the Swedish State Railways. On the latter the trolley wire is sub-divided into sections, one end of each section being anchored and the other attached to blocks and falls and a weight, which puts a definite tension on the wire whatever the change of length may be. The suspending arms are, of course, hinged to allow for automatic adjustment. Messrs. Siemens-Schuckertwerke have carried the catenary system still a step further by arranging two catenaries one above the other. The uppermost has long spans, and the lower is attached to it at frequent intervals by adjustable straps, the adjustment being possible in a vertical direction by altering the length of the strap and in a horizontal direction by shifting the clamp on the trolley wire. Stiffness at right angles to the axis of the trolley wire is obtained by horizontal pull-off wires. It should be noted that in all these systems the catenaries and all wires attached to them are insulated, so that the trolley wire is doubly, and in some cases trebly, insulated from earth.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.

On the resumption of the discussion on Mr. J. F. C. Snell's paper on "The Cost of Electrical Power for Industrial Purposes" before the Institution of Electrical Engineers on the 16th inst.,

Mr. C. P. SPARKS complimented Mr. Snell on his paper, and said that with respect to the driving of mills the average load factor would be from 25 to 30 per cent., and it was not possible to show any considerable financial saving from the introduction of electric driving if the cost of power only was considered. It was the indirect advantages from using electric motors in textile mills which warranted electric driving. These were: the smoother drive, the absence of slip, and the advantage of having the motor close to the machinery driven. He considered that the author's figure of 0·48 per unit was not far wrong for a small mill, and he had also found that the cost of plant could be kept down to between £11 to £13 per kilowatt. This made it almost impossible for a power company to supply such mills. With respect to Table III., he thought that the consumption of only 250 units per horse-power installed per annum was an exceptionally low figure. While he agreed with the author as to the importance of the diversity factor, he did not agree with him that the importance of the lighting business was decreasing. He considered that the introduction of the metallic-filament lamp gave supply engineers a strong weapon with which to fight gas. His experience had shown that the units required for lighting had not fallen owing to the introduction of these lamps, although they gave three times the candle-power for the same energy. He considered that electric lighting was of ever-increasing importance, and that the metallic-filament lamp was the best friend of the supply engineer.

Mr. ROBERT HAMMOND congratulated the author on his communication, and confirmed his remarks as to the effect of the diversity of the load provided by different industries. Thus when an annual charge of £7 per kilowatt of maximum load on the central station was required to meet the capital charges and profit, a diversity factor of 1·66 reduced the corresponding charge to the consumer to £4. 4s. per kilowatt demanded. This on a 20 per cent. load factor was equivalent to ·35d. per unit. He supposed that in the course of time some scale of charges might be devised which would give an equitable rate to the consumer, considering not only his load factor but also the effect of this

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load on the diversity factor. He considered that the figures given in Tables I. and II. for the cost per unit generated from independent plants were too low. Thus, in Table II., for plants from 100 h.p. to 500 h.p. on a 25 per cent. load factor the cost from a steam plant was 0·59d. per unit. The author's own figures from a shipyard with four 250 h.p. steam-engines showed a cost of 0·970d. There was a difference here of over a halfpenny. Again, if these figures were compared with those in Table VIII. it would be seen that the cost from some of the best stations in the kingdom were higher than the author gave for private plants. He hoped that the discussion begun that night would be continued in the House of Commons Committee rooms this year, and that the supply of power to London would be cheaper thereby.

Mr. COWAN said that central-station engineers had been accused of supplying power consumers too cheaply and at the expense of the lighting consumers. The test of this and of the correctness of the scale of charges was that both the lighting and power consumers should gain from the combination. Mr. Cowan proceeded to show in diagram form how the intensity of load could be improved by the combination.

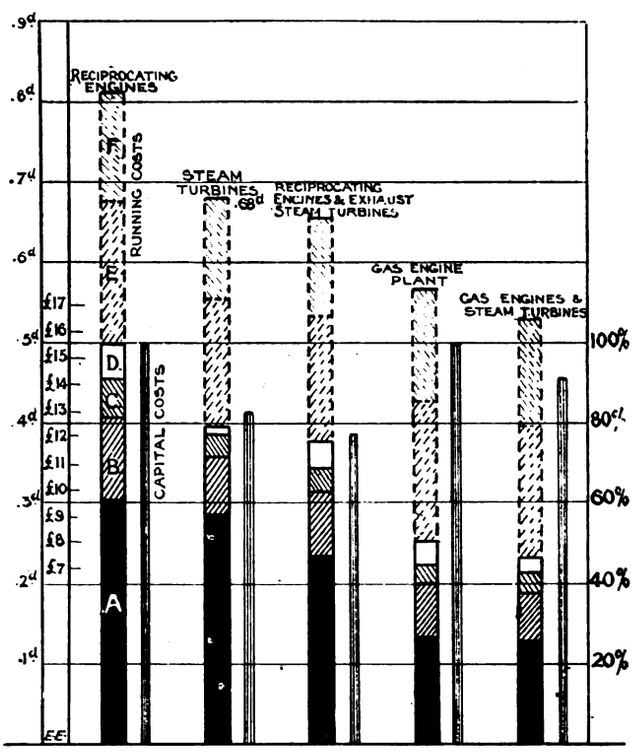
Mr. G. L. ADDENBROOKE did not quite understand the figures given by Mr. Snell in Tables I. and II. For instance, in Table II., were the figures the average for stations between 100 h.p. and 500 h.p.? He had found when looking for consumers in power companies' areas that the manufacturers were fully alive to the best results which could be obtained from new plant. They also knew that their existing equipment would last for a considerable length of time, and were inclined to expect the power company to show them a saving on their existing works cost without allowing anything for capital. Mr. Addenbrooke proceeded to show how the magnitude of a power company's load varied the price which had to be charged to consumers to show a return on the capital expenditure. Thus, with a 3,000-kw. maximum load ·8d. per unit had to be earned, if the load went up to 60,000 kw. ·4d. would pay, or with an 80 per cent. load factor nearly one-half this price. He had found from experience that to gain the full advantage from combination a station should be about ten times as large as that required to supply the load from the largest consumer.

Mr. C. H. WORDINGHAM thought they should be grateful to Mr. Snell for explaining the many fallacies which accounted for the existing position of most of the power companies. The paper would also help central-station engineers, many of whom did not know what the diversity factor on their system was. As regards power companies, the linking up of several towns in which the industries were the same would not improve the diversity factor on the larger station. He also pointed out that when a large system of mains had to be laid it was some years before the load on them became remunerative.

Mr. W. H. BOOTH called attention to the important consideration of the heating of textile mills. If these were electrically equipped, there was no longer any exhaust steam available for heating, and coal would have to be burnt for the purpose. He quoted the case of two new mills owned by one company, one of which was electrically driven. In this case the steam for heating was taken from the other mill, which was driven in the usual way. While a gain of 7·5 per cent. in output was claimed for the electrical mill, it was a question whether the exact cost of heat and power were properly adjusted between the two. Mr. Snell's idea of improving the diversity factor by altering the dinner hour of certain factories would not commend itself to the Lancashire housewife, who now had all her family home to dinner at the same time.

Mr. G. W. PARTRIDGE said that from his experience of 20 years with the supply to London areas he was sure a diversity factor of 1·66 would never be obtained; 1·25 was a more likely figure. He considered the figures in Table VI. much too low for the cost of mains in London. It always took some years to get consumers to come on to load up new mains, and until cables were laid they would not consider the question. Due to the very high cost of street work in London, £30 per kilowatt would be the cost of mains for the first few years. Even at Newcastle the feeders and distributing system cost £26 per kilowatt. If the author had taken £23 per kilowatt for the final cost after the load had been obtained, it would be nearer the mark.

Mr. LEONARD ANDREWS confined his remarks to the difficulty referred to by the author and by previous speakers of supply undertakings catering for power at such rates as to hold their own with local plants. He did not consider competition with private plants of less than 100 h.p. was likely to prove such a great difficulty, inasmuch as the convenience of, and small floor space required for, an electric motor would generally outweigh any saving in actual cost that it might be able to effect, even under conditions most favourable to local plants. The chief difficulty would appear to be that of competing with the local supply to works taking, say, 500,000 units a year and upwards. Previous speakers had attempted to deal with the difficulty by suggesting that Mr. Snell's estimates and Tables I. and II. unduly favoured the local plant. He would prefer to see the problem attacked from the other end—that was, to consider whether it was not possible for the cost of production from a large power plant to be still further appreciably reduced. Mr. Snell had expressed the opinion that there was little prospect of power companies materially reducing their charges for power supply in bulk below the estimates given in Table XIV., say ·68d. for transformed alternating-current supply under conditions of a 20 per cent. load factor and 1·66 diversity factor. He would like to ask Mr. Snell whether, in arriving at that conclusion, he had taken into consideration the recommendations contained in a paper read in 1906 before the American Institution of Electrical Engineers by Mr. Stott, the chief engineer of the Rapid Transport Company, on "Power Plant Economics." In that paper Mr. Stott showed that the cost of supplying current from a large power station could be greatly reduced by dividing the generating plant into two portions. In one portion, which would be reserved for the peak of the load, and only run for a few hours per day, economy in running would be sacrificed to low capital cost. The other portion would deal with the flat part of the load curve, and since it would be running many hours per day, high working economy was obviously of paramount importance. Mr. Stott concluded his paper by tables showing the relative capital and running costs of five different methods of generating power. Mr. Stott's conclusions were reproduced in diagrammatic form, and some further deductions



A, Coal; B, Labour; C, Repairs; D, Oil, Waste, Water, and Stores; E, Interest and Depreciation, 6¼ per cent. on Capita; F, Rent, Rates, Taxes, and Management Expenses, 5 per cent. on Capital.

had been made to bring Mr. Stott's estimates into line with the estimates given by Mr. Snell. It was supposed that Mr. Snell's estimates were based upon the assumption that the generating plant would be steam turbine-driven alternators, and Mr. Stott's estimate of the capital cost of that type of plant had been plotted to correspond with Mr. Snell's figure of £13 per kilowatt. The relative capital costs given by Mr. Stott of other types of plants were plotted to a similar scale. To ascertain the running costs Mr. Snell's figure of ·68d. for steam-turbine generation had been taken, and an item of ·157 had been deducted, which corresponded to Mr. Snell's capital charge of 6¼ per cent. on the cost of the generating plant, mains, and transformers with a load factor of 20 per cent. and a diversity factor of 1·66. A further deduction of ·125d. (corresponding to 5 per cent. on the capital outlay) to cover rent, rates, taxes, management expenses, etc., left a balance of ·4d. to cover running charges, and Mr. Stott's estimates had been plotted to that scale. The capital and running charges for other systems had been plotted in a similar way, Mr. Snell's and Mr. Stott's figures being strictly adhered to in each case. The results appeared to show that by adopting Mr. Stott's recommendation and combining in one generating station the most economical plant obtainable with a plant having the lowest capital cost, it would be possible for a supply company to reduce the figures given by Mr. Snell to the extent of approximately 22 per cent. Those members who had met Mr. Stott would cordially agree that considerable reliance could be placed upon his estimates. He might further mention, as a practical example of what had already been done in that direction, that he recently had an opportunity of visiting a power supply station in Germany

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where gas-engines and steam-turbines were running in parallel, and he was told that high-tension power in bulk was being supplied from these works to a town about 30 miles distant from the generating station (by overhead transmission) at an average price of ·5d. per unit.

Mr. A. M. TAYLOR considered the paper to be full of valuable data and suggestions, but that it did not deal sufficiently with the supply of consumers smaller than 100 h.p. In Table VII. he thought the question of the cost of distribution from the sub-stations connected to the power company had been ignored. In Fig. 1 the low cost assumed for the generating station made the results less valuable to the engineer with an averaged sized system. Even then Mr. Snell found the limit of supply to be 10 miles if private plants of moderate size had to be competed with. In Mr. Snell's paper of four years ago accumulator sub-stations were advocated. He should like to know why no mention was made of them in the present paper. He (Mr. Taylor) found it possible to put accumulators to give 6-kw. output on a 2½-hour discharge on one square yard of floor space, or, if in two tiers, 12 kw. per square yard. The capital cost could be got down to £12 per kilowatt output on a 2½ hours' basis, or £5 per kilowatt on a one-hour basis. He considered that Table VIII. did not give sufficient credit to the municipal undertakings. Thus, for Manchester the figure indicated a cost of £8·48 per kilowatt of maximum demand on the station + ·39d. per unit. He thought that £9·98 per kilowatt and ·2d. per unit nearer the mark. He strongly objected to Mr. Snell's table, which assumed a constant diversity factor of 1·66 for varying load factors on the station. Thus, if the consumer's load factor increased, the diversity factor of the general load must go down. In other words, Mr. Snell should have added a seventh column to Table IX. giving varying values of the diversity factor corresponding with improvements in the class of load. Table XII. also contained what the speaker termed the fundamental heresy of dividing the charge per unit (on account of fixed charges) by the diversity actor.

Colonel R. E. CROMPTON, speaking from the chair, welcomed this further opportunity of discussing the question of power supply. He disagreed with the author's remarks as to the design of central stations being now at the highest level. There was no finality in such matters. The experts now interested in power schemes would, if their schemes were carried out, find their plant in 10 years' time to be quite as out of date as the equipment of the central stations was now said by them to be. He endorsed Mr. Snell's figures for the costs from private plants. The paper was a good one to educate the public as to the usefulness of electricity. In conclusion, Colonel Crompton strongly contradicted the idea that we were behind other countries in this matter. From his experience London was better supplied with electric light and electric power than any other city in the world.

Mr. SNELL, in reply, explained that the Newcastle-on-Tyne Company's figures in Table XIII. were for the year ending 1906. He regretted that the cost of accumulators was too high to allow of their use on a large scale. He believed that the diversity factor here assumed of 1·66 would be found to be too low for London rather than too high.

The meeting concluded with a vote of thanks to the author.

Mr. W. B. ESSON, in a written communication, expressed his agreement with many of Mr. Snell's observations. It appeared to him that the author had adopted throughout an unbiassed attitude, dealing with his subject in a singularly fair manner. Much of the ground covered by the paper was covered by his (the writer's) address on "The Industrial Power Problem" to the Civil and Mechanical Engineers' Society in October, 1906, and Mr. Snell arrived at practically the same conclusions as he did. In the address referred to the cost of electrical power for a factory which could be served by an engine of 500 b.h.p. was considered when Mond gas, suction gas, steam (condensing and non-condensing), and oil were used. It was assumed that the generator would give 350 kw. maximum, and would supply 750,000 units per annum, this corresponding to a load factor of about 25 per cent. The cost of the fuel was put in at rates somewhat different from Mr. Snell's, but the total cost, taking 10 per cent. as the interest on capital outlay and depreciation, worked out, and was given as follows: Mond gas, ·516d. total cost per unit; suction gas, ·564d.; steam condensing, ·513d.; steam non-condensing, ·536d.; oil, ·592d. The figures given by Mr. Snell in Table II. for a load factor of 25 per cent. were: suction gas, ·670d.; steam, condensing, ·590d.; oil, ·584d. Mr. Snell's figures were somewhat higher because he averaged the cost of plants between 100 h.p. and 500 h.p., whereas his were for the higher output. The agreement was sufficiently close, however, to show that under ordinary circumstances the total cost would lie somewhere between ·5d. and ·6d. per unit. Mr. Snell had stated that in Sunderland at the time of the last census "there were 587 motors, representing a total horse-power of 1,634, or an equivalent to 1,220 kw. The maximum demand on the station plant was only 500 kw. There was thus a diversity factor of 2·4." He did not think, however, that the term diversity factor should be used here. There was a diversity factor in lighting as well as in power, but no one would define it as the ratio of the number of lamps fixed to the number simultaneously lighted, though that would be analogous to the definition given by Mr. Snell. Properly, the magnitude of the diversity factor expressed the degree to which the load factor was improved by the diversity in the hours of demand in the industries supplied, and it could only be determined by ascertaining the ratio of the sum of the maximum demands of all the factories served to the maximum demand on the power-house. If it was found that the former was 50 per cent. greater than the latter, the diversity factor = 1·5, because the load factor on the power-house was one-half better than if there were no diversity; if 100 per cent. greater, the diversity factor = 2, because the load factor was twice as good, and so on. The diversity factor could not be got at by taking the sub-station loads as Mr. Snell had done, for the simple reason that at each sub-station the demands of all the factories served therefrom were already averaged up. It was quite possible that, though the real diversity factor might be very large, the sub-station to power-house ratio might be unity. Mr. Snell, under a misapprehension, again referred in this connection to the horse-power of the motors simultaneously running as compared with the total horse-power installed, but that had nothing to do with either load factor or diversity factor, if to these terms were assigned their proper meanings. He agreed with Mr. Snell's remarks in Section IV. as to prices. There was no doubt whatever that for a big increase in the amount of power supplied by the companies at the same rates it would be found that the total receipts were not commensurate with the total costs. The writer referred to his communication of 15 months ago, when he wrote: "At 4d. per unit for lighting and 1d. for power the machinery to produce the same revenue must, when supplying power, run four times as many hours as when supplying light. To produce that revenue nearly four times the amount of coal and oil is consumed, to say nothing of extra wear and tear, all of which goes to show that for a purely power undertaking to be successful it must be conceived on a scale such that the capital cost per horse-power is as low as possible, and the running charges are brought down to the irreducible minimum." The existing London stations were not conceived on those lines, and it was with great regret that, as managing director of a supply company, he had to admit it.

The following were the candidates to be balloted for at the meeting:

Members.—Major W. B. Brown, R.E., War Office, Whitehall, S.W.; H. P. Gibbs, chief electrical engineer to Government of Mysore, Bangalore, India.

Associate Members.—H. W. Arbuckle, Rifle Factory, Ishapur, near Calcutta; R. H. Bradbury, 49, Birmingham-street, Oldbury; L. Burn, 13, Mayhill-road, Old Charlton; F. A. Cole, Sandymount, Helsby; E. Comerford, Abbots Grange, Chester; H. G. Cotsworth, Mining and Technical College, Wigan; R. W. J. Fletcher, 44, Garscabe-terrace, Edinburgh; J. K. Forrest, Tramway la Capital, Avenida de Mayo 761, Buenos Ayres; P. V. Gray, Bombay Electric Supply and Tramways Company, P.O. Box 192, Bombay; C. J. Grimes, care of Port Commission, Calcutta; H. J. Harpin, 47, Temple-row, Birmingham; H. W. Hartnell, Corporation Electricity Department, Cheltenham; W. L. James, 22, Sutherland-avenue, Maida Vale, W.; J. Lloyd, Corporation Electricity Works, Norwich; C. H. Lydall, Cleveland Durham Electric Power, Fylands Bridge Power Station, Bishop Auckland; J. J. McMahon, Clare-mount, Queen's-road, Cheetham Hill, Manchester; A. McPherson, 30, McCulloch-street, Pollokshields, Glasgow; A. W. Martin, Postal Telegraphs, Cambridge; W. L. Maxwell, Electrical Department, Central South African Railways, Pretoria; W. R. May, 134, Denmark-road, Lowestoft; W. F. Mitchell, Electricity Works, Dewar-place, Edinburgh; T. B. Naylor, care of Mr. R. P. Wilson, 66, Victoria-street, S.W.; G. K. Paton, North Wales Power Co., Llanberis, R.S.O.; E. G. Phillips, Heatherbrae, Priory-hill, Dartford; R. J. Roberts, Hopesay Rectory, Aston-on-Clun, R.S.O.; E. Rowarth, Pattersea Polytechnic, S.W.; C. W. Smith, Clandon, Woodside-road, Kingston-on-Thames; Prof. W. Templeton, Ceylon Technical College, Colombo; Sandilands, M.A., B.Sc., Ceylon; S. W. Thomas, Post Office, Sydney, New South Wales; B. Wiesengrund, Ph D., 13, Woodside Park-gardens, North Finchley, N.; P. A. von Wildenrath, Box 36, Premier Diamond Mine, Transvaal; A. R. Woodhall, Midland Engineering Co., 2, Victoria-square, Birmingham.

Associates.—Major J. Bruce Kingsmill, R.A. (retired), Messrs. E. S. Hindley and Sons, Bourton, Dorset; H. Foulds, Faraday House, Southampton-row, W.C.; L. S. Simpson, assistant loco. superintendent, Buenos Ayres and Pacific Railway, Calle 25 de Mayo 227, Buenos Ayres; W. B. Trafford, Sun Fire Office, Threadneedle-street, E.C.

Students.—F. Alexander, Brant House, Wimbledon, S.W.; A. J. Anido, 22, Cheniston-gardens, S.W.; M. B. Baker, Faraday House, Southampton-row, W.C.; A. N. Balme, Vale Cottage, Vale-road, Chislehurst; P. E. Bamford, 56, Curzon-road, Southport; J. T. Baring, Verne House, Brundall, Norwich; L. Barney, Prior Park, Clonmel, Ireland; R. H. Batson, 591, Duke-street, Dennistoun, Glasgow; G. H. Baxter, 20, Brunswick-road, Withington, Manchester; S. Baxter, 1, Laverockbank-road, Edinburgh; C. W. Boak, 5, Robertson-street, Greenock; A. G. Bower, care of Mr. W. J. Bower, East Rudham, King's Lynn; R. A. S. Boyton, 23, Leicester-street,

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Ashton-under-Lyne; H. M. Bruton, 102, Riggindale-road, Streatham, S.W.; L. G. Bulmer, Brook Cottage, Prescot, Lancs.; J. H. P. Burchett, 38, Mortlake-road, Kew; F. E. Burnett, 36, Buckingham-gate, S.W.; M. N. Caird, Faraday House, Southampton-row, W.C.; R. W. Canning, 180, The Grove, Hammersmith, W.; E. G. D. Carr, Amberley Vicarage, Sussex; R. A. Cartland, Faraday House, Southampton-row, W.C.; A. G. B. Chaldecott, Holmwood, Dorking; T. W. Chalk, 51, Drayton-gardens, South Kensington, S.W.; A. Collins, 86, Chesterfield-gardens, Harringay, N.; J. Conway, 11, Monteith-row, Glasgow; N. R. Corke, 16, Auckland-road, Upper Norwood; E. Crawshaw, 41, Plymouth-grove, Manchester; G. G. Cree, Deanston Villa, Doune, by Stirling; A. W. Crompton, 28, Highfield-road, Smithills, Bolton; E. V. E. Crosse, 29, Beckwith-road, Herne Hill, S.E.; S. P. Dass, Napier Villa, Lancaster-road, Rangoon, India; J. J. de De Mesquita, 3, The Esplanade, Dover; A. E. Dent, 54, Hibson-road, Nelson, Lancs.; T. A. F. Dixon, 1, Marlborough-road, Richmond; A. McL. Doig, 123, Plymouth-grove, Manchester; G. O. Earle, 21, Park-hill-road, Croydon; E. W. Eller, 82, Palace-gardens-terrace, W.; G. J. Farrelly, 38, Acombe-street, Whitworth Park, Manchester; A. H. Finnis, Blantyre, Barrowgate-road, Chiswick, W.; F. G. Foote, 39, Meteor-road, Westcliffe-on-Sea; R. Ford-Hutchinson, Faraday House, Southampton-row, W.C.; J. F. Forrest, 61, Musgrove-road, New Cross, S.E.; K. P. Framjee, 83, Finlay-drive, Dennistoun, Glasgow; G. Franklin, Westinghouse Works, Trafford Park, Manchester; F. W. Geoghegan, Rockfield, Blackrock, co. Dublin; J. A. Gibson, Faraday House, Southampton-row, W.C.; L. B. Gilbert, 68, Sydney-street, Chelsea, S.W.; C. M. Gillies, 126, Dora-road, Wimbledon-park, S.W.; W. T. Golden, Faraday House, Southampton-row, W.C.; J. M. Goodall, 27, Tollington-place, Tollington-park, N.; A. G. Gow, 5, Robertson-street, Greenock; M. F. Gower, Orford House, Orford-road, Walthamstow, E.; H. P. Guy, 8, Burghley-road, Highgate-road, N.W.; J. Hacking, 60, Southmount-street, Beeston Hill, Leeds; L. Harding, 41, Russell-street, Eccles; E. A. Hilton, Heath Bank, Marple Bridge, near Stockport; J. H. N. Hingston, 16, Richmond-mansions, Earl's Court, S.W.; S. M. Hitchcock, Sunnydene, Kilworth-avenue, Southend-on-Sea; W. R. C. Hockin, Gloddeth-grove-road, Ramsgate; J. Hollingworth, Lavendon, Douglas-road, Harpenden, Herts; B. W. Holman, 40, Thurlow Park-road, West Dulwich, S.E.; P. E. Hosegood, 6, The Waldrons, Croydon; E. F. James, 1, Rusham-road, Balham, S.W.; E. Josephs, 51, Downs Park-road, Hackney, N.E.; L. J. Jowitt, 114, Cecil-street, Whitworth Park, Manchester; S. Kay, 17, Bark-street, Bolton; R. E. Keelan, 131, Witton-road, Aston Manor, Birmingham; C. Kelley, 2, Connaught-road, Harlesden, N.W.; A. F. Kelly, Elsinore, Cherry Gardens-avenue, Folkestone; T. M. Klein, 12A, Maddox-street, W.; C. T. Kreiser, Faraday House, Southampton-row, W.C.; R. Larkworthy, 13, St. George'-avenue, Holloway, N.; W. R. Lewis, Faraday House, Southampton-row, W.C.; R. F. Long, 1, Elliot-road, Thornton Heath; D. W. Low, Dunlea, Minard-road, Partickhill, Glasgow; W. C. McCallum, 7, Grafton-square, Clapham, S.W.; E. S. McClintock, Faraday House, Southampton-row, W.C.; G. B. Manson, Burghley House, Blackheath-hill, S.E.; H. C. R. Martin, Crystal Palace Engineering School, Sydenham, S.E.; L. C. Martin, 29, St. Edward's-road, Southsea; L. J. Matthews, 24, Hartham-road, Holloway, N.; C. Melbourne, 224, Wilderspool-road, Warrington; E. A. Mills, 58, Radcliffe-lane, Pudsey, Leeds; R. M. Murché, Haslemere, Lovewalk, Denmark-hill, S.E.; R. E. Neale, 10, Wentworth-mansions, John-street, Hampstead, N.W.; V. W. Newman, 33, Combe-park, Bath; J. B. G. Northcott, Lambourne, Callestick, Cornwall; V. S. Padhye, 222, Brunswick-street, Manchester; R. G. Parrott, 63, Northumberland-road, Old Trafford, Manchester; T. H. L. Paull, 18, Elm-grove-road, Barnes, S.W.; M. L. Peel, 5, Regent-terrace, Gateshead-on-Tyne; C. B. Penrose-FitzGerald, The Grange, Midleton, co. Cork; T. C. Pettifor-Catchpool, 38, Forest-drive East, Leytonstone, E.; M. Pitt, 7, Maitland-avenue, Langside, Glasgow; H. E. Poole, 15, Sherriff-road, West Hampstead, N.W.; W. A. Prescott, 23, Moorfield-road, West Didsbury, Manchester; A. Priestley, 74, Arden-terrace, Plantation-street, Accrington; G. R. D. Prince, 24, Tierney-street, Streatham Hill, S.W.; G. H. N. Reay, Faraday House, Southampton-row, W.C.; A. O. Roberts, Ullswater, 291, Green-lanes, N.; W. L. A. Rogers and A. M. Rosa, Faraday House, Southampton-row, W.C.; C. Saxton, Studley Cottage, Undercliffe, Bradford; G. O. Scampton, A. R. Sharpe, R. A. Shiell, and C. W. Short, Faraday House, Southampton-row, W.C.; E. Simkiss, 111, Parliament-street, Derby; H. J. Stenning, 164, Upland-road, Dulwich, S.E.; G. E. Stevenson and A. A. Stone, Faraday House, Southampton-row, W.C.; A. Stubbs, 41, Gladstone-street, Winsford, Cheshire; C. S. Terry, 5, Grotes-place, Blackheath, S.E.; H. M. Thompson, 75, Earl's Court-road, W.; C. P. Tuffnell, 208, Burrage-road, Plumstead, S.E.; E. J. Uhink, Faraday House, Southampton-row, W.C.; H. E. T. Vale, 44, Avondale-road, Southport; H. R. Viall, Whitley-road, Whitley Bay, Northumberland; C. C. Villa, Faraday House, Southampton-row, W.C.; L. N. Vine, Eversley, Exmouth; J. M. Walsh, Faraday House, Southampton-row, W.C.; F. G. Watermeyer, 66, Barons Court-road, West Kensington, W.; W. A. Watkins and H. G. Weaver, Faraday House, Southampton-row, W.C.; J. M. McG. Whellens, The Home Farm, Albury, near Guildford; P. F. R. White, 52, Grand-avenue, Muswell Hill, N.; S. N. C. Whitehead, 24, Queen's-road, Wimbledon, S.W.; W. H. Whitehouse, 29, Francis-road, Edgbaston, Birmingham; H. Williams, 27, Buckingham-street, Moss Side, Manchester; L. F. Willing, Inglewood, Oughtrington, Lymm, Cheshire; G. P. Willoughby, The Parsonage, Heaton Mersey, Manchester; A. C. Yeates, Faraday House, Southampton-row, W.C.; G. E. Yonge, care of Electricity Works, Ladysmith-road, Enfield, N.

Port Hope (Ont.).—The Town Council have decided to erect the necessary buildings and to install a municipal lighting plant.

ELECTRICAL EXHIBITION AT ACTON.

The electricity undertaking acquired by the District Council having now been in their possession about one year, the latter conceived the idea of promoting an exhibition with a view to bringing before the residents of Acton all the advantages of electricity, and giving them an opportunity of inspecting the latest appliances for lighting and heating by electrical means. Such an exhibition is being held this week in the Public Baths, Salisbury-street, W., and from what we observed during our visit on Monday, when the exhibition was yet in an incomplete state, we are inclined to believe that the exhibition will have a good effect upon the public. At all events, visitors will have an object lesson in the adaptability of electricity for domestic purposes as well as for lighting and power. At the stand of Messrs. R. Poulton and Son, Acton, there is seen to advantage the applications of electricity in a tailors', etc., workshop; the Electric Ordnance and Accessories Company, Limited, have supplied a number of electric sewing machines, and the British Thomson-Houston Company some electric irons which are to be seen in operation. For an effective specimen of how electricity may be employed to advantage in lighting showrooms and shop windows we can commend that of Mr. G. C. Berry, 28, Milton-road, Acton. Mr. Berry is electrical contractor to the Acton District Council, and his stall displays a varied selection of artistic fittings, Royal Ediswan lamps, "Linolite," electric radiators, and heating and cooking devices. On a bakery stall we noticed an electric oven, and a variety of electric frying pans, grids and boilers, food and table warmers, tea-kettles, etc., supplied by the British Thomson-Houston Company, the General Electric Company, and the Dowsing Radiant Heat Company. The many kitchen uses to which electricity may be put are well illustrated on this stand. Messrs. Pooley and Austin, 25, Victoria-street, S.W., are showing a "Zone" motor. On this stand are to be seen four switchboard panels for the Acton Council's generating station, which have been manufactured by Engineering Instruments, Limited; also manufactures by Messrs. Spagnoletti, Limited, and Messrs. T. Davies, Limited. Messrs. Pooley and Austen are also making a very effective display of their "Phictoria" electric lamps, also "Osram" high-efficiency metallic-filament lamps, "Phictoria" jointing and sticky tapes for cables and electric wires, patent steam pipe and boiler coverings.

The stand of Messrs. Siemens Bros. Dynamo Works, Limited, York-street, Westminster, is sure to attract attention by reason of the combined display of tantalum lamps and holoplane glassware. These lamps are shown burning two and three in series on the Council's supply on 230 volts. One of the largest stands in the whole building is that of the Dowsing Radiant Heat Company, who are displaying a number of luminous radiators, an electric light bath, and medical apparatus, including an electric vibrator, X-rays, small portable apparatus for high-frequency treatment, etc. Messrs. T. Poore and Son are showing various applications of the use of electricity in a very interesting exhibit of electric telephones, electric bells, and accessories. They are also giving a practical demonstration of the manufacture of "Robertson" electric lamps. Harper's electric piano is another feature of the exhibition which will be highly appreciated by visitors.

The opening ceremony was performed on Monday by the Mayor of Hammersmith (Councillor Dewshaw) in the unavoidable absence of Mr. Herbert Nield, M.P. In spite of the inconvenience of the hour for which this ceremony was timed, there was a very good attendance, including representatives from the neighbouring borough of Hammersmith. Mr. J. Martin Blair, the electrical engineer of the Acton undertaking, as well as the District Council are to be congratulated on having got together such an interesting exhibition. Only 30 months have elapsed since the first consumer was connected to the Council's mains, but rapid progress had been made in the meantime; the present rate of progress being 1,000 8-c.p. lamps per month.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, Feb. 1.

MONDAY, JAN. 27.—"A" Coy.—Technical drill, 6.30 p.m.

TUESDAY, JAN. 28.—"B" Coy.—Infantry drill (recruits), 6 p.m.

WEDNESDAY, JAN. 29.—"A" Badge examination for "A" and "B" companies, 6 p.m.

THURSDAY, JAN. 30.—"C" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

FRIDAY, JAN. 31.—"D" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

SATURDAY, FEB. 1.—Week-end run at Coalhouse for "D" Company.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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NOTES.

Wireless Telegraphy. — It is reported that the German Imperial Secretary of State for Posts and Telegraphs on Tuesday introduced in the Reichstag a Bill for the regulation of wireless telegraphy in accordance with the decisions of the international commission of the Berlin Congress of 1906. The fundamental principle of the measure is to compel shipping companies and owners of wireless stations on land to arrange for intercommunication without regard to the system used. Permission to erect stations or to use wireless telegraphy will not otherwise be given. The Minister said that the measure was aimed at giving the fullest scope to all systems of wireless telegraphy.

Royal Institution.—On Tuesday next, Jan. 28, at 3 o'clock, Prof. F. J. Haverfield delivers the first of two lectures at the Royal Institution on "Roman Britain"; on Thursday, Jan. 30, Major Martin Hume commences a course of three lectures on "The Story of the Spanish Armada"; and on Saturday, Feb. 1, Mr. Lional Cust begins a course of two lectures on "Anthony van Dyck." The Friday evening discourse on Jan. 31 will be delivered by Prof. E. Rutherford on "Recent Researches on Radio-activity"; on Feb. 7 by Mr. Humphry Ward on "Napoleon and the Louvre"; and on Feb. 14 by Dr. C. W. Salleby on "Biology and History." The discourse on March 13 will be delivered by Chevalier G. Marconi, his subject being "Transatlantic Wireless Telegraphy."

Callender's Hospital and Distress Fund.—The fifth annual report of Callender's hospital and distress fund has just come to hand. During the past year a record was established in the greatly increased number of hospital and other letters issued, but a large reduction occurred in the number of members, which made a considerable decrease in the weekly subscriptions. The committee have had an anxious time in carefully considering the many urgent appeals for financial assistance from members in distress, and 81 grants were made, the total amount being £89. 18s. 2d. Owing to lack of funds the individual amounts had to be necessarily small, but were the means of giving some practical help at a time when a little is greatly appreciated. The balance sheet shows a revenue of £366. 16s. 4d. (in which is included £112. 18s. 9d. brought forward from last year); £179. 17s. 5d. was received in penny weekly subscriptions and £69. 19s. in donations, headed with £50 by the firm. Eighty-one gratuities were made to members, thus absorbing £89. 18s. 2d, and £185. 7s. was granted to various hospitals. The fund was left with a total balance at the end of the past year of £85. 19s. 3d.

The Late Lord Kelvin.—An influential meeting of the citizens of Belfast was held on Tuesday last in the city hall under the presidency of the Lord Mayor (Lord Shaftesbury) to inaugurate a movement to establish a fitting memorial to Lord Kelvin. Eulogistic references to the deceased *savant* were made by the chairman, and on the motion of Lord Londonderry the following was carried unanimously: "That for the purpose of commemorating the eminent services of the late Lord Kelvin to the cause of pure and applied science and the enormous benefits he conferred on the navigation and commerce of the world by his wonderful inventions, and recognising his public and private virtues so conspicuously shown throughout a long life, it is fitting that a memorial should be placed in Belfast which will permanently associate his illustrious name with the city of his birth, in which his distinguished father and brother for many years rendered lasting service to education." The Bishop of Down and Connor and Dromore moved a resolution, which was passed unanimously, respectfully tendering the heartfelt sympathy of the meeting to Lady Kelvin. On the motion of Sir Otto Jaffe, it was resolved that the memorial should take the form of a statue of Lord Kelvin, to be erected in such a position in the city as the executive committee should decide. A strong general and executive committee was appointed. It was announced that subscriptions had already been received amounting to £875.

Electrical Energy from Wind Power. — The United States consul at Frankfort sends home some particulars concerning the development of electrical energy from wind power in Europe. He says that in Germany wind motors as power generators for use in agricultural and industrial pursuits are rarely met with, but in Denmark their use has increased very greatly. Since 1897 the Danish Government has contributed about £5,600 for equipments and has even lately erected an experimental station at Askoc. A technical writer describes these experiments, which were made on the initiative of the Danish Government, and also some of the electric works in Denmark which generate electricity by means of wind motors. According to his statements, motors with four wings have given the best results, as a smaller number of wings does not fully utilise the wind power, while a larger number acts detrimentally upon the wind current between the wings. If a medium large wind motor is used with a wing surface of about 48 square metres (517 square feet), 8 h.p. is obtained at a wind velocity of 6m. (20ft.) per second. At a velocity of 8m. (26ft.) the horse-power is more than doubled. A wind with a velocity of 8m. (26ft.) per second is no rarity. The weather reports classify it as No. 3, while the highest wind velocity is No. 12. Since 1903 there has been in existence the Danish Electricity Company, as a result of whose agitation 30 larger and smaller wind-power electrical equipments are in operation in Denmark.

Electrolytically-Produced Fluids.—Many of our readers are doubtless familiar with the Hermite process of making electrolytic disinfecting fluid which has been in operation for nearly two years at Poplar, and of the good results obtained. Dr. Alexander (the medical officer of health) found, however, that the fluid began to degenerate immediately it left the electrolysers, and to diminish in strength. In the *Lancet* he describes what experiments were undertaken to maintain the quality of the fluid, and explains that he eventually observed that upon the addition of caustic soda to the electrolytic fluid a white precipitate was formed, which immediately fell to the bottom of the carboy. The precipitate was hydroxide of magnesium, and the shaking of the carboy caused this compound to be distributed throughout the fluid, and to give it a milky appearance, and it was found that the more milky in appearance the fluid became the more stable was the fluid rendered. By a simple mechanical arrangement the hydroxide of magnesium and the electrolytic fluid are mixed well together by stirring the mixture in the carboy immediately after the process of filling. Dr. Alexander suggests that what occurs during the electrolytic process is that hydroxide of magnesium is formed at the negative pole and unstable compounds of oxygen and chlorine at the positive pole, and the two compounds endeavour to combine. What he advises to be done to render the fluid stable is either to assist the process by the addition of hydroxide of magnesium whilst the electrolysis is taking place, or to complete the process afterwards by the addition of hydroxide of magnesium after the fluid has left the electrolysers, or to combine both methods. From the results of tests given by Dr. Alexander this process appears quite

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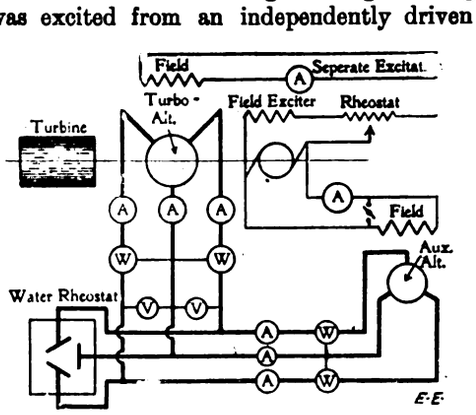
satisfactory, and it is evident that the stable solutions of electrolytically-made hypochlorate of magnesium are preferable to those of sodium and potassium, or even calcium.

Railway Electrification in America.—It is of interest to note that the New York, New Haven, and Hartford Railroad Company have decided to change the equipment of their new Canaan branch—7½ miles in length—from 600-volt direct current to 11,000-volt single-phase. The overhead construction of the line is also being changed to a 11,000-volt single catenary, which will be used instead of the double catenary employed on the main line. The *Electrical World* announces that in addition to the three-phase locomotives which the General Electric Company will supply to the Great Northern Railroad, this company will build the entire electrical apparatus for the Cascade Tunnel equipment. The generating station, which will be located on the Manatchee River, 30 miles from the tunnel, will contain two 2,000-kw., three-phase, 25-cycle generators driven by hydraulic turbines. It is interesting to note that arrangements will be made to take care of energy returned from three-phase locomotives on the down grade. Each locomotive will be designed for hauling a 500-ton train load up a 2 per cent. grade at a speed of 15 miles per hour. The constant-speed characteristic of the three-phase induction motors will serve for controlling the train down grade, as intimated above. By this means the possibility of breakdown due to overheated wheel tyres and brake shoes will be eliminated. Each locomotive will be equipped with three 325-h.p. motors mounted on articulated bogie trucks. The total weight will be 100 tons, all of which will be on the drivers. The tunnel is approximately 2¾ miles in length with no ventilating shaft. There is a uniform grade east of 1·6 per cent. in the tunnel section, making the difficulties of ventilation with steam locomotive operation a very serious factor, both from the standpoint of safety and operating efficiency. Aside from danger of poisonous gases of combustion, the interior of the tunnel has become so fouled with soot as to reduce the tractive effort of the steam locomotives now used by reason of the slippery condition of the rails.

New Publications.—"Electric Wiring and Fitting for Plumbers and Gasfitters," by Sidney F. Walker (London: Scott, Greenwood, and Son, 8, Broadway, Ludgate-hill, E.C. 5s. net). The tendency among plumbers and those of kindred trades to undertake electrical installations shows a marked increase, and proves a *raison d'etre* for such a book as the above. If, as seems likely, a large portion of the wiring of buildings will in future pass into the hands of plumbers and gasfitters, it is essential that such men should have the requisite knowledge of electricity in order to enable them to carry out jobs in a trustworthy manner. Mr. Walker's book is essentially practical. It opens with a full explanation of the electrical terms in common use, then passes on to an account of the insulation of wires, their protection, fixing, etc. A chapter is devoted to lamps, while switches, fuses, distribution boards, etc., are treated in the final chapter of the book. The illustrations are clear and useful.—"The Deinhardt-Schlomann Series of Technical Dictionaries—vol. ii., Electrical Engineering," edited by Chas. Kinzbrunner (London: Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. 25s. net). This is the second volume of a series of technical dictionaries which promises to be of much service to engineers. The dictionary is in six languages—German, French, English, Russian, Italian, and Spanish. The arrangement of the very extensive matter into various chapters follows a logical procedure. First of all, the generation of electricity in batteries and machines is dealt with, next the distribution and measurement, and, finally, the transmission and application of electrical energy. A comparatively large space is devoted to the chapters on telegraphy, wireless telegraphy, telephony, etc. Electrification of railways has not been dealt with, but the editor explains that it will be dealt with fully in the volume "Railway Engineering," which is in course of preparation. Mr. Charles Kinzbrunner has had the compilation of vol. ii. in hand, and he and his collaborateurs are to be complimented on the able way in which they have performed a difficult task.

Test on a Turbo-Alternator.—Mr. T. Fraser describes in the *Electric Journal* of Pittsburg a test recently carried out on a 1,256-k.v.a. turbo-alternator under full load at 80 per cent. load factor. At the place of test the permanent loading arrangement for the turbo-alternator consists of a large iron water-tank with plates arranged in the form of a triangle. The necessary gear is provided for changing the position of the plates to obtain different loads. This, of course, gives a non-inductive load. To obtain 80 per cent. power factor an auxiliary alternator was used, a duplicate of the one under test. The machine was run light as a synchronous motor from the alternator circuit, and its field was gradually weakened until the required power factor was obtained. As it was not convenient to run up to speed and synchronise the auxiliary machine, it was started as an induction motor. From the diagram of connections shown it may be seen that the stators of both machines were electrically connected, the field of the generator separately excited, and the field of the motor short-circuited during starting. The generator field was excited from an independently driven exciter.



The turbine was started, and as soon as sufficient speed was obtained (about 20 r.p.m.) the motor started up. When the motor reached full speed the field circuit was opened and the field excited. Another method of starting was also tried. This was the same as the one already explained, with the exception of the field connections. Instead of being short-circuited, the field was connected directly across the armature of the shunt exciter, the exciter being coupled to the turbine. The field was built up gradually as the turbine's speed increased, the two machines running in synchronism at all speeds. Absolutely no trouble was experienced with either method, and the power factor could be adjusted to a nicety. It will be seen from the diagram that the power factor can be checked in three different ways: (1) from the ratio of wattmeter readings; (2) from the ratio of kilovolt-amperes and kilowatts; (3) from the wattless input to the auxiliary machine.

Power-House Buildings.—The question of design and structure of power-house buildings is one which every station engineer is at some time or other troubled with, in a more or less acute form. The design of some of the earlier buildings was very crude, which is not surprising, considering that the plant they housed was generally small. Such considerations as vibration, noise, nuisance, or stability scarcely required attention, and the buildings

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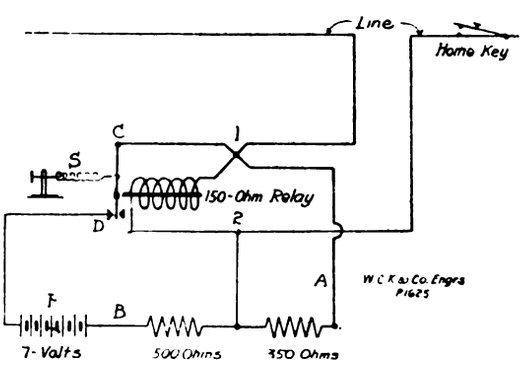
usually consisted of an ordinary shed or a warehouse with a span roof. But those days have gone by, and the generation of electricity is now undertaken on a very large scale, involving the expenditure of considerable sums of money for the buildings alone. An electrical engineer is scarcely the right man to give advice on building structures, and his responsibility may be said to end with the furnishing of the architect with the requirements of the engineering side of the scheme. But, as not infrequently happens, architects fail to recognise that co-operation with engineers in these matters is necessary. In a paper on "Power Works for Electricity," which Mr. Horace Boot, a well-known electrical engineer, presented at a recent meeting of the Society of British Architects, there appeared a number of valuable suggestions as to the selection of site and the erection of buildings for generating plant. Mr. Boot enumerated the considerations that should bear with those in search of a site, and rightly pointed out that in selecting a site for such works provision must always be made for extensions, in most cases to all the buildings, including offices. The following table presented by Mr. Boot shows the cost of buildings as compared with capital outlay in certain towns:

—	Total cost.	Cost of land and buildings.	Kilo-watts housed.	Cost of buildings per kw.
	£	£		£
Brighton.....	717,738	149,431	5,400	2·76
Glasgow.....	1,368,134	211,172	10,993	19 20
Bristol	671,616	53,550	9,050	5 91
Newcastle	1,192,442	169,675	20,000	8·48
Hackney	280,982	42,394	3,372	12·57
Metropolitan	1,802,383	435,777	18,500	23·55
Tonbridge	22,420	7,228	120	6·23
Tunbridge Wells..	81,134	13,207	1,170	11·28

Some interesting remarks were made respecting the style of building. One of the chief things to bear in mind, however, is the importance of keeping the cost of the buildings as low as is compatible with efficiency. Capital outlay plays a very important part in the cost of the production of electricity, and very often in the case of small works in their early days the capital outlay is likely to hinder the healthy and rapid development of the undertaking, owing to the necessity of charging a higher price per unit than would have been the case had the capital outlay been kept moderate, or, rather, in proportion to the business undertaken.

Water Supply and Electricity. — The address which the president of the Royal Meteorological Society delivered last week dealt with the problem of the normal annual rainfall of the British Isles in relation to the general configuration of the land. The importance of such a problem to electrical engineers may not be apparent at once, and it is only when we remember how much our neighbours both in Europe and America benefit from the development of their water resources for the generation of electricity that we realise how much we lack in this respect, and think it worth our while to give attention to questions of rainfall and its distribution. Of recent years the value of the water power which may be generated in the lonely and lofty places amongst the western heights of Great Britain where the rainfall is large and unfailing has been recognised, and chemical works for the production in electric furnaces of what a few years ago were rare substances are becoming familiar features in Wales and the Highlands. If by some means or other it were possible to supply some of the drier districts from the large precipitation of the West, electro-chemistry would not be alone in gaining an impetus; the question of the generation of electrical energy would also be affected, and there might be a better opportunity than there is at present in this country for transmission on the Thury system. Dr. Mill pointed out in his address that: "Every year makes clearer the vast national importance of accurate knowledge of the rainfall of a county, for the problem of the rivers is becoming acute. The growing populations of the great towns are tapping the upper waters and diverting the water from its natural channels, and at the same time they are polluting the lower courses with the waste of the factories and the streets. Toll is taken all along the banks of industrial streams for raising steam and carrying on the multitudinous processes of manufacture. There is sometimes anxiety as to whether the waterways can be kept sufficiently supplied to float the water-borne traffic or to fight the silting action of the tides, and there is growing alarm as to the possibility of fish traversing the depleted and polluted streams to reach their spawning beds." He urged that the question of water supply was national, not parochial, and should be dealt with in the interests of the nation as a whole.

Telegraph System for Electric Railways.—An account of a device for eliminating static effect, which is often the cause of telegraphic communication being seriously affected, is given in the *Railway and Engineering Review* (Chicago). It has been patented by Mr. E. W. Applegate, and tried on the Erie Railroad between Rochester and Mount Morris. The "static pick-up," as the arrangement is called, comprises a back contact relay



and a high-resistance shunt. The current enters the relay, shown on the diagram as 1 and 2, through a 150-ohm coil or magnet, attracting the armature, C. When the line opens by any operator opening his key, the armature, C, falls back, and through the back contact connects point C and D by the aid of a spring, S. The shunt A consists of 350 ohms of carbon stick, and provides a better path for the static than do the magnets, pacifying the magnets to a certain extent. When the line opens and the armature connects with the back stop, C and D, both the A and B shunts are in with the main line and pick up the static which escapes through shunt A, relieving the agitation of the armature so that it can respond to the closing of the line. The shunt A robs the relay of main line battery current very materially, so that it responds to the home key sluggishly. Consequently the auxiliary battery, F, is inserted in shunt B. When the armature, C, falls back, this battery acts upon the magnets, and assists its prompt response to the home key, or to any other operator, to such an extent that the shunt A does not cause noticeable drag. No matter what the line static may be, these shunts "pacify" the instrument, and the static is not felt. The armature spring is adjusted high enough to overcome the wave of static that escapes A and C shunts The aid of the seven-volt battery overcomes this adjustment and leaves the relay very prompt and satisfactory. The resistance of the shunt A must be determined by the distance from the ground and battery at each end of the line. The nearer to the ground the less is the resistance of the shunt, as in close proximity to battery and ground the static is

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more pronounced, and the effect of the main battery upon the relay is likely to be correspondingly diminished. By this arrangement all the telegraph wires are "singled," and metallic circuits, the necessity for which was at one time pending, were discontinued on the line on which it was tried, and the repeater service which they necessitated was also discontinued, so that there is now a spare wire between Rochester and Mount Morris through the entire zone of static interruption.

Regenerative Control.—The following is an abstract of the specification of a patent recently granted to the British Thomson-Houston Company: Railway, etc., motors, particularly of the alternating-current series type, are operated as braking generators to return energy to line by dividing the motors into two groups during braking, one group containing one or more motors having their field windings connected to the supply and their armatures operating to excite the fields of the remaining motors, and the other group having its armatures connected to line through a transformer. The braking action is controlled by varying the points of connection to the transformer.

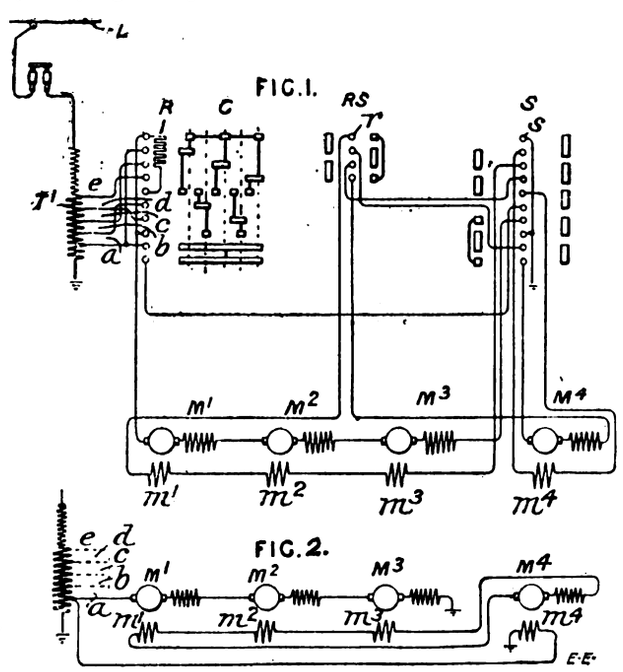
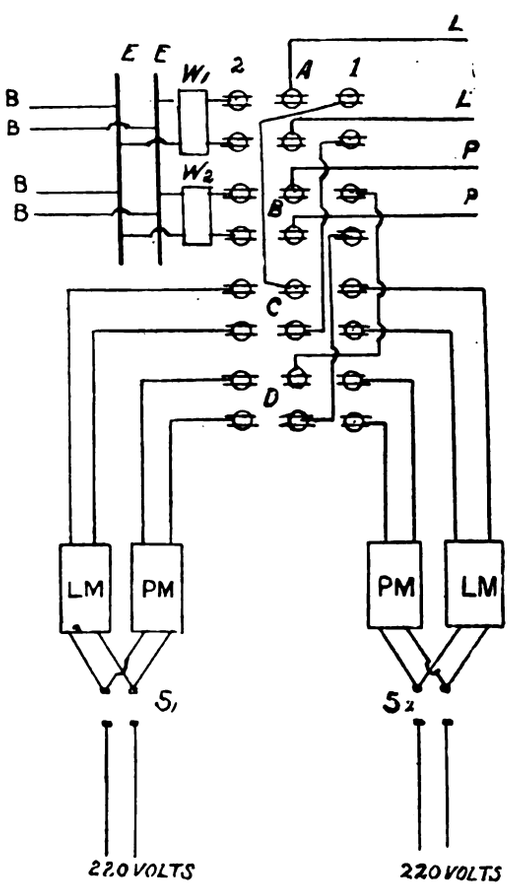


Fig. 1 shows four compensated series motors, M^1, M^2, M^3, M^4, connected to the line, L, through a transformer, T^1, the connections of which are varied by means of a controller, C. R S represents a reversing switch for changing the connections between the armatures and the series field windings, m^1, m^2, m^3, m^4, and S is a commutating switch having left-hand running and right-hand braking contacts. When the controller, C, is turned into the first running position, the switches, R S, S having been previously moved to bring the left-hand sets of contacts into engagement with the stationary contacts, *r*, *s*, the armatures, compensating windings, and series field windings of all the motors are connected in series, together with the resistance, R, between the point *a* of the transformer, T^1, and earth. Further steps of the controller, C, serve to cut out the resistance, R, and to shift successively the point of connection of the transformer to *b*, *c*, *d*, and finally *e*. To cause the motors to act as braking generators, the switch S is reversed, and, in the first position of the controller, C, the armatures and compensating windings of the motors, M^1, M^2, M^3 and the field winding m^4 of the motor M^4 are connected between the point *a* of the transformer and earth, as shown in Fig. 2, while the field windings of the motors M^1, M^2, M^3 and the armature of the motor M^4 are connected in closed circuit. Further steps of the controller, C, serve to vary the transformer connections, *a*, *e*, as before.

Isolated Plant Emergency Connections.—One of the essential steps in the design of isolated plant wiring, where emergency central-station service is to be supplied, is the provision of a simple and flexible scheme of switching over from the plant 'bus bars to the entering lines. Many special problems arise in different conditions of this kind, one of which, with its solution, is described in the *Western Electrician*. In this case it was desired to operate separate 220-volt lighting and power circuits, L L and P P, normally on the plant's generator 'bus bars, E E, and to be able to throw either circuit in case of emergency upon either of two outside supply circuits, S_1 and S_2. It was



desired to separately meter all current used respectively for lighting or power service. To accomplish this, four double-pole switches of the double-throw type, A, B, C, and D, were installed and connected as shown with the lighting and power circuits, the 'bus bars, and the four wattmeters L M and P M. The wattmeters W_1 and W_2 record the energy consumed in the lighting and power service when the current is generated in the plant itself. The designers did not wish to throw the working circuits in multiple to the extent of carrying part of the lighting load on the generators and part on the outside supply. The same thing applied to the power service. By throwing the switch A upon position 1 the lighting circuit is carried to the centre terminals of switch C. Accordingly, as switch C is thrown to position 1 or 2 it will draw current from the lighting wattmeter of circuit S_1 or S_2. Thus three sources of supply exist for the lighting circuit, L L, and the same conditions apply to the power circuit, P P, through switches B and D. In each case the metering is separate, and the exact demand upon each of the supply circuits is registered. Either the lighting or the power circuit can be supplied from the plant generators, while the other power or lighting service is handled by the outside supplies. Ordinarily circuit S_1 is reserved for emergency lighting supply and S_2 for power.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE STAFF OF SMALL CENTRAL STATIONS.

SIR,—I am pleased to see that in the article headed as above in your issue of the 3rd inst. your writer invites discussion, and with your consent I willingly join issue. I am in agreement with him in that the amount spent on salaries and wages plays a very important part in the economic running of a small central station, and of the wide difference shown in stations of equal kilowatt capacity and apparently running under similar conditions. The size of station taken is a fairly average one—namely, having a capacity of 450 kw. and about 500 consumers, running an evening shift and an early morning one during the winter months.

I quite agree with the qualifications as assigned to the chief engineer, but it seems to me that less money spent on the clerical staff and more on the technical would be not only more conducive to economy and reliability of continuous supply, but give greater peace of mind to the chief. The staff as outlined is only a fair-weather one, and, although one does not like to anticipate trouble, I am much afraid that the writer of the article would wish for fewer clerks and more skilled assistance when a breakdown occurred. I am of the opinion that in a station of the size outlined, after the first rush of work consequent upon successfully starting the undertaking, the chief would find ample time to do the small amount of clerical work appertaining to the technical side of the station. My own experience of, firstly, a municipal undertaking is that the heavy clerical work is generally undertaken by the town clerk or accountant, and, therefore, it is only a few technical letters which fall to the chief's lot to deal with; and, secondly, that there is, perhaps, a little more clerical work to do in the case of a company, but nothing to justify the extravagant office staff which your writer proposes.

My suggestion is that an assistant should take the place of the chief clerk who will be quite capable of successfully settling or seeing to the minor points of station routine and of interviewing consumers in the absence of the chief. (I hold that the personal attention of the chief to his consumers' complaints, be they trivial or well founded, goes a long way to ensure a successful undertaking.) This assistant, who is considered a luxury by your writer, will be available to act as chief when the latter is absent on holidays or illness, and, in the event of trouble on the mains or in the station, be a far more reliable man to deal with the vagaries accruing therefrom than the poor overworked fitter-driver. The junior clerk can also be dispensed with, as it will not do the day apprentice the smallest amount of harm—in fact, rather the reverse—to acquire an insight into the office work of a central station when not engaged in his weekly duty of taking the voltages and gravities of the storage battery, or assisting generally inside the station or out

We now come to the fitter-driver question; undoubtedly this is the point of the whole paper, and I think the most difficult of satisfactory solution. I cannot quite understand the class of man that your writer expects to get; he is to be shift engineer, driver, fitter, jointer's mate, and a "jack of all trades," having the privilege of working at least 20 hours out of the 24 in the winter time, and a fair nine hours per day in the summer. From the foregoing I am inclined to believe that the writer of the article has never tried working with a fitter-driver under the conditions he names, for I am sure no man could have time to carry out the duties. A glance at the article will show the force of my remarks. For instance, it is stated that "he should easily be in a position to keep all repairs up to date, and be available, if necessary, to take on outside work during the daytime." "The fitter-driver should have standing orders to be about the works during the evening run." "The fitter-driver can easily manage to put in service during the daytime, using his day stoker as mate." "The chief engineer has to be away, and in his absence it is advisable to make the fitter-driver take charge of all plant and mains." If the fitter-driver is only to be about the works during the evening run, and not, as the wording implies, strictly on duty, who then is to be in charge? Is it expected of the chief, or left to the tender mercies of the evening apprentice or stoker? And, again, is the fitter-driver (taking this word in its usual meaning) the man to leave in charge—and sole charge at that—of a central station? For myself I think a driver necessary, and I mean by this a man who can undertake the usual driving, gland packing, etc., necessary in a station, and also put in morning work under the mechanical assistant in the summer months and outside work when necessity arises. The present steam plant runs long periods without requiring attention, and it may be possible to run the sets so that the whole plant can be overhauled in turn during the summer months by a first-class fitter borrowed from the engine builders; but, unfortunately, fine repairs and adjustments are occasionally required at other times of the year, and, therefore, our arrangement of the summer fitter would not help us. A way out of the difficulty would be to have another assistant, and with reasonable care the chief would be able to arrange the selection of his two assistants—one having a first-class mechanical experience and a fair amount of electrical, and the other with first-class electrical and fair mechanical. The chief would thus provide himself with a reliable highly-trained staff to second his efforts, and be fit to cope with any breakdown, either electrical or mechanical, outside the station or in.

With the remarks *re* stokers, apprentices, and mains men as mentioned in the article I quite agree with, excepting in one of the duties of the mains man. This man "would find that his duties are divided over many jobs." Quite so; and if the average jointer one meets with is the class of man your writer would entrust to repair meters, I should be very sorry to have to fight a consumer over his account in court on such a repaired meter. This meter repairing, and also testing, should fall on the shoulders of our electrical assistant. The storekeeper is an absolute waste of money. The stores are usually situated in some convenient place near the engine-room and the day-book kept handy, and can easily be filled in by the apprentice on duty as there is very little to do in this department of a station up to 500 kw. capacity.

To sum up, my idea of a small central-station staff which will ensure safe running in the station and smooth going with the outside work is as follows: chief engineer; chief assistant (good mechanical and fair electrical know-

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ledge); second assistant (good electrical and fair mechanical); two apprentices, one to assist generally throughout the day and do morning running in the winter, and the other to look after switchboard on the evening run; driver; two stokers, one morning and the other evening; and jointer. A labourer could be added if there if much street-lighting and busy service work. And I contend that such a staff would be very little more costly than your writer's, and its extra cost would be more than outweighed by the safer conditions under which the station would be running.—Yours, etc.,

ONE WITHIN THE FIVE HUNDRED.

LIQUID FUEL.

SIR,—In the issue of your journal dated Jan. 3 there appears an article on liquid fuel as it affects electric power stations. It is not sufficiently well known that, besides the crude petroleums and petroleum residues, there are other by-products which serve quite well for liquid fuel Water-gas, tar, blast-furnace oil, the by-product from producer-gas plants, and other hydrocarbons are all available for fuel if properly used with suitable burners. It is true that a sprayer fitted over the furnace door of a coal-fired boiler will help matters when there is a sudden demand for steam, but this is not the best way to meet the case if smokeless combustion is aimed at.

Being interested as inventor and maker of all kinds of liquid fuel burners, etc., the question of how best to deal with various electric power stations in London was submitted to me professionally three years ago, when the price of coal was not as high as it is at present, and although an actual saving in cost of fuel could not then be shown if oil fuel at 35s. per ton was used, there would, nevertheless, have resulted economies in other directions. The difficulty of making suitable contracts for the supply of oil fuel over a term of years, and also the difficulty of overcoming a considerable reluctance or prejudice to abandon the use of coal, lost me some important contracts for oil-fuel appliances. Since then the price of coal has gone up very much, and it is safe to say that any power station in London could be entirely fired with liquid fuel at the present moment and show a saving as against coal, provided the price of oil fuel in London is no more than it was three or four years ago.

The supply of oil fuel for the use of London power stations is having attention by at least one oil fuel supply company, and in the near future London stations may easily obtain supplies of oil fuel at prices which will make coal too dear to use.

The cost of the appliances which would be necessary for the successful adoption of oil fuel for steam raising would not be great, as the general arrangement of the furnace with ordinary firebars as used for coal will serve without alteration, and this would admit of coal being reverted to temporarily should circumstances call for this.

It is remarkable that little interest is taken in the use of liquid fuel by engineers generally, but this is steadily passing away, and in the near future liquid fuel and smokeless combustion will I feel sure form a very attractive and economical feature of every power station in London.

Pending the change in the attitude of engineers towards liquid fuel for steam-raising purposes, great strides are being made in its application to furnaces of all kinds for industrial processes, where it is valuable on account of economy of working, the perfect control over temperature, and its perfect combustion.

For process work liquid fuel is capable of doing from three to four times the work of coke or coal, pound for pound, and for electric power station work it will do twice the work of coal, all things being considered, and the absolute cleanliness and freedom from dust attending its use makes it an ideal fuel for station work.

Some of the London power stations that I have inspected are cumbered with coal conveyors and elevators and with mechanical stokers, all of which are expensive to install and somewhat costly to maintain in good working order. The introduction of oil fuel would do away with these costly appliances, it would simplify the arrangement of the station, and it would reduce the number of the fire-room attendants.

Where liquid fuel is used the output of a boiler may be increased by at least 30 per cent. as a normal figure beyond what it accomplishes with coal, and the fires can be regulated in a moment to meet the demand for extra power, or they can be reduced as readily to any degree or extinguished altogether.

The ease with which the oil fuel can be pumped from point to point without the need of costly and complicated machinery for the purpose, and the ease with which it can be stored in suitable tanks, should certainly claim the attention (with its other advantages) of all electric power station engineers —Yours, etc.,

J. J. KERMODE, M.I.MECH.E.

Liverpool, Jan. 20, 1908.

[We believe that much of the objection to oil fuel among central-station engineers is due to the extreme fluctuation in price of crude oil. In one or two cases we know of this price has been suddenly raised as soon as the suppliers think they have secured the customer, and that in consequence of expenditure incurred on apparatus to burn the oil it is indispensable.—ED., *E. E.*]

THE RAILWAY CRISIS.

SIR,—It has become clear that agreement on this question is at present impossible; each side has laid its case before your readers, and if some interest in the questions raised has been stimulated, "Writer" will agree with me that the correspondence has not been useless.

With one remark on his last letter I, therefore, wish to terminate my part in this pleasant controversy. It is that I have never proposed to confiscate Jones's £1 saved from his salary. I only submit that he should only be permitted to spend it in such ways as will not limit the lawful liberties of other people—that is, he should not be allowed to gain power over his fellows by buying and owning the machine or other necessities to their gaining a livelihood.—Yours, etc.,

STAFFORDIAN.

[What real right is there to impose conditions upon this pound saved any more than upon the other pounds earned and spent? Yes, I agree interest is stimulated in all such discussions, even when it ends in the view that opponents honestly hold different opinions.—WRITER]

RE QUESTION No. 1,019.—SINGLE-PHASE POWER FROM THREE-PAASE CIRCUITS.

SIR,—Mr. K. Faye-Hansen is correct in saying that in considering the one-armature rotary I disregarded the armature drops, to which he attributes some of the unbalancing. He, however, overlooks the fact that we were dealing with the double-wound type of machine, in which, given constant flux, the drops would be equal and the load balanced. Q.E.D.

It may also be taken as proved and granted that the degree of unbalancing (with equal numbers of turns in the three phases) is dependent on the field design, and not, as with static transformers, a fixed ratio: that it may thus be reduced or even eliminated. The impracticability or otherwise of having unequal numbers of turns in the three phases is determined by the degree to which this is done. With a nearly constant field the amount of unbalancing which would have to be compensated in this manner would be small and the no load currents by no means serious, although with a light field (such as that of an alternating-current to direct-current converter) they would, of course, be large. It was this possibility which led to my alternative suggestion of an induction regulator in one phase, which would enable balance to be obtained at any load, and could easily be adapted for automatic operation if necessary. This seems to have escaped Mr. Faye-Hansen's notice. It is thus, I think, proved that theoretically there is no reason why a suitably designed rotary should not convert from balanced three-phase to single-phase.

Mr. K. Faye-Hansen considers that tests on standard alternating-current to direct-current rotaries—possessing

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none of the above features which it is agreed are absolutely essential—prove the contrary. His results confirm the reasoning given above (and in my previous letter), which proves that when it becomes necessary to design a machine for this class of work it will be possible to do so, and that it will be very unlike those which he has tested. Until such a machine has been tested I maintain that there are no experimental data which do not confirm the conclusions arrived at above.—Yours, etc., J. S. MESSENT.

OBITUARY.

Germany has to lament the untimely loss of one of the pioneers of her flourishing electrical industry. At the comparatively early age of 49 years Wilhelm Lahmeyer died in Bonn on Dec. 9 last. A belated announcement to this effect has appeared in one of our German contemporaries. Lahmeyer was the son of a mining official in Clausthal. His initial experience of engineering work was obtained in connection with the mine plant. After his early schooling in Clausthal he studied mathematics in Göttingen and Gieszen, then devoted his attention to electrotechnics in Hanover and Aix-la-Chapelle. The invention of an arc lamp by him resulted in the establishment of the Deutschen Elektrizitätswerke, Garbe, Lahmeyer und Co. at Aix-la-Chapelle. This firm soon took up the manufacture of dynamo machinery, and proved very successful. The chief service which Lahmeyer rendered the electrical industry was in designing and introducing with splendid tenacity the Lahmeyer dynamo. This machine differed considerably from any of its prototypes—for instance, the flat-ring and horseshoe types—and must be regarded as the standard design for all modern continuous-current machines. In the autumn of 1890 Lahmeyer founded the firm of W. Lahmeyer und Co., Komm.-Ges., at Frankfurt-a-M., now Felten und Guilleaume-Lahmeyerwerke, which, unlike the Aix-la-Chapelle establishment, is laid out for the manufacture of the largest machines. Lahmeyer attempted to solve the problem of electrical power distribution with the help of high-tension continuous current and rotary transformers, and obtained a considerable measure of success. We need but recall here the 2,000-volt continuous-current transmission line from Offenbach to the electrical exhibition at Frankfurt in 1891. When polyphase currents began to be talked of in 1891 Lahmeyer at once recognised their importance, and by securing the Haselwander patents established a right to manufacture polyphase machines. His labours in this field were also rewarded with complete success. The great firm at Frankfurt and its numerous branches remain to perpetuate his fame.

BOILER EXPLOSION AT ELECTRICITY WORKS.

The Board of Trade inquiry into the cause of the fatal boiler explosion which occurred at the generating station of the South Metropolitan Electric Light and Power Company at East Greenwich on Dec. 20, 1906, was concluded on Wednesday last. The commissioners found that the plate, the fracture of which had caused the explosion, and which was supplied by Messrs. Beardmore and Co., was satisfactory, the fracture not having been due to any defect in the metal. Primary responsibility for the accident was placed upon the shoulders of Messrs. Babcock and Wilcox, the manufacturers of the thermal heating drum, it being held that that was defectively constructed, owing to the end-plate having been injured by indentations caused by a hydraulic machine used to make the end-plate and the shell of the drum fit. It was mentioned that the firm had, since the explosion, altered their method of manufacture, so as to do away with these indentations. The commissioners also held responsible, with regret, Mr. H. W. Bowden, the chief engineer of the electric light company, who should have known there was danger and ordered the shutting down of the boiler. Mr. Constable, the resident engineer of the company, was further held responsible in a degree for not having realised that the condition of the drum was serious. Messrs Babcock and Wilcox were ordered to pay £400, their works manager (Mr. McLaren) £50, Mr. Bowden £50, and Mr. Constable £30 towards the cost of the inquiry.

BURY'S ELECTRICITY UNDERTAKING.

Proposed Important Extension

The Bury Corporation have decided upon an important extension of their electrical undertaking, which is rendered necessary by increasing demands, particularly of motive power from manufacturers.

It is little more than 11 years ago (on Nov. 5, 1896) since the electricity works were opened, there being then 41 consumers with 2,481 8-c.p. lamps. On March 31 last there were 488 consumers having an equivalent of 62,189 8-c.p. lamps, the output for the 12 months being 1,045,469 units for light and power and 1,230,799 units for tramways, a total of 2,276,266.

Whilst the adoption by the Corporation of electric tramways in 1904 gave considerable impetus to the undertaking, it is to the increasing popularity of the use of motors for driving purposes that the success of the works is largely due. The nucleus of this "day load" (which has added so considerably to the department's finances) was formed about 12 months after the works opened, with a supply to five motors = 12 h.p. A steady growth followed, and now electricity is afforded to motors = 1,500 h.p. Hitherto, driving by this means was most largely adopted by engineers, but the subject is now being seriously dealt with by the textile trades, and a recent application for power = 300 h.p. (on the alternating-current principle), rising to 1,000 h.p. at the end of 12 months, may be said to have brought matters to a "head."

From a special report prepared by the engineer, Mr. S. J. Watson, M.I.E.E., it appears that the total capacity of the plant at present installed is 2,260 kw., his estimated maximum load this winter for light, power, and traction being 1,750 kw.—thus giving a surplus of only 510 kw. of plant. Electricity is generated only on the continuous-current system (which is not suitable for supplying large consumers at any considerable distance from the works), so it is felt very desirable that extensions to meet both ordinary demands and those of large power consumers should be made forthwith. The present works are capable of further development, but as the same would, in the opinion of the engineer, only meet possible requirements for a comparatively short time, and also on account of an insufficient water supply and the cost of carting fuel, the committee decided to secure another site.

A plot of land adjoining the railway (thus giving facilities for delivery of coal direct into the bunkers), possessing an abundant supply of water in close proximity, as well as allowing for ample extensions in years to come, has been secured. A generating station with two steam alternators (each of 2,500 h.p.), boilers, switchboards, and other auxiliaries are to be erected, and with the mains and converters to supplement the direct current at the present works (but exclusive of land) will necessitate an estimated expenditure of £70,000. As additional large consumers are obtained it is proposed to spend a further £15,000 in supplying alternating current to their manufactories. The Council have decided to adopt the Electricity Committee's recommendations and give instructions for application to be made to the Local Government Board for sanction to borrow the necessary money.

The undertaking since 1903 has been self-supporting, and, besides contributing to the relief of rates and repaying losses incurred during earlier years, possesses a reserve fund of £4,587. The committee are, therefore, sanguine that the intended extension with its attendant possibilities, alike advantageous to consumers and ratepayers, will prove a still more gratifying outlay than the £85,000 expended since the inception of the original scheme.

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COMPUNCTION OF CONSCIENCE.

It is interesting to note that gas companies are manifesting a certain amount of tender conscience in their dealings with their customers Whether this is altogether the effect of moral teaching on Sundays, or whether it may be attributed to regrettable incidents in the past, may be left to conjecture.

A rather interesting instance of the almost fatherly care that the gas companies are now taking with regard to their consumers is instanced by a slip which is being sent out by the Newcastle Gas Company attached to their quarterly accounts, and which reads as follows:

"*Water-Slide Chandeliers.*—This type of gas fitting—which is not recommended or supplied by the company—is obsolete, unnecessary, and a source of danger unless the water seal is frequently renewed. *Consumers* are, therefore, *strongly recommended* either to substitute modern pendants for such chandeliers or to have them converted to fixtures. Any gasfitter will make the necessary alteration at a small cost. Should any difficulty be experienced, a post-card to this office will secure attention."

It will probably be the opinion of many of our readers that this caution with regard to the danger of gas fittings is necessary.

NOVEL CONDENSING SCHEME.

To utilise sewage water for condensing purposes is, so far as Scotland is concerned, something quite new in connection with electric power stations. It was only after much consideration that this novel and bold suggestion was adopted in Edinburgh, and the work is now practically accomplished. When it was decided to provide condensing plant for the McDonald-road electric power station, the Electric Lighting Committee of the Edinburgh Town Council had various proposals under survey. These included purchasing land and constructing an artificial lake, laying pipes to the sea and pumping sea-water, erecting cooling towers and taking the water supply from the city mains, and bringing water from the river called the Water of Leith, or from a large pond at Lochend. All these schemes had disadvantages, and in each case the cost was large, too large to be faced with equanimity, even by a rich Corporation. It appears, however, that a large sewer belonging to the Water of Leith Purification Commissioners runs along McDonald-road on its way to the sea at Seafield. Mr. L. Bennett Barclay, C.E., engineer to the Water of Leith Purification and Sewerage Commissioners, suggested tapping the sewer at a point near the power station and utilising the water. Sir Alexander Kennedy was consulted and gave his approval, and plans were at once prepared.

A shaft 26ft. in diameter has been sunk in McDonald-road to a depth of 35ft. This shaft is lined with cast-iron rings. In actual work the earth was excavated, and the rings placed one on top of the other, and forced downwards as the material was removed from the hole. The topmost rings were heavily weighted, and gradually sunk into position until the requisite depth was attained. The sewer is a 6½ft. tunnel of brickwork, and the portion running through the shaft was removed, an inlet on one side and an outlet on the other being left. A suction pit was constructed about 3ft. below the inlet. This pit is 8ft. long by 5ft. wide. Screens of copper wire guard the suction pit, and prevent solid matter from entering. Centrifugal pumps draw the water from the pit through four 18in. pipes upwards to the condensers in the power station. After use the water is returned through a 26in. pipe to the shaft, and is discharged into a chest 4ft. square, in which is placed an arrangement of "baffle" plates—steel plates ¼in. thick and measuring 4ft. by 18in. Dashing off these plates, the water is violently disturbed, and any foul gases that may have been generated are thrown off. Two motor pumps are so arranged that they will pump the gases by a special pipe back to the power station, where they will pass into the furnace and be consumed. Furthermore, to prevent the possibility of the escape of any noxious gas through the outlet sewer from the shaft, the outlet chamber has been "sealed." A calculation of the available sewage water traversing the sewer at normal flow puts it at 10,000 gallons per minute; in the event of rainy weather this volume of water will be exceeded. A weir has been constructed to intercept the flow and force the water through the screens into the suction pit, but in flood times this weir will not be used, and is made to be operated by hand winches.

This method of condensing with sewage water has, so far as regards the McDonald-road power station, many advantages over the other proposals. The first cost is very much less. Exclusive of the new plant required for the station, the cost of introducing this sewage water supply will be under £6,000. Moreover, the work was only begun in August last, and is now completed.

FIRES ON LONDON UNDERGROUND ELECTRIC RAILWAYS.

The following report has been issued by the Board of Trade:

We have, in the usual course of our duty, inquired into the circumstances under which an explosion and electric flashing took place in a car on the evening of Jan. 8 at Sloane-square Station on the Metropolitan District Railway. We made a very careful examination of motorcar No. 34, which alone was concerned in this case, before any repair work had been carried out or any of the effects of the explosion and flashing had been removed. Above floor level there was some blistering of the varnish on the woodwork surrounding the end left-hand window and doorway, and two panes of glass were blackened with smoke and fumes. No glass was broken, and it was possible by rubbing off the blistering on the wood to see that the red paint work underneath was undamaged. Below floor level, the metal pipe carrying the electric lighting wires and a metal junction box were fused. The underside of the timber flooring immediately above this pipe and junction box was charred in places. The charring nowhere exceeded ¼in. in depth. No mark of fire could be found inside the car on the flooring, seats, or sides.

We may here remark that all the woodwork on the company's cars in proximity to electric conductors has been rendered non-inflammable. This, and other occurrences of a similar kind, have proved that the wood will char under the effect of intense heat from electric flashing, but will not catch fire. The real combustibles in this fire, if we use the word, were copper, iron, and brass. Such electric arcs continue until they exhaust or burn themselves out, or until the current is cut off, as was done at Sloane-square. The ordinary method of extinguishing a fire is useless for electric arcs. This particular case was caused in all probability by failure of the insulation of the electric lighting wires owing to damp. The heating of the wires resulted in the liquefaction of a small plug of bitumen. An explosion of bitumen vapour followed, causing smoke and fumes. Subsequently electric flashing took place along the pipe and at the junction box under the car.

The conductor in charge of the car states that he immediately entered the door at the corner where the explosion had taken place, and worked the air-valve which actuates the double doors in the centre of the car. The doors opened in the usual way; they had not to be forced or held apart. The passengers, eight in number, stepped out on to the platform through the open doorway, without any apparent panic or alarm. No complaint of injury or danger was made to either the station inspector or any of the company's officials. Arrangements also exist on underground as well as on tube railways to allow passengers, in case of need, to descend from a train at either end.

In our opinion, the apprehensions of danger which have been expressed by writers to the newspapers are not justified by the facts. The main danger in any such cases of fire will be from panic. For this reason we deprecate the writing for publication of alarmist letters.

The report is signed by Major J. W. Pringle, inspecting officer of railways, and Mr. A. P. Trotter, the electrical adviser to the Board of Trade.

UNION ELECTRIC COMPANY, LIMITED.

The Union Electric Company, Limited, threw open for inspection on Thursday, Jan. 16, the extended portion of their new premises in Park-street, Southwark, S.E. Little more than one year has elapsed since we had an opportunity of going over the works and stores of the Union Electric Company, which even then impressed us as offering excellent facilities for the prompt and adequate handling of their numerous specialities. But with the completion of the extensions (which, when we visited them, were rapidly nearing that stage) these facilities will be considerably increased, and should better enable the company to cope with the heavier demands made upon them by customers. A new shop is being fitted up on the top floor, which is to be devoted solely to the repairing and testing of arc lamps. Separate benches are provided for dealing with direct-current and alternating-current types. The new switchboard erecting department is illuminated by the "Union" indirect system of lighting by means of an invisible inverted arc. The rays of the latter are thrown upwards and reflected from the ceiling.

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A very good and even illumination is obtained thereby, with an almost complete absence of shadows. This system of illumination strikes us as being particularly efficient for workshops. Other structural improvements include a complete rearrangement of the office premises, with sub-division of the various departments and easy means of intercommunication.

But if the premises have been extended, it is not only for the purpose of coping with the greater demand now made for the Union goods, but also in order to enable a number of new specialities to be stocked. One of those which deserve mention is a low-tension switch with renewable spark contacts, actuated by a spring. A type of self-locking cable coupler was to be seen which presented novel features, and small carbon "Kohinor" lamps, for indoor use, and with hood and protection for outdoor use, were burning. New types of two and three phase induction motors are now being offered by the Union Company. The three-phase motors are constructed with either squirrel-cage rotor (normally for powers up to 5 b.h.p.); wound rotor, with slip-rings and brush gear, the brushes acting continuously on the rings: and slip-ring rotor, combined with mechanically-operated brush-raising gear and short-circuiting device. The visitors were shown over the premises by Mr. Justus Eck, the engineer-in-chief and manager of the company, and his assistants, to whose unfailing courtesy was due the pleasure of the visit.

At night the staff dinner was held in the Café Royal, Regent-street, W., when a company numbering over 100, and including many gentlemen prominently connected with the electrical trade and industry, enjoyed the hospitality of the company. Mr. Justus Eck presided over the function, and expressed the regret of his co-directors at their inability to be present, giving as the reason that they were engaged at the works. The toast-list was commendably brief, and that of "The Visitors," cordially given by Mr. Eck, was responded to by Alderman Henry Ward and Mr. J. E. Lloyd-Barnes, both of whom referred to the straight dealing and ability which characterised the business of the Union Electric Company, Limited. "Absent Friends" found an effective spokesman in Mr. Bearwinkel—an erstwhile secretary of the company who spoke of the advance which the business of the company was making in foreign lands. A smoking concert followed the dinner and wound up an enjoyable evening in an appropriate manner.

DEMONSTRATION OF ELECTRIC HEATING AND COOKING.

At the *Tribune* offices there is this week being held an exhibition of winter foods and drinks which is interesting, inasmuch as the cooking, boiling, etc., is done entirely by electricity. All the apparatus required for the purpose is being loaned by the General Electric Company, Limited, and it is possible at this exhibition to obtain a fair estimate of the wide range of such apparatus at present on the market. On the demonstration platform there are two ovens heated by three heating coils, each coil taking half unit. We understand from the users that these ovens are performing their work very satisfactorily, and that they are entirely free from noxious fumes, dirt, and other inconveniences. It is impossible to say much about the cost of current consumed by these ovens, but with current at 1d. per unit this should not be much more than with gas. Of course, with current at higher rates the cost of electric heating will be a little more than that of its nearest rival, but it is a question whether the greater convenience secured with the use of electricity does not make it worth while undertaking a little higher expense. There are also to be seen a number of convector radiators, consisting of coiled resistance wire wound spirally round china bodies. This system of radiation is giving every satisfaction. At the stands of the various exhibitors are to be seen in use many hot plates taking anything from two to four amperes, electric kettles, urns, cigar lighters, etc. The whole of the heating is done on the General Electric Company's well-known "Archer" system of electric heating, the current being taken from the *Tribune's* own generating plant at 220 volts pressure. The exhibition remains open until to-morrow (Saturday), and is deserving of a visit from those of our readers in London who wish to see a practical demonstration of electric heating.

CATALOGUES, PRICE-LISTS, ETC.

Messrs. Roberts Bros., Dukinfield, Manchester, are sending out Section C of their catalogue, which deals with disc grinders, and shows an interesting variety of types of this apparatus.

Simplex Conduits, Limited, have sent us a large illustrated price-list of Simplex conduit fittings and accessories. The frames of this list are of steel conduits, and the whole is very suitable for hanging on walls.

Messrs. A. Reyrolle and Co., Limited, Hebburn-on-Tyne, are placing on the market a new watertight wall plug and an enclosed switch. These are designed for use in exposed positions, mines, factories, etc., and made to withstand rough usage.

Messrs. E. S. Hindley and Sons have just issued their latest catalogue dealing with steam and gas engines, boilers, hoisting and sawing machinery, which contains a large number of new illustrations, together with additional details and dimensions.

The Worthington Pump Company, Limited, 153, Queen Victoria-street, London, E.C., in issuing their latest catalogue of Worthington Triplex power pumps are able to disclose many noteworthy improvements in the design of power pumps. The design of a power pump presents a problem of far greater complexity than that of a direct-acting steam-pump, and we would draw our readers' attention to the solution proposed by Messrs. Worthington in the latest catalogue.

The Bastian Meter Company, Bartholomew Works, Kentish Town, have issued a booklet describing the Bastian meter as it is now manufactured. Every meter sold is guaranteed by the company to withstand the effect of temporary short-circuit or a 100 per cent. overload for an indefinite period; to remain accurate at all loads to within 2 per cent., and otherwise in good working order for a period of three years. We are glad to learn that the sale of the Bastian meter has increased so largely within recent times. The company inform us that they are doing all their business direct from their works, and not through agents as hitherto.

FORTHCOMING EVENTS.

FRIDAY, JAN. 24.

Northampton Institute Engineering Society. — At 5.45 p.m., "Electrical Illumination," by Mr. J. C. Rennie.

Physical Society. — At 5 p.m., at the physics laboratory at the Royal College of Science, Imperial Institute-road, South Kensington, "Recalescence Curves," by Mr. W. Rosenhain; "An Experimental Examination of Gibb's Theory of Surface Concentration regarded as the Basis of Adsorption, and an Application to the Theory of Dyeing," by Mr. W. C. M. Lewis.

SATURDAY, JAN. 25.

Royal Institution of Great Britain.—At 3 p.m., "The Electrification of Railways" (Lecture II.), by Prof. Gisbert Kapp.

North-East Coast Institution of Engineers and Shipbuilders.—At 7 p.m., at the Institute Lecture Hall, 4, St. Nicholas's-buildings West, Newcastle-on-Tyne, two or more of the following subjects will be introduced and discussed: "Electricity compared with Gas for both Lighting and Power"; "Apprentices' Advancement Scheme" (Mr. Spence's paper); "The Behaviour of Ship's Structure under Stress"; "Premium and Bonus System."

MONDAY, JAN. 27.

Sheffield Society of Engineers and Metallurgists.—"Electrical Driving in Rolling Mills," by Mr. Gerald J. Hooghwinkel.

TUESDAY, JAN. 28.

Institution of Civil Engineers.—At 8 p.m., discussion of papers on "Masonry Dams."

Institution of Electrical Engineers (Manchester Students' Section).—At 7 30 p.m., "The Design of Polyphase Induction Motors," by Mr. W. D. Redfern.

Liverpool and District Electrical Association.—At 8 p.m., at the Common Hall, Hackins Hey, Liverpool, "Fuel Economy in Steam Generating Plants," by Mr. R. Greenhalgh.

WEDNESDAY, JAN. 29.

Society of Arts.—At 8 p.m., at John-street, Adelphi, W.C., "The New Patent Act," by Mr. J. W. Gordon.

FRIDAY, JAN. 31.

Royal Institution.—At 9 a.m., at Albemarle-street, Piccadilly, W., "Recent Researches in Radioactivity," by Prof. Ernest Rutherford.

SATURDAY, FEB. 1.

Institution of Electrical Engineers (Glasgow Local Section).—Annual smoking concert at Grosvenor Hotel.

APPOINTMENTS VACANT.

Shift Engineer, Wolverhampton Electricity Works. Applications to the Electrical Engineer.

Engineer and Manager, Neath Rural District Council electric lighting station. Commencing salary, £200 per annum. Applications to the Chairman of the Council by Feb. 1. See advertisement in last issue.

One Armature Winder and five Electrical Fitters. Wages, 34s. per week for the first month, and 36s. afterwards if satisfactory. Apply to the Electrical Engineer's Department, H.M. Dockyard, Sheerness. See advertisement.

Working Engineer Foreman, Netherne Lunatic Asylum, Merstham, Surrey, to take charge of the steam boilers and plant in the above asylum, including the water supply, heating, electric lighting, and laundry machinery. Applications to M. E. Reed, Esq., County Hall, Kingston-upon-Thames, by Feb. 1.

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PERSONAL.

Mr. S. T. Allen, chief assistant electrical engineer for Plymouth, has accepted the appointment of city electrical engineer at Carlisle.

Mr. F. Parkinson, Eldon Mount, Guiseley, near Leeds, has been appointed representative for the Yorkshire district of Rhodes Motors, Limited.

We are informed that Mr. Chas. Pullan, electric engineer and contractor, has now opened more commodious offices and showrooms at Market-place, Shipley.

Mr. J. D. Caird has been presented with a silver tea service by the employés of the Aberdeen Corporation tramways on the occasion of his leaving Aberdeen for Halifax.

The salary of Mr. A. Redfern, chief assistant to the Darlington Corporation electricity and tramways department, has been increased to £156, rising to £170 in 12 months.

Mr. J. W. Galloway, of Rochdale, has been appointed rolling-stock superintendent in connection with the Halifax Corporation's tramways at a commencing salary of £130 per annum.

Mr. Oswin Hanson, the electrical engineer to the Fleetwood and District Electric Light and Power Syndicate, has been retained as electrical adviser by the Chorley Corporation.

The Council of the Institution of Electrical Engineers have elected Lieut.-Colonel R. E. B. Crompton, C.B., to the presidency of the Institution, vacant by the death of Lord Kelvin.

The annual dinner of the works staff of Messrs. Crompton and Co., electrical engineers, Chelmsford, took place in the clubroom on the 18th inst., and was a most successful and enjoyable function.

We are informed that Messrs. Tetley and Co., manufacturers of electric light, power machinery, and accessories, have appointed Mr. H. C. Hodgson, electrical engineer, of 577, Mansion House-chambers, 20, Bucklersbury, London, E.C., as their sole selling agent for London and district.

Mr. F. N. Saxelby, M.Sc.(Vict.), B.A.(Lond.), for the past four years head of mathematics at the Technical College, Belfast, has been appointed to a similar position at the Battersea Polytechnic. Previous to his appointment at Belfast, Mr. Saxelby was head of the mathematics department at the Royal Technical Institute, Salford.

Mr. H. A. Balchin, F.C.I.S., and Mr. G. F. Schulz, who were secretary and chief inspecting engineer respectively to the Alliance Electrical Co. for seven years, have recently joined partnership under the title of Messrs. Balchin, Schulz, and Co., and will carry on the business of electrical and general engineers and contractors at Lennox House, Norfolk-street, Strand, W.C.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Eagley.—Messrs. J. and P. Coates have had one of their Eagley mills electrified throughout.

Woolacombe.—A proposal has been mooted to supply this popular North Devon coast resort with electric light.

Woolwich.—The London County Council have agreed to lend the Borough Council £3,000 for electric lighting purposes.

Clifton.—The Clifton and Kearsley Coal Co. are about to adopt electrical appliances at the new pits which they are sinking at Astley.

Vegreville (Alberta).—A private company are contemplating the installation of an electric light plant for both street and house lighting.

New York.—The Public Service Commission has resolved to investigate the affairs of the electric light and power companies of the city.

Barnsley.—The Council have decided to obtain an electric motor for the laundry at the baths. This will displace an old engine, now useless.

Tynemouth.—A Local Government Board inquiry will be held on Jan. 28 into the Council's application for sanction to a loan of £4,000 for street-lighting.

Manitoba.—The Government have taken over the Bell telephone system. A reduction in the rates under public ownership is promised in six months' time.

Finchley.—The Local Government Board will hold an inquiry on Jan. 30 into the application of the Council for sanction to borrow £22,000 for electric lighting.

Yarmouth.—The Electricity Committee of the Town Council have approved requisitions by the electrical engineer for mains, stores, and public lighting at a total cost of £571.

Port Arthur (Ont.).—The Pigeon River Lumber Co. have applied to the city for 50,000 h.p. electrical energy to be used in the operation of large pulp mills they propose erecting.

Oban.—The Town Council have approved of a suggestion by the Standing Joint Committee that the police station at Oban should be connected with the local telephone system.

South Shields.—The Council are seeking sanction to borrow £7,052 for purposes of their electricity undertaking, and an inquiry will be held by the Local Government Board on Jan. 29.

Islington.—The Borough Council have decided to apply to the London County Council for a loan of £23,304 for the purpose of providing additional plant at the electric lighting station.

E.M.F. Manufacturing Co.—This company have established a business at 10, Ironmonger-lane, Cheapside, for the manufacture and supply of all electrical requirements for light, power, heat, etc., which their extensive works will enable them to turn out.

Stock Exchange.—The Stock Exchange Committee has appointed Feb. 5 a special settling day in Banteng (Selangor) Rubber Estates' 26,000 shares of £1 each (12s. 6d. paid), Nos. 1 to 26,000.

Shetland.—The postal telegraph authorities notify that communication with Lerwick has been restored. Telegrams for Orkney, Shetland, Iceland, and the Faroe Isles can now be accepted.

Bermondsey.—The London County Council have agreed to lend the Borough Council £2,154 for the extension of electric lighting mains in the neighbourhood of the Surrey Commercial Docks.

Londonderry (N.S.).—The Londonderry Iron and Mining Co. purpose developing power at Nixteaux Falls. From the proposed works they expect to secure the necessary power to operate their mines.

Haslingden.—In response to representations made to them by the Town Council, the Board of Trade have consented to extend the electric lighting order held by the Corporation for a further period of 12 months.

Westminster.—The Electricity Committee are recommending the City Council to enter into a contract with Messrs. Speedy, Eynon, and Co. for the maintenance of the electric light installation at Caxton Hall.

Havelock (Ont.).—The Northumberland-Durham Power Co. are about to make application to the Dominion Government for permission to develop power at the Upper Healey Falls. It is said 14,000 h.p. can be developed there.

Dundee.—Intimation has been received by the town clerk of Dundee to the effect that all the requirements of the Board of Trade had been complied with in connection with the Dundee electric lighting extension order.

Chislehurst.—At the District Council meeting it was reported that the Chislehurst Electric Light Co. were going to spend £3,000 on the erection of a transmission station at Lower Camden, in order to improve the electric light.

Mountain Ash.—The Local Government Board have written the District Council intimating their intention of deferring the consideration of the question of revoking the electric lighting order for 12 months from the present date.

Mirfield.—At the meeting of the District Council the clerk reported the receipt of a notice from the Yorkshire Electric Power Co. of their intention to lay a service main from the station to Messrs. Crowther, Sykes, and Co.'s works.

Stepney.—The London County Council have sanctioned the borrowing of £42,150 by the Borough Council, repayable within 20 years on the instalment system, for the equipment of a new electric generating station at Blyth's Wharf, Limehouse.

Plymouth.—The Corporation Works Committee have received an application from the National Telephone Co. for permission to extend the underground telephone system in the borough. The matter has been referred to the sub-committee for report.

Lichfield.—At the meeting of the City Council the town clerk reported that Messrs. Foote and Milne had paid £175 under their agreement of 1905 with the Corporation in respect of the costs incurred in obtaining the electric lighting order of 1901.

West Ham.—The Electric Lighting Committee have decided to light several streets with single 50-c.p. Osram lamps. The alterations will go on gradually, on the understanding that the price will be reduced to £2. 12s. 6d. for a single 50-c.p. Osram lamp.

Wimborne.—The Rural District Council have given consent to the proposal of the National Telephone Co. to erect a line of 39 poles and stays on the roadside from West Moors Station to the junction of the County Council road at Ferndown from thence to Longham.

Heath Town (Wolverhampton).—The Midland Electric Corporation for Power Distribution, in accordance with instructions, have sent their terms to the District Council for public lighting, and they were referred for consideration by the General Purposes Committee.

Acton.—The Brentford Gas Co. have been fined £10 upon two summonses and 100 guineas costs for using a lower quality gas with an improved burner at a test. The bench held that the burner mentioned in the Brentford Gas Act of 1868 must be used for the test.

Cardiff.—The Cardiff Electrical and Lighting Committee and officials, with the ward members interested, visited on the 17th inst. the South Adamsdown, Splott, and Roath Wards in order to inspect the public lighting and to decide upon improving it in certain streets.

Stretford.—A Local Government Board inquiry has been held into the application of the Urban District Council for sanction to the borrowing of £42,718 for extensions to the electricity undertaking; £36,990 of this sum is to be expended upon structural alterations and new plant.

Big Telephone Scheme.—The Associated Swedish, Danish, and Russian Telephone Co. to-day increased its share capital by £400,000. The proposal is to link up St. Petersburg, Moscow, Warsaw, Copenhagen, Stockholm, Berlin, Christiania, Frankfurt, and Paris by telephone in the course of this year.

Liquidation.—The *London Gazette* announces that a general meeting of the members of Electrical Turney will be held on Feb. 24 at 10 a.m. at 76, Cheapside, for the purpose of receiving the liquidator's report showing the manner in which the winding-up has been conducted and the property disposed of.

Faraday House Old Students' Association.—The fourth annual dinner will be held at the Queen's Hotel, Leicester-square, on Friday, Feb. 21, at 7.30 p.m., with the president, Mr. G. W. Partridge, M.I.C.E., M.I.E.E., in the chair. Tickets may be obtained from the hon. secretary, Faraday House, Southampton-row.

Maesteg.—The Board of Trade, in agreeing to extend the electric lighting order until Dec. 31 next, have decided that "It must be

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clearly understood that if at the expiration of that period the undertakers cannot furnish evidence that the order is to be put into force it will be revoked forthwith and without further notice."

Heaton Norris.—The Urban District Council have written the National Telephone Co. asking when they propose to carry out their promise to lay their telephone wires to underground, and pending the carrying out of the work that they remove the stay supporting the telephone pole on the tennis ground at the Heaton Moor ground.

Brynmawr.—At the last meeting of the Brynmawr Chamber of Trade complaints were made as to the quality of gas, and it was said that on several occasions business had to be suspended at night owing to the gas failing. It was decided to communicate with the gas company and to ask the District Council to enforce the penalties under the Act.

Salford.—Great damage was done by a fire which broke out early on the 21st inst. at the electrical fittings works of Messrs. Cowan, Limited, a big three-storeyed building in Springfield-lane, Salford. The damage was very considerable, probably about £5,000, and several thousand pounds' worth of property was destroyed on adjoining premises.

Tunstall.—An electric motor for blowing the organ has been installed in the Congregational Church, and works most satisfactorily. The organist has made himself responsible for more than half of the cost of the installation, the remainder being contributed out of church funds. The organ is now one of the most up-to-date instruments in the district.

Southwark.—At the next meeting of the Borough Council a report of the auditor of the municipal electric light undertaking will be submitted according to which the undertaking, which in the past has been a loss to the ratepayers, last year showed a profit of £473. Now the Council is "free wiring" consumers' premises, and thereby anticipates a great increase in the demand.

Stokesley.—The superintending engineer to the Post Office Telegraph has given notice to the Rural District Council of the intention of the Postmaster-General to lay underground telegraphs along the main roads passing through the Council's district by way of Crathorne and Yarm, and the Council have given the necessary consent provided that the roadway is made good and to the satisfaction of the surveyor.

Willington.—At the last meeting of the Urban District Council strong complaints were made respecting the gas lighting of the district. It appeared to be useless for the Council to complain, as, according to the statement of the clerk, the company would not reply to his letters. The Council resolved to again complain to the company, and express regret that a reply had not been received to previous letters of complaint.

Stoke Newington.—The Borough Council have adopted a scheme for the erection of an electricity generating station as an addition to the dust destructor. The scheme is estimated to cost £3,700, and a saving of £370 per annum is expected, as compared with the price now charged for the current by the electric supply company. It is computed that the generating station will be capable of meeting about two thirds of the present demand.

Taunton.—The Corporation Electricity Committee have found it necessary to provide a further capital sum of £2,000 to cover the next three years' estimate for the supply of meters and cables, and on their recommendation the Council have decided to make application to the Local Government Board for their sanction to the borrowing of such sum. The total connections to the mains during the past quarter were equivalent to 897 8-c.p. lamps.

Ilford.—The electrical engineer has presented his estimate of the cost of proposed extensions to plant, etc., to the Urban District Council, the total being £23,900. The surveyor has also presented his estimate of the cost of alterations and additions to existing buildings, amounting to £2,900. These estimates have been approved, and the clerk is to make application to the Local Government Board for their sanction to the borrowing of £27,000.

Hampstead.—The Council have decided that the loan of £8,155 (the borrowing of which has been sanctioned by the London County Council in respect of the estimated capital expenditure on the electric lighting undertaking during the present financial year) shall be borrowed from Lloyds Bank at the current bank rate, with a minimum of 3 per cent. and a maximum of 5 per cent., but 3½ per cent. to be charged when the Bank of England rate is 3 per cent.

Huddersfield.—To the Town Council the electrical engineer reported that the numbers of consumers and lamps connected in January were 2,630 and 193,801 respectively, increases of 19 and 1,030 on the previous month, and 180 and 18,819 respectively, compared with January last year. At the end of 1907 58·8 miles (primary) and 43 0 miles (secondary) of mains had been laid. Accounts amounting to £1,293. 8s. 4d. were passed for payment.

Gillingham.—At the last meeting of the Council Electricity Committee the engineer reported that the equivalent of 560 8-c.p. lamps had been connected with the mains, and that the equivalent of 33 8-c.p. lamps had been disconnected owing to the premises being closed, since the last meeting of the committee, making a total of 28,838 equivalent in 8 c.p. lamps with 321 consumers connected, and that applications had been received for the equivalent of four 8-c.p. lamps.

Long Eaton.—The Local Government Board will hold an inquiry on Jan. 31 into the Council's application for sanction to borrow £10,000 for their electricity undertaking. At the last meeting of the Council it was decided to oppose the Draycott Gas Co.'s Bill to supply electrical energy to Wilsthorpe parish, so far as that parish was concerned. The Electric Lighting Committee reported that during the past quarter 260,722 units had been generated, an increase of 20 per cent.

Fleetwood.—The Mayor of Chorley and several members of the Corporation visited Fleetwood last week to view the electric light installation and the generating station. Fleetwood is one of the towns where house refuse is used for the purpose of generating electricity, and Chorley is contemplating something similar. Mr. Oswin Hanson, the electric engineer for the Fleetwood and District Electric Light and Power Syndicate, has been retained as electrical adviser by the Chorley Corporation.

Paddington.—The Parliamentary Committee of the Borough Council having found that under the London Electric Supply Bill, promoted by 14 electric supply companies, with a collective capital of £13,000,000, to obtain power for such companies to amalgamate their undertakings or to enter into agreements for mutual assistance, the right of the Borough Council to purchase the Paddington undertaking of the Metropolitan Electric Supply Co. would be affected, the committee are recommending the Council to oppose the Bill.

Burnley.—An alarming gas explosion took place in Bivol-street on Wednesday evening of last week. It appears that there was a leakage in the main in the street, and the escaping gas found its way under the footpath and into the houses Nos. 23 and 25. The explosion damaged both houses, but No. 25 the most, the plaster being blown off the ceiling, etc. The framework of the window was also set on fire, and had to be extinguished by means of a chemical extinguisher brought by the fire brigade, which had been summoned.

Richmond (Surrey).—At the last meeting of the Council the General Purposes Committee reported consideration of the London and District Electricity Supply Bill and the London Electric Supply Bill, both of which were similar in their proposals to those before Parliament last session. In the event of their passing in their present form the rights of the borough would be adversely affected. They recommended that authority be given to watch these Bills and to take action if desirable or necessary. The recommendation was agreed to.

Clacton.—As the result of a special report from the Electricity Committee, a distiller for distilling the water for the battery, capable of distilling 2½ gallons per hour, is to be purchased by the Urban District Council. The committee have also recommended that the electrical engineer use the office at the works and that his present office at the town hall be vacated by him; also that telephonic communication be established between the clerk's office and the engineer's office. These recommendations have also been adopted.

Coulsdon.—At an isolated spot on the Brighton road, half way between Merstham and Coulsdon, the National Telephone wires have been cut and taken away, evidently by a gang of expert thieves. The value of the wires is estimated at £200. It is surmised by the police that quite half a dozen men were engaged, and that they had more than one cart or van in which the spoil was carried away. Nearly the whole of the wires on the route, over a thousand yards in length, were cut and the telephone system was disarranged. The thieves left no traces behind them.

East Preston.—The Board of Guardians are seeking a better method of lighting the infirmary than that hitherto existing. Frantic efforts and extraordinary offers are being made by the Littlehampton Gas Co. to secure the contract. In order to keep out possible electrical competitors the gas company are prepared to sell meters to the Guardians at cost price, lay all inside and outside piping, including material and labour, and to consider the cost of same included in their original offer, which did not allow for such outlay. The matter has been deferred for a fortnight.

Electricity in the Mine.—At Houghton-le-Spring on the 16th inst. a young man, George Craig, employed at an electric coal-cutting machine in the Lambton pit of Lambton Collieries, was charged with a breach of mining regulations. It was stated that, owing to the fact that defendant had allowed the cable to get between the cutter and the wall, some of the insulating material was rubbed off, the cable fused, and the machine fired. The defendant received a shock, but fortunately for him the fusing cable broke the circuit, otherwise he would have been killed. The defendant was fined 10s. and costs.

Exeter.—The results of the nine months' working of the electric lighting department to Dec. 23 last show an improvement in all departments over those of the corresponding periods of 1906. The total revenue has increased by 16 per cent., with total units generated only 14 per cent. in excess of last year, this result being due to improved economy in distribution. The above increase has been attained with additional generating costs of only 7 per cent., although the price of coal has risen 20 per cent. The general results show an increase in gross profits for the nine months of about £800 over the corresponding period of last year.

Brighouse.—At the monthly meeting of the Town Council it was decided to purchase for about £800 a plot of land with a frontage to the Huddersfield-road, near Perseverance Mills, on which to erect an electric transforming station, in connection with the arrangement with the Yorkshire Electric Power Co., to purchase electricity from the company, and distribute the same throughout the borough. It was also decided to give notice to the owners of the Alexander Mills site that in consequence of the adoption of the new scheme of purchasing electricity in bulk the site of the old mill would not now be required by the Corporation. The cost of the latter site was £1,800, and for over a year the Corporation have been paying interest at the rate of 4 per cent. on this sum.

York.—At the last meeting of the Education Committee the chairman read a communication from the city electrical engineer, which stated that he had been instructed to write and ask if the committee would sanction the exhibition buildings being lighted throughout by means of electricity. The only parts at present not lighted by electric light were the entrance, the entrance hall, and the central hall. The total cost of lighting the large hall and other parts lighted by electric light during the year ended Dec. 31 last was £26. 7s. 8d., and the total cost of lighting the whole of the buildings with gas during 1905 was £146. 19s. 6d. It was apparent, therefore, that a saving could be effected if electricity were substituted for gas throughout.

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It was agreed that the matter be referred to the Higher Education Sub-Committee.

Bromley.—To the Rural District Council a letter was read from Messrs. Lees, Butterworth, and Donnell with regard to the London and District Electric Supply Bill and the London Electric Bill. The Clerk said the London and District Electric Supply Bill affected the parish of Mottingham, and the same two features appeared in the Bill which the Council had objected to very strongly for several sessions past—namely, with regard to overhead wires and underground routes. They were in an unfavourable position as compared with the smallest urban district in the country. The second Bill had the same objectionable feature so far as underground routes were concerned. He had seen the parliamentary agents and they did not recommend any steps with regard to the second Bill. After some discussion it was decided to lodge a petition against the first Bill.

Stourbridge.—At a special meeting of the Stourbridge Urban District Council the clerk reported in reference to the action, the Council *v.* the Shropshire, etc., Electric Power Co., in the Chancery Division of the High Court, instituted to secure a settlement of a transfer of a provisional order under the Electric Lighting Acts, made by the Council to the Shropshire and Worcestershire Electric Power Co., and approved by the Board of Trade. The Town Clerk said he was glad to announce that the transfer in its original form, would be carried out, and the Council would receive a consideration in money in respect of it. He had also asked that the defendant company should pay the full costs which the Council had incurred. The Council have decided to settle the action on the defendant company paying the amount claimed and the costs of the action.

New Publications.—The first issue of *Railways and Tramways* should appeal very successfully to the class of the community to which it appeals. The magazine is well illustrated, and contains interesting articles on the ancient history of the locomotive, as well as such modern problems as to tramway legislation, tramway accidents, and the railway outlook, besides a fair share of personal gossip. It is clear from the contents that the writers are closely in touch with the staff of both railway and tramway systems, and without being too technical it offers information of a character hitherto not procurable. Business matters receive a fair share of space, openings for business, etc., are detailed, and included is a companies' stock and share list, besides which the traffic returns of railways and tramways are all tabulated. The publishing offices of this promising new monthly are at 139-140, Salisbury-court, Fleet-street, London.

Milnrow.—At the last Council meeting Councillor Meadowcroft complained strongly of the quality of the gas supplied to the Newhey Spinning Co. At the present time there were 40 operatives off work owing to illness, and they had told the overlookers they thought it was the gas. He asked if the Council had no power to appoint someone to inquire into the matter. The Chairman said they had power. The Clerk observed that under the Milnrow Gas Co.'s Act they had power to appoint an inspector to test the gas for illuminating purposes, but under the General Gasworks Act they could appoint an inspector to test gas issued for other purposes. The Chairman said if five consumers of the gas complained and got an order signed by two magistrates, he thought they could appoint an inspector. After other expressions of dissatisfaction had been made it was decided to exercise what power they had got in the matter.

Lowestoft.—To a meeting of the Electric Light Committee the town clerk reported that he had made all the deposits required and served all necessary notices in connection with the application for a provisional order for the electric lighting of Oulton Broad. The town clerk reported that he had made application, as required by the Electric Lighting Acts and Board of Trade rules, to the Urban District Council of Oulton Broad for their consent to this Council's application for the provisional order, and submitted a reply from the clerk to the Urban District Council dated 2nd inst., that having regard to the fact that his Council are themselves applying for a provisional order empowering them to light their own district with electricity they cannot, therefore, give the consent asked for. The committee recommended that it be referred to a sub-committee to confer with the Oulton Broad Urban District Council as to the applications of the two Councils.

Nottingham.—A meeting of delegates from the combined traders' associations of Nottingham—namely, the Nottingham Drapers', Merchants' and Traders', Grocers', Chemists', Pawnbrokers', Butchers', Ironmongers', Boot and Shoe Trades', and Tailors' Associations—to consider the question of electric light charges by the Nottingham Corporation was held on the 21st inst., when the following resolution was passed unanimously: "That this meeting of the representatives of the various traders' associations in the city of Nottingham considers the present system of charging for electricity for lighting purposes most unsatisfactory, and they beg to suggest to the Electricity Committee that in future a uniform or flat rate, not exceeding 3d. per unit, be charged to all consumers, believing that this method of charging would be much more satisfactory to consumers generally, and that a copy of this resolution be sent to the town clerk and the Press."

Johnstone.—The Town Council have been asked to consider the proposed provisional order of the Strathclyde Electricity Supply Co. to supply electric current within the burgh, and have decided to oppose it because the order injuriously affects their interests and the interest of the inhabitants of the burgh. It is considered that the powers thereby conferred would seriously affect the streets, and so would be a source of danger to foot passengers and vehicular traffic, and, further, that the order would not protect the local authority in respect of sewer pipes, gas-pipes, and drains belonging to them in streets to be used in connection with the order. They also consider that they should themselves, as local authority, apply for an order to produce or purchase and distribute electric current within the burgh. They have, however, decided to intimate these resolutions to the promoters of the company, and ask, if they are agreeable, to meet the Council with a view to avoiding opposition.

Linthwaite.—Owing to the indifferent quality of gas supplied by the Slaithwaite Gas Co., the District Council have approached the Huddersfield Corporation seeking terms upon which a supply of electricity could be obtained. The Corporation have stated that the Electricity Sub-Committee were suggesting an extension of their electricity mains to Linthwaite on the following terms and conditions: The private lighting and the street-lighting must be taken together, as the Corporation could not extend their mains for the private lighting only or the street-lighting only. The price per lamp (for all-night lighting) to be £2. 10s. per annum. The offer should be subject to the consent of the Board of Trade being obtained for overhead wires, to the consent of the Tramways Committee for fixing the wires and lamps to the tramway standards, and to the consent of the Linthwaite Council to the wires being carried overhead through their district. A committee has been appointed to consider the terms.

East Greenwich.—A Board of Trade inquiry into the cause of the fatal boiler explosion which occurred at the generating station of the South Metropolitan Electric Light and Power Co. on Dec. 20, 1906, was concluded at the Town Hall, Greenwich, on the 22nd inst., when Mr. A. A. Hudson, who conducted the inquiry, read the findings of himself and his colleague, Mr. J. H. Hallett. As the result of the explosion Mr. W. W. Shaw, a boiler insurance inspector, and a fitter named Coombes were blown to pieces. The commissioners found that primary responsibility for the accident must fall upon the shoulders of Messrs. Babcock and Wilcox, the manufacturers of the thermal heating drum, it being held that it was defectively constructed. The commissioners also held Mr. H. W. Bowden, the chief engineer of the electric light company, responsible, holding that he should have known there was danger and ordered the shutting down of the boiler. Messrs. Babcock and Wilcox were ordered to pay £400, their works manager (Mr. McLaren) £50, Mr. Bowden £50, and Mr. Constable £30 towards the cost of the inquiry.

Models of Aeroplanes.—A prize competition for models of aeroplanes will take place during the exhibition "Munich, 1908," under the management of the Sports Committee and with the co-operation of the Munich Aerial Navigation Club. Models with and without motors are eligible for competition, but only those without motors can enter for the race. The bearing superficies of models must neither be less than one square metre nor exceed two square metres. The total weight of models entering for the race must amount to at least 0·5 kilo per square metre. No restrictions are placed on the weight of models provided with motors. The aeroplane race will take place during the exhibition "Munich, 1908," in a suitable hall as arranged by the Sports Committee. No model shall be eligible for a prize which does not succeed in covering a distance of at least 15m. measured horizontally from the starting place, the said starting place to be at a height of 2m. The flight may be repeated twice. All competitors are required to show off their models to the general public. Constructors of aeroplanes or flying machines which do not fulfil the requirements of the competition will also be allowed to show their machines during the exhibition. Names must be entered by March 1, 1908. Further particulars will be sent gratis to intending competitors on application to the office of the Sports Committee, Neuhauserstrasse 10, Munich, Bavaria.

Walsall.—The total number of consumers supplied by the Corporation electricity department on Dec. 31 last was 531, as compared with 493 at same date previous year. During the past month the total units generated at the station was 222,837, as compared with 213,941 for the same period previous year. The total output from the main generators was 216,892 units, as compared with 208,042 for the same period previous year. The total units registered on meters was 157,866, as compared with 156,818 units for the same period previous year. The machinery was run for 740 hours, as compared with 740 for the same period previous year. The wages paid amounted to £169, against £143 previous year. Instructions have been given for the main to be extended from Lysways-street to four new houses in Birmingham-road at a cost of £50. The engineer has reported that on Dec. 18 last one of the transformers at the Imperial Hall broke down, causing an interruption of supply for seven minutes, and that in his opinion this was due to unsuitableness of the building as a transformer station. The town clerk has been requested to ask the borough member to use his best efforts to get the Board of Trade to reintroduce the Electricity Supply Bill in the coming session, with a view to its being passed into law. The town clerk has been instructed to make a representation to the Board of Trade, as suggested by the Corporation of Hastings, that it is desirable local authorities who own electricity undertakings should be empowered to supply electric fittings to consumers on the hire-purchase system.

Coatbridge.—At the last meeting of the Council the Town Clerk stated that he had received from the engineers for the Clyde Valley Electrical Power Co. intimation that on the expiry of a month they intended to exercise the powers conferred on them by their Act, and to carry out the work of laying a line of cable within the burgh specified in their intimation and shown on a plan they had sent. The matter being urgent, he had consulted the convener of the committee on the subject, who thought that the route proposed to be taken in laying the line of cable through the town, as shown on the plan sent, would have the effect of causing a good deal of disturbance to the main streets, which it was desirable to avoid as much as possible, and that an alternative route should be suggested. This had been done, and Mr. Robertson, the company's engineer, and Mr. Starr, the company's manager, were accordingly in attendance at the meeting to discuss the proposal. After considering the matter, it was resolved that the line of cable should run along the north end of Coatbank-street, north along Jackson-street and Portland-street to Alexander-street, thence along that street to Dunbeth-road, thence along that street and Burnbank-road as shown on the plan submitted. On this

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understanding the committee unanimously agreed to approve of the proposal. Subject to the Town Council's consent being given, it was remitted to the conveyancer and the master of works to arrange with the company as to the carrying out of the work.

Walton.—The Highways Committee reported to the Urban District Council at their last meeting the Woking Electric Supply Co.'s application for consent to break up certain streets with the Council's district, and it was resolved that the consent of the Council be given to the granting to the company, by provisional order or by a special clause in the Act of Parliament confirming any such order, of parliamentary authority to break up streets situate in the urban district of Walton, for the laying of mains for the transmission of electrical energy to the company's areas of supply, and for inspecting, testing, repairing, and renewing such mains from time to time, provided that so far as one mentioned road was concerned the sanction of the County Council was obtained by the company. The clerk reported that he had since seen the company's engineer, who stated that he would very much prefer to alter the route for a more direct route, which they asked for in the alternative. This would involve the laying of just under a mile of cable in the Council's district, whereas the route set out in the committee's report represented a mile and one-sixth. The shorter route would enable the company to supply the Urban Electric Supply Co., by arrangement, with current for the lighting of houses in the road, the Urban Co. being willing and anxious to take power for that purpose. The Woking Co. themselves could supply no current in the Walton district except through the Urban Co. There were scarcely any houses along the route recommended by the committee, whereas there was a considerable number along the other route.

Hull.—A long report on the last breakdown at the Hull electric light works has been presented to the Council, and the Electricity Committee have recommended the Council to authorise the committee to purchase three new high-pressure dynamos. The engineer's report states that the breakdown was due to the failure and burning out of the armatures of three of the high-pressure machines. The burn out occasioned a cessation of supply throughout the greater part of the centre of Hull from 4.20 to 4.50 on the day in question, the district immediately surrounding the station being kept supplied by low-tension generating plant. He states: "The Hull system is, so far as it relates to the Sculcoates undertaking, quite an uncommon one, known as the 'high-tension direct-current system,' and entails risks in running which are absent with more modern systems; coupled with this fact, the Hull undertaking is by far the largest of its kind working at 2,200 volts in the United Kingdom. The consequence has been that from the very beginning of the Sculcoates-lane scheme in 1897 any dynamos which have been made for the Corporation have been largely experimental, and, generally speaking, confined to a very small number of manufacturers. The result of this is that the large dynamos in question—seven in number—in Sculcoates-lane embody features in their design which preclude any likelihood of their continued successful running in the future." The engineer consequently did not feel justified in accepting further responsibility in connection with them. The Council have agreed with the recommendation of the committee.

Fulham.—At the last Borough Council meeting the Electricity Committee reported that on July 27, 1904, the late Council authorised the first section of a large scheme of extension of the electric lighting undertaking in this borough at a total cost of £52,042, and passed the necessary estimates of expenditure to cover the cost thereof, upon the recommendation of its Finance Committee. The extension is now nearly completed, and, in accordance with instructions, the borough electrical engineer has presented the following report—viz.: "I am pleased to be able to give you the figures of the total expenditure connected with this vote up to date. We have made this out most carefully, the figures have been submitted to the borough treasurer, and he agrees with them as they stand. The only part of the work unfinished is the second stoker of the last order, and this will require about £50 to fix. For your information we have divided the actual sum up into two headings—machinery and buildings. In considering these figures you should bear in mind that almost all the work as put in was much larger than was originally contemplated, but we have been able to carry it out, as you will see, without asking for any additional vote. I take this opportunity of pressing for the enlargement of our present workshop, which is quite inadequate for the work we have to carry out. So much so that we are compelled to send part of our work to neighbouring firms, and also send our fitter with it to see the work is carried out properly. We need about £100 spent on tools, which, if expended, will still leave a balance on the vote. If you agree to this I shall be glad to bring prices forward at next meeting. I shall be glad if you can pass this amount, as we should find in our present circumstances the tools extremely useful for the spring overhaul." The Council approved of the report.

TRACTION.

Willesden.—The District Council have decided to appeal to the Middlesex County Council for a better service of trams.

Keighley.—The Corporation have decided to provide office accommodation at the car-shed in South-street at a cost of £20.

Norway.—A movement is on foot having for its object the construction of an underground electric tramway which is to cost £75,000.

Kincardine (Ont.).—The surveys for the West Shore electric railway will be commenced shortly from Kincardine. Construction is expected to commence in May.

Madras Electric Tramways.—The traffic receipts for the fortnight ending Jan. 15, 1908, were Rs.19,685; corresponding period of 1907, Rs.17,255—increase, 14 per cent.

Moscow.—The British firm which has obtained the contract for the installation of an electric tramway service in Moscow has deposited with the Russian Imperial Bank the sum of £10,000 required as guarantee.

Croydon.—The County Council have received a petition signed by numerous inhabitants in the neighbourhood of Portland-road asking for a service of trams down that thoroughfare. The Council have referred the matter to the Tramways Committee.

Dalmuir.—Operations have been commenced at Dalmuir in connection with the new electric tramway line from Dumbarton to Dalmuir, and it is expected that passengers will soon be enabled to travel all the way from Balloch to the city by electric tramway.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Jan. 14, 1908, converted to gold, were £3,553; corresponding period 1907, £3,697; decrease, £144. Aggregate from Jan. 1, 1908, £7,730; aggregate from Jan. 1, 1907, £7,708; increase, £22.

Kamloops (B.C.).—Incorporation will be sought at the next session of Parliament for a company to build a railway from Nicola Lake to Vancouver. The proposed route follows the Nicola, Coldwater, Coquihalla, and Fraser River valleys to the railway bridge across the Fraser at New Westminster.

London and North-Western Railway.—The company has informed the Watford Urban District Council that, owing to the unfavourable state of the money market, it does not feel justified in attempting at the present time to raise the large capital which would be required to construct the new Euston-to-Watford electric railway, but that it will certainly do so at a more favourable time.

Tunstall.—The Urban District Council has resolved to oppose the draft order for which the Potteries Electric Tramway Co. is applying to the Board of Trade, in order to secure that no tramrail shall be laid within 8ft. 8in. of a footpath without the consent of local authority concerned. It is intended to secure the support of the other local authorities in opposing the order and securing the desired result.

Central London Railway.—The directors of the Central London Railway have declared (subject to audit) dividends of 3 per annum on the ordinary stock for the half-year ended Dec. 31, 1907, 4 per cent. per annum on the preferred stock for the half-year ended Dec. 31, 1907, and 2 per cent. on the deferred stock for the year ended Dec. 31, 1907, carrying £10,000 to reserve and £10,218 forward.

Glasgow.—As the result of a conference with representatives of Partick regarding the widening of Dumbarton-road at the tramway shunting place at Whiteinch, the committee have recommended that, if the County Council of Renfrew are prepared to bear the cost of widening the road so far as within that county, the Tramways Committee and the burgh of Partick should each undertake to pay one-half of the cost of executing the remainder of the work.

Wolverhampton.—The Bill promoted by the Wolverhampton Corporation to extend the time for the construction of tramways and to make further provision in regard to the tramway and water undertakings of the Corporation, and the health, local government, and improvement of the borough, was down for consideration before Mr. Jeune, one of the examiners of Standing Order Proofs, at the House of Commons on the 22nd inst., but was postponed until Feb. 3.

Haslingden.—The Tramways and Electricity Committee of the Council have decided to serve notices upon owners and occupiers of property abutting upon the various crossings which it is proposed to reconstruct on the tramway route. It was resolved that the question of through-running fares and the running of the trams on to the loop or crossing at the borough boundary be left in the hands of the borough accountant to arrange with Mr. Wilson, the manager of the Accrington Corporation tramways.

Walsall.—The following are particulars respecting the working of the tramways: four weeks ending Dec. 29, 1906—number of passengers, 372,800; receipts, £2,064. 14s. 5½d.; car miles run, 46,703; receipts per car mile run, 10·61d. Four weeks ending Dec. 28, 1907—numbers of passengers, 403,624; receipts, £2,245. 4s. 11d.; car miles run, 47,186; receipts per car mile run, 11·42d. Wages paid (including repair of permanent way)—four weeks ending Dec. 27, 1906, £607. 3s. 8d.; four weeks ending Dec. 26, 1907, £631. 16s.

Barnsley.—Replying to complaints of the Corporation, the Barnsley and District Electric Traction Co. have expressed regret at hearing further complaints regarding the dangerous condition of the overhead electric tram wires. A thorough inspection had recently been made, and repairs had been carried out where necessary. The Council could, however, rest assured that every attention would be given to the wires, and periodical inspections would be made by qualified wiremen. It was also their intention to substitute stronger wire than that at present in use.

Dundee.—Mr. Peter Fisher, general manager of the Dundee Corporation tramways, in his report to the Town Council states that for the year ended May 15 last, after meeting interest, sinking fund, depreciation on plant, and renewals, there was a balance of £85. 19s. 10d. This balance being less than the sum received for advertising, rent, and receipts from parcels, consequently the cost per passenger carried was more than the receipts per passenger, the average fare per passenger being ·878d., while the total outgoings amounted to ·888d.

Cardiff.—The new system by which passengers by the Cardiff trams can secure transfer tickets along the various routes, enabling them to travel to and from certain centres and exchanges from one route to another, came into operation on Monday. There were numerous applications for the new privileges, and many people availed themselves of the advantage of taking short return trips for a penny, but the tramway officials when questioned on Monday evening stated that though they were perfectly satisfied with the

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result of the first day's working of the new system, it was too soon to say whether it would prove a success or not.

Southampton.—The Tramways Committee of the Corporation have considered the question of running a motor-'bus service down Northam-road. Messrs. Thornycroft and Co. are prepared to place a 'bus on the Northam route at an approximate cost of 10d. per mile, the company providing driver, petrol, and executing all repairs, the Tramways Committee to find the conductor and clean and house the vehicle. The general manager has been directed to prepare a time-table for a 10 and 20 minutes' service, and obtain the best terms from Messrs. Thornycroft, the whole question to be again considered at the next meeting of the sub-committee which has this matter in hand.

Richmond (Surrey).—To the last Council meeting the Tramways Committee reported as follows: "Referring to the resolution passed at the last meeting of the Council relative to the proposals of the London United Tramways as regards the tramways across the King Edward VII. Bridge at Kew, the committee have settled draft agreement embodying the terms upon which the Council then agreed to 'request' the company to promote their Bill in the ensuing session of Parliament, and such draft had been sent to the company's solicitors for approval, and in the event of its being approved the committee recommended the Council to seal an engrossment thereof." The recommendation was adopted.

South Shields.—An alarming statement was made at the last meeting of the Town Council by Councillor Fownes to the effect that the rolling stock of the electric tramway service was unsafe and unfit for use. Since then a committee has inspected the cars. Three were specially pointed out by the manager, but the only fault that could be found with them was, it is now reported, that the flanges of the wheels had been somewhat seriously affected by wear and tear. The three cars were ordered to be withdrawn from the service and put into the repair shop. The members of the committee did not consider the condition of the rolling-stock to be such as to justify any alarm, and, although divided on the point, they agreed by a majority not to call in the aid of an expert.

Darwen.—The annual social gathering of the employés of the Corporation tramways department was held on the 16th inst. at the Industrial Hall, and was attended by about 100 ladies and gentlemen. The hall was prettily decorated for the occasion. After tea had been served, the chair was occupied by Councillor Cattarall, the chairman of the Tramways Committee, who was supported by the Mayor, Messrs. J. H. Ellison (borough treasurer), R. W. Smith-Saville (borough engineer), F. J. S. Hoeken (depôt superintendent), M. Stokes (traffic manager), J. Stirrup (chief inspector, Blackburn section), J. Hacking (secretary of the Amalgamated Association of Tramway Workers), and other gentlemen. The chairman and the mayor briefly addressed the gathering. The Orchid Band, conducted by Mr. Venly, played for dancing, and during the evening musical items were rendered by the Misses Hetty Marsden and B. J. Lightbown and Messrs. Hall, Lightbown, and Kerrigan.

Accrington.—On the 15th inst. Lieut.-Colonel Druitt, of the Board of Trade, made an inspection of the Baxenden tramway section, the last length of the undertaking. He was accompanied in the car by the mayor, town clerk, borough engineer, tramway manager, and others. The whole of the tramway system has now been completed, and every section has had the approval of the Board of Trade without the slightest alteration being necessary, and there has not been a single hitch since the work was started. Lieut.-Colonel Druitt, with regard to the permanent-way construction and laying of the rails, expressed himself thoroughly satisfied. This reflects great credit on the borough engineer, who has had charge of the whole of the work, which has been carried out efficiently and expeditiously considering the abnormally wet summer and the frost. In spite of the bad weather, which knocked off eight weeks, the whole of the 11¼ miles of tramways have been completed in between six and seven months.

Deptford.—The General Purposes Committee of the Borough Council have considered the London County Council Tramways and Improvements Bill, 1908, which has been promoted by the London County Council for powers to construct tramways in various parts of the county. The only portions of the Bill affecting the borough of Deptford are the provisions by which it is sought to revive for a period of three years the powers granted by the London County Council Act, 1902, for the compulsory purchase of property required for widening the portion of Queen's-road in the borough, and for requiring the Deptford Borough Council to contribute one-third of the net cost of such widenings. These provisions are in accordance with an arrangement made between the Council and the London County Council on the matter, except that the Deptford Council's resolution of Oct. 22, 1907, was to contribute one-third of the net cost of the widenings up to a sum not exceeding £8,500, and the committee have recommended that a communication be addressed to the London County Council with a request that the Bill may be modified to that extent. This recommendation has been adopted by the Council.

Bexley.—At the last meeting of the Urban Council the clerk submitted prints of the Tramway Bill which the Erith Urban District Council are promoting in the next session of Parliament, and reported that Section 7 thereof provided that the Erith Council should have running powers over the tramways of the Urban District Council of Bexley authorised by the Bexley Tramways Act, 1901, upon terms to be agreed between the respective Councils, and failing agreement to be determined by the Board of Trade. The committee recommended the Council, if the Bill be proceeded with, to oppose the same, and for that purpose have instructed the clerk, as the Council's solicitor, to prepare petition against the Bill for sealing by the Council in due course. They recommended that the clerk be appointed to act as the Council's solicitor in opposition to the Bill. These recommendations were adopted. The engineer reported that a hitch had occurred in connection with the synchronisation of the Bexley and Erith tramway services, the Erith Council having referred back to their Tramway Committee the report containing the proposed arrangements made between the respective tramway managers, and approved by the tramway committees.

Aberdeen.—The first of the Aberdeen Corporation cars to be fitted with top covers since the repairing of the cars had been placed under the charge of Mr. Pilcher, the tramway manager, was out on the King's Gate route on the 16th inst. The cars are built to the specification used for the last cars fitted with top covers under the supervision of Mr. Bell, the electrical engineer, and they are identical in pattern and workmanship, the only difference being that there are eight electric lights in the roofs in the new tops compared with six in the last fitted tops. The work has been carried out by a firm of contractors—Hurst, Nelson, and Co., Motherwell—at a cost of £30 per car cheaper than the tops built by the Corporation's workmen under the old arrangement. Another of the newly-covered cars will be ready for use this week, and each week will see an additional covered car running until the six are in service. The names of the various routes on which the newly-covered cars are to run have been painted on the panels under the top windows, and the letters are much larger than on the signboards used on the other cars. The new cars are all fitted with holders, so that the names of the permanent routes can be covered with a blackboard, thus permitting the use of the cars on special runs, or as extra cars on other routes.

Huddersfield.—To the Tramways Committee of the Corporation at their last meeting the borough engineer submitted a list of sections to be doubled, together with estimated cost, and a request that the cost be charged to depreciation. The particulars are as follows: Westgate (from a point 20 yards above New-street to the end of existing double lines), cost, £545; Trinity-street (from Park-drive to Snodley), £1,657; Westbourne-road (from Mitre-street to Croppers' Arms), £1,440; Lockwood-road (from end of double line near Dr. MacGregor's to the White Lion Hotel, Salford), £2 600; St. John's-road (from Fitzwilliam-street to Blacker-road), £3,456; Moldgreen (from Somerset-road to Junction Inn, Moldgreen), £2,600; King-street junction (relaying existing junction and cross-over road), £275—total £12,573. It was resolved that the cost be charged to depreciation. The borough treasurer's financial report for the nine months ended Dec. 31, 1907, showed that the capital outlay to date was £412,902. The miles run were 1,473,459, as compared with 1,369,022 last year. The income (including £62,656 passengers, £878 parcels, and £630 coal haulages) totalled £65,006, equal to 10·59d. per car mile, as compared with £61,890, equal to 10·85d. per car mile last year. The total working expenditure amounted to £32,054, equal to 5·22d. per car mile, as compared with £31,344, equal to 5·49d. per car mile last year. The gross surplus was £32,952, equal to 5·37d. per car mile, as against £30,546, equal to 5·36d. per car mile last year. After allowance for £14,596 (2·38d. per car mile), compared with £12,190 (2·14d. per car mile last year), £7,402 for redemption of debt, and £904 rent of leased lines, and £9,290 for depreciation (at the rate of 3 per cent.), a net surplus is shown of £5,306, equal to ·87d. per car mile, as compared with £2,900, or ·51d. per car mile last year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Brussels.—The Belgian State Railways invite tenders for telegraph construction material. Tenders by Feb. 5.

Bury.—Tenders are invited for the erection of a chimney shaft at the electricity works. Tenders by Jan. 27.

Bourges.—Tenders are invited by the Military Authorities for one five-ton electrical crane. Tenders by Feb. 14.

Campina (Bucharest).—The Municipality invite tenders for the electric lighting of the town. Tenders by Feb. 9.

Paris.—The Post and Telegraph Department invite tenders for lead-covered telephone cables. Tenders by Jan. 31.

Melbourne.—Tenders are invited by the Postmaster-General for switchboards and telephone sets. Tenders by May 26.

Portsmouth.—Tenders are invited for the supply of coal at the power station. Tenders to the Town Clerk by Feb. 3.

Sydney.—The Postmaster-General invites tenders for 33 switchboards for common-battery working. Tenders by March 4.

York.—Tenders are invited by the North-Eastern Railway Co. for the erection of an electric sub-station. Tenders by Jan. 27.

Edinburgh.—The Corporation invite tenders for an extension switchboard panel. Tenders to the Town Clerk by Feb. 10.

Madrid.—The Public Works Department invite tenders for the construction of a tramway at Santander. Tenders by Jan. 30.

Oporto.—The Municipality invite tenders for the construction, maintenance, and working of tramways. Tenders by March 11.

Cologne.—The Prussian Government Railways invite tenders for the supply of telegraph construction material. Tenders by Feb. 6.

Wimbledon.—Tenders are invited for the annual supply of flame arc lamp carbons to the Electricity Department. Tenders by Feb. 18.

Paris.—The Post and Telegraph Department invite tenders for indiarubber-insulated cotton-covered copper wire. Tenders by Jan. 25.

Islington.—The Borough Council invite tenders for the supply of electrical and engineers' stores. Tenders by Feb. 28. See advertisement.

Pilsen (Austria-Hungary).—The Austrian Government Railways invite tenders for the supply of electric lighting materials. Tenders by Jan. 30.

Rome.—Tenders are invited by the Post and Telegraph Department for 20,000 accumulator cells and 17,000 insulator holders. Tenders by Jan. 28.

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Brazil.—The Government invite tenders for the installation of electric light and power supply in the city of Florianopolis. Tenders by March 5.

Croydon.—Tenders are invited for coal-conveying plant for the electricity works. Particulars from the Borough Electrical Engineer. Tenders by Feb. 10.

Cheltenham.—The Corporation invite tenders for the annual supply of stores, including electric lighting fittings and indiarubber goods. Tenders by Jan. 31.

Innsbruck.—The Austrian Government Railways invite tenders for the necessary plant for electrically lighting Bishofshofen Station. Tenders by Jan. 30.

Portsmouth.—Tenders are invited by the Tramways Committee for the supply of points, crossings, and junctions. Tenders to the Town Clerk by Feb. 3.

Salford.—The Tramways Committee invite tenders for the supply of tramrails. Particulars from the General Manager, Tramways Office, 32, Blackfriars-street, Salford.

Norwich.—Tenders are invited for the supply of an electric motor and other apparatus. Particulars from Mr. A. E. Collins, city engineer. Tenders by Feb. 4.

Witten.—Tenders are invited for electrical motors and conduits for working the machinery in the workshops of the Prussian Government Railways. Tenders by Jan. 30.

Great Yarmouth.—The Corporation invite tenders for the supply, delivery, and erection of one 400-kw. continuous-current traction steam generator. Tenders by Feb. 1.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Slough (Bucks).—The Urban District Council invite tenders for street lighting for one year. Tenders to Mr. G. H. Chardsley, clerk, 11, Mackenzie-street, Slough, by Feb. 6.

Ghent.—Tenders are invited for 30 electric cranes for the new dock. Particulars from the Public Works Department, 15, Rue des Augustins, Brussels. Tenders by Feb. 1.

Bermondsey.—The Borough Council invite tenders for the annual supply of stores for the Electricity Department. Particulars from the Borough Electrical Engineer. Tenders by Feb. 17.

Rathmines.—The Rathmines and Rathgar Urban District Council invite tenders for the annual supply of stores to the Electricity Department Tenders to the Town Clerk by Feb. 13.

Hanover.—The Prussian Government Railways invite tenders for iron wire, steel wire, wire rope insulators, cotton wire, insulated wire, and telegraph construction material. Tenders by Jan. 29.

Leeds.—The Corporation invite tenders for steam, exhaust, overflow, and other pipes, valves, etc., in connection with a 3,000-kw. steam turbo-generator. Tenders to the Town Clerk by Feb. 10.

Wallasey.—The Urban District Council invite tenders for the annual supply of stores for the Tramway Department. Particulars from the General Manager, Liscard, Cheshire. Tenders by Feb. 12.

Paris.—The Municipality invite tenders for centrifugal pumps to be driven by three-phase motors for the Clichy sewage pumping station. Particulars from the Clerk to the Municipality. Tenders by Feb. 18.

West Ham.—The Corporation invite tenders for engine-room stores, indiarubber-covered wire, electric wiring materials and accessories. Particulars from the Borough Electrical Engineer. Tenders by Feb. 6.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1.

Sydney.—The Postmaster-General invites tenders for cables and conductors, and 10 switchboards for 100 metallic circuits. Particulars from the Agent-General for New South Wales, 72, Victoria-street, Westminster. Tenders by Feb. 5.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1.

Wolverhampton.—The Tramways Committee invite tenders for the supply of clothing for the tramway employés. Particulars from Mr. W. A. Luntley, the general manager, at the Car Depôt, Cleveland-road, Wolverhampton. Tenders by Feb. 11.

Islington.—The Lighting Committee have been authorised to invite tenders for the carrying out of the work and for the supply of plant and machinery at the electric lighting station, pending the sanction to the borrowing of the sum of £23,304 being obtained.

Battersea.—Tenders are invited for the supply of oils, engine-room stores, coal, carbons for arc lamps, electricity meters, service joint-boxes, etc., incandescent electric lamps, ironmongery, tools, etc., for the ensuing year, for the Electricity Department.

Tunbridge Wells.—The Corporation invite tenders for the supply of high and low tension cables for 12 months. Specifications, etc., from Mr. Horace Boot, consulting engineer, at the Electricity Works. Tenders to the Town Clerk by Feb. 1. See advertisement.

Bristol.—Tenders are invited for the supply of cables and appliances for conveying electrical energy to the Avonmouth Docks, and for construction and maintenance for 12 months. Tenders to the Secretary of the Docks Committee, 19, Queen-square, Bristol, by Feb. 17.

Rawtenstall.—The Corporation invite tenders for the supply and erection of one balancing set, rotary transforming plant, and static transformers, feed pumps, boilers, condensers, circulating pumps, steam and water pipes, valves, etc., at the Electricity Works. Tenders to the Town Clerk by Feb. 7.

Wimbledon.—The Corporation invite tenders for one 1,000-kw. steam-driven turbo-alternator, with condensing plant, two water-tube boilers, economisers, pipe work and feed pump, high-tension main switchboard, and switchboard gallery. Particulars from the Borough Electrical Engineer. Tenders by Feb. 18.

Adelaide.—Tenders are invited for the supply and delivery, c.i.f. Port Adelaide, of special work, points, and crossings for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C. Tenders to the Chairman, Municipal Tramways Trust, Adelaide, by Feb. 11.

West Hartlepool.—Tenders are invited for the erection of an electrical sub-station at West Hartlepool, for the North-Eastern Railway Co. Plans and specification may be seen and quantities and further information obtained upon application to Mr. William Bell, the company's architect, at York. Tenders to the secretary, Mr. R. F. Dunnell, York, by Jan. 27.

Samara (Russia).—According to the decision of the Town Council of Samara, Russia, the Chairman invites tenders from contractors for the construction and the working of a central electric station, and also to take charge of the organisation of the tramways at Samara. The above undertaking to be given in a concession. For particulars and conditions write to l'Administration de la Ville de Samara.

London.—The London County Council invite tenders for the manufacture, delivery, and laying of about five miles of low-tension lead-covered electric cable, and about two miles of telephone cables, etc., and the laying of stoneware cable ducts, building manholes, repaving, etc., for the reconstruction for electric traction of the Council's tramways in Caledonian-road and Seven Sisters-road. Tenders to the Clerk, County Hall, Spring gardens, S.W., by Feb. 4.

London, N.—The London County Council invite tenders for the road work and platelaying required for the reconstruction for electric traction on the conduit system of the Council's existing tramways in Caledonian-road and Seven Sisters-road. The total length of the above-mentioned lines is about 5¼ miles, single track. Particulars from the chief engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W. Tenders to the Clerk by Jan. 28.

RESULTS OF TENDERS.

Lowestoft.—Messrs. J. W. Brooke and Co. have received the contract for the supply of brake blocks for the tramways.

Battersea.—The Borough Council have accepted the offer of Callender's Cable Construction Co. for the supply of cables, etc, for one year.

Belfast.—The Corporation have accepted the tender of Messrs. Dick, Kerr, and Co. for the construction of the electric tramways on the co. Down side of the harbour.

Rawtenstall.—The Town Council have accepted the tender of Browett, Lindley, and Co. for supplying steam dynamos, and that of W. T. Glover and Co. for supplying electric lighting and tramway cables.

Bradford.—Mr. Chas. Pullan, 52, King's-arcade, has obtained the contract for the conversion of lighting to tantalum lamps at the Conditioning House, Bradford, for the Corporation. This covers between 300 and 400 lights.

London.—The London County Council have received the following tenders for the supply of a car traverser for the central car repair depôt: Appleby's Limited, London and Leicester, £515. 10s. (accepted); Heenan and Froude, Worcester, £580.

London.—The Highways Committee of the London County Council have accepted the tender of Bullers, Limited, for the supply of 2,000 track insulators at 3s. 5½d. each; and that of Callender's Cable and Construction Co., amounting to £800, for the supply of the cable.

Recent Contracts.—Messrs. Cowans, Limited, Salford, Manchester, have recently received the following orders: Switchboards for H.M. battleships "Minotaur" and "Shannon," also for Gibraltar Dockyard, for the Admiralty; switchboards for the lighting of the Franco-British Exhibition, including Andrews's patent discriminating devices, and a repeat order for sub-station switchgear for the Hammersmith Borough Council, including Andrews's reverse-current relays.

Metropolitan Asylums Board.—The Board have received the following tenders for electric lighting and power at the Mead ambulance station:

T. Potter and Sons, Putney Bridge Ironworks, Fulham*	£139	0	0
Speedy, Eynon, and Co., 3, Adelaide-street, Charing Cross	143	0	0
C. Pullan, 52, King's-arcade, Bradford	145	0	0
A. V. Gifkins and Co., 68, Victoria-street, S.W.	149	0	0
Smeeton and Page, 63, Queen Victoria-street, E.C.	178	2	6
Electrical Co., 121-125, Charing Cross-road, W.C.	180	0	0
Dargue, Griffiths, and Co., 51, North John-street, Liverpool	183	0	0
H. J. Cash and Co., Caxton House, Westminster	185	0	0
Edmundson's Electricity Corporation, Broad Sanctuary-chambers, Westminster	186	10	0
G. Weston and Sons, 153, Fenchurch-street, E.C.	189	0	0
A Plucknell, 1, Gresham-street, E.C.	192	0	0
J. Wilson, Ferrier Works, Fairfield-street, Wandsworth	192	0	0
C. Cooper and Co., 14, Gloucester-road, South Kensington	210	10	0
Jenkins and Cawte, Chard, Somerset	229	15	0
Fulham Electric Supply Co., 43, High-street, Fulham	253	0	0
W. G. Cannon and Sons, 107, London-road, Southwark	266	16	11
Kevan Electric Co., 88, Charing Cross-road	335	0	0

* Recommended for acceptance.

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Huddersfield.—The Council have accepted the following tenders in connection with the doubling of lines: Rails and fishplates, Bolckow, Vaughan, and Co.; points and crossings, Hadfields, Limited; bolts and nuts, Ibbotson Bros.; tiebars, Walter Scott Limited; copper bonds, Lahmeyer Electrical Co. The tender of Messrs. Pearson, Huggins, and Co., London, has been accepted for uniform clothing for motormen and conductors, tunics and trousers; Messrs. J. Smith and Co., Derby, and Mr. E. A. Washington for caps; and Messrs. Mackintosh, Manchester, for mackintoshes.

OPENINGS FOR CONTRACTORS.

ABERDARE—Forty houses, Abernant Building Club; alterations at Trinity Chapel, additions to schools, etc., Trustees; villa at Llewydcoed—Mr. J. L. Smith, architect.

ABERDARE—Workmen's dwellings (£20,000), District Council.

ABERBEEG—Church at Christ Church, Ecclesiastical Commissioners.

ABRAM—Parish church, Ecclesiastical Commissioners.

ALCESTER—Secondary school, Education Authority.

ALNMOUTH—Additions and alterations to Ladies' Golf Clubhouse, Mr. W. R. Hindmarsh.

ALNWICK—Club premises, Togston-terrace, Mr. G. Reavell.

ALTHAM—Important developments at Messrs. Hargreaves' collieries.

AMBLESIDE—Erection of hospital (£3,000), Urban District Council.

ARDEE—Scheme for the erection of labourers' dwellings, Rural District Council.

ASHTON—Weaving shed, Flora-street, Makerfield Mill Co.; workrooms, etc., Princess-road, Mr. James Ince.

ASHTON-IN-MAKERFIELD—Erection of conveniences, Urban District Council.

AYSGARTH—Church at Stalling Busk, Ecclesiastical Commissioners.

BANTRY—Workmen's dwellings (£16,636), Rural District Council.

BARNSLEY—Additions to corn mill, Summer-lane, British Co-operative Society; alterations to Miners' Rest, Old Town, Barnsley Brewery Co.; girls' school, Huddersfield-road, Barnsley Education Authority; two houses, Park-grove, Mr. H. Needham.

BEARSDEN—Higher-grade school, Education Committee.

BEDFORD—Erection of mill, Hall Lane Spinning Co.

BELFAST—Remodelling offices and stores, Great Patrick-street, Messrs. J. and R. O'Kane.

BERKSHIRE—Improvements to County Hospital (£20,000).

BERMONDSEY, S.E.—Factory, The Grange, Mr. G. Parker.

BERRYWOOD—Isolation hospital (£2,000), County Council.

BIRKENHEAD—Library, Rock Ferry, Mr. J. R. Mewton.

BIRMINGHAM—Sanatorium, City Corporation.

BLOXWICH—Alterations and additions to Swan Inn, High-street, Bloxwich Brewery Co.; offices for the Talbot Stead Tube Co., Green-lane; private electric station, Birchill's Furnaces, Limited, Green-lane; extensions to shop, Litchfield-street, and alterations and additions to Elms Dale, Birmingham-road, Mr. J. Beebe; house, Sandbank, Mr. T. Hughes; additions to house, Sandwell-villas, Sandwell-street, Mr. H. H. McConnal; storerooms, Wolverhampton-street, Messrs. J. Joberns and Co.

BOLTON—Hotels and extensions for Messrs. Sharman and Sons, Marshall and Co., and W. Long and Son.

BOOTLE—Pavilion at Derby Park, Town Council.

BORRISOKANE—Workmen's dwellings (£37,800), Rural District Council.

BOURNEMOUTH—Pavilion, winter pleasure grounds, Town Council.

BRADBOURNE—Restoration of parish church (£600), Churchwardens.

BRADFORD—Alteration to shops in possession of City Corporation.

BRISTOL—Alterations to Old Dutch House, New Streets Committee.

BROUGHTON—Elementary school, Education Committee.

BUDBROOK—Elementary school (£1,850), Warwickshire Education Committee.

BUGBROOKE—Additions to Council school, Northampton County Council.

BUXTON—Public mortuary (£200), Urban District Council.

CAMBERWELL, S.E.—Enlargement of Camden Church, Ecclesiastical Commissioners.

CAMBRIDGE—Elementary school, Education Committee; school for agriculture (£20,000).

CARDIGAN—Woollen factory, Town Council.

CHADSMOOR—Higher-standard school to accommodate 400 scholars, Cannock Urban District Council.

CHELMSFORD—Alterations to the Chelmsford Star Co-operative Society Stores—Messrs. C. and W. H. Pertwell, architects; improvements to infirmary (£4,000).

CHORLEY—Additions to municipal slaughter houses; new spinning mill at Coppull.

CLAREMORRIS—Workmen's dwellings (£14,615), Rural District Council.

CLEATOR MOOR—New club premises, St. Patrick's Club. Messrs. Pickering and Crompton, architects.

CLONEYGOWAN—Workmen's dwellings (£7,009), Rural District Council.

COEDELAY—Thirty-eight dwellings, Tyleha Fach Building Co.

COTON—School to accommodate 800 scholars, Nuneaton Education Committee.

COVENTRY—Forty-eight workmen's dwellings, Narrow-lane, Housing Committee.

CREWE—Chapel, etc., Christ Church.

CROYDON—Swimming bath, Town Council.

DARLEY DALE—Elementary school to accommodate 250 scholars.

DARLINGTON—Elementary school, Town Council.

DEWSBURY—Extensions at the infirmary (£4,500), Guardians.

DINNINGTON—House and shop, Mr. W. C. Holmes.

DOVER—Clubhouse, Curzon-street (£865), Mr. J. Wise; four houses, Park-avenue (£1,600), Mr. C. Horton.

DRIFFIELD—Motor garage, Messrs. G. Dowson and Son.

DUNDALK—Workmen's dwellings (£112,728), Rural District Council.

DUNDEE—Restoration of warehouse, Constable-street, Messrs. Malcolm Ogilvie and Co.; dwelling-houses, Forfar-road, Mr. James Alexander; alterations and additions to property, Powrie-place, Mr. W. Thomson; warehouse, Union-place, Messrs. Halket and Adam; villa, Farington-road, Mr. T. M. Cappon.

DUNKELD—Restoration of cathedral, Messrs. Dunn and Watson.

DURHAM—Schools at Ryhope and Cornforth-lane, Durham County Council.

EASINGTON—School, Murton Colliery, County Council; alterations to New Inn, Thornley Colliery, Mr. R. Hedley; house and shop, Shotton Colliery, Mr. F. Kidson; two houses, South Hetton, Mr. Lowe.

EDINBURGH—Houses, Canongate, Mr. J. B. Smith; construction of platforms, etc., Balgreen-road, N.B. Railway Co.

ERDINGTON—Technical schools, Warwickshire Education Committee.

ERDINGTON—Council house (£600); library (£600).

ESTON—Hospital, Urban District Council.

FALMOUTH—Improvements to isolation hospital, Town Council.

FARNWORTH—Carnegie Library (£6,000), Town Council; extensions to St. Gregory's Catholic School.

FERRYHILL—Twenty-three houses, Morgan's-gate, Mr. T. Golightly; 18 houses, Darlington-road, Mr. E. Robinson; three houses, Convers-terrace, Mr. G. W. Lazenby; two houses, Chilton-buildings, Mr. S. Channam; three houses, Old Trimdon, Mr. H. Brown.

FINCHLEY—Electric lighting (£22,000).

FLEETWOOD—Factory near Wyre Dock, Messrs. J. S. Spencer and Co.

FLINT—Elementary school, Education Authority.

GOLBORNE—Elementary school, Education Committee.

GORTON—Wesleyan church, Circuit Steward.

GOVAN—Street widening for the construction of tramways, Town Council.

GREATWORTH—Additions to Council school, Northampton County Council.

GREENHEYS—Alterations and additions to Ducie-avenue Municipal School, Manchester Education Committee.

GRETTON—Elementary school (£3,450), Gloucestershire Education Committee.

HALIFAX—Houses, Lindon-road, Messrs. Jackson and Fox.

HALSTEAD—Elementary school, Education Committee.

HANDSWORTH—Church for the parish of St. Andrew, Ecclesiastical Commissioners.

HARPENDEN—Additions and alterations to Moreton End House, Rev. A. Bowling.

HARPOLE—Enlargement of All Saints' Church, Ecclesiastical Commissioners.

HARROGATE—Pavilion adjoining Royal Pumproom, Corporation.

HASLINGDEN—Extensions to secondary school, Town Council.

HASTINGS—Additions to house, Grosvenor-crescent, Messrs. Wallis and Harmer; house, Canute-road, Mr J. Hunt, architect.

HENDON—Houses at Child's Hill, Urban District Council.

HEREFORD—County isolation hospital, County Council.

HERNE BAY—Church at Beltinge, Ecclesiastical Commissioners.

HEYWOOD—Paper mills, Yates, Duxbury and Sons; extensions, Heywood Spinning Co.

HILLSBOROUGH—Labourers' dwellings, Rural District Council.

HOLMFIRTH—Additions to Wesleyan day school (£285).

HOOK—Elementary school, Surrey County Council.

HOUNDGATE—Additions to town clerk's office, Darlington Corporation

HUCKNALL—Five houses, Ebor Meads, Mr. Wm. Henson.

HUDDERSFIELD—Clubhouse, Cobcroft-road.

HULL—Car-shed, Cottingham-road, Town Council.

HULME—Forty dwelling-houses, Manchester Corporation.

HURST—Primitive Methodist chapel, Trustees.

ILFORD—Extensions to electricity works and additions to buildings Urban District Council.

KESSINGLAND—Extension of St. Edmund Church, Ecclesiastical Commissioners.

KEW—Houses for gardeners, H.M. Office of Works.

KILWINNING—Public offices at Byres-road (£1,000).

KIRKHEATON—Elementary school, Education Committee.

KNIGHTON—Alterations, etc., at Board-room and union offices Guardians.

KNYPERSLEY—New school, Staffs Education Committee.

LANCASTER—Additions to workhouse, Board of Guardians.

LARGS—Public slaughter-house, Town Council.

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LEICESTER—Alterations and additions to library, Garendon-street, Municipal Libraries Committee.
LEIGH—Mill for the Hall Lane Spinning Co.
LEMINGTON—Premises for Blaydon Co-operative Society.
LEOMINSTER—Secondary school, Hereford County Council.
LEYTON—Additions to isolation hospital, Urban District Council.
LITTLE HORTON — Wesleyan Reform chapel, Messrs. Walker and Collinson.
LLANDOVERY—Alterations of house, etc., at Dolgam, Llwyny Brain, Mr. H. Thomas.
LLANDRINDOD—Additions and extensions at the Rock House Hotel.
LLANSAINTFFRAID-GLAN-CONWAY—Extension of St. Ffraid Church, Ecclesiastical Commissioners.
LONDON—Coal store at the Brook Hospital, Metropolitan Asylums Board.
LONDON, N.E. — Council schools, Haggerston, London County Council.
LONG EATON—Electricity undertaking (£10 000).
LONGWOOD—Dwelling-house, Longwood-road, Yorks. Mr. J. Ainley, architect.
LOWESTOFT—Secondary school, Corporation Education Committee.
LUDLOW—Restoration of parish church (£1,000).
MALDON—Mineral water factory. Mr. P. M. Beaumont, architect.
MANCHESTER—Oil works, Messrs. Bentley and Co., Trafford Park.
MANCHESTER—Alterations and additions to Ducie-avenue school, Manchester Education Committee.
MARCH—County buildings, Isle of Ely County Council.
MERTHYR—Elementary school (£1,816), Merthyr Vale Education Committee.
MERTHYR TYDFIL—Additions to Treharris Council Schools, Education Committee.
MIDDLEHAM—Restoration of Middleham Castle, Mr. J. Maughan.
MILNROW—Butterworth Hall Mill; extensions to Coral Mill.
MONAGHAN—Scheme for workmen's dwellings, Rural District Council.
MORPETH—Secondary school, Higher Education Committee of the County Council.
MOUNTAIN ASH—Elementary school (£380), District Council.
NAAS—Workmen's dwellings, Rural District Council.
NEW BROUGHTON—Elementary school to accommodate 500 scholars.
NEWBURY—Rebuilding of St. Mary, Speenhamland, Ecclesiastical Commissioners.
NEWPORT—Housing scheme, Cross Hands, Chepstow-road, Town Council.
NEWTOWN—Alterations to Mechanics' Arms, Warrington-road, Oldfield Brewery Co.
NEWHAY—Stationmaster's house.
NORTH DARLEY—Elementary school to accommodate 250 scholars.
NORWICH—Electric motor and apparatus. Mr. A. E. Collins, city engineer.
NORWICH—Enlargement of St. Mary's Church, Haddiscoe, Ecclesiastical Commissioners.
NOTTINGHAM—Albert Hall (£17,000), Mr. A. E. Lambert.
NOTTINGHAM—Bleaching works and dressing rooms, Mr. F. Ball.
NUNEATON—Public conveniences (£360).
OLDHAM—Electricity undertaking (£1,500).
OLD TRAFFORD—Church for the parish of St. John, Ecclesiastical Commissioners.
OSWALDTWISTLE—Additions to Roe Greave Commercial Mill Co.
PADDINGTON, W. — Additional accommodation at the infirmary (£8,000), Guardians.
PARKSTONE—Four shops and residences, Bournemouth-road, Messrs. Smart and Wyeth.
PEMBERTON — Thirteen houses, Billinge-road, Messrs. Clough and Gaskell.
PEMBROKE—Additions to school, Pembrokeshire Education Committee.
PETERHEAD—Houses, Messrs. A. Reid; fish store, Messrs. Webster, Limited.
PLUMPTON—Rebuilding of St. John the Evangelist, Ecclesiastical Commissioners.
PONTYPRIDD—Twenty-two villas, Macintosh-road Building Club.
PONTYPRIDD—Administrative offices, Court House-street, Guardians.
PRESTON—Thirteen houses, Mr. A. Bond.
RATHDRUM—Workmen's dwellings (£41,950), Rural District Council.
READING—Alterations and additions to school. Mr. W. R. Howell, architects.
REDDITCH—Extension of Redditch Technical School, Worcester County Council.
RHYL—Assembly room on foreshore, Urban District Council.
RICHMOND — Forty houses, North-road, Dancer-road, etc., Town Council.
RICHMOND (SURREY)—Workmen's dwellings (£9,400), and secondary school (£7,000), Corporation.
ROCHFORD—Additional accommodation at the infirmary (£10,000), Guardians.
ROSS—Elementary school, Hereford County Council.
ROTHESAY—Enlargement of post office, Commissioners of H.M. Works.
RUGBY—Technical school, County Education Committee.
RUNWELL (ESSEX)—Extension of St. Mary's Church, Ecclesiastical Commissioners.
RYHOPE—Seven houses, Front-street, Ryhope Colliery.
ST. DOGMAELS—Additions to Cambrian Mills, Mr. T. L. Williams.
ST. PINNOCK—Alterations and additions to elementary school, Cornwall Education Committee.
SCARBOROUGH—Hippodrome (£8,000), Mr. W. Peacock, York.
SEAHOUSES—Primitive Methodist manse, Mr. G. Reavell.
SELLY OAK—Council school, Raddle Barn-lane, Mr. J. P. Osborne.
SHANKLIN—Kursaal, etc., north end of esplanade, Town Council.
SLOUGH (BUCKS)—Public lighting for one year, Urban District Council.
SLOUGH—Six houses, Wellesley-road, Messrs. Woodhead and Son; two houses, Queen's-road, Mr. J. Young; two houses, Ragstone-road, Messrs. Dowsett and Son; three houses, King Edward-street, Mr. N. Grove; three houses and shops, High-street, Mr. F. Cornish; two houses, Arthur-road, Mr. R. Cozens.
SOLIHULL—New isolation hospital, District Council.
SOUTHALL—Boiler-house, etc., Southall-Norwood Urban District Council.
SOUTHAMPTON—Extensions to grammar school, Education Committee.
SOUTH ELMSALL — Branch grocery stores, Pontefract Industrial Society.
STALYBRIDGE—Public conveniences, Town Council.
STARTFORTH—Isolation hospital, Rural District Council.
STRABANE—Workmen's dwellings (£97,486), Rural District Council.
STRABANE—Technical schools, Strabane Technical Committee.
STRETFORD—Special subjects centre, Education Committee.
SUNDERLAND—Additions to Little Sisters' Home, Bishopwearmouth Without.
SWADLINCOTE—Two shops, High street, Mr. J. H. Haywood; alterations to church, Hill-street, Baptist Trustees; house, Wood-lane, Newhall, Mr. J. Lane; two houses, North-street, Mr. J. R. Winson.
SWANAGE—Extensions and alterations to bank premises, Lloyds, Limited; additions to Highcliff, Mr. J. Parsons; additions to house, Victoria-avenue.
SWANSEA—Extension of High-street Station, Great Western Railway.
TANTOBIE—Workmen's club. Mr. T. E. Taylor, Lanchester, architect.
TAYPORT—Alterations, Nelson-street Hall, Town Council; shop and store, Guardbridge Co-operative Society.
TODMORDEN—Theatre, Building Committee.
TORQUAY—Pavilion, Town Council.
ULCEBY—Wesleyan chapel (£1,300).
URQUHART—Additions and alterations at United Free Church. Mr. J. Wittet, architect.
USK—Elementary school, Monmouthshire Education Committee.
UXBRIDGE—Additions to The Firs, Harefield, Mr. A. H. Tarleton; six houses, Cowley Beach, Mr. J. E. Blick.
WADEBRIDGE—Alterations and additions to elementary school, Cornwall Education Committee.
WAKEFIELD—Additional rooms at County Hall, West Riding General Purposes Committee.
WALSALL—Four houses, Birmingham-road, Mr. G. Haynes; alterations and additions to shop, Arcade, Sir E. T. Holden; two houses, Birmingham-road, Mr. S. B. Cleghorn; pavilion, Bloxwich Hockey Club; workshop, etc., Walsall Co-operative Society.
WARWICK—Higher-grade school, Warwickshire Education Committee.
WATFORD—Reconstruction of the electricity works, Urban District Council.
WEST HARTLEPOOL—Electrical sub-station, North-Eastern Railway Co.
WESTPORT—Workmen's dwellings (£17,831), Rural District Council.
WHITLEY BAY—Goods station, North-Eastern Railway Co.
WIGAN—Six houses, Westminster-street, Mr. J. Atherton; rebuilding Colliers' Arms, Frog-lane, Albion Brewery Co.; rebuilding King's Head, Market-street, and Millstone Inn, Wigan-lane, Messrs. Magee, Marshall, and Co.; four houses, bakehouse, etc., Victoria-street, Mr. A. Rathbone; seven houses, Spring-street, Messrs. W. and J. Johnson; four houses, Harper-street, Mr. Munroe.
WILLINGTON—Alterations to Pagebank Council schools, County Education Committee; two shops, Mr. Clish; three houses, Belle Vue, Mr. J. H. Armory.
WIMBLEDON—Theatre and public hall, Mr. J. B. Mullholland.
WOODLEY—Alterations and additions to Council school. Mr. J. W. Bain, Bredbury, architect.
WORCESTER—Extension of St. Mary-at-Hill Church, Ecclesiastical Commissioners.
WORKINGTON—Alterations and additions to houses, Griffin-street, Corporation.
WORSBROUGH—Elementary school at Worsbrough Dale, Education Committee.
YELVERTOFT—Additions to Council school, Northampton County Council.
YORK—Wesleyan chapel and classrooms, Clifton, Mr. E. Taylor.
YORK—Extensions to Post Office, Commissioners of Public Works.

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COMPANIES' MEETINGS AND REPORTS.

DIRECT UNITED STATES CABLE.

The report of the Direct United States Cable Co. for the six months ended Dec. 31, 1907, to be presented at the meeting on the 28th inst., states that the half-year's revenue, after deducting out-payments, amounted to £58 268, as compared with £60.379 for the corresponding period of 1906, showing a difference of £2,111 against the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of cable maintenance, amounted to £25.103, leaving a balance of £33,164 as the net profit, making with £2,515 brought forward from the previous half-year a total of £35.680. For the corresponding period of 1906 the working expenses and other payments amounted to £25,380. Interim dividends of 4s. per share for the quarter ended Sept. 30, 1907 (paid Oct. 26, 1907), and of 4s. per share for the quarter ended Dec. 31, 1907, together amounting to £24,284, have been declared, and after setting aside £5,000 to the reserve fund account, the balance of £6,395 on the revenue account has been carried forward. The reserve fund account has been debited with £5 097 for the cost of cable maintenance, and after being credited with interest on the investments, profit on sale of securities, and amount set aside from revenue, now amounts to £501,565.

METROPOLITAN RAILWAY.

The directors of the Metropolitan Railway Co. recommend a dividend upon the ordinary stock for the past half-year at the rate of 10s. per cent. per annum, carrying forward about £5,500. The dividend on surplus lands stock will be at the rate of 2½ per cent. per annum, carrying forward about £900. Similar dividends were declared last year.

NEW COMPANIES REGISTERED.

Incandescent Supply Agency, Limited.—Registered Jan. 10 in Edinburgh. Capital, £3,000 in £1 shares. Objects: to carry on in the United Kingdom or elsewhere the business of manufacturers of, agents for, and dealers in gas and electric light fittings or other accessories, novelties for illumination, etc. Registered office: 55, Mitchell-street, Glasgow.

Trough-Gully Copper Co., Limited—Registered Jan. 8 in Dublin. Capital, £17,000 in £1 shares. Objects: to acquire certain mines, mining rights, claims, lands, and timber lands situate at Tamworth, New South Wales, known as the Trough-Gully Copper Mine, and the mining claims and lands adjoining same. Registered office: 47 and 49, Dame-street, Dublin.

South Italy Copper Mines, Limited.—Registered Dec. 31 by Vallance and Co., 18, Bishopsgate-street Within, E.C. Capital, £300,000 in £1 shares. Objects: to acquire copper mining property in Tusbany, province of Pisa, Italy, and to carry on the business of copper and general miners, smelters, calciners, and refiners of ores, metals, and mineral substances, etc. No initial public issue.

M. and W. Motor Syndicate, Limited.—Registered Jan. 4. Capital, £4,000 in £1 shares. Objects: to adopt an agreement with E. G. Williams and P. Mavrogordato, and to carry on the business of proprietors of motor and other cabs and public or private conveyances, whether worked by petrol, electricity, or other power, or by animal traction. No initial public issue. Registered office: 43, Great Windmill-street, W.

Liens Registered.

Mexican Rubber Co., Limited, London, E.C.—Lien Jan. 9, £1,000 6 per cent. debentures, part of £3,000. Amount previously issued, £1,750. No trustees.

Bastian Meter Co., Limited, Kentish Town.—Issue on Dec 31 of £1 000 6 per cent. debenture, part of series created Aug. 4, 1905, to secure £6,000. Charged on the company's undertaking and property, present and future, including uncalled capital.

New Gutta Percha Co, Limited, London, E C.—Particulars required by Sub-Section 4, Section 14, of the Companies Act, 1900, Jan. 11, relating to a series of £13,500 first mortgage debentures. No trustees. Secured on the whole of the property and undertaking, present and future, including the uncalled portion of the nominal capital of £200,000.

British Duplex Motor Engine Syndicate, Limited (London).—Issue on Jan. 6 of £100 5 per cent. debentures, part of series created Dec. 19, 1907, to secure £5,000. Charged on the company's patents and other property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £300.

LEGAL INTELLIGENCE.

CLAIM AGAINST AN ELECTRICAL COMPANY.

Erratum.

In the report of the case Sanderson *v.* Pearson, which appeared in our issue of last week, we regret that, owing to an error on the part of our reporter, we reported the judgment in favour of the wrong party. This case was tried in the City of London Court, and plaintiff, a member of the Stock Exchange, sued Mr. G. Pearson, of Poplar, an electrical engineer, for £20, money lent. Judge Rentoul gave judgment in favour of the defendant, but without costs. We sincerely regret this error, and apologise to the defendant for it.

PROPOSED ELECTRIC LIGHTING SCHEME FOR ROME.

Mr. Justice Grantham and a special jury, in the King's Bench Division on Tuesday last, had before them the case of Signor Girolamo Taddei and Signor Paolo Bellani, who sought to recover damages from Sir John Denison Pender, Lord John Hay, and Mr. Richard Enfield, the executors of the late Sir John Pender, for alleged breach of a contract made in December, 1889, between the plaintiffs and the Hon. Pietro Delvecchio and the late Sir John Pender and Mr. Jabez Spencer Balfour, by which the defendants agreed to purchase the property known as the Villa d'Este and the water rights thereon. There was also a claim by the plaintiffs for work done and services rendered. Defendants denied that they were at fault, alleged that the plaintiffs did not carry out the agreement, and that they had not obtained the necessary concessions, and counterclaimed for £12,000, judgment obtained against the plaintiff, Signor Taddei.

In opening the case for the plaintiffs, Mr. HORRIDGE, K.C., said the action arose in connection with the property known as the Villa d'Este, a beautiful estate distant about 17 miles from the city of Rome. At the time negotiations were first entered into the villa was owned by the Cardinal Prince Hohenlohe. He was the life tenant, and could sell it, provided the consent was obtained of the Royal House in Austria, who sanctioned the sale in respect of which that action arose. About that time the eyes of engineers in England were turned towards Italy as a country in which to exploit electrical energy. The plaintiffs were two gentlemen of considerable position in the engineering world in Italy, and in 1889 it occurred to them that a very fine scheme indeed could be inaugurated for using the water power which passed through the property surrounding the Villa d'Este for the purpose of supplying light and electric power to the city of Rome. The river which ran by the estate was diverted into the grounds to form beautiful lakes and to feed playing fountains, and afterwards was led back to the river. The idea was to turn this water to motive power, but Prince Hohenlohe would not sell the water rights separate from the estate. The plaintiffs came to England and saw Sir John Pender, who was a gentleman very prominent in the electrical world, in regard to the enterprise, and he was very impressed with it. They had arranged to give £24,000 for the water rights. For those rights they had paid a deposit of £2,000. There was a rival company in Rome, and the electrical rights the plaintiffs had obtained were subject to any rights of that company in the city. When the matter was brought before Sir John Pender he said he wished to have associated with him the late Mr. Jabez Spencer Balfour, and was desirous of forming a company for the exploiting of electrical energy in Italy. The plaintiffs arranged for the sale of the Villa d'Este to the National Education Convention at Tivoli for £18,000. The agreement between the plaintiffs and the defendants was entered into, under which the property was to be sold for £100,000, of which £50,000 was to be paid by March and the second £50,000 when the plaintiffs had obtained the necessary concessions from the Government, and a declaration of public utility, which carried with it compulsory powers to purchase land which might be required in the course of constructing the lines from the Villa d'Este to Rome. Subsequently owing to the tightness of money in consequence of the Baring crash, and the difficulty of floating a company, Sir John Pender said he would have nothing to do with the scheme. The question was whether or not the defendants broke the contract in the sense that they never gave the plaintiffs an opportunity of carrying out their part of it, and thus rendered all expenditure useless. Counsel argued that the plaintiffs had done everything they were bound to do, and that they were entitled to damages.

The hearing was adjourned.

CONSULTANTS' FEES.

In the City of London Court on Tuesday, before Judge Rentoul, K.C., the Commercial Electro Chemical Analysis Co., 15, Queen-street E.C., sued the X Electric Accumulator Co., 18, Leadenhall-street, E.C., to recover four guineas for making an analysis of oil of vitriol and fees for consultations in connection therewith. Mr. A. M. Longhurst appeared for the plaintiffs and Mr. McCanna for the defendants

Mr. E. B. VAUGHAN, secretary of the plaintiff company, said he was a Fellow of the Chemical Society, and he had other diplomas. The plaintiff company was claiming £1. 11s. 6d. for making a qualitative analysis of a sample of oil of vitriol for the defendants, who wanted to see what quantities of iron and ammonia were contained in it. They were also claiming 2½ guineas for consultations. He did not make a quantitative analysis.

Mr. MCCANNA said the defendants were engaged in some litigation in which they were suing a firm of Messrs. Burke. Defendants had supplied acids to Burkes, and the defendant company wanted two separate analyses made for the purpose of submitting to the Court. Mr. Matthew J. Cannon was instructed by the defendants to make one analysis and the present plaintiffs were selected as the other firm to make the analysis. It turned out that the plaintiffs had not a chemist on their premises at the time, and they sent the matter out, oddly enough, to Mr. Cannon, who made a second analysis. Of course, the defendants had paid Mr. Cannon for the analysis which he made for them, but the plaintiffs had destroyed the purpose with which a second opinion was sought for. The defendants could not be called upon to pay the plaintiffs under those circumstances. The plaintiffs gave the defendants the total residue, but that was not enough. Mr. Cannon made a proper analysis. What the defendants wanted was separate analyses. Mr. Cannon's analysis was both quantitative and qualitative. Plaintiffs' was only quantitative.

Mr. LONGHURST said it was both. The plaintiff company's consulting analyst was Mr. Vickery, but he had been employed by Messrs. Burke in the litigation mentioned. The plaintiffs could not possibly know

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that Mr. Cannon had been employed by the defendants. The plaintiffs were quite at liberty to employ whom they liked.

Mr McCANNA said the defendants relied on the plaintiff company's advertisement that they could make the analysis themselves, and they did not think they would put it out. Plaintiffs had advertised that they were specialists on the matter, and defendants thought plaintiffs would themselves make the analysis.

Mr. LONGHURST said that was the first that they had heard of that.

JUDGE RENTOUL said the difficulty for the plaintiffs to get over was that defendants wanted two opinions, and only had one.

Mr. LONGHURST: He did not tell us anything about that at the time. The plaintiff company could employ anyone they liked.

JUDGE RENTOUL: The plaintiff company were expected to have a permanent chemist of their own.

Mr. LONGHURST: They had, and that was Mr. Vickery, but we could not go to him.

Mr. VAUGHAN added that the plaintiff company was formed to give consultations on electricity and to make analyses. One of the consultations with the defendants took half an hour.

Mr. McCANNA said he thought he was going to get an analysis made by one of plaintiffs' staff. Mr. Vaughan was no use to them when they got before the judge. He offered his help and all that sort of thing. Witness consulted all sorts of very big people in the profession, and Mr. Vaughan knew practically nothing about the matter. He never had any consultations with him.

Mr. ALBERT TANNER, one of the plaintiffs' directors, was called in support of their case. Mr. Vaughan he considered had rendered the defendants much material help on the technical part of the dispute.

Mr. McCANNA said what was wanted to find out was whether iron was injurious to electric batteries. The whole subject touched the bedrock of the electric accumulator building business. No doubt Mr. Vaughan was very interested in the subject.

JUDGE RENTOUL said defendants would never have sent to the plaintiffs if they thought they were going to get Mr. Cannon's opinion. Defendants had not get any value from the analyses sued for. Plaintiffs were unfortunate, but he must find for the defendant company with costs.

PROVISIONAL PATENTS, 1908.

JAN. 10.

577. **Improvements in electric-driven vehicles.** Peter Kopp, 20, Prince's-square, Bayswater, London.

578. **Improved electrical alarm for safes and strong-rooms.** Thomas Albert Sprake Munford, 6, Cardiff-road, Merthyr Vale, Glam.

606. **Improvements in electric motors and generators.** Jules Lecoche, 28, Mexfield-road, Putney, London.

608. **Improvements in electric switch and fuse boxes or cases.** William Edward Garforth and George William Bousfield, 33, Chancery-lane, London. (Complete specification.)

613. **Improvements in fluid contacts for electrical purposes.** John Owen Girdlestone and John William Jones, 37, Warwick-road, Ealing, London.

626. **Improvements in lamp clusters.** Wallace Fairweather, 65, Chancery-lane, London. (Benjamin Electric Manufacturing Company, United States.) (Complete specification.)

658. **Improvements in or relating to pictorial telegraphy.** The Amalgamated Radio-Telegraph Company, Limited, and Nevil Maskelyne, 7, Southampton-buildings, London.

660. **Improvements in multiple-rate electricity meters.** Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Jan. 11, 1907, being date of application in Germany.) (Complete specification.)

661. **Improvements in and relating to dynamo-electric machine.** Ernst Fredrik Werner Alexanderson, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Jan. 12, 1907, being date of application in United States.) (Complete specification.)

JAN. 11.

665. **New material for the purpose of separating or enclosing plates of secondary batteries.** Arthur Percy Strohmenger, Bridge-bank, Bessborough-road, Harrow-on-the-Hill, Middlesex. (Complete specification.)

700. **Improvements in or relating to electric type-printing apparatus.** Gustaf Axel Mauritz Agrell, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, Jan. 12, 1907, being date of application in Sweden.) (Complete specification.)

732. **Improvements in and relating to incandescent electric lamps.** The British Thomson-Houston Company, Limited, and Harry Hampton Needham, 83, Cannon-street, London.

JAN. 13.

27412A/07. **Improvements in electric arc lamps.** Henry Bevis and Arthur Earnest Angold, Peel Works, Adelphi, Salford. (Date applied for under Rule 13, Dec. 12, 1907.)

741. **Improvements in the treatment of resins, wax, gums, fats, oils, or similar substances with chlorine.** The Electrolytic Alkali Company, Limited, Charles Cunningham Connor, and John William Stubbs, 4, Clayton-square, Liverpool.

784. **Improvements in trolley-pole contacts.** Edwin Sheldon, 188, School-road, Crookes, Sheffield.

796. **Improvements in electrically-controlled apparatus for igniting and extinguishing lamps.** Albert Maurice Aubert and Jean Marcel Aubert, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

811. **Improvements in insulating electric wires, cables, and the like.** John Edward Glenister and George William Glenister, 4, South-street, Finsbury, London.

JAN. 14.

852. **Improvements relating to locking joints of drain and electrical machines and the like.** Richard Goodhind, Francis Ernest Owen, and Ernest Blackmore, trading as Francis E. Owen and Co., 61, Warwick-road, Stratford, London.

865. **Improvements in electrolytic meters.** Wilfred Bertram Thorpe, 185, Fleet-street, London.

871. **Improvement relating to electric bells, induction coils, or other electrically-operated vibrating appliances.** Basil Alexander Pilkington, 12, Atholl-place, Edinburgh.

873. **Improved method of controlling electric motors.** Henry Charles Edward Jacoby, 21, Finsbury-pavement, London.

877. **Improvements in automatic stopping devices for electric hoists.** Siemens Bros. Dynamo Works, Limited, and Arthur Stebbings Clift, Queen Anne's-chambers, Broadway, Westminster. (Complete specification.)

878. **Arrangement on electricity meters for determining the maximum consumption.** Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Broadway, Westminster. (Elektrizitats-Akt.-Ges. vormals Schuckert und Co., Germany.) (Complete specification.)

880. **Improvements in or relating to electric lamp sockets or holding devices.** Alfred Julius Boult, 111, Hatton-garden, London. (Benjamin Electric Manufacturing Company, United States.) (Complete specification.)

889. **Improvements in and relating to radio-telephony.** Georg Seibt and the Amalgamated Radio-Telegraph Company, Limited, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Jan. 14, 1907, being date of application in Germany.) (Complete specification.)

892. **Improvements in and relating to alternating-current motors of the induction type.** Crompton and Co., Limited, James Colquhoun Macfarlane, and Harry Burge, the Arc Works, Chelmsford.

893. **Improvements in or relating to alternate-current motors.** Valere Alfred Fynn, 70, Chancery-lane, London.

897. **Testing installation for electromagnetically operated sparking plugs.** Robert Bosch, trading as the firm of Robert Bosch, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 22, 1907, being date of application in Germany.) (Complete specification.)

898. **Improvements in bearings for electromagnetic sparking machines.** Robert Bosch, trading as the firm of Robert Bosch, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Sept. 23, 1907, being date of application in Germany.) (Complete specification.)

899. **Improvements in electric cable boxes or troughs.** Siemens-Schuckertwerke G. m. b. H., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Sept. 16, 1907, being date of application in Germany.) (Complete specification.)

JAN. 15.

5506A/07. **Connection system for dynamo-electric machines.** Benjamin Garver Lamme, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Section 91 of the Act, March 15, 1906, being date of application in United States. An invention comprised in application No. 5506, dated March 7, 1907.) (Complete specification.)

936. **Preserving and fixing of telegraph, telephone, or other electric wires to insulators.** John Munro, Achnarigh, Darnaway-road, Inverness, N.B.

949. **Improvements in electric batteries.** Frank Richmond, 54, Colne-road, Burnley. (Application for patent of addition to No. 3962/07.)

951. **Electrical connector for electric lamps and other apparatus.** Albert Cecil Greene, 23, Ellingham-road, Shepherd's Bush, London.

956. **Improvements in electrical controlling mechanism, chiefly applicable for use with ships' steering gear.** John Faulkner Stott, 55, Market-street, Manchester.

977. **Improved gas governor (electrically fitted).** John Dobson Allatt, 49, Crewdson-road, Clapham-road, London.

980. **Improvements in apparatus for straining telegraph, telephone, and like wires.** Robert Bolton Ransford, 24, Southampton-buildings, London. (W. A. Manson, Natal.)

996. **Improvements in dynamo-electric machinery.** Frank Michael Lewis, Norfolk House, Norfolk-street, London.

997. **Improvements in apparatus for the electrodeposition of metals.** Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

1005. **Improvements in secondary or storage batteries.** Harold Williamson Lake, 7, Southampton-buildings, London. (Charles Henry Clare, United States.) (Complete specification.)

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1003. Improvements in electrical release devices for the control of electrical energy. Harold Sheen Martin, 6, Lord-street, Liverpool.

JAN. 16.

1019. Improvement in electric cycle lamps. Meyer H. Goldstone, James H. Ward, and Albert Goldstone, Sampson Works, Salford, Manchester.

1034. Improvements in electrically-controlled locks and latches. Thomas Oldbury Summers, Oliver John Wootton, Thomas Hill, and William Henry Green, trading as the Reliable Lock and Brassfoundry Company, Royal London-buildings, Wolverhampton.

1100. Improvements in or relating to electrical ignition for explosion engines. Frederick William Vallatt, 111, Hatton-garden, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Jan. 30.)

1906.

24582. Phase transformers specially applicable for transforming single-phase electric currents to polyphase electric currents or vice versa. Bruce Peebles and Co. and La Cour.

27445. Electrical contact making and breaking devices. Parsons and Ball.

1907.

298. Magnetic clutches and brakes. Ravenshaw, Middleton, and Townsend.

523. Electro-capillary apparatus. Goddin.

2595. Dynamo-electric machines. Ateliers Thomson-Houston (Anciens Establissements Postel-Vinay). (Date applied for under International Convention, Feb. 2, 1906.)

3927. Electric servo-motors. Cousade. (Date applied for under International Convention, Aug. 13, 1906.)

3996. Magneto-electric ignition apparatus for internal-combustion engines. Electric Ignition Company and Hall.

4429. Synchronous operation of phonographs and kinematographs by electric servo-motors. Cousade. (Date applied for under International Convention, Sept. 19, 1906.)

5751. Electric melting furnace. Mackenzie. (Ludwig Bolle and Co.)

6133. Signalling systems for railways and the like. British Thomson-Houston Company. (General Electric Company.)

7141. Dynamo-electric differential driving gear more especially intended for motor road vehicles. Albrecht. (Date applied for under International Convention, May 12, 1906.)

7408. Electric locomotives. British Thomson-Houston Company. (General Electric Company.)

8287. Lightning arresters. British Thomson-Houston Company. (General Electric Company.)

9515. Insulators for telegraph poles and the like. Bullers, Limited, and Chambers.

9516. Combined door latch and electrical alarm. Thomas.

10597. Apparatus for automatically operating electric switches for starting and stopping electrically-driven pumps. Taylor.

11621. Means for operating alternating-current machines in parallel. Brooks and Akers. (Date applied for under International Convention, Jan. 18, 1907.)

11828. Transformers for use in making electrical measurements. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

12932. Means for preventing inductive disturbances in telephone and other electrical transmission circuits. British Westinghouse Electric and Manufacturing Company. (Westinghouse Electric and Manufacturing Company.)

13940. Trolley-pole holders for electric railways. Forster.

14838. Compounding of alternate-current dynamo-electric machines. Siemens Bros. Dynamo Works, Limited. Siemens-Schuckertwerke Ges.)

15453. Single-phase electric motors. Latour. (Date applied for under International Convention, July 5, 1906.)

16618. Transformers and controlling apparatus therefor. Allgemeine Elektricitats Ges. (Date applied for under International Convention, July 19, 1906.)

18319. Apparatus for automatically limiting an electric current to a predetermined value. Girdlestone and Jones.

19955. Transmitters for electromagnetic waves. Artom. (Date applied for under International Convention, Feb. 2, 1907.)

20651. Carbon-holders for electric furnaces. Hartenstein.

21030. Magnets for lifting. Markische Maschinenbauanstalt-Ludwig Stuckenholz Akt.-Ges. (Date applied for under International Convention, March 21, 1907.)

22301. Current-collecting devices for dynamo-electric machines. Noeggerath. (Date applied for under International Convention, Oct. 10, 1906.)

23497. Spring support for an electric motor arranged on the axle of a vehicle. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, Oct. 25, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¼-⅜
—— Ord., 1,125 000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1	..	9/16-11/16
—— Ordinary, Nos. 1 125,000	1	..	5/32 9/32
British Aluminium Co., Ordinary, 2 001-40 000	5	..	5¼-4½
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4⅝ 5¼
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4¼-4⅝
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100 103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	97-100
British Insulated and Helsby Cables Ord., 1-100 000	5	..	6¼-7
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100	..	103-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85 89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275 001-375 000	3	..	3-1
—— 4 per cent. Mortgage Debenture Stock	100	..	[40 50
Brush Electrical Engineering, Ordinary, Nos. 1-105 751	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	¼-½
—— 4½ per cent. 1st Debenture Stock	100	..	83-86
—— 4½ per cent. 2nd Debenture Stock	100	..	63-66 xd
Callender's Cable, Debentures	100	..	104-106
—— Ordinary	5	..	9¼ 10¼
—— 5 per cent. Pref.	5	..	5¼ 5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1 9/16-1 13/16
—— 5 per cent Debentures	100	..	94-97 xd
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1¼-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	99-102
Edison and Swan United, "A" Shares, 1-99 261	5	..	⅝-1⅛
—— "A" Shares, 01-017,139	5	..	1½-2⅛
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112,100	2	..	¼-½
—— 7 per cent. Cumulative Pref.	2	..	1⅛-1⅝
—— 4 per cent. Perp. 1st Mort. Deb	100	..	62-66 xd
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅜-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10¼-11½
—— 4½ per cent. Preference	5	..	4⅞-5⅛
—— 4½ per cent. Debentures	100	..	104½-106½
India Rubber, Gutta Percha, and Telegraph Works	10	..	11⅜-15¼
—— 4 per cent. Debentures	100	..	97-99
National Electric Construction Co., 1-170,000	1	..	⅛-¼
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	28½-30½
—— 5 per cent. Bonds	100	..	99-102
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4⅝-5½
Bournemouth and Poole, Ordinary	10	..	10-11
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	10-11
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	10 10½
—— 4½ per cent. Debenture Stock, Red.	100	..	99-102
Bromley (Kent) Electric Light and Power Co	5	..	4⅜-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-98
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6¼-7⅜
—— Nos. 80,000-100.000	5	..	5⅜-6¼ xd
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	100-104
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	4½-5
—— 4½ per cent. Cum Pref., 1-80.000	5	..	4¼-5
—— 4 per cent. Debenture Stock, Red.	100	..	97-100
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5	..	4¼-4½
—— ditto (1905) 40,001-80.000	5	..	3¼-4¼
Chelsea Electricity Supply	5	..	5⅜-6¼
—— 4½ per cent. Debentures	100	..	103-105
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	11¼-12¼
—— 5 per cent. Debenture Stock	100	..	120-123
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	97-100
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3¼-4¼
—— 5 per cent Preference, 1-50,000	5	..	4⅛-4⅞
County of London Elec. Supply, Ordinary	10	..	6¼-7⅛
—— 6 per cent. Cum Pref.	10	..	10⅜-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	103-106
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	95-98
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	⅜-½
—— 6 per cent. Cum Pref.	5	..	⅜-½
—— 4½ per cent. First Mort. Deb	100	..	75-80 xd
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 20-year Gold Bonds, 10 751-15 750	—	..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2¼-2⅝
—— 5 per cent Debenture Stock, Red	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	91-93
Folkestone Electric Supply, Ord., Nos. 1-10 000	5	..	4¼-5
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-13 000	5	..	6⅜-6⅝
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	98-101 xd
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	¼-½
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10½

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Name.	Amount paid.		Last price.
	£		£
London Electric, Ordinary	5	..	1½-1⅝
—— 5 per cent. Pref.	5	..	4⅛-4¼
—— 4 per cent 1st Mortgage Debenture Stock, Red....	100	..	90-94
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100	..	92-95
Metropolitan Ordinary, 100 001-150,000	5	..	5⅛-5⅜
—— 4½ per cent. First Mortgage Debenture Stock.....	100	..	101-105
—— 4½ per cent. Cum. Pref.	5	..	4⅞-5⅛
—— 3½ per cent. Mortgage Debenture, Red	100	..	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000)	—	..	76-73 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	50-52
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	87-89
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	..	96-98
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	..	6¼-6⅜
—— do., 57,010-75,000	5	..	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	..	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5	..	5-5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)....	5	..	5-5⅛
Notting Hill Electric Lighting	10	..	11¼-12¼
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	..	95-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5	..	5¼ 6
—— 4 per cent. Debenture Stock	100	..	93-95 xd
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	..	21/32-25 32
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	⅛-1
—— 5 per cent. Debenture Stock, Red	100	..	94-97
Rosario Electric Co 6 per cent Cum Pref., 1-20 000	5	..	4⅜ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15 000	5	..	4⅛-5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	—	..	93-101 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	..	⅛-1⅛
—— 4 per cent. Debenture Stock	100	..	71-75
South London Ordinary	5	..	2⅛-3
South Metropolitan Electric Light and Power, Ord.	1	..	⅛-⅜
—— 7 per cent Cum Pref.	1	..	1⅛-1⅜
—— 4½ per cent 1st Mort. Deb.	100	..	101 104
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	7⅜-8¼
—— 7 per cent. Pref.	5	..	6⅛-7⅛
—— 3½ per cent. Deb.	100	..	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	1⅛-2⅛
—— 5 per cent. Cumulative Preference, 50 001-80,000....	5	..	2-2⅛
Westminster, Ordinary	5	..	8¼-9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	..	5-5⅛

Electric Tramways.—

Name.	Amount paid.		Last price.
	£		£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,007	5	..	5⅛-5⅛
—— 10 per cent. Non-Cum 2nd Pref., 2 0 008-80,007	5	..	7⅛-8⅛
—— Permanent 6 per cent Debenture stock, 1888	100	..	125-128 xd
Auckland Elec Trams, 5 p.c. 1st Mor. Deb. Stk, Red.	100	..	102-105
Barcelona Tramways, Ord., 1-20 000	10	..	—
—— 5 per cent. Cum. Pref shares, 1 10 000	10	..	—
—— 5 per cent Deb., Red., 1-600	100	..	—
—— 4½ per cent. Red. Deb Stock	100	..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	..	11/16 13/16
—— 5 per cent. Cum Pref. Shares, 1-75 000	1	..	13/16-15/16
Birmingham and Midland Trams., 4½ p.c 1st Db. Stk, Red.	100	..	93-96
Blackpool and Fleetwood Tramroad	10	..	13⅜ 14⅛
Bombay Elec Supply and Trams Co, 6 per cent. Cum. Pref.	10	..	9⅜-9⅝
—— 4½ per cent. Deb. Stock, Red.	100	..	92 94
Brisbane Tramway Invest., Ord., 1-75,000	5	..	3 3/16 3 7/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4⅜ 4⅞
—— 4½ per cent Deb. Stk, Red., Prov. Certs. all pd.	100	..	97-101
British Columbia Electric Railway Co., Ord Def.	100	..	125-128
—— Ord. Pref.	100	..	105-109
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	93-10 xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40	..	100-103
—— 4½ per cent. Vancouver Power Deb.	100	..	99-102 xd
British Electric Traction, Ord. 1-300 000 & 60 001-90,000	10	..	1⅜-1⅞
—— 6 per cent. Cm Pf., 30,0001-60 000	10	..	4⅛ 5⅜
—— 5 per cent. Perpetual Debenture Stock	100	..	92-95
—— 4½ per cent 2nd Deb. Stock	100	..	69-74
Buenos Ayres and Belgrano Trams	5	..	4 17/32-4 21/32
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4⅜-5⅛
—— "B" 6 per cent Cm. Pf., 1-27 500	5	..	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	..	105-115
—— Prov. Cert.. all paid	100	..	—
Buenos Ayres Electric Trams, 5 p.c Deb. Stk., Red.	100	..	89-91
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red. 1-1,500	100	..	99-103
—— 6 per cent. Deb. Bonds, Red. 1-2,275	100	..	99-103
Buenos Ayres Lacroze Trams Co., Stg 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	89-94
Calcutta Tramways, Ord., Nos 1-137,610	5	..	6⅜-6⅞
—— 5 per cent. Cum. Pref., Nos. 1 70 000	5	..	4⅞-5⅜
—— 4½ per cent. 1st Deb. Stock. Red.	100	..	99-103
Cape Electric Tramways, Nos. 1-480,000	1	..	⅛-⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	..	4⅛-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3,000 (1917)	100	..	96-99
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1935	100	..	99-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	93-97
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13-14
—— 6 per cent. Cum Pref.	10	..	12⅞-13⅜
—— 4 per cent. Debentures	100	..	90-95
Dublin United Tramways (1896), Ord., Nos 1-60,000	10	..	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	12⅞-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	..	80 85 xd
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5	..	⅛-⅜
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100	..	87-91
—— 6 per cent "B" Deb. Stock	100	..	71-75
Kidderminster and District Lighting and Traction, Pref.	5	..	10-10⅛
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100		92-95
—— £296 500 2nd Mort. Deb. Stock	—	..	—
—— £83,130 Deferred Deb. Stock (all fully paid)	—	..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	..	⅛-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	..	13/16-1 2/16
—— 5 per cent. Mort. Deb., 1-5,000 Red	100	..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	7⅛-8⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red	100		80-84
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100		95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	88-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 201-21 635 and 23,436 25 000	5	..	4½-5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	..	98-98
Metropolitan Elec Trams., Defd., 1 000 001-1 314 016	1	..	1/16 3/16
—— 5 per cent. Cum Pref. 500,001 1 000 000	1	..	13/16- 5/16
—— 4½ per cent. Deb. Stock. Red.	100	..	91-94
Mexico Trams. Co, Gen. Cons 1st Mort 50-year 5 per cent. Gold Bonds	—	..	84-86 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 20-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1 000	..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2 000 1922	100	..	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5	..	⅜-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	2
—— 5 per cent. Cum. Pref.	10	..	8⅜-9
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	..	98 102
Potteries Electric Traction Ordinary 1-245.000	1	..	5/16-9/16
—— 5 per cent Cum Pref., 300 001-545 000	1	..	⅛-⅜
—— 4½ per cent Debenture Stock	100	..	93-96
Provincial Tramways Co., Ordinary 1-24 912	10	..	4½-5
—— 6 per cent. Cum. Pref., 1-10.000	10	..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref., 1-20.000	5	..	5-5⅛
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	..	96-97
Sao Paulo Tramway, Light, and Power Co.	$100	..	117-121
—— 5 per cent. 1st Mort Deb., Red. 1929. 1-11,000	$500	..	92-94 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169 570, Prov. Certs.	1	..	⅛-1⅛
—— 4 per cent. Deb Stock. Red. 1-40	100	..	78-82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	..	60-70
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	..	1-1⅛
—— 6 per cent. Cum Pref., 1-46,261	5	..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	82-86

Electric Railways.—

Name.	Amount paid		Last price.
	£		£
Central London, Ordinary	100	..	66-68
—— 4 per cent. Pref.	100	..	84-86
—— " " deferred	100	..	4-46
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid) ..	100	..	100-103 xd
City and South London, Consolidated Ordinary	100	..	44-46
—— 4 per cent Debenture Stock	100	..	101-104
—— 5 per cent. Pref. Stock '91	100	..	116-119
—— " " " '96	100	..	114-117
—— " " " '01	100	..	113 116
—— " " " '05	100	..	109-112
Liverpool Overhead, 5 per cent. Pref	10	..	10-10½
—— Ordinary, 1-50 000	10	..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	—	..	36-40

Telegraphs and Telephones.—

Name.	Amount paid.		Last price.
	£		£
Amazon Telegraph Co., 1-25,000	10	..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000	..	86-88
Anglo-American Telegraph Co., Ordinary	100	..	56-59
—— 6 per cent. Preferred Ordinary	100	..	100¼-102¼
—— Deferred Ordinary	100	..	15-15½
Anglo-Portuguese Telephone Co, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	99-102
Chili Telephone Co., 1-44,000	5	..	6⅜-7⅛ xd
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	..	83-84
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	..	6¼-7¼
—— 10 per cent Preference, 1-6 000	10	..	15½-16½
Direct Spanish Telegraph Co., Ordinary	5	..	3⅛-4⅛
—— 10 per cent. Cum. Preference	5	..	8¼-8⅜
—— 4½ per cent Deb., 1-600	50	..	97-100
Direct United States Cable Co.	20	..	13½-14½ xd
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1 200 Red.	100	..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	..	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	..	98-101
Eastern Extension, Australasia and China, 1-300,000	10	..	12⅜-12⅞ xd
—— 4 per cent. Mort. Deb. Stock, Perp.	100	..	100-103
Eastern Telegraph Co., Ordinary Stock	100	..	131-136 xd
—— 3½ per cent. Preference Stock	100	..	82-85 xd
—— 4 per cent. Mortgage Debenture Stock	100	..	99-102
Great Northern Telegraph Co. (of Copenhagen)	10	..	30-32
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	..	99-101
Indo-European Telegraph Co.	25	..	52-55
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1	..	9/16-11/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	..	⅛-1
National Telephone, Preferred	100	..	110½-112½
—— Deferred Stock	100	..	107½-109½
—— 6 per cent. Cum. First Pref.	10	..	11-13
—— 6 per cent Cum. Second Pref.	10	..	10-12
—— 5 per cent Non Cum. Third Pref.	5	..	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	..	96½-98
—— 4 per cent Deb. Stock, Red.	100	..	98-101
Oriental Telephone and Electric Company	1	..	1 1/16-1 3/16
—— 6 per cent. Cum Pref	1	..	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	..	97-100
United River Plate Tele. Co., Ordinary, 1-100,000	5	..	6⅛-7
—— 5 per cent. Cum. Pref., 1-40,000	5	..	4⅜-5⅛
—— 5 per cent. Debenture Stock, Red.	100	..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	..	98-101
West African Telegraph Co.	10	..	10-10⅛
West Coast of America, 1-30 000 and 53 001-53,008	2½	..	1 13/16-2 1/16
—— 4 p.c. Debs., 1-1 500, guar. by Western Telegraph	100	..	97-100
West India and Panama Telegraph Co., Ordinary	10	..	⅜-½
—— 6 per cent. Cum. 1st Preference	10	..	7⅜-7⅞
—— 6 per cent. Cum 2nd Preference	10	..	7⅛-7⅜
—— 5 per cent. Debs., Red., 1-800	100	..	99-102
Western Telegraph Co., 1-207,930	10	..	12⅜-13⅜
—— 4 per cent. Debenture Stock, Red.	100	..	97½-100½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Jan. 15	1,120	1,181	- 61	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	Nov. 17	1,019	966	+ 53	- 176	8	8	,, 15	15,283	3,603,789	378,834	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	Jan. 18	3,000	2,296	+ 704	+ 2,484	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 19	944	967	- 23	—	23·53	23·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 11	6,057	—	—	—	56¼	5[illegible]	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 15	886	933	- 37	+ 3,103	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 16	285	310	- 25	- 1,252	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	Jan. 19	2,056	1,921	+ 135	+ 5,924	42	42	March 31	111 294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 15	1,256	1,297	- 41	+ 1,552	29¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 11	4,075	4 061	+ 14	+ 4,317	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10·79	2,421	—
Brighton Corporation	,, 19	663	714	- 51	- 3,224	17·191	17·191	,, 31	50,652	10,759,310	1,798,605	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 17	4 561	4,695	- 134	—	53½	51½	,, 31	265,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 18	1,169	1,141	- 28	—	19¾	19¾	,, 31	62,699	11,967,498	1,205,830	1·31	12·48	5,825	8·21
Burton Corporation	,, 5	238	274	- 36	- 585	9⅞	8½	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	,, 11	1,894	1,918	- 24	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	,, 16	144	146	- 2	- 20	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 18	6,214	6,417	- 203	- 548	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,357	55·22a
Charing X, Euston, & Hamp. Ry.	,, 18	3,190	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 19	3,390	3,011	+ 379	+ 1,285	9	6¼	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 15	146	169	- 23	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 16	378	418	- 40	- 161	15½	15½	Dec. 31	25,032	5,966 364	891.9·8	—	6·74	—	4·78
Croydon Corporation	,, 17	1,200	—	—	—	12 c	12 c	March 3	62,065	13,514,918	1,602,408	1·08	9·76	3,125	6 67
Darwen Corporation	,, 10	207	225	- 19	- 43	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1,124	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Jan. 17	86	92	- 6	- 25a	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 17	4 719	4,726	- 7	- 270	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 15	1,034	1,012	+ 22	+ 1,589	22	22	May 15	57,672	15,554.905	1,162.792	·878	11·9	4,352	7·3
East Ham Corporation	,, 18	812	799	+ 13	+ 392	14	14	March 31	47,140	15,049,240	1,062,151	·74	10·49	3,636	7·14
Glasgow Corporation	,, 18	16,337	16,230	+ 107	+16,123h	177½	169	May 31	887,381	224,063,088	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 15	197	222	- 25	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 18	5,390	3,574	+1 816	+ 5,661	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,986	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	,, 18	1,433	1,361	+ 69	+ 3 057	35½	35	,, 31	81,196	15.252,150	1,804,745	1·22	10·79	2,770	5·92
Hull Corporation	,, 18	2,446	2,204	+ 141	+ 5,836	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 11	362	423	- 61	—	10½	10½	,, 31	26,499	6,586,754	645,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 15	114	114	—	+ 371	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1,733	4·95
Lancashire United Tramways	,, 15	1,016	1,032	- 16	+ 73	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 11	5,899	5,895	+ 4	+11,430	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5 58
Leicester Corporation	,, 11	1,986	2,015	- 29	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 11	10,012	10,728	- 716	+ 1,152	104	104	Dec. 31	563.793	122,094,528	12,115.934	1 108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 19	1,402	1,389	+ 13	- 162h	9·25	6 65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 4	29.016	25,474	+3,542	+608,788	98	98	March 31	1378,014	314,227 090	30,130.297	1·05	10 98	—	8·56
Lowestoft Corporation	,, 11	144	150	- 6	+ 101	3½	—	Sept. 30	11,009	2,622,922	343,190	1·03	7·9	2,156	6·39
Maidstone Corporation	,, 2	140	76	+ 64	—	4¼	2	March 31	5,913	1.186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 18	13,725	13,469	+ 256	+ 41,295	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 18	8,919	8,002	+ 917	+ 2,531	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 19	15,815	16,010	- 215	- 149	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 18	127	134	- 7	- 45	2¾	2¾	March 31	7,309	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 18	3,805	3,794	+ 11	+ 1,215	59⅛	57¼	,, 31	210,491	45,596,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 11	560	545	+ 15	+ 2,034	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10 01	1,525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·259
Portsmouth Corporation	May 25	2,330	1,578	+ 752	+ 632	28½	28½	,, 31	98,911	20,668.825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,661	8,130,179	918,825	·95	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10·45	2,691	7·38
Salford Corporation	Jan. 13	4,077	4,189	- 112	+ 5,906	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7·01
Sheffield Corporation	,, 19	5,423	5,187	+ 241	+10,963	65¼	65¾	March 25	276,907	73.966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 15	234	255	- 21	+ 63	9	9	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 12	1,129	1,239	- 110	- 1,378	20	20	,, 31	72,396	17,483.132	1,535,425	1·006	11·261	3,687	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	Jan. 16	161	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 18	689	722	- 33	+ 613	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·5
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,865 296	429 785	—	10 724	1,989	6·95
West Ham Corporation	,, 9	2,089	2,228	+ 139	+ 2,110	14·7	14·7	,, 31	122,881	35,202,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 15	748	823	- 75	+ 412	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·095

1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE

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ELECTRICAL LEGISLATION.

Those of our readers who take an interest in gardening will know the meaning of the mysterious letters which appear after the names of certain flowers in the catalogues. "H.P." there stands for hardy perennial and not horse-power, and "H.H.A." for half-hardy annual. We wonder under which of these categories the Government would place their Supply of Electricity Bills which are drafted every spring, and by their capability of coming up again might be looked upon as perennials. From the gardener's point of view they are half-hardy annuals, dying at the first contact with the parliamentary frosts. Due to the neglect of these Bills by the present Government, and also by the one which preceded it in office, the supply of electricity is still governed by the provisions of the 1888 Electric Lighting Act. Beyond the saving in printer's ink and paper allowed under the Electric Lighting Clauses Act, there has been no modification whatever by Parliament of this antiquated measure. That many changes are needed in order to facilitate the spread of electric lighting and power supply to outlying areas is acknowledged by the Bills prepared, we believe, by the officials in the Board of Trade office each year. If the draft, for instance, of the 1905 Electric Lighting Bill had become law, there would have been little need for many private Bills which have been introduced since. But the Government prefer to waste their time over measures which raise effective opposition and fail. One provision of this 1905 Bill, which was included in both its predecessor and successor, was that under which a municipal authority or group of such authorities could purchase in course of time a large central station erected outside their areas to supply the same. If this was now law, the principal objection—in fact, we may say the only valid objection—to the Bill to be introduced this year on behalf of the London supply companies would be taken away. Again, this Bill practically allowed the linking up of a number of the supply areas so as to form one undertaking under a joint Board representing the ratepayers in each area. It did not include a similar clause for the large London companies, but this is a logical development of the Bill. It seems to us that if Parliament secures to the consumer a proper share of the economies gained by this linking up, and at the same time passes the purchase clause referred to above, there remains no valid ground for opposition. There is another Bill coming before Parliament which is practically the London County Council scheme of last year under company management. This there seems little room for. Reverting to the futile efforts of the Government to remodel our electrical legislation, the town clerk of Hastings has been circularising other municipal authorities owning electricity supply undertakings. He points out that it is a great waste of money for each of the undertakers to obtain by a private Bill powers which a Government measure would confer upon all. It is true that the particular point he has in mind is a hire-purchase or some similar system of assisting those persons who are installing electric light and power. For example, Woolwich and Pontypridd obtained powers to do this by private Acts in 1903, Ealing in 1905, and Huddersfield and Kingston-upon-Hull in 1906. We know that this particular point will raise opposition, but powers have been granted to certain corporations and, we believe, refused to others. Hence the question is one which Parliament should settle once and for all, and it could be well done at the same time as the larger and more important changes are made in our existing electrical legislation. We trust that the Right Hon. D. Lloyd-George, the President of the

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Board of Trade, will see that this year the Bill for the reforms in question is not introduced at the fag end of the session and then included in the annual massacre of the innocents.

HIGHER TECHNICAL EDUCATION.

The presidential address delivered by Mr. E. C. R. Marks before the Birmingham and District Electric Club was on the relation of the University of Birmingham to the electrical and allied trades of the city and district. Mr. Marks pointed to the lack of co-operation between the university and the municipal technical school, and he urged that whilst every encouragement and help should be given to the one, the other should receive corresponding consideration. He complained that in Birmingham there was no recognition by the university of the work of the technical school. The Victoria University of Manchester granted degrees in technology for subjects not taught in the university itself, and the bulk of the students in the faculty of technology received their training at the Manchester Municipal School of Technology. At their own university no support was given to evening classes, nor was any student officially recognised unless he were an internal student. There were in Birmingham, he said, a goodly number of young men now actively engaged in local industries who were worthy of being admitted graduates of any university, but he was afraid that the policy of their own university would drive these young men elsewhere for that recognition which they would gladly receive, and should be gladly forthcoming in their native city.

FLAME IN GAS AND PETROL MOTORS.

We have just received from the Royal Institution of Great Britain an illustrated copy of the lecture delivered in the early part of last year by Mr. Dugald Clerk on the above subject. This lecture was illustrated by some beautiful experiments, and adds to the debt which the engineering world owes to the author for his researches on this subject, which he has made particularly his own. As is well known: "Flame produced by the combustion of inflammable gas, or vapour and atmospheric air, forms the working fluid of gas or petrol engines. Such engines differ from other heat engines—as steam and hot-air engines—in that the necessary heat is evolved within the working fluid by combustion, instead of added to the working fluid by conduction through metallic walls. In all practicable heat engines the source of heat is the same—the combustion of fuel—but in one type heat is evolved within the working fluid, while in the other type heat is applied externally, and passes to the working fluid by conduction." We would refer our readers to this publication for the details of the experiments shown and for the arguments used by Mr. Dugald Clerk to draw his valuable conclusions from these experiments. He concluded his lecture with the following statement, which is worthy of entry in the note-books of all our readers: "As engineers, we are vividly interested in the progress of knowledge as to the working fluid, because, without that knowledge, it is not possible to attain the ultimate practicable heat conversion by means of the internal-combustion motor. At present, however, the internal-combustion motor is by far the most efficient means of converting heat into mechanical work; 37 per cent. conversion has been achieved, and, so far as present indications point, it will be possible to make an engine converting over 50 per cent. of the whole heat given to it into mechanical work. This has been made possible only by the study of the properties of flame, not only on the physical, but on the chemical side and on the mechanical side, using devices of sufficient delicacy and rapidity to deal accurately with large volumes of a very difficult working fluid. The mean temperature attained by the working fluid in many engines is as high as 1,800deg. C. It has been found that attempts to measure the temperatures in the cylinders by platinum thermometers always result in the melting up of the platinum wire. Flame has required over one hundred years' effort by engineers and scientific men to enable it to be handled as it is to-day. The results so far are most satisfactory, as is shown by the many thousands of engines continually in operation, both fixed and locomotive. Much, however, remains to be done, and the immediate problem to be faced is the application of such engines to marine work."

GAS IN LIBRARIES.

Our enterprising contemporary, the *West Ham Electrical Bulletin*, contains in its January number a fresh testimony to the injurious effect of gas on the furnishings of a home. Mr. C. Whitwell, the librarian at the central library of the municipality, is of the emphatic opinion that gas should not be tolerated in any institution where gas combustion may reach the bindings of books. The sulphurous fumes from gas are said to attack all classes of leather bindings, especially russia leather and calf skin, rendering them liable in a comparatively short time to crumble at the slightest touch. From his own experience he states that many of the books in the various public libraries in West Ham were first collected and stored in Old Rokeby House, in which gas was used throughout. When the time came to remove the books to their new home, it was found that a number of the volumes bound in calf had suffered so much from the gas fumes that the bindings were irretrievably ruined. When they were handled, the leather absolutely crumbled into dust and looked something like Scotch snuff. On removing to the new library in Romford-road, where nothing but electric light is used, these books were rebound, and although eight years have since passed their bindings are at the present moment as good as new. Mr. Whitwell points out that it is a common experience of librarians that leather loses all its natural oil by long exposure to the excessive heat resulting from the burning of gas in any place where books are stored. He, therefore, states his opinion that no one who loves his books should allow a single gas jet to be fitted up in his library, unless the whole of the fumes are carried at once into the air—an arrangement that is very rarely practicable in the houses inhabited by ninety-nine out of every hundred book lovers at the present day. The testimony of a librarian of such experience is of considerable interest in the present era of controversy between gas and electricity.

THE DESIGN OF LIQUID RESISTANCES.

In testing large generators, especially alternators, it is often necessary to employ water resistances, and Herr Carl Richter in a recent number of *Elektrotechnik und Maschinenbau* gives some useful notes on their correct design and dimensioning. The resistances often take the form of one or more casks filled with water and having metal electrodes dipping into them. Such resistances are cheaper than wire ones, and are especially suitable for alternating currents, as no reactive E.M.F.'s are set up in them. The specific resistance of pure water is extremely high (about 10^7 ohms per metre length and one square millimetre section), so that very high voltages can be dealt with in moderate-sized vessels. Except in cases where water is scarce, it is more convenient to arrange for a constant flow of water through

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the resistance, so as to keep below the boiling point, than to allow the energy to be dissipated in the form of steam. Experiment has shown that at ordinary temperatures and using wooden vessels the heat radiated is negligible compared with that generated, so that a fairly definite idea of the flow of water required to keep the temperature to any desired value can be obtained from theoretic considerations alone. The following table shows the supply of water necessary when 1,000 kw. is being dissipated (1) if the water is allow to boil, and (2) if the temperature rise is limited so as to be below the boiling point to a greater or less extent:

Water allowed to boil.		Water kept below boiling point.	
Temperature of water supply.	Necessary water supply in gallons per minute.	Difference between temperature reached and temperature of supply water.	Necessary water supply in gallons per minute.
5deg. C.	5·02	10deg. C.	318
10	5·08	20	159
15	5·11	30	106
20	5·15	40	79·5
25	5·19	50	63·5
30	5·22	60	53
—	—	70	45·2
—	—	80	39·7
—	—	90	35·2

In deciding the size of vessel and the distance apart of the electrodes for a given voltage and current, it is advisable to make a preliminary test of the specific resistance of

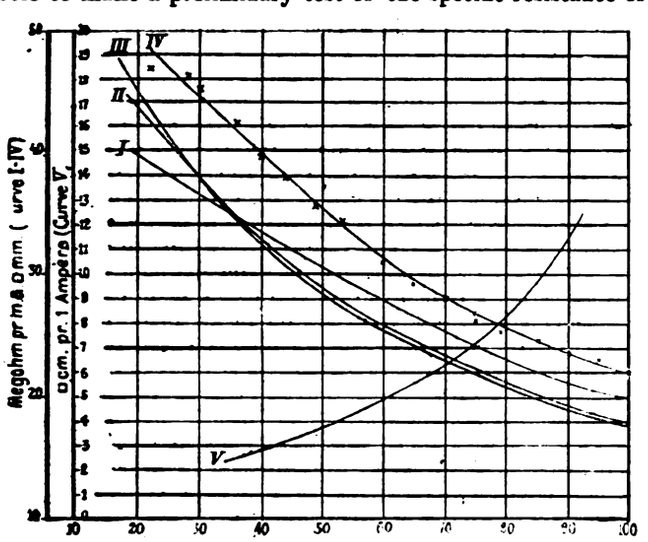

FIG. 1.

the water to be employed at various temperatures, or, at least, at the steady temperature expected. In many districts the impurities in the water reduce its specific resistance very considerably below that of pure water. The test can be simply carried out by filling a glass or porcelain vessel of regular section with the water, covering two of the opposite sides with metal electrodes and passing an alternating current through. The resistance is then obtained by simultaneously measuring the current and the voltage between the electrodes at various temperatures—taking care to stir the water well, and to allow the temperature to reach a steady state before each measurement. Curves I., II., and III. in Fig. 1 show the results of such tests on three samples of water between iron electrodes, and Curve IV. refers to the same water as Curve II, but with zinc electrodes. Curve V. shows the minimum number of square centimetres required for each ampere if disturbance at the surface of the electrodes in the shape of steam and gas bubbles is to be avoided.

In deciding the distance required between the electrodes for a given voltage—*i.e.*, the effective resistance $r = \frac{\text{volts}}{\text{amperes}}$—both the specific resistance of the water and the method in which the current spreads out between the electrodes must be allowed for. In fact,

$$r = \frac{l}{f} \times \sigma \times K,$$

where l = distance between electrodes in centimetres; f = area of one face of an electrode in square centimetres; σ = specific resistance of the water in ohms per centimetre cube; K = a variable depending on the shape of the vessel.

By making certain assumptions it can be shown that for rectangular vessels of width S and depth H, into which two electrodes each of width s dip to a depth h, the approximate value of K is

$$\frac{s\,h}{\mathrm{H}\,s - \mathrm{S}\,h} \log \frac{\mathrm{H}\,s}{\mathrm{S}\,h},$$

and for the special case of H = 1, S = 1, s = ·5, the values of K for various depths h are as follows:

h =	1	·8	·6	·4	·2	·1	·05	·005
K =	·693	·629	·544	·446	·305	·201	·129	·023

Assuming a current density of ·1 ampere per square centimetre and a specific resistance of 2,000 ohms per centimetre (20 megohms per metre and square millimetre), with K = ·6 the distances required between the electrodes for various voltages are as follows:

Volts =	1,000	2,000	4,000	10,000	20,000	30,000
Distance between electrodes in cm. =	8·3	16·6	33·2	83	166	249

If the resistance is to be used for varying the load, it must be possible (1) to increase the distance between the electrodes, or (2) to vary the depth immersed, or (3) to alter both distance apart and depth immersed simultaneously.

If the distance alone is varied, it must be done in proportion to the load—*i.e.* for one-quarter the load the distances

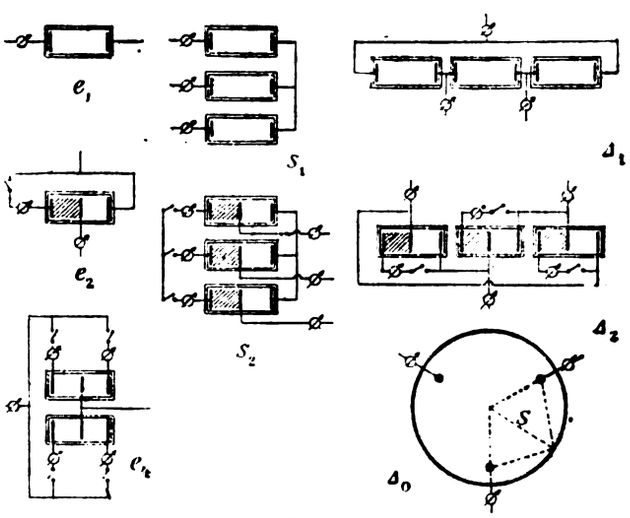

FIG. 2.

must be four times as great as those given above. If the immersed depth is altered, care must be taken to avoid even increasing the current density above the allowable value, and for deciding this point the values given above for the variation of K with h will be found useful. In practice the minimum dimensions will be attained if distance and immersed depth are both varied simultaneously in such a way that the current density always has the maximum allowable value. Since

$$r = \frac{l}{f} \times \sigma \times \mathrm{K}$$

and

$$\text{Current} = \frac{\text{volts}}{r} = \frac{\text{volts}}{\frac{l}{f} \sigma \times \mathrm{K}}$$

$$\therefore \text{Current density} \left(= \frac{\text{current}}{f} \right) = \frac{\text{volts}}{l \sigma \mathrm{K}}.$$

∴ If, for given volts, the current density is to remain constant whilst the actual current varies, the product $l \times \mathrm{K}$ must be made a constant. On this basis the distance required between the electrodes in order to reduce the load to one-quarter of its full value, instead of being four times the full-load distance, works out at only 2·1 times the full-load distance, making the same assumptions for specific resistance, current density, and $\frac{s}{\mathrm{S}}$ as above.

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In some cases it is preferable to vary the load by placing several vats in series. Baffle plates placed so as to reduce the effective section of the liquid at certain points also serve to reduce the load by increasing the value of K.

Fig. 2 shows some methods of arranging the vats for single and three phase work. e_1 is the ordinary single vat, S_1 the ordinary three-phase star arrangement, and Δ_1 the three-phase mesh arrangement. e_2 shows a single-phase arrangement for regulating the load by altering the position of a single central plate, and, finally, by cutting out one of the two paths through the vat (shown shaded) by means of the switch. S_2 and Δ_2 are the corresponding star and mesh three-phase arrangements. e_4 is a single-phase connection with four paths, which can be separately disconnected. Δ_0 shows a simple three-phase arrangement without separate adjustment of the different phases. The electrodes here are wires or tubes fixed at equal distances from one another. The load is altered by varying the immersed depth. For calculation purposes the end surface for each path may be taken as half the immersed area of one rod, and the central area as the length at S (Fig. 2) multiplied by the height, H, of the water surface above the floor of the vat.

In order to safeguard the attendants at high-tension tests with these liquid resistances, considerable care must be exercised. The water inlet and outlet pipes must be well earthed and insulating stands must be provided, whilst unauthorised persons must be kept away from all parts of the apparatus.

SEARCHLIGHTS.

This article is not, as it might at first sight appear to the unwary, a series of pungent paragraphs for persuasive publicity pushers, after the style of American magazines. Its purpose is the commonplace consideration of the points which underlie the construction of that very useful piece of apparatus, the electric searchlight, which, although so widely used, is now considered to be so old established that nothing can be done in connection with it except repeat orders. It is, however, some time since anything concerning searchlights generally considered has appeared in the technical Press, and as the composition of business firms and even Government departments changes with the lapse of years, a few notes on the points for which to look in a good searchlight may be of some value to prospective buyers.

The great point to aim at in the construction of searchlights (technically known as projectors) is the combination of the maximum of strength with the minimum of weight. It not unfrequently happens that a projector is subject to very rough usage, a case in point being the extensive operations of the Electrical Engineer Volunteers in the South African war, where the searchlight corps were often called upon to transport their gear across very difficult country. Strength of such gear lies in simplicity of construction, and any piece of searchlight apparatus which upon examination reveals a large number of working parts requiring delicate adjustment should be carefully eschewed.

Speaking generally, the projector consists of a cylindrical body which carries the arc lamp and the mirror. The cylinder is mounted on trunnions, which in turn are attached to a revolving base. At the back of the cylinder are handgrips, by which the operator may slew or elevate the projector in any direction. One of the points to look at in selecting the searchlight is the construction of this cylinder. It should be made of sheet steel and carefully stiffened at each end by rings of angle iron to give sufficient rigidity to withstand rough knocking about. The drum should be ventilated in such a way that although the hot gases evolved from the arc may be carried away, there is no danger of the heaviest deluge penetrating to the interior mechanism.

To facilitate the rapid and easy movement of the projector on its base—a most important point where rapid searching operations have to be effected — the turntable should be provided with a ball race to reduce friction to its minimum. The range of vertical play of the projector in the trunnions should be about 60deg., equally halved above and below the horizontal. If airships for war ever come into fashion, of course, there is no saying to what extent these limits will have to be exceeded, but at present these satisfy ordinary working conditions for land and sea practice. Clamping screws on the trunnions and turntable should be provided to hold the projector in position, if required; and for slow movements, as, for example, in following an enemy's gunboat, hand wheels and gearings should be fitted to control the horizontal and vertical motions. In some cases an apparatus can be applied by means of which the horizontal sweep of the projector can be regulated some distance away by means of tension on ropes. This is useful where it is necessary to keep under cover, as a searchlight is, of course, a good mark for an enemy's fire.

The lamp itself is the most important part of the apparatus, and when the large amount of movement taking place in the use of the projector is considered it will be apparent that there are difficulties in the way of smooth burning. Formerly the lamp usually adopted was one having the carbons at a slight inclination to the vertical, in order to get the greatest intensity of light projected directly out from the crater. The carbons were fed together as required by hand. Now, however, the Admiralty pattern has horizontal carbons mounted on standards which can be moved backwards and forwards by an electromagnetically operated ratchet and pawl Arrangements are also made that the lamp may be either operated by hand, or by an automatic feed due to shunt control and series striking magnets. The impressed voltage on the arc can also be regulated by means of a rheostat worked by a handle at the back of the lamp. To aid the operator in controlling the lamp, sight holes of darkened glass should be provided in the body of the projector, and there should also be ventilating holes to allow the hot air from the arc to pass away. At the back of the lamp is placed a silvered glass mirror, parabolic in shape, which collects all the rays of light from the lamp, except those thrown straight forward, and reduces them to a parallel beam. Until a comparatively recent date it was impossible to obtain mirrors of the requisite size and quality manufactured in England, and they had to be imported from Germany. Now this blot is to a large extent removed.

Most searchlights have a plain glass front, as no divergence of rays is usually necessary. Where, however, it is necessary to spread the light out fanwise in a horizontal plane, as in marine or coast defence work, diverging lenses made of strips of glass, convex in shape, are fitted to the front of the projector, and spread the light out horizontally through angles of from 16deg. to 30deg, diminishing the intensity, of course, but rendering the zone of examination much wider. Boats going *via* the Suez Canal are frequently provided with projectors having lenses so arranged that they give a wide fan of light with a dark interval in the centre. In this way they are able to keep both banks of the canal under observation, while they avoid dazzling the lookout on vessels travelling in the opposite direction through the canal.

The uses of searchlights in times of peace, quite apart from their tremendous importance in military and naval operations, are many and various. Navigators, of course, find them essential. They should form an invaluable adjunct to lifeboat service. A powerful projector driven by an oil-engine was recently installed by Messrs. Crompton and Co. at the mouth of the River Tyne in order to assist the rescue of ships wrecked near the entrance of that harbour, and it would be a public boon if more of these auxiliaries to life-saving were installed. Heliography on a large scale can be effected by these means. Communication was established with Ladysmith in the South African war, long before our troops reached the beleaguered town, by means of searchlight signals. And lastly, but not least, in this age of feverish publicity, searchlights may be strongly recommended for advertising purposes provided that the local authorities are sufficiently inert. There is, perhaps, nothing so attractive to the mob as a strong beam of light gliding through the air, and at many of the exhibitions abroad, and in some at home, this method of attracting attention has been adopted.

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ELECTRIFICATION OF RAILWAYS.—I.*

BY DR. GISBERT KAPP.

(Continued from page 119.)

Classification of Electric Railways.

We may classify electric railways either by the kind of current supplied to the train or by the kind of motors used. It is obvious that the two classifications need not necessarily be identical. We might, for instance, supply single-phase current to the train, and by using converting apparatus on the train use three-phase motors or continuous-current motors. Taking, however, the motors as the basis of classification, we have in chronological order: (1) the continuous-current system; (2) the three-phase system; (3) the single-phase system. In the oldest system, which at present also has the greatest mileage, the motors are of the series type, and are worked on what is known as the series-parallel control. That is to say, by means of a special multiple-contact switch the motors are put in series at the start, and as the train gathers speed their connection is gradually changed to parallel, the finer subdivisions of speed being obtained by variable resistance in the armature circuit and by varying the magnetic flux in unit, taking current from the third rail or overhead trolley wire as if it were running alone, but, by reason of the electric control, it takes the current exactly in the same way as any other motor coach in the same train, so that all the motor coaches take an equal share in propulsion. In this manner a large part of the total weight of the train is adhesive weight, and it is quite easy to get an acceleration as high as 3ft. per second per second. The high acceleration is of great advantage in tube railways and other urban lines where, on account of the small distance between stations, a rapid start is essential for quick travel. The multiple-control system has also the advantage that the efficiency of control is quite independent of the length of the train, that trains can be made up without any need to observe a special grouping of coaches, and that in the event of one motor equipment failing it can be cut out of circuit, and its coach will then simply become a trailer, the other motor coaches working as usual. To reduce the stress on drawbars, it is customary to make the first and last coach motor coaches, but this is not essential to the system.

The General Electric Company of America have arranged an equipment of a motor coach for multiple control for a line where part of the way continuous current is supplied whilst the remainder receives single-phase alternating

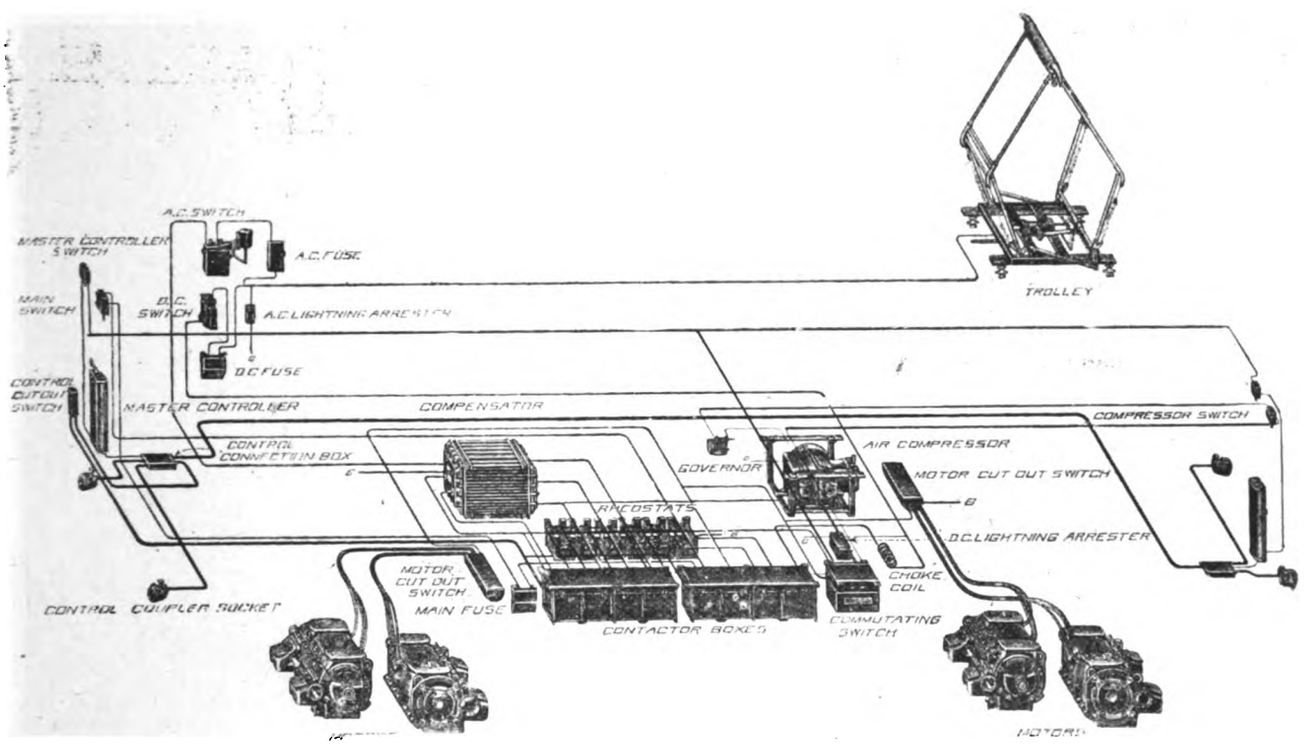

FIG. 18.—Arrangement of Sprague-General Electric Type M Control on Car.

the field system. A further development is the so-called "multiple-control system," which, although first used with continuous-current motors, has also been adapted to the other motors. Both the series-parallel and the multiple control are the invention of Mr. Sprague, and have been adopted in one form or another by all makers of electrical equipment. The leading idea is this: Each motor coach is provided with its own equipment of switches, called "contactors" (Fig. 18), which regulate the supply of current to the motors of that coach alone. Any desired number of such motor coaches can be made up into a train with or without the insertion of "trailers"—that is, coaches not equipped with motors. All the coaches are joined by a multiple cable which carries the relay currents for working the contactors. The ends of this control cable, also called the "train line," are connected from coach to coach by coupling sockets, much in the same way as the brake pipes in our railway trains are connected. In each motor coach there is a master controller by which the relay currents for working the contactors are regulated, and it is thus possible to work the whole train from any motor coach. Each motor coach forms an independent current. Such a condition of supply may arise where the main-line system joining two towns has to be interlinked with urban systems at either end. If the urban lines are worked by continuous current, the main-line train must be fitted to take this also, whilst for the main line proper high-tension alternating current is the only commercially possible method of power supply. The single-phase commutator motor can also be worked with continuous current, and part of the equipment, such as resistances and contactors, can be used for both. There are only some minor alterations necessary when passing from one kind of supply to the other, and these are made by the turning of a switch handle. There is a master controller at each end of the coach. The propulsion is effected by four motors, which at starting are all put in series connection. When half speed has been reached the connections are altered to two in series and two parallel, and when nearing full speed all the four motors are put in parallel. Since the motors are series wound the speed adjusts itself within wide limits to the load—that is to say, with the controller in the same position the speed will be much higher on the level than on an up grade. The same is the case with commutator single-phase motors. Also with such an equipment the motors run slower up hill than on the level, and the demand for power does not vary within quite so

* Lecture delivered before the Royal Institution of Great Britain, Saturday, Jan. 18.

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wide limits as would be the case were the run made with constant speed irrespective of gradients.

Such a condition of working is, however, not only possible with three-phase motors, but it is their normal condition, and if we wish to get away from it we must apply special means. The speed of a three-phase motor is only very slightly influenced by the load. When running loaded the speed may drop some 3 or 4 per cent., and this is so small a variation that we can say the speed is independent of the load. It depends only on the construction of the motor (number of poles, gear ratio, and diameter of wheels), and on the frequency of the supply current. This, of course, is constant. At starting, resistance is inserted into the secondary circuit and gradually withdrawn as the motor speeds up, but once all the resistance is withdrawn, and the motor runs at the full speed corresponding to the frequency, it will keep that speed whatever the gradient of the line may be. There is no possibility of running faster to make up lost time, but there is also no possibility of racing downhill; the train runs its even pace.

The impossibility of racing on a down grade is a valuable property of the three-phase system, but the necessity to take up gradients at full speed may be inconvenient because putting too heavy a strain on the plant. There is, of course, no absolute necessity of working the motor always at full speed; we can run it permanently in the starting condition when the slower speed is attained by the inser-

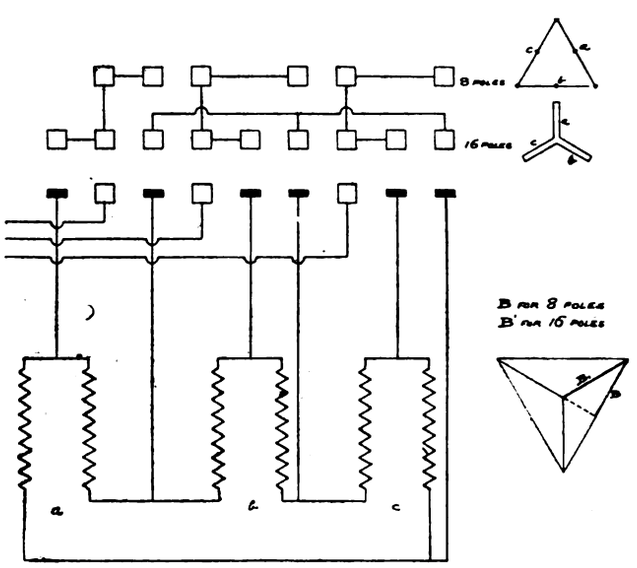

FIG. 19.—Brown-Boveri Controller for changing a 16-Pole to an 8-Pole Stator on Simplon Locomotive.

tion of inductionless resistance into the rotor circuit, but such an expedient would be very wasteful, and there would be some difficulty in dissipating the heat generated in these resistances. A method had therefore to be found which would allow three-phase motors to be used at different speeds without wasting energy in resistances. Two such methods have been put into practice. The one consists in using a winding for stator and rotor which allows an alteration in the number of poles. The speed of the motor being inversely proportional to the number of poles, it is obvious that we can run at half speed if we double the number of poles. This may be done by a system of winding in connection with a controller which permits every alternate coil to be reversed. Such an arrangement (Fig. 19), designed by Messrs. Brown, Boveri, and Co. is used in their latest Simplon locomotives.

Another method of changing speed without wasting power is the use of what is known as "cascade working." This method has been brought to great perfection by Messrs. Ganz and Co., who have used it first on the motor coaches for the Valtellina line five years ago. Each coach runs on two four-wheel trucks, and each of the two axles is direct driven by a motor surrounding it. The rotor is not keyed on the running axle, but on a quill with sufficient clearance to allow for the play of the springs. The motor is suspended from the floor of the coach, and the connection between its rotor and the driving axle is by means of flexible links. Of the two motors on each truck, one is wound for 3,000 volts and the other for 300 volts. The latter is the cascade motor. It receives current from the rotor of the high-pressure motor when starting, or, when running up hill, the motors are coupled, and both are contributing about equal shares of tractive force. The speed is halved. When running on the level the cascade motor is cut out and runs idle, whilst the high-pressure motor is doing all the work at full speed. In this case the starting resistance is by the action of the controller detached from the cascade motor and placed in direct connection with the rotor of the working motor. The transition from half to full speed is thus made gradually. In another arrangement of cascade working the two motors are placed into the same housing and the rotors are permanently connected, so that only one set of slip-rings is required. If the switch is placed to the right, the working is in cascade; if to the left only, the high-pressure motor is giving power.

In both arrangements here described the speed can only be halved, since the cascade motor has the same number of poles as the high-pressure motor. If more than two speeds are required, this can be accomplished by giving the two motors different numbers of poles. Thus if two motors are used, and one has 8 and the other 12 poles, we can get three speeds, which are in the ratio 1/8, 1/12, 1/20. But in this case both would have to be high-pressure

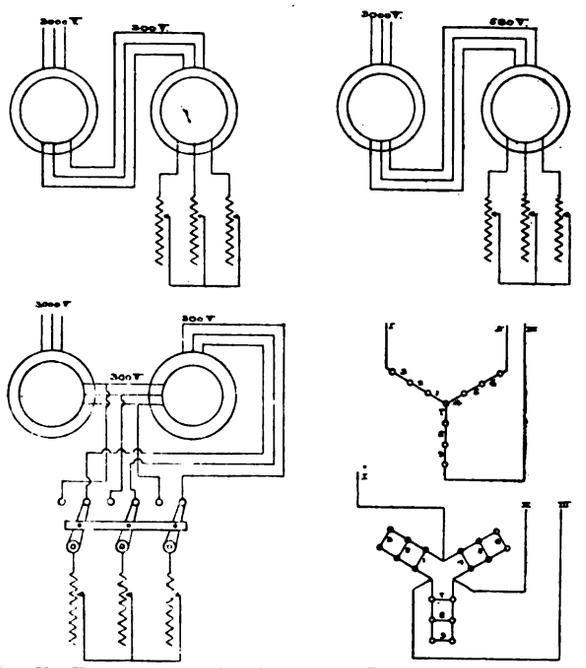

FIG. 20.—Valtellina Motor Car—Diagram for Four Motors, each 150 h.p., connected in cascade—two motors 3,000 volts, two motors 300 volts; weight of car, 53 tons.

motors, since either must be capable of taking the supply direct from the trolley. Since the rotor of the first motor cannot conveniently be wound for high pressure, a step-up transformer would have to be inserted when working cascade, and to avoid this complication Koloman von Kando has devised an ingenious way of winding the stator of the cascade motor so that it may be either supplied at low voltage when working cascade or at high voltage when working direct. In this device each phase has three windings, which are placed in parallel and delta connected when working cascade, and are placed in series and star connected when working direct. (Fig. 20). The leads are brought out through the case at the top. Corresponding to the three speeds the switch has three positions, and the position taken up depends on which of the three cylinders receives air from a reservoir under pressure which is also used for working all the other regulating appliances and the brakes. It should be noted that in this, and, in fact, in most motors made by Ganz and Co. for main-line working, the slip-rings are fitted outside of the crank so as to utilise the whole of the space between the bearings for the motor itself. (Fig. 21). In some cases it may be desirable to build locomotives for four standard speeds, and this may be done by using "double cascade." Here the main motor has four poles, and if used alone will give a speed

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of 50 miles per hour. (Fig. 22). By combining it with the two cascade motors of two and six poles respectively, a speed of 16·7 miles per hour can be had ; by using the main motor with the six-pole cascade motor the speed is 20 miles per hour, and if used with the two-pole cascade motor it is 33·5 miles per hour.

It is interesting to compare the weights of the three types of motors—namely, the continuous-current, the single-phase, and the three-phase. In construction the single-phase resembles the continuous-current motor, the only difference being that its field must be laminated, and that a compensating winding must be added to reduce self-inductance. Since the supply of power is pulsating, the torque for equal weight and magnetisation can only be $\frac{1}{\sqrt{2}}$ of the torque of the continuous-current motor—that is to say, the single-phase motor—especially as its power factor can never be unity, must be 40 to 50 per cent. heavier than an equally powerful continuous-current motor. In point of bulk and weight the three-phase motor has a great advantage. For equal armature loading (by which I mean ampere turns per unit length of rotor circumference) the torque is about the same as that of a continuous-current motor. Theoretically it should be 16 per cent. greater, but as the power factor (although better than that of a single-phase motor) can never be unity, the advantage of these 16 per cent. is lost, but the assumption of equal loading is not correct. In the continuous-current motor the ampere wires on the armature are only one-half to three-eighths of the field. It is true that by the introduction of commutating poles the disproportion may be somewhat reduced, but the gain is small since, owing to saturation of armature teeth, the distortion of the main field is accompanied by a reduction of useful flux, so that after a certain point is reached the torque does not increase by loading the armature further. In the three-phase motor the load on the rotor is always nearly equal to that on the stator ; there is no distortion of the field, and the torque is only limited by the heat capacity of the wires. For this reason three-phase motors are lighter than continuous-current motors of equal power and tractive effort. Their over-all dimensions are less because the slip-rings may be put outside the bearings, whilst in a continuous-current motor the equivalent part—namely, the commutator—must be inside the motor case. Mr. Valatin has introduced the conception of "weight factor," which is a number obtained by dividing the product of speed and weight by the horse-power. Taking on this basis the weight factor of a continuous-current motor as 100, the weight factor of a corresponding single-phase motor comes to about 140 and that of a three-phase motor to 60.

What other Countries are doing.

Before entering into the technical details of some of the work done in electrification of main lines, it will be interesting to briefly glance at the proposals for electrification on a large scale made by the Governments of various countries.

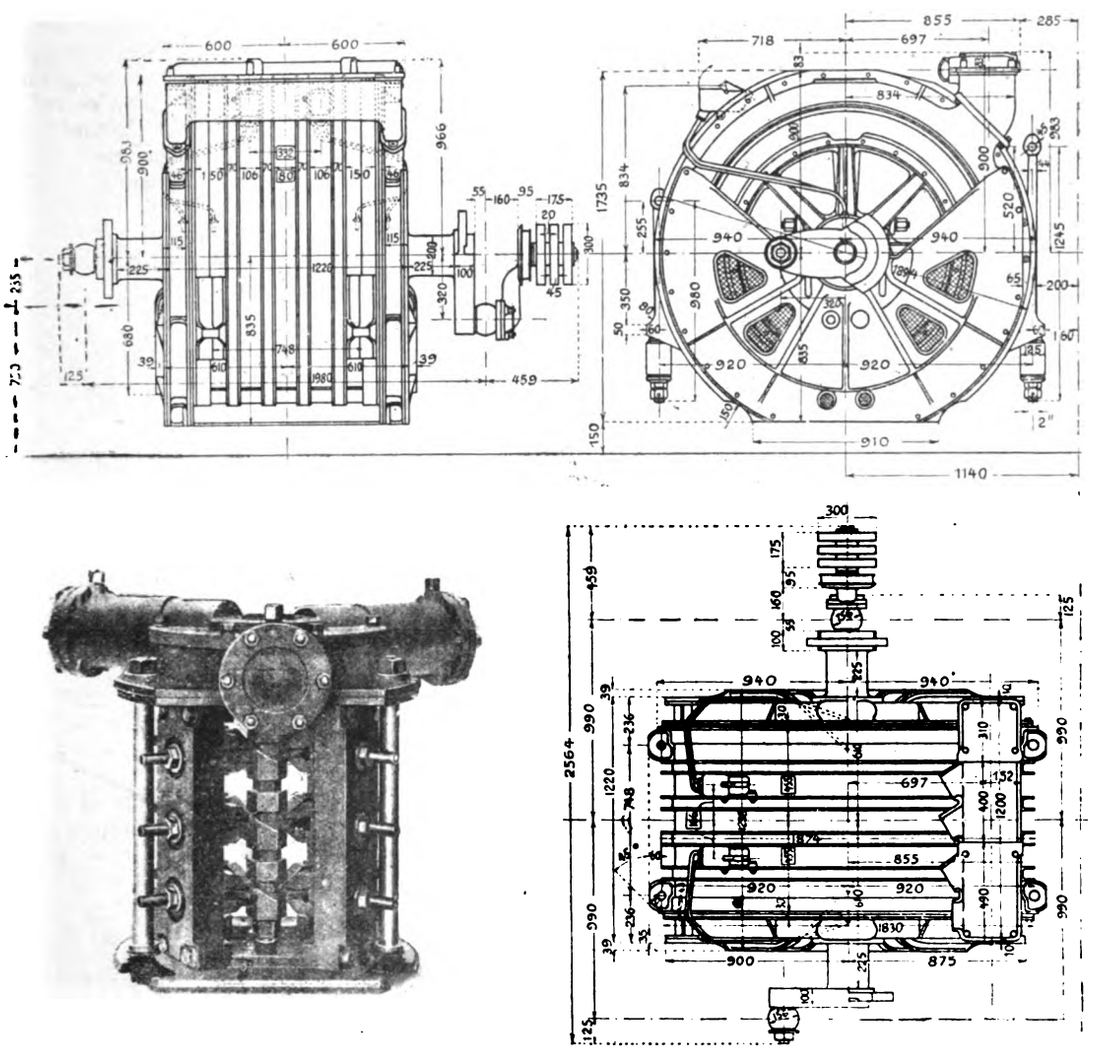

Fig. 21.—Details of Ganz Double Motor and Controller.

Italy.—To the Italian Government belongs the distinction of having from the first realised the enormous advantage electric railway service has for that country. The Milan-Ponto Cerese and, shortly after, the Valtellina lines were built under Government sanction, and with the intention of being eventually taken over by the Government when the transfer of the steam roads to the State should take place. The experience gained on both these lines has been so favourable that the Italian Government has decided to electrify some other lines at once, and it may be expected that this process will go on steadily, so that eventually all the Italian lines will be worked electrically. For a country which has no coal but plenty of water power, this is obviously a sound policy. There was another circumstance which prompted the Government to set aside a considerable

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sum (nearly three million pounds) in its last budget for electrification. The whole of the coal used for industrial purposes in Milan and other centres in Lombardy comes by sea *vid* Genoa. The railway lines from Genoa to Milan climb the steep slope of the Apennines north of Sanpirredarena, and owing to the heavy gradients only short trains can be dispatched. In addition to the coal traffic there is a large goods traffic for Switzerland and Germany passing over the same metals, so that at times the lines are very congested, and last winter Milan was on the brink of a coal famine. With electric traction the capacity of the existing lines will be nearly trebled, so that the supply of coal to the vast industry of Milan and of Lombardy generally will be assured. On the proposal of the Government the Italian Parliament voted in the last session 1·52 million pounds for power stations, sub-stations, and line equipment and 1·28 millions for electric locomotives, the intention being to retain the existing passenger and goods rolling-stock and simply change the steam locomotives for electric locomotives. The present programme comprises the electrification of 11 main lines, of which two are in Upper Italy, one in Central, and one in Southern Italy. The total mileage is 247, and the total length of track 337 miles. The system throughout is three-phase current, with 3,000 volts on the trolley wires at 15 frequency. The pressure on the feeders

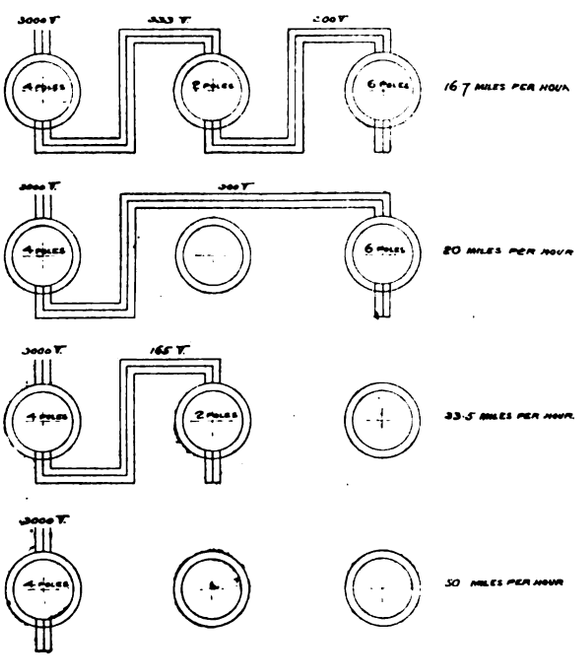

FIG. 22.—Diagram of Ganz Double Cascade Connections for Four Speeds.

is 13,000, 20,000, and 25,000 volts, according to distance, and the sub-station will be fitted with four transformers of 750 kw., of which three connected in delta will supply the line, whilst the fourth is spare. The locomotives will weigh 60 tons, and have five driving axles. They will be fitted with two 1,000-h.p. three-phase motors. The engineers of the Italian Government are evidently strong believers in the three-phase system, which is probably the result of the very satisfactory working of the line which Messrs. Ganz and Co. have electrified in the Valtellina five years ago. This line has a total mileage of 67, and presents a maximum of difficulties. Of the section Lecco-Colico, 33 per cent. is tunnel, there are curves of 1,000ft. radius (on switchings and crossings only 500ft.), and there are gradients up to 20 per 1,000. The pressure in the feeders is 20,000 volts, and that in the trolley wires is 3,000 volts. The rails act as one of the conductors. Although the opponents of the three-phase system have prophesied all sorts of trouble with the two overhead conductors there has been none, and the officials are so satisfied with the system that a proposal is now being considered to change the continuous-current equipment on the Milan-Gallerate-Ponte Caresio line for three-phase equipment. This must not be taken as an adverse criticism on the oldest electric main line in Italy. The line is working very satisfactorily. Since its electrification the number of trains has been quadrupled (the trains being shorter and more frequent), and the number of passengers carried is 2½ times what it was in steam days. Still, the Italian engineers seem to think that the line could do better still if converted to the three-phase system.

Switzerland.—As regards lack of coal and abundance of water power, Switzerland is very much in the same position as Italy, but the condition of its railway service is somewhat different, as nearly all roads are very hilly, very high speeds are not required, and summer tourist traffic is of greater importance than elsewhere. In the beginning of 1904 the Swiss Government called together a committee of experts, and instructed them to report on the electrification of the whole of the Swiss railways, which meanwhile have become State property. There is in Switzerland a growing tendency for the nationalisation of the more important water powers, and an apprehension that by the time Government is ready to electrify the railways there will be no water powers left out of private hands. Hence the committee were instructed first of all to ascertain what amount of power will be required for the railway service, so that the Government may secure the necessary powers ere it be too late. Besides Swiss railway officials and Prof. Wyssling, who acts as general secretary, the committee contains representatives of the large Swiss electrical firms and the societies of electrical engineering and central stations. The reference for the labours of this committee is as follows: (1) what power is required for electrifying all Swiss railways; (2) report on the various systems of electric traction; (3) give a list of those water powers

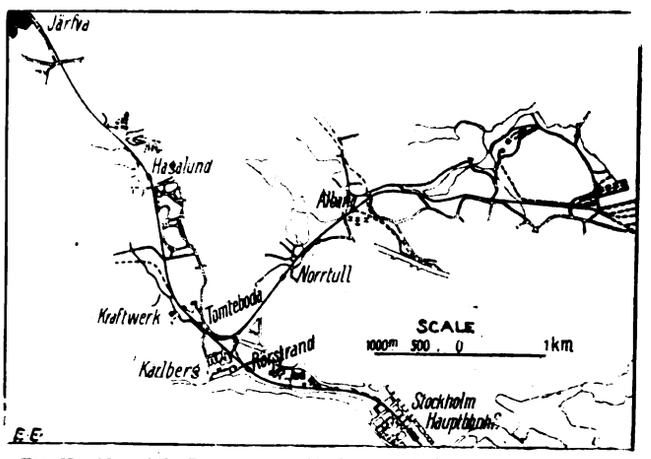

FIG. 23.—Map of the Railways near Stockholm which have been Electrified.

which could be utilised; (4) give capital cost and annual working expenses; (5) establish standards for electrification. The committee has issued an interim report dealing with the first reference. It is still working, and further reports may be expected during this year. The demand for power has been calculated on the basis of the actual goods and passenger traffic on the busiest day in summer and winter. In making the calculation for every train the profile of the line and the energy wasted in starting were taken into consideration, the air resistance was calculated from Barbier's formula corrected by the results of the Zossen trials, and no pains have been spared to get accurate results. The summer traffic is, of course, heavier than the winter traffic, but in winter the energy for heating and lighting has also to be supplied. Both together amount on the average to 13 per cent. of the energy required for traction. The energy that has to be supplied per day per passenger for heating has been found from experiments on the Frieburg-Murten Railway (where the coaches are electrically heated) to be 1,100 watt-hours. For lighting the daily energy is only 230 watt-hours per passenger seat, the low average being due to the fact that, with the exception of the Gothard, there are no lines on which passenger trains run the night through. To be on the safe side, the committee figured on weight of trains somewhat in excess of those now prevailing in steam traction, but they assumed that the whole service would be by locomotives, not motor coaches. This, although not the most economical, is an unavoidable method of working, since the Swiss lines must take over the International trains as they are delivered over the frontier from four different countries. The com-

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mittee also made a very safe estimate as regards over-all efficiency (only 40 per cent.), and did not allow anything for recuperation, which is quite a valuable feature on the Valtellina line. Since the system to be adopted is not yet decided, it was, perhaps, as well that recuperation of energy on down grades and slowing up, which is a peculiarity of one particular system, should be left out of account I merely mention the matter to show that the estimate made is certainly rather above than below actual requirements. Yet the total power required is astonishingly small. The total energy to be developed on the shaft of the turbines in 24 hours is only 2·4 million horse-power hours, or a steady load of 100,000 h.p.

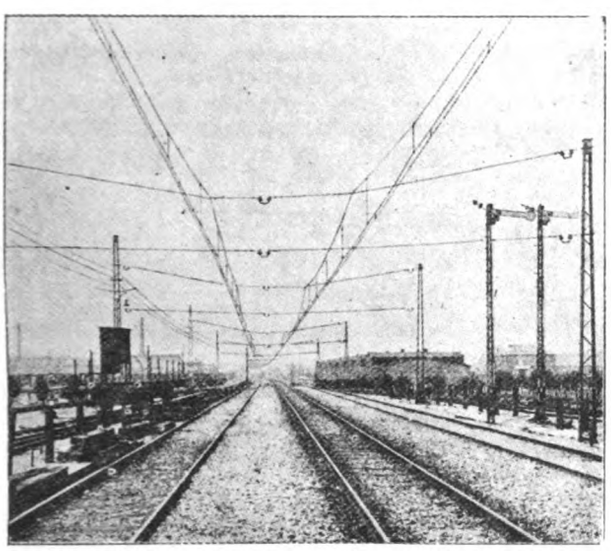

FIG. 24.

The committee have also reckoned cautiously as regards the overlapping of the demand which may come on to the same power-house from various lines. They assume that the maximum demand may be as much as five times the average, and thus they find that the total power of the turbines which will be required in the various power-houses will aggregate to 500,000 h.p. It is interesting to compare with these estimates the amount of energy actually developed by locomotives as far as an estimate is possible from the amount of coal used. The Swiss railways consume annually over three-quarter million tons, or 2,200 tons daily, which corresponds to about 800,000 horse-power hours of tractive

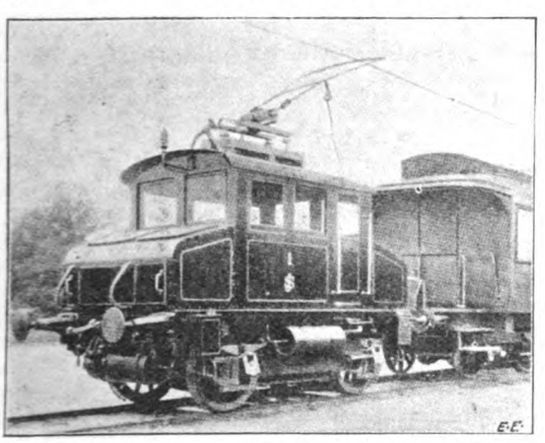

FIG. 25.—Westinghouse Locomotive used on Swedish Main Lines.

energy. The committee reckon 40 per cent. of 2·4 million, or 960,000 horse-power hours.

Sweden.—This country should prove a promising field for electrification, in so far as it has water power and coal is dear, the price paid by the Swedish railways reaching and exceeding sometimes 22s. per ton. On the other hand, the enormous distances and the low density of population of only 30 inhabitants to the square mile are adverse factors. When one considers that the cost of feeders, sub-station, and electric equipment of the permanent way comes to about £2,000 per mile of track, it is easy to see that the capital outlay and maintenance, although not important items on a line with plenty of traffic, will be a rather heavy burden on lines which have only little traffic. Yet the Swedish Government has made a beginning with electrification. Some years ago it sent its chief electrician, Mr. Robert Dahlander, to the Continent of Europe and to America to study the question of working main lines electrically, and on his return in the beginning of 1904 the Swedish Parliament voted £23,500 for experiments on two short lines running out of Stockholm to the north-west and north. (Fig. 23). At Tomteboda a power-house was fitted with two De Laval turbo-generators of 270 h.p. each, producing 500-volt single-phase current at 25 frequency. The generators are arranged for variable speed, so that a frequency of 20 and one of 15 can also be had. Only single-phase current is being used, Mr. Dahlander having come to the

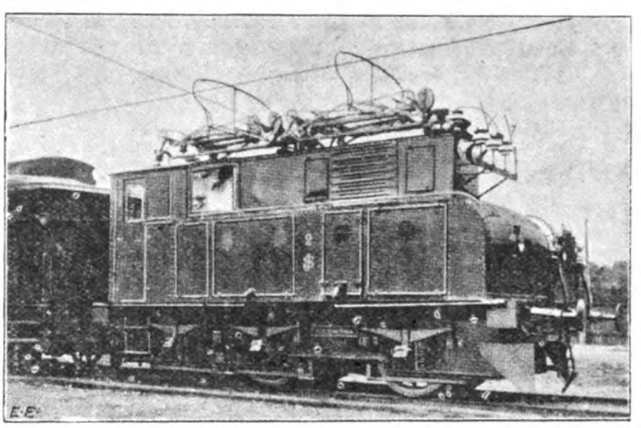

FIG. 26.—Siemens Locomotive for the Railways in Sweden.

conclusion that neither of the other two systems is equally suitable on lines on which, by reason of their great length, a very high pressure in the trolley wire is essential. To lower the pressure and use more sub-stations would on lines with little traffic not be economically justifiable, whilst the higher efficiency of either of the other systems is of little importance in a country where water power is not only cheap, but supplied from lakes which form natural storage reservoirs to be drawn upon for the peak loads. The trolley line is suspended from single (Fig. 24) and on certain parts from double catenaries. The same posts also carry telephone wires, and it was observed that the latter assumed a potential of 4,500 volts to earth when the trolley wire received current at 20,000 volts. Means had, therefore, to be found to carry off to earth the

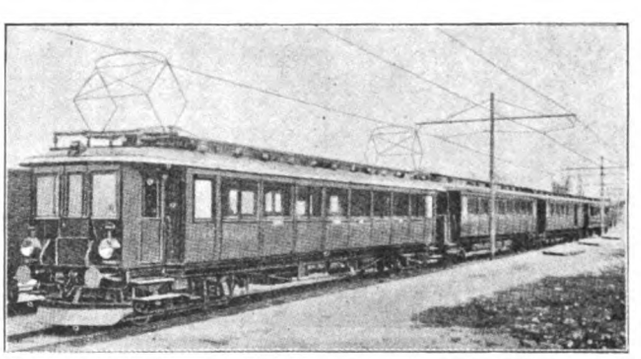

FIG. 27.—Motor Car Train in Sweden equipped by the Allgemeine Elektricitats-Gesellschaft.

charge induced in the telephone circuit without interfering with its use as a telephone line. In addition to drilling in the usual way to eliminate induced currents, an electromagnet with double winding was put at either end as a shunt to the line and the middle point of the winding connected to earth. The self-induction of this magnet is sufficiently great to prevent any appreciable part of the telephonic currents being shunted, whilst static charges flowing to earth through the middle point to the winding, and, therefore, through the windings in opposite sense, encounter no self-induction. The trolley voltage is obtained by step-up transformers in the power-house, and the latter are so arranged that by changing the connections of the sub-divided winding pressures varying from 5,000 to

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37,500 volts can be obtained. The British Westinghouse Company, the Siemens-Schuckertwerke, and the Allgemeine Elektricitäts-Gesellschaft of Berlin have each supplied rolling-stock for this experimental line. The Westinghouse locomotive (Fig. 25) is adapted to take current at 3, 6, 12, 15, and 18 thousand volts; it has two driving axles each fitted by spur gear with a 150-h.p. motor, and the maximum tractive effort is four tons. The Siemens locomotive (Fig. 26) is built for a trolley voltage of 20,000 volts; it weighs 36 tons and its maximum tractive effort is six tons. It has three driving axles, and is fitted with three compensated series motors of 110 h.p. normal capacity, the voltage of 350 being obtained by a transformator of 350 k.v.a. output carried on the locomotive. The motors are cooled by air blast taken through a gauze filter to prevent dust getting to the motors. The motor-coach train (Fig. 27) was supplied by the Allgemeine Elektricitäts-Gesellschaft. Each motor coach is fitted with two 120-h.p. Winter-Eichberg motors adapted to take current at 6,000 volts. The gear

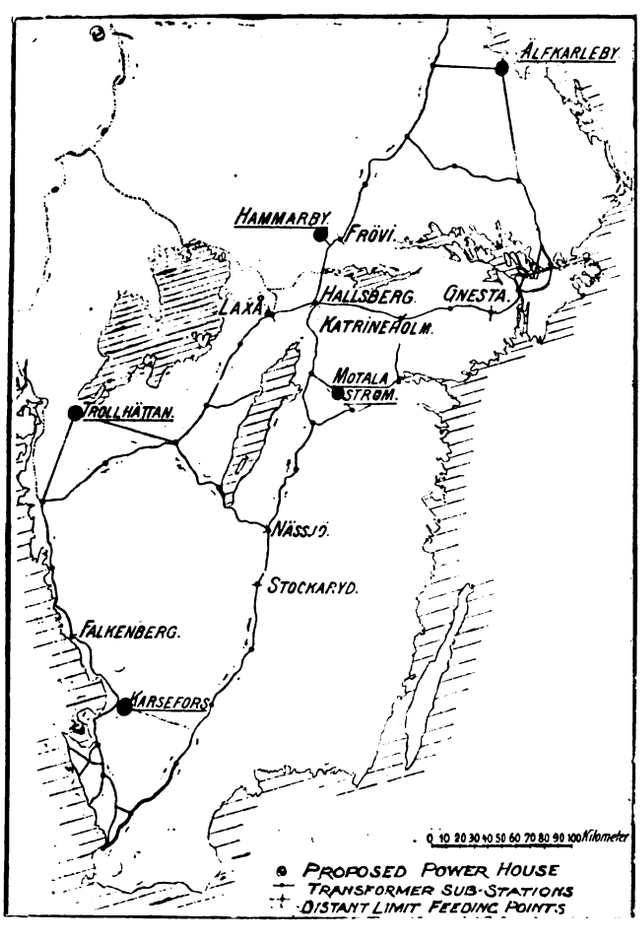

FIG. 28.—Map of the Swedish Main Lines to be Electrified.

fitted at present permits of a maximum speed of 28 miles per hour, but other gear wheels have been supplied, so that by putting these on the speed may be increased to 40 miles per hour. The motor coaches are fitted with the usual bow collector, but as it is intended to experiment also with the Oerlikon system, the necessary provision for the Oerlikon rod has been made on the roof of the coach. The regular service by electric traction was started on the Stockholm-Jarfva section on Feb. 23 of last year, the rolling-stock here described being used. Whilst the experiments were in progress the Swedish Government purchased three waterfalls with an aggregate of 24,600 h.p., which, with the Trollhattan and Elfkarleby Falls (Fig. 28) already in its possession, will enable it to supply over 50,000 h.p. for railway traction in the southern part of Sweden over about 1,300 miles of line. For this part of the country Mr. Dahlander has worked out complete plans and estimates for electrification. There will be five large power-houses, and the water power now in possession of the State will suffice for present requirements, but Mr. Dahlander estimates an increase of 60 per cent. in the traffic by 1920, and to provide for this he supplements two of the power stations by steam plant, the fuel being peat. The pressure in the feeders will be 50,000 volts, and that in the trolley 15,000 volts. The lines total up to 1,380 miles, and the single tracks, including sidings, to 2,800 miles. The five power houses will contain steam and water turbines, with a total of 80,000 h.p., and the cost of the generating plant, including the purchase of water rights, comes to £1,540,000, whilst the cost of feeders, sub-stations, and electric equipment of the permanent way amounts to £2,620,000, so that the total outlay is estimated at £4,160,000. The cost of electric locomotives is not included in this sum. In estimating the cost of maintenance and working expenses, Mr. Dahlander includes locomotive charges. He also assumes that for the present fifty of the existing steam locomotives would be retained as reserves, and that each of these would do about 6,000 miles per annum. The net result of these calculations is that with coal at 22s. a ton the annual saving in 1920 will amount to about £200,000.

(To be continued.)

STANDARD PERFORMANCES OF ELECTRICAL MACHINERY.*

BY DR. RUDOLPH GOLDSCHMIDT, ASSOCIATE-MEMBER.

Modern engineering is divided into so many branches, all so complex, that the specialist in any one of them can hardly be expected to be intimately acquainted with the qualities of machines built by specialists in the other branches. In such cases he looks for advice to the standards committees of our great engineering societies, who have not only aimed at standardising manufacture, but have also drawn up rules for the benefit of the user of machinery. Little information of a definite nature as to standard performances of motors and dynamos is, however, available, probably because it is very difficult to obtain agreement between all the parties concerned. For instance, a purchaser of a 10-h.p. motor will look in vain for information as to what the efficiency of such a machine ought to be. If there were any standard rule prescribing that the efficiency should be 85 per cent., manufacturers would probably endeavour to obtain 85½ per cent., and it might become a point of honour to exceed the conditions of the rules. Suggestions for standard performances, standard power factors, standard efficiencies, etc., from a private quarter may, however, be acceptable, and, after criticism and discussion, may become very useful as a private standard.

Although they might not be quite indisputable, such normal figures would be of assistance in many respects. The mechanical engineer cannot be expected to know what will happen if, say, in a machine tool or crane a gear is arranged to be cut out and the motor speed reduced. The effect is entirely different with two-phase, three-phase, single-phase, or direct-current machines, depending on the periodicity and other considerations, and it, therefore, requires a good deal of special knowledge to decide upon the most suitable type of machine to employ. I will mention only one of the many cases I have come across. A 5-h.p. two-phase induction motor for a crane had been fixed at as low a speed as 500 r.p.m., the overload capacity had been specified as 150 per cent., and the frequency was 50 ~. It does not appear at first sight that the current consumption of such a motor is about double that of a machine running 250 revolutions faster, or that a somewhat smaller overload capacity would have improved matters. The mechanical parts of the crane had been finished, and the motor had to be built contrary to the better judgment of "all who knew." In such a case a timely warning would have been of value. It is needless to say that approximate standard performances, if fairly complete, can be used for the practical and, perhaps, also for the theoretical comparison of different classes of machines and of different supply systems. For these reasons I was induced to write this paper, an additional encouragement being the well-known fact that the performances of different makes of machines do not differ very

* Paper read before the Institution of Electrical Engineers

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much in actual practice, so that there must exist something like a "standard performance."

In compiling the paper I have avoided as far as possible dealing with such generalities as are to be found in text-books, and have endeavoured to demonstrate the results by means of curves, restricting myself to comments on these only. By the exclusion of all questions of design as well, the compass of the paper has been considerably reduced. All electric motors and dynamos work through the interaction of the magnetic flux and the ampere-turns. Whatever machine one may select, whether it be an induction motor, an alternator, a synchronous motor, or a direct-current machine, one always finds a cylinder carrying

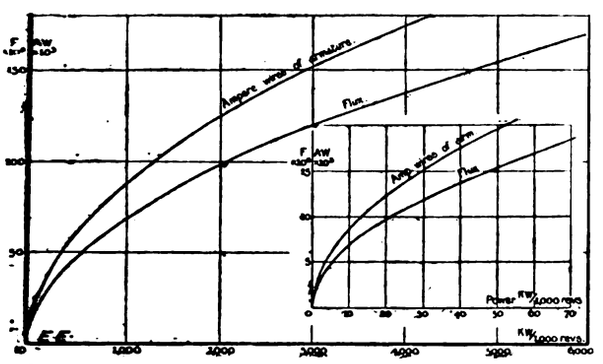

FIG. 1.—Direct Current. Standard Fluxes and Ampere-wires of Armature.

ampere-turns on its circumference and a magnetic flux entering this cylinder in a radial direction. The torque is the product of both; or, taking

$$\text{Torque} = \text{constant} \times \frac{\text{K W}}{\text{revs.}}$$

and calling "power" the kilowatts reduced to 1,000 r.p.m., then

"Power" = K W at 1,000 revolutions = constant × ampere wires × flux = constant × A W × F.

With direct-current machines, polyphase alternators, and polyphase induction motors, the constant averages 0·165

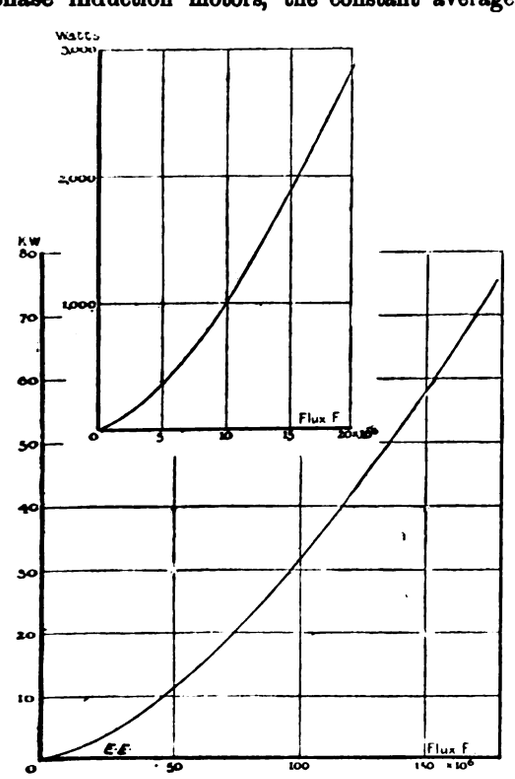

FIG. 2.—Direct Current. Core Loss at 1,000 Revs. per Minute with different Fluxes

× 10^{-9}; with single-phase machines it averages 0·145 × 10^{-9}. By "ampere wires" is understood the total number of conductors which are cut by a plane in the middle of the armature at right angles to the shaft, multiplied by the number of amperes per conductor. With induction motors the ampere wires are those of the rotor only. The flux is the sum of all fluxes entering the armature from all poles together. It is naturally possible to obtain a certain "power" with an infinite number of combinations of ampere wires and fluxes. In actual practice the figure for both will be of the same order if we express A W in 10^3 (kiloamperes) as unit, F in 10^6 (megalines; 1 megaline = 167 kapplines).

The conditions fixing A W and F vary for every class of machine, and are not always those of economy of design. With direct-current machines the commutation, with alternating motors the pull-out, with alternators the voltage drop, come into consideration. Of the two factors, A W and F, working together to produce the output, one, F, is constant, while A W increases with the load. A W tends to destroy F, and causes sparking or voltage drop. Therefore, in order to produce a good machine, F must not be too weak. It is due to these well-known conditions that F and A W do not actually vary so very much. The effect on the efficiency, which is the chief item about to be considered, is very small indeed, even if F varies by quite a considerable amount, as will presently be

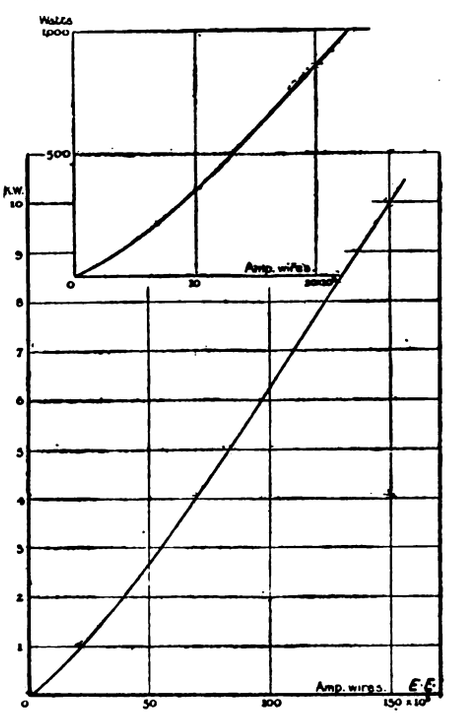

FIG. 3.—Direct Current. Copper Loss of Armature with different Ampere-wires

seen. There are certain sections required for F and A W, as the density must not exceed a certain figure, limited by heating or saturation (teeth). Further, the length of path which the flux and A W have to flow in is also very nearly fixed, as both are interlinked, and have to surround one another. Therefore, if the A W and the size are given, the copper losses due to A W are pretty well fixed, as well as the core loss, provided the speed at which the flux revolves is known. Figures in detail on this point for direct-current machines are given below.

DIRECT-CURRENT MACHINES.

Fig. 1 shows F and A W for different K W at 1,000 revolutions, and the figures may be considered normal for machines having no commutating poles. In most cases these fluxes are identical with the most economical flux, especially with moderate speeds. With commutating poles the flux may be 25 per cent. or even 35 per cent. less. There is also some variation, dependent on whether the machine is very narrow or excessively broad, on the number of poles, etc. We will disregard this for the present. The core loss caused by a certain flux, F, is proportional to the speed. Taking 1,000 r.p.m. as the unit of speed, Fig. 2 shows the core loss at different fluxes. If it is desired to know what the core loss of a 500-kw. machine is likely to be, the speed being 250 r.p.m., we take "power" = $500 \times \frac{1,000}{250}$ = 2,000 kw. at 1,000 revolutions, and take from Fig. 1 flux F = 99 megalines; Fig. 2 shows that the core loss

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p_{fe} = 31,000 watts with F = 99 at 1,000 revolutions—that is, at 250 revolutions $\frac{250}{1,000} \times 31,000 = 7,750$ watts, or $\frac{7,750}{500,000} = 1{\cdot}55$ per cent. It must be understood that, if p_{fe} = constant × revolutions, this is not correct for one and the same machine. There are eddy-current losses, which

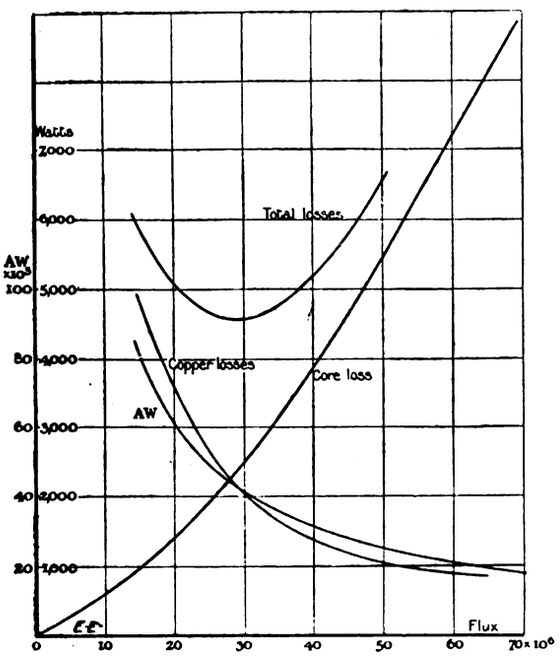

FIG. 4.—Direct-current Generator. 100 k.w., 500 Revs. per Minute, Losses in Armature, with different Fluxes and A W

increase as the square of the speed, the hysteresis only being proportional to it. But in our case the machine with more flux is a different machine, more iron section being provided. This is the reason why we are entitled to make the core loss practically proportional to the speed. The armature copper loss is dependent on A W only, as shown by Fig. 3. In the case of our example, we take from Fig. 1 for 2,000 kw. at 1,000, A W = 125 kiloamperes, and from Fig. 3, 8,100 watts copper loss, $p_{cu} = \frac{8,100}{500,000}$ = 1 62 per cent. Copper and iron loss together amount to 1·62 + 1·55 = 3·17 per cent. Picking out the same figures

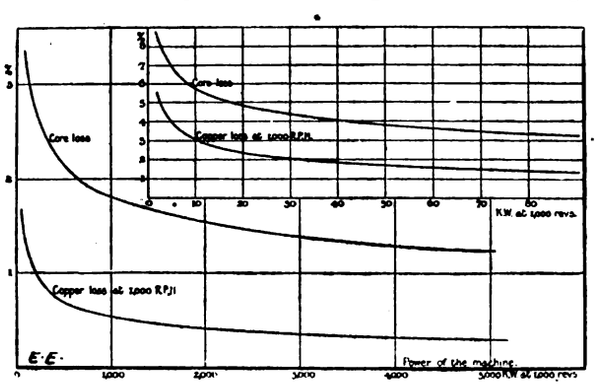

FIG. 5.—Direct Current. Armature Core and Copper Losses in per Cent. of Output

for a 100-kw. machine, running at 500 revolutions, we find, from Fig. 1, F = 31, A W = 40, and from Figs. 2 and 3

Core loss = 2,650 watts.
Copper loss = 2,000 watts.
Total, 4,650 watts = 4·65 per cent.

If F were reduced by 20 per cent., or to 25 megalines, A W would rise to 50 kiloamperes, and

Core loss = 1,950 watts.
Copper loss = 2,650 watts.
Total, 4,600 watts = 4·6 per cent.

The total losses, therefore, have not changed. In Fig. 4 the A W, copper, core, and total losses have been drawn up for 100-kw. 500-revolution machines designed with different fluxes, and it will be noticed that the total losses are practically unchanged—that is, only between 4,550 and 5,000 watts—if the flux is altered from 21 to 37 megalines. The losses with well-designed machines cannot be far from this minimum, as it is very expensive to provide surface for extra losses.

For convenience sake I have combined Figs. 1, 2, 3 to form Fig. 5, where the losses are expressed in percentages of the output, and as a function of the "power" kilowatt at 1,000 revolutions. By expressing them as a percentage, p_{fe} is now independent of the speed, whilst p_{cu} is inversely proportional to it. As unit of speed we take again 1,000 r.p.m. For a 100-kw. machine at 500 revolutions:

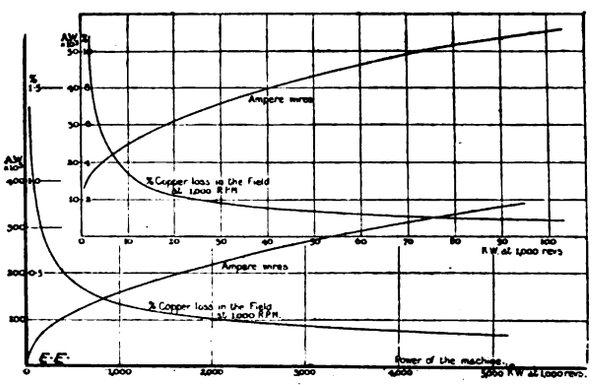

FIG. 6.—Direct Current. Field Copper Loss as per Cent. of Output

Power P = 200, core loss 2 65 per cent., copper loss $1 \times \frac{1,000}{500} = 2$ per cent. of 100 kw. The ampere-turns of the field magnets are a function of armature ampere-turns and flux, the former demagnetising and the latter requiring to be driven through the air gap. These ampere-turns have to surround the flux coming from the armature, which fixes their mean path, so that there exists a law which connects the power of a machine with the losses in the field.

I will define the expression "field ampere wires" as the field ampere-turns per pole multiplied by the number of poles and multiplied by 2. The field A W and the losses as a function of the power are shown in Fig. 6. The losses are again expressed in percentages of the output, and for correction require to be varied in inverse ratio to the

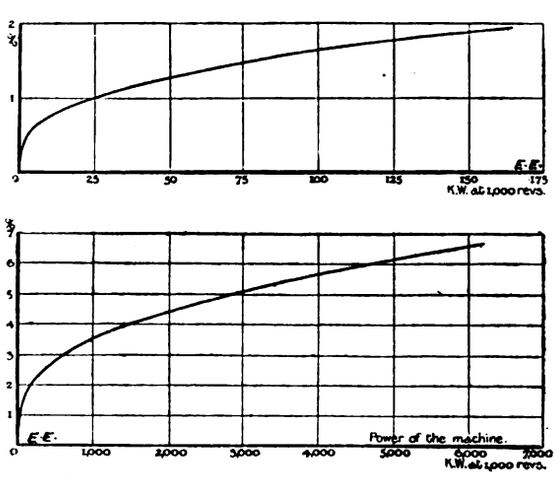

FIG. 7.—Brush Friction Loss at 1,000 Revs. and 200 Volts

speed, 1,000 r.p.m. being again taken as normal. It may be noted that with large machines the field A W is about 25 per cent. more than the armature A W, and that 1,000 A W is about the lowest figure found with very small bipolar machines. A 100-kw. machine, running at 500 r.p m., would have (Fig. 6) $0{\cdot}67 \times \frac{1,000}{500} = 1{\cdot}33$ per cent. losses in the field magnets. In machines with commutating poles the losses in the main poles are reduced, but this reduction is made up for by the losses in the commutating poles.

It remains to consider the friction losses. The most difficult question is that of the brush friction, but here also there exists a definite relation between current, current density in the brushes, and voltage drop, coefficient of

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friction, and friction losses. Also the commutator diameter can be approximately determined from the output; so that, choosing 200 volts and 1,000 revolutions as normal, a curve can be plotted (Fig. 7) giving the percentage brush friction as a function of K W at 1,000. These figures vary inversely as the voltage and directly as the speed.

Example.—100-kw., 500-revolution, 500-volt dynamo. Power, 200 kw. at 1,000. From Fig. 7: 2·1 per cent. $\times \frac{500}{1,000} \times \frac{200}{500} = 1{\cdot}7$ per cent.

The bearing friction and windage are practically independent of the "power," and depend almost solely on the angular velocity—that is, the revolutions per minute. Fig. 8 gives practical average figures for this class of friction. The voltage drop in the brushes expressed as a percentage may be taken as $\frac{200}{\text{volts}}$. It is somewhat less with high-current and somewhat more with high-voltage

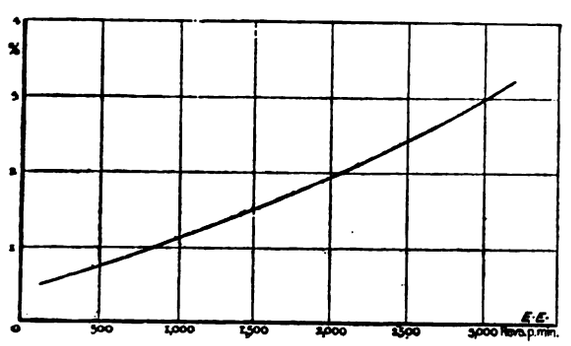

FIG 8.—Bearing Friction and Windage.

machines. With copper brushes it may drop to about $\frac{100}{\text{volts}}$, but ought not to be assumed to be lower. For instance, a 500-volt machine would have a loss of $\frac{200}{500} = 0{\cdot}4$ per cent., due to voltage drop in the brush contact. Figs. 5, 6, 7, and 8 enable the efficiency of any direct-current machine to be estimated. Referring again to the example of a 500-volt, 100-kw., 500-revolution machine, we find:

Core loss	2·65	per cent.	
Armature copper loss	2·00	,,	
Field ,, ,,	1·35	,,	
Brush friction	0·45	,,	
Windage and bearing friction	0·75	,,	
Brush drop	0·40	,,	
Total	7·60	,,	of output
Output	100·0	,,	
Input	107·60	,,	
Efficiency	92 9	,,	

To avoid going into details, the total efficiency has been plotted in Figs. 9 and 10 for different speeds and as a

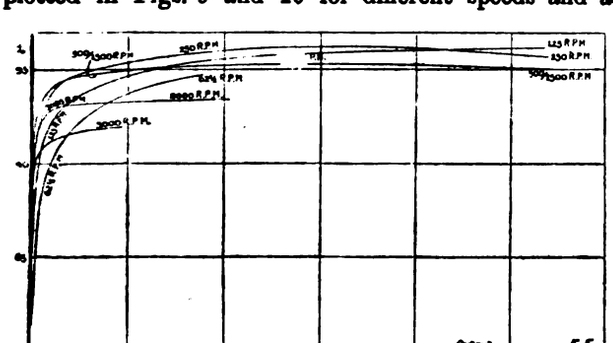

FIG. 9.—Efficiencies of Direct-current Machines, 500 Volts.

function of the actual output (not "power" in this case) of the machine, Fig. 9 giving the efficiencies of dynamos up to 5,000 kw. In Fig. 10 the abscissæ represent brake horse-power, but naturally motor and dynamo efficiencies are practically identical, so that Fig. 10 can also be used for dynamos. The voltage has been assumed to be 500 volts. If the voltage is different, a correction may be carried out in the brush friction and brush drop. The comparatively low efficiencies at very high speeds are due chiefly to friction and core loss. Figs. 9 and 10 give only the full load efficiency. An idea of the performance with smaller loads can be gained by referring to the curves giving the losses in detail.

Rotary Converters.

The efficiency of a rotary converter may be obtained from the efficiency of the corresponding direct-current machine, making allowance for the losses on the alternating-current slip-rings. For this purpose the curves in Fig. 7 may be used, reducing the friction found in this way to about one-half. This is naturally only very approximate. The output of a direct-current machine can be increased by a certain percentage if used as a rotary, with three-phase current by 33 per cent., and with six-phase by 90 per cent. As the power factor is not always unity, and a slight deviation from this reduces the output again, it cannot be

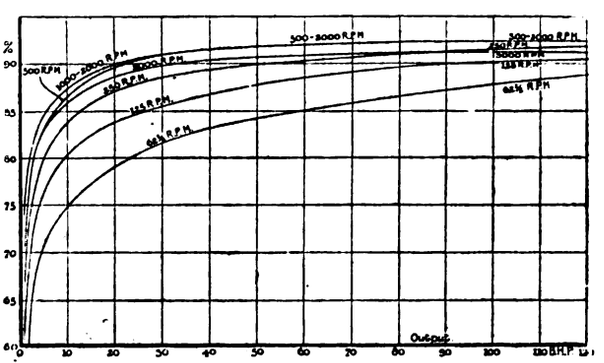

FIG. 10.—Efficiency of Direct-current Machines, 500 Volts.

assumed that the latter is increased by the full amount, but only, say, by 20 per cent. and 40 per cent. respectively. For approximate estimates the following formulæ may be used:

$$g_r = \frac{g}{0{\cdot}93 + 0{\cdot}07 \times g}$$ for three-phase, and $$g_r = \frac{g}{0{\cdot}81 + 0{\cdot}19 \times g}$$ for six-phase, where g_r is the rotary efficiency and g the efficiency of a direct-current machine, which is $\left(\frac{1}{1\,20} - 1\right)$ = 17 per cent. and 28 per cent. smaller; g is to be taken from Figs. 9 and 10. Thus a 500-kw. direct-current machine at 250 revolutions would as a three-phase rotary have an efficiency of $\frac{94{\cdot}7}{0{\cdot}93 + 0\,07 \times 0{\cdot}947} = 95$ per cent.

(To be continued.)

PERSONAL.

The staff of the electrical department of the North Staffordshire Railway Co. celebrated their eleventh annual dinner on the 23rd inst.

Mr. J. W. Farrell, of Manchester, has been appointed mains foreman in the electric supply department of the Birmingham Corporation.

The Wolverhampton tramways employés held their annual dinner last week. Mr. Luntley, the tramways manager presided, and a very enjoyable time was spent.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, Feb. 8.

MONDAY, FEB. 3.—"A" Coy.—Technical drill, 6.30 p.m.

TUESDAY, FEB. 4.—"B" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

WEDNESDAY, FEB. 5.—"A" Badge examination for "C" and "D" companies, 6 p.m.

THURSDAY, FEB. 6.—"C" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

FRIDAY, FEB. 7.—"D" Coy.—Infantry drill, 6 p.m.
Technical drill, 7 p.m.

SATURDAY, FEB. 8.—N.C.O.'s mess dinner at the Cafe Monico at 7.15 p.m.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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THE MIDLAND RAILWAY ELECTRIFICATION.

As is well known, the Midland Railway Company have equipped for trial purposes about nine miles of their railway near Heysham. Messrs. Siemens Bros. Dynamo Works, Limited, have carried out the work, and have so far completed it that the first trials have been successfully made. On this line the overhead trolley wires are suspended on the Siemens double catenary system, as shown in Fig. 1. The pressure on this trolley wire is 6,000 volts. Fig. 2 shows the work of erecting the gantries in progress. From these gantries which span the track the trolley wire is supported. These photographs were shown by Prof. Gisbert Kapp in his second Royal Institution lecture last Saturday. The rolling stock on this line is being supplied partly by Messrs. Siemens-Schuckertwerke and the rest by the Westinghouse Company.

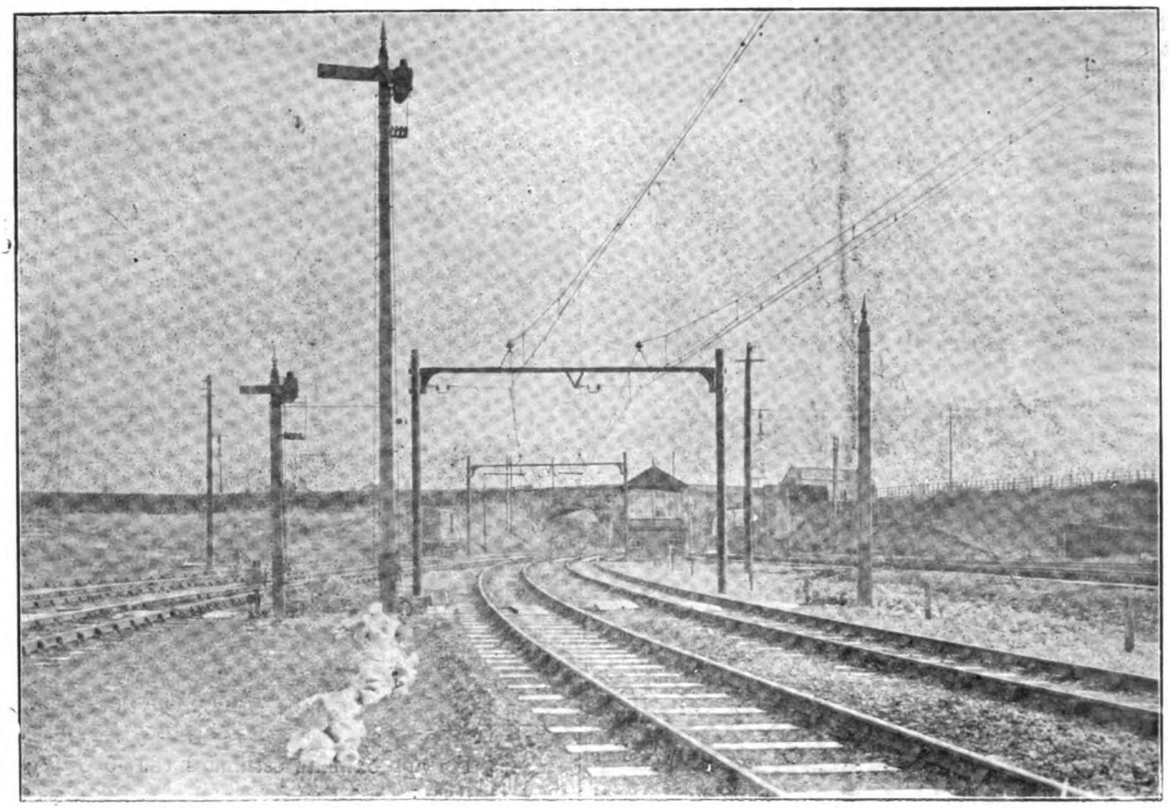

FIG. 1.—View of the High-Tension Overhead Construction on the Midland Railway.

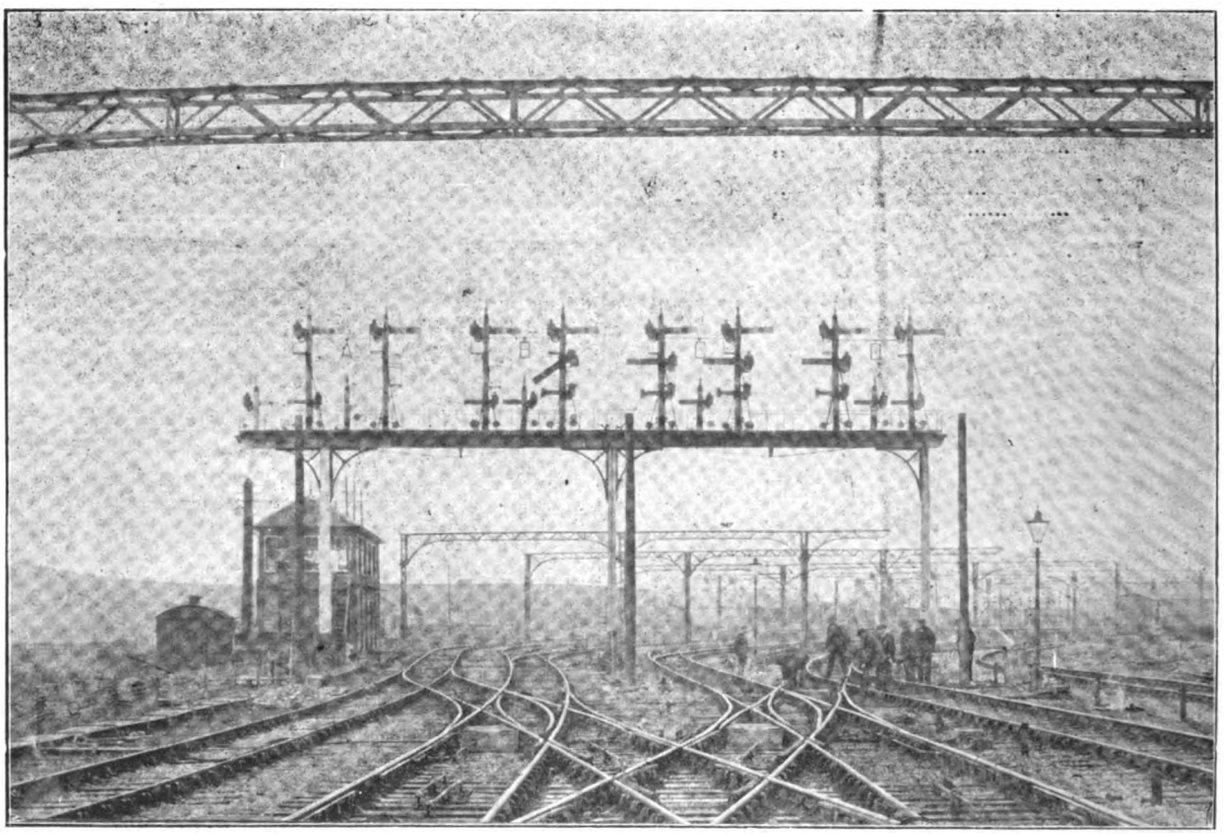

FIG. 2.—The Electrification Work at an important Junction on the Midland Railway.

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NOTES.

Electro-Harmonic Society. — We are informed that, in consequence of the non-completion of the new St. James's Hall, the "Ladies' Night" concert on Friday, Feb. 21, will be held at the Bechstein Hall, Wigmore-street, W.

French Electrotechnical Committee.—We read in our contemporary, *L'Industrie Electrique*, that two commissions were appointed by this committee at a recent meeting—one of these for the purpose of inquiring into the scheme for a dictionary of French and English technological terms, proposed by the English committee, also to go into the question of symbols and photometric units; the second to inquire into the various questions arising from the use of the word "standardisation." We may here add that the committee have been advised to adopt the term "uniformisation" as the French equivalent for standardisation.

Institution of Civil Engineers.—The council of the Institution of Civil Engineers have made the following appointments to scholarships under the Yarrow educational fund: No. 9, Fred Harrison, to assist him to take a course of apprenticeship to Messrs. Heenan and Froude, of Manchester; No. 10, George Edgar Morgan, to assist him to follow a course of study at the Royal College of Science; No. 11, Frederick Hickey, to assist him to follow a course of study at the Royal Naval College, Greenwich; No. 12, Charles Oliver Callcott Reilly, to assist him to take a course of apprenticeship to an engineering firm; No. 13, Joseph John Elliott, and No. 14, Duncan Davidson Forbes, to assist them to take courses of apprenticeship with sessional study at the East London College; No. 15, Henry William Turner, to assist him to follow a course of study at the Royal College of Science. Applications for these scholarships have to be made in accordance with regulations, copies of which and further particulars may be obtained from the secretary, Dr. J. H. T. Tudsbery, at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W. No further appointments to scholarships under this fund can now be made until the autumn of 1910.

London University and Lord Kelvin.—The following letter has been sent to the Vice-Chancellor and Principal of the University of Glasgow: "We are desired by the Senate of the University of London, who met yesterday (Jan. 23) for the first time after the Christmas vacation, to tender to you, and through you to the University of Glasgow at large, an expression of our sincere sympathy in the loss which you have suffered by the death of your chancellor. Lord Kelvin's researches into the operations of Nature and his contributions to the sum of human knowledge, by which the work of all the universities of the civilised world has been so notably advanced, have given additional lustre to the illustrious name of the University of Glasgow. It must ever remain to you a source of the proudest satisfaction that a career nobly and beneficently devoted to the welfare of humanity was throughout associated with the body over which he was presiding when the world lost him. We are proud to remember on this occasion that Lord Kelvin was one of the only two men, outside the circle of Royalty, upon whom the University of London has ever conferred an honorary degree." The letter was signed by Lord Rosebery (chancellor), Sir A. W. Rücker (principal), and other members of the senate.

The Migration of Industries.—The tendency of manufacturers to move into country districts from large centres still continues; an instance in this direction being the move taken by the well-known firm of Messrs. Chubb and Sons' Lock and Safe Company, Limited, who have arranged to purchase 10 acres of freehold land on the Fallings Park Estate within the borders of the borough of Wolverhampton. A fact that has weighed heavily with this firm in deciding upon a removal of their works was the greater facilities and the cheaper cost of electric power in the Wolverhampton district compared with London. Before finally deciding upon removal, Messrs. Chubb tested the district for seven years as a manufacturing centre and found that the cost of manufacture there was more favourable to them than in London. It is their intention, we understand, as soon as the negotiations are finally concluded, to begin the new works by erecting the first part of a large and commodious steel structure giving ample space for building in any quantity and any size strong rooms and safes of their well-known types. The building will be fitted with high-speed electrical machinery, cranes, etc. The men and machinery from the experimental works at Wolverhampton will be moved to the new building as soon as it is ready, and the men and machinery from the larger works now in London will be gradually transferred.

Manchester Electrical Exhibition.—At a representative meeting held on Monday, Jan. 20, in Manchester, the organising committee with reference to this exhibition was completed. Councillor Kay, J.P., of Manchester, was elected chairman of the committee, and Councillor Barrett, J.P., of Salford, deputy chairman. The secretary gave a full report of the scheme as existing up to date, and it was unanimously decided to put same into effect, and to enter into the necessary arrangements for holding the exhibition in Manchester next October. In order that matters should be dealt with promptly, an executive committee was appointed, consisting of the following gentlemen: the chairman, the deputy chairman, the consulting engineers (Messrs. Pearce and McCowan), and Messrs. H. Berry, H. Bevis, D N. Dunlop, F. Nalder, C. D. Taite, and H. Talbot. In order that the committee may be able to decide definitely as to the size of the buildings which is immediately necessary to place the contract for, it is intended to send out a preliminary circular to the trade asking for an indication as to space required by various exhibitors, and the design of the buildings will be such that extensions can readily be effected up to within three months of the date of opening. Large numbers of applications, we understand, have already been received from the principal electrical and engineering firms throughout the country, and it is hoped that all those likely to be interested will assist the committee in concluding their final arrangements for this important exhibition, by dealing with the matter promptly and by getting in touch with the management at the earliest possible moment. The executive committee were also instructed to enter into agreements with Messrs. Northcote and Davenport for the carrying out of their requirements.

Electricity in Medicine.—In addition to the discovery of new methods of treatment in medicine and surgery, it is interesting to note how modern scientific ideas bring about the revival of an old method which, probably for want of better knowledge, had been allowed to fall into disuse. The *Lancet* gives an instance of this in the local introduction of drugs through the unbroken skin with the aid of the electric current. This is generally known as cataphoresis, and the method is nearly as old as our knowledge of the electrolytic process itself. At one time it was employed to a considerable extent both at home and abroad. In the electrolysis of a normal saline solution there is a migration of ions; the basic (sodium) ions

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travel from the anode to the cathode, while the acid (chlorine) ions move from the cathode to the anode. This process is not stopped by the intervention of animal membrane or skin. As being more in harmony with modern ideas, the method is sometimes spoken of as "ionic medication." As our knowledge and experience increase there is every probability that this principle, which has already been found useful in several instances, will be employed in a gradually increasing degree.—The announcement is made that the fourth international congress on electrology and radiology will be held at Amsterdam from Sept. 1 to 5, 1908. The results of the three former congresses—at Paris in 1900, at Berlin in 1903, and at Milan in 1905—having proved their utility and importance, the fourth congress will be organised on the same lines. The programme will comprise electrophysiology and electropathology, electrodiagnostics and electrotherapeutics, diagnostics and therapeutics of Röntgen rays, the study of diverse radiations, and medical electrotechnics. In conjunction with the congress an exhibition will be arranged of new or modified apparatus used in clinical and laboratorial work, and also a collection of important radiographs.

Shape of Winding for Measuring Instruments.—In electrical measuring instruments it is desirable that the ratio of torque to weight of moving element should be as large as possible, for in this way the effect of friction in the moving system is reduced, and any inaccuracies due to this cause are greatly diminished. An interesting solution of this problem of design of moving-coil instruments is put forward by Mr. A. P. Young in the New York *Electrical World*. Mr. Young shows that a coil revolving in a magnetic field of uniform density exerts the maximum torque per unit weight when it is circular in shape. An examination of the equations shows that the torque erected by a coil in a uniform field varies directly with the area which the coil surrounds, quite independent of its shape. Comparison between the torque for a rectangular coil and for a circular coil shows that the latter gives approximately 27 per cent. greater torque than a coil of square section, using the same length of wire in each case, and assuming that the magnetic field in which the coil moves is uniform. This conclusion is interesting, and is probably of greatest practical importance as applied to the case of a watt-hour meter of the commutator type. An instrument of this type consists of a rotating armature made up of a number of coils such as Mr. Young has assumed, and the torque exerted by this armature is proportional to the average value of the torque exerted by each coil. The conclusion shows that in such cases the spherical drum form of armature is the most economical. In the case of permanent magnet instruments, where there is a rectangular coil moving in a radial magnetic field of permanent value, the torque is dependent solely on the current passing through the coil and independent of the angular position of the coil. For such instruments it is seen that the square form of coil is the most economical, which means that for an instrument of this type the square section of coil gives the greatest torque for certain values of the magnetic strength, moving-coil turns, moving-coil current, and length of wire used.

Tramway Bills in Parliament.—Of the seven Tramway Bills being promoted this year by private companies no fewer than five affect London. The London United Tramways Company propose to construct tramways in the parish of Brentford, and they are asking for an extension of time in respect of the construction of several authorised lines. An interesting proposal is that for the conversion of the old cable tramway to electrical on the Highgate-hill. The Metropolitan Electric Tramways Company are seeking to extend their tramway from Harrow-road to the Edgware-road. The Croydon and Southern Districts Tramways Bill proposes to incorporate a new company with a capital of £85,000 for the construction of tramways in the parish and borough of Croydon and in Beddington, Coulsdon, and Warlingham, with compulsory running powers over the tramways of the Croydon Corporation. The proposal under the West London, Barnes, and Richmond Bill to construct a new line of tramways to connect Richmond, Mortlake, and Barnes with Hammersmith is meeting with little local support, and if persisted in is likely to be strenuously contested. The section is being promoted by the Richmond Electric Light Company and the London Electric Supply Corporation, and the greater portion of the proposed line would traverse high-class residential districts. A representative meeting of ratepayers of Barnes and Mortlake have, by 450 votes to 6, protested against the construction of the tramways, and representations by memorial and deputation have been made to the local authority urging that the Bill be opposed in Parliament. Power is given in the Bill for the County Council to construct any of the proposed tramways in their area and lease them to the company. With regard to the provinces, the Nottingham and Derbyshire Tramways Company want to extend the time limited by their Act of 1903 for the completion of authorised works, while the Macclesfield and District Tramways Company wish to abandon all the powers granted them by their Act of 1906, except certain tramways within the urban district of Hazel Grove and Bramhall, which tramlines have been vested in the local authority Authority is further asked to dissolve the company.

New Publications.—"Modern Electrical Theory," by Mr. Norman Robert Campbell, M.A. (Cambridge University Press. 7s. 6d. net). Mr. Campbell explains in a prefatory note the scope and intention of this volume. It was begun with the idea of providing a text-book from which students, well grounded in the elementary branches of physics, might obtain some knowledge of the later developments. But departures from this scheme are obvious. There are lengthy descriptions of theories which may be assumed to be familiar to such students, and there are discussions on controversial questions also, which are more suitable for advanced students. Mr. Campbell has attempted to expound the subject in its logical order, to analyse the arguments by which the various phenomena are correlated, and to draw special attention to the assumptions that are made, and to show which of these assumptions are fundamental in the modern theory of electricity and which may be expected to be abandoned in the further progress of investigation. The first part of the book deals with the electromagnetic field, the second and third parts discuss the electron theory—inductive and deductive methods—and the fourth part electricity and matter.—We have just received, somewhat late in the day, a copy of the 1908 edition of the "Practical Electrician's Pocket-Book and Diary." (London: S. Rentell and Co., Limited, 36, Maiden-lane, Covent-garden, W.C. 1s. 6d. net.) This little publication has in past years been of great service to electricians, and with each succeeding issue its value is increased by the deletion of antiquated matter and the inclusion of new matter. The present issue has been increased by 32 pp. Important sections have been added dealing with such subjects as "Ignition Accumulators" (by Mr. Peto), "Curtis Turbines," "Time Lags," "Switchboards," "Time Switches," "Photometry," "The Home Office and other Rules," "I.E.E. Tables," etc. As in last year, the leather-bound copies contain a special coupon,

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insuring the sum of £25 to the next of kin of any holder of the book who may be killed by electric shock.

Greenwich Boiler Explosion Inquiry.—The report of the Board of Trade respecting the explosion of a thermal storage drum which took place at the works of the South Metropolitan Electric Light and Power Company, Limited, Greenwich, in 1906, was summarised in our issue of last week. The inquiry occupied an unusually long time, and great interest was evinced in the question of its probable outcome. We need not repeat the information of which our readers are already possessed, nor go into the question of the fixing of the responsibility and the amounts to be paid to the Board of Trade towards the cost of the investigation by the parties held responsible. We might, however, mention one point to which the commissioners drew attention. The explosion may have formed a ground for false impressions as to the safety of thermal storage drums; the commissioners, however, have placed on record the fact that nothing occurred at the inquiry to throw any doubt as to the safety of these drums. But they point out that if they are badly constructed or are not worked under safe conditions, explosions will occur just the same as in the case of any other boiler. Quite apart from questions such as the safety of thermal storage drums and (in the case under consideration) of the effect of the indentations in the steel plate, another question arises from the inquiry, and this is not likely to be lost sight of. It has frequently been suggested that there should be in a large central station a well-qualified mechanical engineer, in addition to the chief electrical engineer. In most stations, however, both the electrical and mechanical duties are entrusted to one man. The observations of the commission on this point are of importance. They state: "In the management of electrical power stations, when the chief engineer is an electrical specialist, as he should be, it seems to us desirable that some arrangement of the staff should be made so that the engineer's responsibility for the safe working of the boilers should be lessened, or transferred to an engineer having a thorough knowledge of the working of boilers. A man of the working class, such as a boiler-house foreman, does not seem to us to be sufficient." It remains to be seen whether this inquiry is likely to have the effect of ensuring a speedy reorganisation of the staffs of central stations so that a fully-qualified mechanical engineer should be included, wherever required.

Standardisation of Design.—The interesting paper which Dr. Rudolph Goldschmidt read last week before the Institution of Electrical Engineers deserved to attract much wider attention from the designers and manufacturers of electrical machinery than the discussion gave evidence of having done, for it dealt with a subject about which little definite information is known, but which is of the utmost importance as regards both the efficiency and economy of electrical machinery. The publication of the paper, however, will serve to make its contents more widely known, and gain for it a due appreciation. In this paper Dr. Goldschmidt attempted to show the necessity for standardisation of design, and presented a number of suggestions for standard performances, standard power factors, standard efficiencies, etc., which he considered as likely to be useful for adoption as private standards. It is needless to say that approximate standard performances, if fairly complete, can be used for the practical and, perhaps, also for the theoretical comparison of different classes of machines and of different supply systems. The reasons which induced Dr. Goldschmidt to write his paper were, as he explained, that as "the performances of different makes of machines do not differ very much in actual practice, there must exist something like a 'standard performance.'" His results were demonstrated by a number of interesting curves. It would be useful to know, before considering whether standardisation of design is desirable, how Dr. Goldschmidt arrived at his results, because the difference in their value, if based on theoretical calculations, or, on the other hand, on observations made in actual practice, must be obvious. Fortunately, Dr. Goldschmidt has been able to relieve our doubts on this matter, and from the explanation of his method, given by him at the meeting, it is clear that no better means could be adopted for arriving at the necessary conclusions. His plan was to get, first of all, at first principles, then to work upon practical experience. For this purpose he not only considered machines of his own design, but compared them with machines designed by others. Under these circumstances his results may be recommended as a useful guide to what can be done in the way of designing machines for higher efficiencies. It may be urged that an attempt to standardise design which is practically laid down upon existing practice would retard development in dynamo and motor building. But it cannot be gainsaid that an incalculable benefit may accrue—especially to mechanical engineers—from a knowledge of standard performances of electrical plant. Dr. Goldschmidt's paper undoubtedly contains much that will be helpful.

Electrical Legislation.—The parliamentary session which opened on Wednesday does not promise to excite very great interest in electrical circles. In the first place, the London power proposals are somewhat tame in comparison with the various proposals submitted during the two previous years, and it is yet uncertain whether this year will see a solution of the bulk supply problem. Three Bills are being promoted: (1) The London and District Electricity Supply Bill—promoted by the London supply companies, and in some respects resembling the one introduced in the House of Commons last session, but without success; (2) the London Electric Supply Bill—which contains proposals for the constitution of a joint committee; and (3) the Bill promoted by the West-end companies. The two first-named Bills are threatened with much opposition by the local authorities owning electrical undertakings, and it seems improbable that the present House of Commons will allow a Bill to pass placing the powers to supply electricity in bulk in the hands of a company. It is satisfactory to note meanwhile that an attempt is to be made to secure the reintroduction of the Supply of Electricity Bill, which has been introduced into Parliament by the Board of Trade on several occasions. Each time the Bill has been numbered among the "innocents" that the Government have sacrificed towards the end of the session in order to find time for the passing of other measures, and pressure should be brought to bear upon the Government on this occasion not only to take such a measure in hand, but to see that adequate facilities for its passing are provided. The general principles of the Bill, by enabling undertakers to give supplies to each other, seem favourable for cheapening such supplies generally, and likely to tend towards ending the struggle which has been going on before Parliament for a number of years past between public and private bodies desirous of obtaining powers authorising additional sources of supplies of electricity.—With regard to the general political situation and the probable bearing and prospective legislation upon industry, we would call attention to the proceedings of the recently concluded conference of the Labour party at Hull. Old-age pensions was one of the chief topics discussed, and a resolution was carried in favour of non-discriminatory, non-contributory pensions, applying to

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those who had reached the age of 65 or were physically unfit for work. The Chancellor of the Exchequer has publicly declared the preference of the Government for non-contributory pensions, but it will be seen that the Labour party's demands are decidedly more sweeping. Old-age pensions seem destined to come sooner or later, in one form or another; but it is greatly to be pitied that so momentous a change should be dependent upon the usual machinery of party politics.

Junior Institution of Engineers.—At the last meeting of this institution, held at the Society of Arts, the chairman, Mr. F. R. Durham, presiding, a very interesting, well-illustrated, and useful paper on "The Conduit System of Electric Tramway Construction and Recent Improvements" (now being reprinted in the *Electrical Engineer*), was read by Mr. Fitz Roy Roose, of the London County Council engineer's department. The salient features of the original line from Westminster to Tooting were first briefly described, and the differences between them and the present system of construction were dwelt upon at length. The extended yokes which were now used, besides carrying the slot rails, formed anchors to which the track rails were fixed at intervals of 7ft. 6in., and would be found of great advantage when renewals of track rails had to be carried out. A cast-iron plate now formed the cover to the insulator pockets, instead of cast-iron boxes as previously, which as they became worn by traffic had to be replaced, and were also the cause of a great deal of dirt getting into the conduit. Drainage, insulators, cable connectors, etc., were dealt with, and special work at cross-overs and junctions and insertion of junctions during reconstruction were referred to. The side-slot system was touched upon, as also the electrical supply to the line. A description was given of the plough or collector, and in conclusion the following figures were cited as the cost per mile (single) of the respective systems, including special work as pipe diversions, etc.; conduit, £17,000; surface-contact, £9,700; overhead, £9,200. On the following Saturday afternoon, as a supplement to the paper, by permission of Mr. Maurice Fitzmaurice, chief engineer to the London County Council, an inspection was made of the reconstruction work in progress in Stockwell-road, the members being shown over by the resident engineer (Mr. Alex. Millar) and the author. The method of forming the concrete conduit by means of the improved sheet-iron centering, the process of inserting the copper connecting pieces between the lengths of conductor bars, the insertion of the insulators and manner of carrying out other special work was demonstrated. The members, conducted by Mr. J. Bowden, rolling-stock superintendent, afterwards proceeded by one of the latest types of cars, Class E 1, to the sheds at Clapham High-street. Switched off the main track the car was run into the shed on to the electric traverser, and moved thereon to illustrate the method of bringing the cars into their place in the depôt. The motor school where the drivers are instructed in the manipulation and operation of the controllers, brakes, etc., was then shown, much interest being manifested in the skeleton stationary and working car. All the leads, etc., for traction and lighting being visible, the men can be readily taught how the various connections are made. The sub-station was also seen, containing three motor-generators (a fourth is now being erected). Delivered at a pressure of 6,600 volts from the generating station at Greenwich, the three-phase alternating current is transformed to 550 volts continuous for use on the lines. About five miles of double track are fed from the station. The ensuing meeting of the institution on Feb. 7 is to be quite special in its character. The subject of "Aerial Navigation" is to be discussed, some of the leading authorities in France and England being expected to take part in it.

Gas-Engine Research.—The third report to the Gas-Engine Research Committee was communicated by Prof. F. W. Burstall to the Institution of Mechanical Engineers on the 17th inst. The report represents an enormous amount of work, and shows that Prof. Burstall and his assistants at Birmingham University, if they have not made any wonderful discovery, have at least carried us a step further in our knowledge of how to build gas-engines in a more efficient and economical manner than is at present being done. The engine used in the tests was a commercial engine, inasmuch as it was supplying the necessary current for power and lighting to the new University of Birmingham. It was one of the Premier Company's existing types, capable of giving 150 h.p. at a speed of 170 r.p.m. In order to enable the engine to run at a compression pressure of 200lb. per square inch, with charges which were estimated to give an initial pressure of 600lb. per square inch, the diameter of the cylinder was reduced to 16in., and other modifications were adopted. The engine worked entirely with Mond producer gas, and high-tension ignition of the Lodge type was adopted. The tests were undertaken to determine, in the first place, the thermal efficiencies based on the indicated horse-power at various compressions, having regard to the richness of the mixture, and, in the second place, to formulate, if possible, the law connecting efficiency and compression. The calculations were made by means of a special arrangement consisting of a modification of the Junker calorimeter (worked by Mr. D. H. Lea, Prof. Burstall's first assistant on this work). The tests showed that for each compression there was a particular mean pressure which gave the highest economy for that compression. This pressure appeared to range between 85lb. and 95lb. for all the compressions, with the tendency to increase as the compression rose. Higher mean pressures than these caused the efficiency to fall off. The rise in efficiency with the compression was very marked in some of the trials, rising from a minimum of 28 per cent. up to a maximum of 39 per cent. After this point the efficiency increased comparatively slowly, reaching the maximum of 43 per cent., and then diminishing to 39 per cent. on the highest compressions of all. This result did not accord with the usual belief that economy increased with compression when a suitable mixture was used. For the particular engine experimented upon the most economical compression pressure was apparently 175lb. per square inch. In order to obtain higher thermal efficiencies by the aid of higher compressions, it would be necessary to increase the stroke of the engine in proportion to its diameter. Very high mean pressures extending to some 114lb. per square inch were proved to be decidedly uneconomical, the economy falling from 39 per cent. to 32 per cent. in some cases. In the actual tests the maximum pressure that was allowed was 550lb., and this was only rarely reached. The whole of the experiments appeared to point conclusively to the fact that the most economical mean pressure was very considerably below the maximum which could be obtained, and that the highest economies were obtained with a comparatively low maximum temperature. That, of course, only applied to the indicated power, and the conclusions as to brake horse-power would be widely different. If, however, the engine was constructed to work only with these moderate pressures and temperatures, the whole of the working parts might be very much lightened, and thus a good mechanical efficiency obtained with the very moderate mean pressures.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE QUESTION 1,019—SINGLE-PHASE CURRENTS FROM THREE-PHASE CIRCUITS.

SIR,—Mr. T. S. Messent seems to admit that balanced load on a three-phase circuit cannot be obtained by means of standard single-wound rotaries when single-phase power only is used, while his answer in your issue of Dec. 13 must give the impression that machines similar to the three-phase direct-current rotaries might be used.

He cannot, however, see that double-wound machines are as unsuitable for the purpose. I will in this connection only refer to my letter of 17th inst., with the further explanation that under the internal voltage drop I do not mean the ohmic drop only, but the total impedance drop. In this respect there is no fundamental difference between single and double wound armatures.

From the distinction Mr. Messent makes between machines with heavy and light field it would follow that for a given machine the currents would be balanced at low loads, while at heavy loads they would be unbalanced—an effect which, of course, does not take place.

If Mr. T. S. Messent still is of the opinion that he can build a single-armature rotary or combine it with other apparatus in such a way that he commercially can take single-phase current from a three-phase supply and obtain balanced load, I can only advise him to build a test apparatus. The demand for three-phase to single-phase conversion is large enough to make it a commercial success as soon as he can make it a technical one.

As further going into this question before new tests are forthcoming would mean a too lengthy and too theoretical discussion to interest your readers, I close herewith my contribution to this correspondence.—Yours, etc.,

K. FAYE-HANSEN.

EXTENSION OF WORKS.

SIR,—As an item of possible interest, we beg to inform you that our Italian house — the Tecnomasio Italiano Brown-Boveri —has lately amalgamated with Messrs. Gadda and Co., who were formerly their most important Italian competitors. In the future, Messrs. Gadda will not themselves manufacture electrical machinery, but will confine themselves to contracting for electrical plants and managing the same. Moreover, Messrs. Gadda have bound themselves to buy from the Tecnomasio Italiano Brown-Boveri all the electrical material they — or their sub-contractors—may require.

The Tecnomasio Italiano Brown-Boveri will take over Messrs. Gadda's works at the Via Castiglia, Milan, which employ about 1,000 workmen, and are equipped with the most modern tools and machinery. The old works of the Tecnomasio Italiano Brown-Boveri in the Via Pace will be shut down and handed to Messrs. Gadda for sale. The erection of the new works of the Tecnomasio at the Porta Romana, which were started some time ago, will now be held back till required. After completion of these new works, which will allow of a considerably increased output, the Tecnomasio intend to abandon the Via Castiglia works and to remove entirely to the Porta Romana.

The capital of the Tecnomasio Italiano Brown-Boveri will be increased shortly to 6,000,000 lire (£240,000). Our Baden house intends to subscribe such a proportion of this increase as will enable the A.-G. Brown, Boveri, et Cie. to hold half the whole capital. Both the technical and commercial management of the Tecnomasio Italiano Brown-Boveri will remain in their hands. Yours, etc.,

BROWN, BOVERI, AND CO., LIMITED.

London, S.W., Jan. 29, 1908.

FORTHCOMING EVENTS.

FRIDAY, JAN. 31.

Royal Institution of Great Britain.—At 9 p.m., at Albemarle-street, Piccadilly, W., "Recent Researches in Radioactivity," by Prof. Ernest Rutherford.

SATURDAY, FEB. 1.

Institution of Electrical Engineers (Glasgow Local Section).—At 7.30 p.m., at the Grosvenor, Gordon-street, Glasgow, annual smoking concert.

Institution of Electrical Engineers.—At 10.30 a.m., students' visit to National Physical Laboratory.

MONDAY, FEB. 3.

Institution of Electrical Engineers (Newcastle Local Section).—At 8 p.m., at the Armstrong College, "Experimental Determination of the Losses in Pole Shoes due to Armature Teeth," by Messrs. T. F. Wall and S. P. Smith.

Institute of Marine Engineers.—At 8 p.m., at the London Institution, Finsbury-circus, E.C., "The Treatment of Copper for Steam-Pipes," by Mr. J. T. Milton.

TUESDAY, FEB. 4.

Institution of Electrical Engineers (Manchester Local Section). At 7.30 p.m., at the University Physical Laboratory, "Protective Devices for High-Tension Transmission Lines," by Mr. J. S. Peck.

Institution of Civil Engineers.—At 8 p.m., further discussion of papers on "Masonry Dams."

THURSDAY, FEB. 6.

Civil and Mechanical Engineers' Society.—At 8 p.m., at Caxton Hall, Westminster, "Some Devices for the Absorption of Shock on Wheeled Vehicles," by Mr. F. G. Woollard.

Institution of Electrical Engineers.—At 8 p.m., at the Institution of Civil Engineers, "Protective Devices for High-Tension Transmission Circuits," by Mr. J. S. Peck.

Institution of Electrical Engineers (Leeds Local Section).—At 8 p.m., smoking concert at the Hotel Metropole, Leeds.

FRIDAY, FEB. 7.

Institution of Civil Engineers (Students' Section).—At 8 p.m., "Electric Hardening and Annealing Furnaces," by Mr. P. T. Steinthal.

Junior Institution of Engineers.—At 8 p.m., at the Royal United Service Institution, Whitehall, "Aerial Navigation," by Mr. Herbert Chatley.

SATURDAY, FEB. 8.

Junior Institution of Engineers.—At 6.30 for 7 p.m., dinner at the Hotel Cecil.

Fire.—A destructive fire occurred at the works of Messrs. Cowans Limited last week. Arrangements were immediately made for the carrying out of contracts and orders in hand to avoid delay. Messrs. Cowans desire to express their thanks for the many offers of assistance they have received from other firms. The registered address of the company is at the present time 62, Lancaster-avenue, Fennell-street, Manchester, to whom all communications should be addressed.

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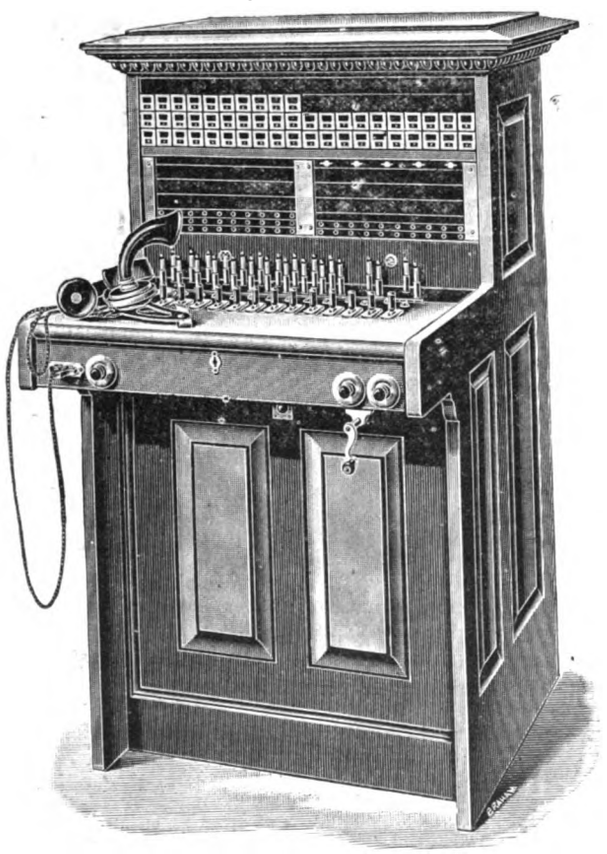
G.E. CO.'S NEW TELEPHONE CATALOGUE.

The tenth edition of the telephone catalogue just issued by the General Electric Company, Limited, embraces telephone apparatus for all purposes, and includes among other items domestic telephones for fitting on existing bell circuits, battery call wall and table telephones for offices, warehouses, hotels, etc.; intercommunication wall and table telephones, including

Central Battery Te ephone, Residence Type.

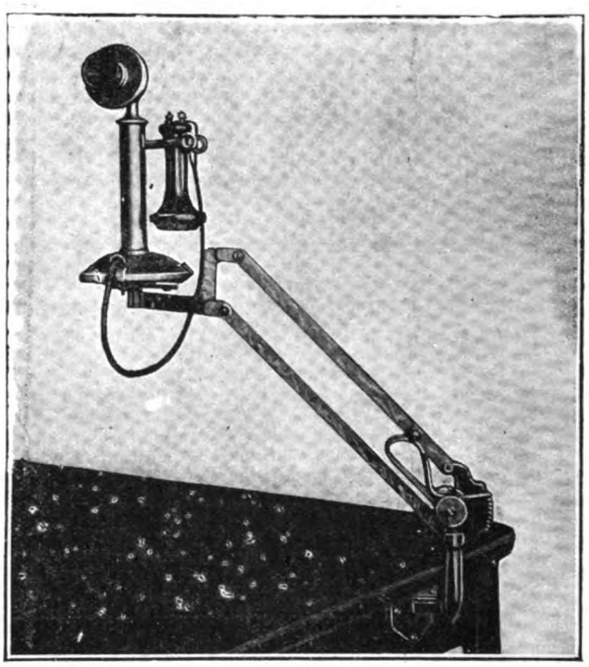
the "S.R." self-replacing telephone, an ideal telephone for offices, etc.; the "S.S." secret-service telephone, an intercommunication system which ensures absolute privacy of conversation between stations connected; the "Reply and Call" system, especially useful where it is undesirable for offices connected to speak to each other, except by prearrangement with the manager, who can control and overhear all conversation.



witchboard for Private Branch Exchange, Visual Line Single Type.

Magneto call telephone for short and long distances are listed in a variety of types and designs for various purposes; watertight telephones, battery and magneto call for mining, ships, and engine-house use; rifle range telephones and specialities; military telephones, traction telephones, and switchboards for battery and magneto call are also fully described and illustrated. A complete line of central-battery wall and table telephones is also included, and special attention should be paid to the all-steel cases and enamelled wall telephone, which certainly seems an ideal set for fitting in hotels, offices, and private residences. The type of instrument of this class which we illustrate is fitted with a "solid back" central-battery transmitter, mounted on an adjustable knuckle joint, polarised call bell wound to 1,000 ohms resistance, and fitted with 2½in. nickel-plated gongs, automatic switch hook with pure platinum contacts, induction coil, two-microfarad condenser, enclosed terminals mounted on ebonite, bell receiver in unbreakable ebonite case with concealed terminals, and flexible silk-covered connecting cord. All metal parts interchangeable, and all external brasswork polished and nickel-plated.

Central-battery switchboard construction also claims this company's attention, and in the designing of the switchboards (a type of which we illustrate) the important features of efficiency and pleasing appearance have evidently had the serious consideration of the company's engineers. We understand that the company is now prepared to manufacture and install complete equipments for central-battery exchanges of any capacity in any part of the world. The "Phone-Eze telephone bracket is another of the specialities for which this company is finding a ready sale, and, used with central-battery desk telephones, is an extremely convenient device for keeping



"Phone-Eze" Telephone Bracket

the desk clear of the telephone whilst retaining it within reach for immediate use.

The catalogue also includes a complete list of fire-alarm apparatus, amongst which we notice a very useful thermo-static heat detector, the invention of Lieut.-Colonel Fox, of the London Salvage Corps, which can be fitted up in conjunction with existing electric bell circuits. Water-level indicators, electric self-winding and regulator clocks, and watchmen's tell-tales are also to be found in this interesting catalogue.

A comprehensive alphabetical index and telegraphic code are to be found at the end of the list. We understand also that loose sheets of the pages in the catalogue are also stocked, so that an illustrated description can always be forwarded to a customer without mutilating the catalogue. These catalogues are issued post free to the trade only on receipt of trade card.

TRADE NOTES AND NOVELTIES.

High-Tension Switchgear.

Messrs. A. Reyrolle and Co., Limited, of Hebburn, have during the past years been engaged upon designs for high-tension switchgear of the "Merz-Price" protective system. Little has hitherto been known about this class of apparatus, the reason, no doubt, being that the manufacturers have had to strain their resources to satisfy the demands of the supply companies in Northumberland and Durham. We learn from Messrs. Reyrolle, however, that they have recently made further facilities in their works for the production of this apparatus outside the area mentioned, and as we think the objects obtained by the designs may be of general interest, we make no apology for presenting our readers with a few brief notes concerning them, which we are able to do through the courtesy of Messrs. Reyrolle. The designs

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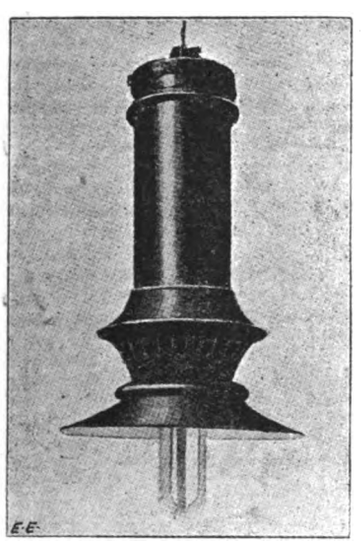
include a complete system of high and low tension switchgear up to 10,000 volts, and the protective gear embodies the "Merz-Price" system. When applied to feeder protection, any faulty section upon a power transmission scheme will be automatically isolated without interference with sound sections upon the same system. The protection covers any system of high-tension network, including ring mains, loops, tees, multiple feeders in parallel, etc. The "Merz-Price" system also includes devices by which any faulty transformer will be automatically isolated from a bank of transformers without interference with any other transformer. By reason of the complete enclosure of all dangerous parts, the mechanical construction of the gear is such that accidental contact with live conductors becomes an impossibility. A very special study has been given to the most efficient method of insulation, and the parts are so substantial and of such a nature that there is no fear of deterioration. In view of the complete enclosure and the careful study of the details in design, apparatus is produced which minimises insurance risks and reduces maintenance costs. Also the apparatus is suitable to withstand rough usage, and can be even exposed in damp places. The extra high-tension gear is so constructed that a hose pipe may be played upon it whilst alive without fear of the water reaching the high-tension insulation. We need only state that up-to-date sub-stations have been equipped with about 200-1,000 kw. panels.

Arc Lamps.

The British Arc Lamps, Limited, 9½, Union-court, Old Broad-street, London, E.C, have now placed upon the market a new long-burning arc lamp, which is made at their works in Phipp-street, Great Eastern-street. The lamps of this type are of ordinary construction, of the well-known central-tube type,



Arc Lamp for Indoor Use (British Arc Lamps, Limited).

and they burn up to 400 hours with one set of carbons, although tests have shown that 450 hours can be obtained. It is claimed that in these lamps not only is there a saving in cost of carbons, but 30 per cent. more light per watt is given. The light is powerful, white, and absolutely steady from the start. The long arc produces a perfect distribution of the light vertically and horizontally. From figures supplied by the manufacturers, we find that the cost of maintenance of a four-ampere lamp running on 110 volts at 1½ per unit is, including carbons and attendance, only £2. 16s. per 1,000 hours, and that of a five-ampere standard lamp on 110 volts £3. 9s. 9d. On the other hand, high-pressure gas lamps cost £4. 6s. per 1,000 hours. Our illustration shows the type of lamp specially designed for indoor use.

Heating and Cooking Devices.

The Phœnix Electric Heating Company, Limited, 17, Morwell-street, Tottenham Court-road, London, W.C., have sent us an illustrated catalogue and price-list of electric cooking and heating devices, and we can only say that the articles depicted and the prices which are asked for them afford ample evidence of the marked advance which has of late been made in the improvement of this class of apparatus. The Phœnix electric log-fire and the Phœnix electric coal-fire radiators, are extremely good imitations of wood and coal fires in existence. They are fitted with two sets of terminals, and are so arranged that the user may switch on either light or heat, or both at will. Radiators are also available in Doulton ware, as well as in the ordinary metals. Cooking ovens, coffee roasters, toasters, pads, hot-plates, etc., are also included in the list.

Incandescent Lamp Tests.

The Westminster Electrical Testing Laboratory, of York-mansion, York-street, Westminster, inform us that they have just completed a series of tests on most of the principal makes of incandescent lamp, including Ediswan, Stearn, Cryselco, Sunbeam, Robertson, Edison, Gabriel, Pope, Lowden, Premier, Brush, and A.E.G. Six lamps were tested of each make. Of these, three were purchased in November and a second three were purchased three weeks later, the object being to avoid obtaining all six lamps out of one day's make. The lamps were all purchased over the counter by agents of the laboratory, the sellers having no opportunity to supply picked lamps. The lamps were ordered to be 200 volts, 16 c.p., and of ordinary efficiency. The lamps were run on life test for a period of 500 hours at a pressure of 200 volts, maintained constant to within ½ per cent. by means of an automatic regulator. The lamps were tested for mean spherical candle-power (the only really fair comparison), watts, and watts per candle-power at start, and after 100, 200, 300, 400, and 500 hours' run. The results of the test have been printed in full and bound up in one leather-covered volume. Besides giving all individual results the average is given of all six lamps of each make at each period, and the average of all six lamps of each make throughout their 500 hours' run. The latter figures are the best guide as to the respective merits of the different lamps.

Catalogues and Lists.

The Electrical Company, Limited, Charing Cross-road, London, W.C., have issued a list dealing with a new house-service type of watt-hour meter.

We have received from the Electric and Ordnance Accessories Company, Limited, Stellite Works, Cheston-road, Aston, Birmingham, a batch of leaflets dealing with "Eclipse" electric heaters, "Stellite" dynamos and motors, and "Victor" flame arc lamps.

Messrs. H W. Sambidge and Son, Limited, Highgate-street, Birmingham, have sent us a copy of their new electrical fittings supplement. In this list special attention is devoted to the current styles of Adam, Sheraton, Georgian, etc., fittings, and good examples of these are being put on the market at attractive prices.

The Imperial Improvements Company, 2, Jewry-street, London, E.C., send us a list of users of their patent "water seal" steam-traps, which includes a number of electricity stations in London and the provinces, as well as other large works. This apparatus is based on the properties of expansion and contraction of metals when subjected to different temperatures, and a very effective opening of the water-discharge valve is obtained by the use of multiplying levers.

Messrs. Ed. G. Herbert, Limited, new specialities includes a file-testing machine which automatically tests files of any size up to 18in. and draws a diagram indicating exactly the work done (cubic inches filed away), sharpness, as indicated by the rate of cutting, and durability, in number of strokes taken before the file ceases to cut. Thus makers can at once judge the effect of any alteration in manufacturing processes, while users are enabled to place their orders on the basis of quality and check the files supplied.

Messrs. Ward and Goldstone, Springfield-lane, Salford, Manchester, are issuing a small pamphlet referring to the Sampson auto-transformers, which, in view of metal-filament lamps, are meeting with a large sale. These transformers enable the lamps to be connected direct. On private house-lighting particularly these transformers will be found of great value, as they enable the use of 25-volt Osram lamps, which give about the same light as the ordinary 16-c.p. lamps, and are about equal in size and appearance, and can be burnt in any position.

WEST HAM ELECTRICITY UNDERTAKING.

Future Requirements.

We are pleased to see that the West Ham load continues to increase, and that this increase is giving rise to a demand for more machinery at the Corporation electricity works. West Ham has just exhausted a loan of £57,588, which was sanctioned by the Local Government Board in 1906, in providing new generating plant, carrying out works in connection with the Silvertown extension, and in meeting the requirements of ordinary distribution. It is now intended to apply for a further loan of £64,880 to meet the requirements during the next two years. In a report presented this week to the Electric Lighting and Tramways Committee, Mr. A. Hugh Seabrook, the borough electrical engineer, has submitted estimates of capital requirements until March 31, 1910, and as these are of considerable interest to a large proportion of our readers we give below particulars showing the purposes for which the proposed loan will be used:

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Generation.

Boiler-house plant.	£
Five chain-grate stokers, complete, and including driving gear, completing all existing boilers	1,750
Feed-water purifier: capacity, 8,000 gallons per hour	550
Feed-water settling tank: capacity, 38,500 gallons	500
Feed-water pipework	450
Boiler-house sundries: testing apparatus, etc.	300
Railway siding	1,000
Ash conveyor: 40 tons per hour	1,200
Grab	175
	5,925
Switchgear, etc., No. 11 turbo, etc.	
Exciter switchboard	150
Cellular switchgear, to complete gear on present level	600
Cellular switchgear on high level, No. 12 turbo, etc.	
Platforms and stairway	475
Switch cells and operating gear	1,550
Pressure regulators and instruments	300
Testing cables (water load)	400
Step-up transformers.	
Two transformers (500 kw.)	600
Cellular control and isolators	200
	4,075
Turbine-generators.	
One 1,500-kw. turbo-generator, No. 11	7,900
Pipework	400
Foundations	200
Cables	250
Sundries	200
One 3,000-kw. turbo-generator, No. 12	10,000
Pipework	600
Foundations	450
Cables	480
Sundries	300
	20,780
Circulating-water equipment.	
Spray coolers, capable of cooling 750,000 gallons per hour	3,000
Increasing capacity of circulating-water supply from the river	1,600
Circulating-water sundries	100
	4,700
Station lighting and power.	
Transformer chamber	400
Tools and tackle (not workshop tools)	200
Workshop tools	500
Office sundries	50
Total generation	£36,630

Distribution.

(Based on expenditure against last estimate and allowance for reduced price of copper.)

No. 3. ·2 extra high-tension triple-concentric feeder to Silvertown, pulling in and jointing	4,000
(Including conduits and groundwork for ditto.)	
Switch and transformer chamber for above, including all gear	500
High-tension cable	3,000
Extra high-tension cable	4,000
Low-tension cable	1,500
Conduits and groundwork	5,000
Transformer chambers, switchgear, etc.	8,000
Meters	2,000
Testing apparatus	250
Total distribution	£28,250
Generation	36,630
Distribution	28,250
Total	64,880
Excess on previous application	7,045
Total applied for	£71,925

APPOINTMENTS VACANT.

Car Fitter, Swindon Electricity Works. Apply to the Engineer. See advertisement.

Assistant Manager, Harland and Wolff, Limited, Belfast, electrical department. See advertisement.

Engineer and Manager, Neath Rural District Council electric lighting station. Commencing salary, £200 per annum. Applications to the Chairman of the Council by Feb. 1.

Working Engineer Foreman, Netherne Lunatic Asylum, Merstham, Surrey, to take charge of the steam boilers and plant in the above asylum, including the water supply, heating, electric lighting, and laundry machinery. Applications to M. E. Reed, Esq., County Hall, Kingston-upon-Thames, by Feb. 1.

LEGAL INTELLIGENCE.

APPEAL BY POOLE DISTRICT ELECTRIC TRACTION CO.

The Master of the Rolls and Lords Justices Fletcher Moulton and Buckley on Thursday heard the appeal of the defendants in the action brought by the Corporations of Bournemouth and Poole against the Poole District Electric Traction Co. from the judgment of Mr. Justice Joyce. Mr. Danckwerts, K.C., and Mr. Tomlin appeared for the company, and Mr. Hughes, K.C., and Mr. George Lawrence for the Corporations.

Mr. DANCKWERTS said the question arose as to whether Mr. Justice Joyce had rightly decided that the company were to pay to the Corporation three sums—a deposit of £1.875 which had to be paid under the Light Railways Act, and which was returnable when the line was opened for traffic, a sum of £544. 9s. 4d. due from sundry debtors to the company, and a sum of £1,410 cash in hand and at bankers. The company was formed to construct a light railway between Bournemouth and Poole in 1899, and it subsequently acquired an extension order and powers to construct another tramway to Christchurch. They also had running powers over the Bournemouth Corporation tramways. The Bournemouth Corporation also had sundry tramway undertakings, and they had powers to construct another line in respect of which they had to commence within a year of the date of the order. The company alleged that they had not done so, and an action was brought to restrain them from carrying the order out. The Chancery Judge found in favour of the Corporation, but his decision was reversed on appeal. The Corporation intended to appeal to the House of Lords, but the litigation was compromised by an agreement for the sale of the company's enterprises in Bournemouth to the Corporation, and it was in respect of this agreement that the present dispute arose. The Corporation were to pay £5 500 in cash, and a sum, which was fixed by arbitration at £100,000, as being the fair market value of the undertaking as a going concern. Mr. Justice Joyce had decided that the Corporation were, in addition, entitled to the three sums he had mentioned, but the appellants contended that they did not form part of the undertaking as defined in the agreement.

Mr. HUGHES, K.C., supported Mr. Justice Joyce's judgment, and contended that the three sums were all included in the valuation of £100,000, which the Corporation had paid.

There was also a cross-appeal by the Bournemouth Corporation in respect to two sums of £6,476 odd out of a bank loan of £7,000, and £2,570 for "sundry creditors," which the judge below had allowed to the company.

The MASTER OF THE ROLLS, in giving judgment, said the deposit had been returned to the depositors before the date appointed for the transfer of the undertaking, and he found nothing which gave the Corporation any claim to it. He found, if possible, still less ground for the second item for sums due from sundry debtors to the company, because it was really an accountant's mode of apportioning sums which had been paid over a period partly extending beyond the appointed day. Every word he had said with regard to the deposit applied with equal force to the third item of cash in hand and balance at the bank. It was only part of the company's undertaking that was purchased, and there was no ground for the suggestion that any part of the cash in hand was acquired by the Corporation. As to the second appeal, the Corporation had undertaken to indemnify the company in regard to liabilities or engagements outstanding on the appointed day, and he saw no ground whatever for limiting it as the Corporation proposed.

The other Lords Justices agreed and the company's appeal was, therefore, allowed and the Corporation's appeal dismissed in both cases, with costs.

TADDEI AND ANOTHER v. PENDER AND OTHERS.

Water Power Rights.

This case, which occupied the attention of Mr. Justice Grantham and a special jury in King's Bench Division for several days, and the opening of which was reported in the *Electrical Engineer* of last week, came to a satisfactory termination on Monday last. It was an action brought by Signor Girolamo Taddei, of Turin, and Signor Paolo Bellani, of Milan, civil engineers, against Sir J. D. Pender, Lord John Hay, G.C.B., and Mr. Richard Enfield, as executors of the late Sir John Pender, G.C.M.G., for damages for breach of contract and for payment for work done for and services rendered to the defendants. The defendants denied the breach, and counterclaimed against the plaintiff Taddei the sum of £12,265 alleged to be due on a judgment obtained against him.

Shortly after the resumption of the case on the fourth day it was announced that terms had been agreed upon between the parties, and it had been arranged that a juror should be withdrawn. The terms of settlement were not disclosed.

EXHIBITING ELECTRIC APPARATUS.

In the City of London Court on Monday, before Judge Rentoul, K.C., an action was brought by Messrs. Isenthal and Co., electrical engineers, 85, Mortimer-street, W., to recover the sum of £35 for certain electrical apparatus supplied to the defendants, Mr. F. E. Brown, 83, Station-street, Birmingham, and Mr. W. C. Geary, 71, Queen Victoria-street, and Mr. L. J. Aarons, Villa-road, Handsworth, Staffs, which was exhibited by them at an electrical exhibition in Birmingham last year. Plaintiff said that Mr. Brown wrote to him and said that he and some friends were forming a syndicate to exhibit some electrical goods at the Birmingham exhibition last year. Aarons and Geary said they were employed by the General Electric Co., Queen

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Victoria-street, but that as their company was also exhibiting at Birmingham they did not want their own names to appear more than necessary. The three defendants ordered certain electrical apparatus and it was exhibited. Mr. Brown in his evidence said he was only the secretary of the syndicate at a salary of £2 a week. As a fact the syndicate was never actually formed, but he never pledged his own liability to the plaintiffs. It was true he asked the plaintiffs for a commission, but that was only to be sure that the others were getting absolutely bedrock prices.

JUDGE RENTOUL said that all the defendants were liable to the plaintiffs. He had some doubt at first about Mr. Brown's liability, but he had mixed himself up in the matter. Judgment for the plaintiffs for the amount claimed, with costs.

TAMPERING WITH MAINS.

At Pontypool Police Court last week an electrician was summoned for laying or causing to be laid an electric wire to communicate with a main, the property of the Pontypool Electric Light Co., without their consent, at Pontypool on Dec. 23; further, for improperly using or burning electricity supplied to him by the company on the same date, and also preventing the meter from properly registering the amount of electricity consumed.

Mr. W. J. MAYBERRY, the company's engineer, said he visited defendant's premises, and found that a connection had been made from the company's main fuse to a wire beyond the meter, thus diverting the course of the electricity supplied, so that the meter did not register properly. Witness asked the defendant for an explanation, and he replied that he had been testing with an ammeter, but when that was produced he found it was useless for the purpose of testing the wires. Witness had the supply cut off.

DEFENDANT said he had received a complaint about a showcase which was near the entrance to his premises, and he gave instructions to his workmen to go down into the basement and find out what was the trouble. The connection was not made by his instructions, and the first he knew of it was when Mr. Mayberry drew his attention to it. He admitted that he used the company's electricity in order to test the showcase.

The Bench dismissed the first summons, but imposed fines of 20s. and 10s. in the second and third respectively.

HALIFAX TRAMCAR COLLISION.

The Halifax Corporation were sued at the County Court the other day for £56 damages resulting from a collision between an electric tramcar and a cart. The plaintiffs' case was that on Sept. 4 their light cart was being driven down Dungeon-street, a side street which crosses Gibbet-street, and an approaching tramcar, coming from Highroad Well and crossing the bottom of Gibbet-street, collided with the vehicle, with the result that one of the horses was knocked down and injured For the defence it was urged that there was no negligence by the tramcar driver; if there was any negligence at all, it was by the driver of the cart. After hearing evidence, his Honour said that he was not satisfied that the driver of the plaintiffs' cart kept a sufficiently sharp lookout at that particular point where the collision occurred. Evidently the tramcar driver rang his bell, and the other driver ought to have seen that the tramcar was approaching. He gave a verdict for the defendant Corporation, with costs.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ALUMINIUM.

An extraordinary general meeting of the shareholders of the British Aluminium Co. was held on the 23rd inst.. Mr. J. D. Bonner presiding. The meeting was held for the purpose of considering a resolution having for its object the division of the £10 conversion share, created in 1906, into two shares of £5 each, one of which should be a 7 per cent. preference and the other an ordinary share.

In moving the adoption of the resolution, the CHAIRMAN said they were all aware of the demoralisation of the metal markets of the world last summer consequent upon the slump in copper, and also of the subsequent serious fall in metal prices generally, which brought to an abrupt termination their little "boomlet" in aluminium. Nevertheless, their profits for 1907 would not, it was estimated, fall very materially below the £155,000 which they made in the previous year. They brought forward over £34,000 from 1906, so that they would have a large disposable balance. It was their intention to deal with it upon the same conservative lines that they had proceeded upon in recent years, and after making large appropriations to depreciation, etc., paying the usual 7 per cent. upon the ordinary shares, and to carry forward to the current year a sum somewhere in the neighbourhood of £50,000. They expected this year, now that they had started construction at their temporary Leven works and at their Norwegian works, to produce about twice as much aluminium as they produced last year. Although the price was at present only about £100 per ton, if they should succeed in disposing of the whole of the increased production, which he was hopeful of doing, there should not be any material shrinkage in their profits, especially as some increase could be confidently counted upon from their investments. At all events, they had a larger tonnage of aluminium sold for forward delivery than ever before. This was not merely an aluminium company or a manufacturing company, but a great power company, which in almost the immediate future, when all their great power schemes were completely developed, would have at its command somewhere about 60,000 h.p. per annum. They had had the advantages of their Foyers power for some years. Their Norwegian power was not so important, but it was a very cheap one. Their Leven power, which was their largest, would be, on account of its uniformity and location, one of the finest powers in the whole world. They had dredged Loch Leven and were building what was virtually a small harbour at the head of the loch, so that steamers of large tonnage would be able to approach at all times to within a few hundred yards of the works. Cheap freights were thus assured for all materials required there and for any material produced. They were also proceeding with the building of a village, which would ultimately have a population of some 6,000 to 8,000 people, so as to have accommodation available for the labour which was necessary for the utilisation of the power. They had a very valuable asset at Leven, and they were eagerly looking forward to the time when the large sum which they had expended upon it would become productive. The scheme was costing materially more than was originally estimated, and it was taking longer also to develop. Approximately, when their works were finished, their debenture debt and capital would stand at just over two millions sterling, the greater part of which had yet to become profit-earning.

Mr. E. E. SAWYER seconded the resolution, which was unanimously approved.

EAST LONDON RAILWAY.

The half-yearly meeting of the East London Railway Co. was held on Monday, Lord Claud Hamilton presiding. Although this railway is not an electrical, the proceedings at the half-yearly meeting were of sufficient interest to our readers to warrant reference in these columns.

In moving the adoption of the report, the CHAIRMAN said that he met the proprietors again under circumstances of great depression, and without being able to hold out to them any improved prospects of the immediate future. He could quite understand the proprietors becoming somewhat impatient at hearing their chairman half-year after half-year, first of all warning them of the impending danger to them of the electrification of the District and Metropolitan Railways, and latterly bewailing the realisation of the fact without being in a position to offer them any definite crumb of comfort, but he could assure them that though the directors had constantly had this matter before them, it really surpassed the wit of man under existing conditions to find an effective remedy. They were absolutely unable as a company to find the money necessary for the electrification of their line without the help of the lessee companies in some form or another, and as at present advised the lessee companies would not move. The District and the Metropolitan Companies, and especially the latter, would, he had some reason to think, gladly see a resumption of the through services, but their own experience of electrification up to the present had not been of such a character as to tempt them, or even to justify them, in coming to their assistance. He thought they must take it for granted that their experience of electrification, from a shareholder's point of view, had proved a disappointment, though it had conduced both to the advantage and to the comfort of the travelling public; but with the continued advance in electrical knowledge and science and the concentration of the energies of men of practical experience upon the problem of cheapening the production of the motive power of electricity, he did not despair of the enterprise of those two railways being ultimately rewarded. One thing was certain, they could not go back to steam; they must continue in the course they had laid down for themselves; and that being so, he trusted they might be induced to join in some scheme which would result in the resumption of the through traffic over an electrified East London Railway. He stated that if any scheme could be devised by which certain companies would contribute towards the electrification of their line, he would use all the influence he possessed on the Board of the Great Eastern Railway Co. to make them a party to it.

DIRECT UNITED STATES CABLE.

The ordinary general meeting of the shareholders of the Direct United States Cable Co. was held on Tuesday, Mr. E. M. Underdown, K.C., chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said that the revenue for the six months ended Dec. 31, 1907, after deducting out-payments, amounted to £58,268. The deduction of £25 103 for expenses, including income tax, but exclusive of cable repairs, left a net profit of £33,165, to which had to be added £2,516 brought forward, making a total of £35,681. This had been appropriated as follows: an interim dividend of 4s. per share to Sept. 30 absorbed £12,142; a further interim dividend of 4s. per share to Dec. 31 took a further equal sum; £5,000 was set aside to reserve fund; and £6,397 remained to be carried forward to the current half-year. Compared with the corresponding period of the previous year the revenue showed a reduction of £2,111, which occurred chiefly during the months of August and September. That small decrease could be explained by the complications which had occurred in America. He thought, however, that they might now look forward to a period of steadier prosperity. With regard to the working expenditure, there was a considerable decrease in the cost of maintaining buildings in consequence of special expenditure already incurred. As to maintenance of the cables, there was the inevitable outlay representing compensation paid to fishing vessels on account of damage. The Company had short cables in comparatively shallow water between the end of the main cable and the American station. Fishing vessels were now accustomed to make use of heavier anchors and longer cables, which sometimes inevitably fell foul of the Company's telegraph cables. When that occurred, rather than take the risk of having the latter pulled up and damaged in the effort to recover fouled ground tackle, the Company found it prudent, after proper examination, to pay compensation for

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lost tackle of this kind. It was the most economical thing to do, for any repair, even in shallow water, was an expensive matter. The reserve fund had been debited with £5,097 for maintenance of cables. The investments had declined in value to some extent, but on the whole, thanks to the care with which the securities had been selected, they had suffered very little. It would be remembered that at the previous meeting it was resolved to create a special reserve of £10 000 in order to meet any deficiency which might arise, and since then very little change had taken place in respect of the value of the investments.

Sir JAMES PENDER, Bart., seconded the motion, which was adopted.

GREAT NORTHERN AND CITY RAILWAY.

The report of the Great Northern and City Railway Co. for the half-year ended Dec. 31 last, to be submitted at the meeting on the 6th proximo, states that the total revenue receipts for the six months amounted to £47,582, and the cost of working to £24,778, being at the rate of 52 07 per cent. Inclusive of the balance brought forward from June 30 last, and after providing for interest on debenture stock and other charges, and setting aside £500 to renewal fund, there remains a balance of £379, which the directors recommend be carried forward. The number of passengers for the six months, including season-ticket holders, was 7,543,174, as against 7,901,923 for the corresponding period last year. The number of local season tickets issued during the half year was 3,703, as against 3,013 for the half-year ended Dec. 31, 1906. The number of three-route season-ticket holders using the Company's line during the past half-year was 2,565. The directors, after consideration, and in conjunction with the Great Northern Railway, decided upon a revision of fares which involved certain increases. This new arrangement came into operation on Nov. 1, 1907. The effect has been to a large extent to check the decline in revenue arising from the severe competition which the Company has had to contend with during the past half-year.

DUBLIN UNITED TRAMWAYS.

The report of the Dublin United Tramways Co. (1896) for the half-year ended Dec. 31 last, to be submitted at the meeting at Dublin on the 4th prox., states that the amount available for division is £64,840, out of which it is recommended that dividends be paid for the half-year at the rate of 6 per cent. per annum, free of income tax, on the ordinary shares, together with a bonus of 1s. per share, also free of income tax, on the ordinary shares. It is proposed to set aside £5,000 to reserve and renewals fund, £1,000 to accident insurance fund, £10,000 towards reconstruction and maintenance, and £2,000 as further provision against the guarantee to the Irish International Exhibition, 1907, in addition to the £6,250 already paid in respect of this guarantee and charged to revenue in these accounts. The dividends recommended and the sums added to reserve, etc., will absorb £56,100, leaving £8,740 to be carried to next account.

BRITISH ELECTRIC TRACTION.

In a circular the directors state that they have had under consideration the question of the payment of the half yearly dividend on the 6 per cent. cumulative preference shares on Feb. 15 next, and the majority are of opinion that this dividend should be paid, but the two directors who joined the Board last year are of opinion, having regard particularly to the present depreciation of some of the Company's investments, that the available profits should not now be distributed. In these circumstances the directors, in order to avoid disunion of the Board, which would be prejudicial to the interests of the Company, have agreed to the settlement of this question being postponed until the general meeting, which will be held as soon as the accounts for the year ending March 31 next can be presented. The directors have had an estimate prepared of the profits for the year. It shows: dividends and interest on shares, debentures, and consols, £153,000; interest on loans, etc., £7 200; net profit on working sundry undertakings, £5 500; sundry profits on contracts, etc., £14 000; net profit on sale of investments, £20,000; balance of Bombay profits, £41,900 — total, £241,600. From this must be deducted general and sundry expenses, £24 000; sundry losses and provisions, £12,000. There then remains £205 600. The interest for the year on the first and second debenture stocks amounts to £97,484, and the interim dividend paid on the preference shares from April 1 to Aug. 15 last amounts to £36,754, leaving £71,362, to which is added the balance brought forward of £13,115, giving a sum of £84,477 available for further dividends, and the Company has cash in hand to approximately this amount. The half-year's dividend on the preference shares to Feb. 15 requires £48,431. The whole of the profits of the year will be realised in cash, with the exception of the Bombay profits, and with regard to these it may be stated that the ordinary shares of the Bombay Co. are marketable at or above par.

MARCONI'S WIRELESS TELEGRAPH.

The following announcement, dated 25th inst., has been issued by Marconi's Wireless Telegraph Co.: "The postponement of the general meeting beyond the date originally proposed for it, of which the shareholders were duly advised by the circular of June 29 last, has rendered desirable a new audit of the accounts, and the auditors, Messrs. Cooper Bros., are now engaged upon it. The accounts will be made up to Sept. 30, 1907, and the directors propose to hold the general meeting so soon as the accounts are prepared. Due notice will, of course, be given to the shareholders, but it is anticipated that the auditors will have finished their work not later than the second week in February, which will enable the directors to call the shareholders together early in March. Mr. Marconi returned to England on 12th inst., and both from his reports and from the practical tests to which the stations have been subjected in transmitting many thousands of words for Press purposes, the directors are of opinion that the problem of designing stations for establishing wireless telegraphic communication across the Atlantic on a commercial basis has been solved. While continuing the Press service, which has now been carried on successfully for three months, it is proposed to open the stations at the beginning of February for ordinary commercial messages."

NEW COMPANIES REGISTERED.

Electric Fittings Co.—Registered Jan. 18. Capital, £15,000 in £1 shares (3,000 6 per cent. cumulative preference). Objects: to acquire business carried on by Samuel Heath and Sons at 38, Conduit-street, W., as Electrical Fittings Co. No initial public issue. Registered office: 38, Conduit-street, W.

British Electrics (Moseley's Patents), Limited—Registered Dec. 21. Capital, £10,000 in £1 shares. Objects: to acquire and turn to account inventions relating to the manufacture of electric, magnetic, telegraphic, telephonic, and other appliances and certain patent rights and other property referred to in an agreement dated Nov. 19, 1907, between W. Moseley and F. de H. Larpent, and with a view thereto to adopt an agreement with the said F. de H. Larpent. No initial public issue.

Bahia Rubber and Fibre Plantations, Limited.—Registered Jan. 21 by Grundy Kershaw, Samson, and Co., 89, Gresham-street, E.C. Capital, £150.000 in £1 shares. Objects: to acquire certain landed property known as Schindler's Estate, in the State of Bahia, Brazil, and other assets; to adopt an agreement with the Bahia Estates Syndicate (promoters) and to carry on the business of cultivators and manufacturers of and dealers in rubber, guttapercha, gums, cocoanuts, etc. The above-mentioned syndicate is to sell the property to the company for £90,000 (£20,000 cash, £50,000 shares, and balance in cash and/or shares at company's option). The syndicate is purchasing the said property from S. S. and F. M. S. Schindler for £50,000 (£10,000 cash and balance in shares), and will out of the £90,000 payable to them satisfy the said £50.000 and also pay £6.000 in cash and/or shares to the Bahia Rubber Owners' Association for services rendered in connection with the promotion. The company has also to pay to the said S. S. and F. M. S. Schindler the cost (not exceeding £5,000) of additional plantations made on the estate since July 1, 1907. The capital of the Bahia Estates Syndicate is £6,000 in £1 shares, of which Sir Ralph W. Anstruther holds 100, Baron de Sousa Deiro 400, and J. Harrison 100. No initial public issue.

Liens Registered.

Lancashire Dynamo and Motor Co., Limited, Manchester.—Lien Jan. 14 £1,800 5 per cent. first debentures, part of £75,000. Amount previously issued, £65 000. Trustees: E. F. Sheppard and A. Tongue. Secured on the entire assets.

Newcastle-upon-Tyne Electric Supply Co, Limited.—One-third mortgage debenture Jan. 14 for £300.000 and 5 per cent. interest to Lloyds Bank, Limited, Newcastle-on-Tyne. Third charge on the undertaking and all the property, assets, and effects, present and future, including the uncalled capital.

Delhi Electric Tramways and Lighting Co., Limited, London, E C.—Trust deed Jan. 17 for securing a series of £50,000 5 per cent. first mortgage debentures. Trustees: R C. Pearman and J. Greig. First specific charge on the lands, properties, rights, etc., together with a floating charge on the undertaking, business, goodwill, and assets, but excluding the uncalled capital.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Redditch.—An inquiry will be held on Feb. 5 into the application of the Council for power to borrow £500 for purposes of the electricity undertaking.

Abertillery.—The Local Government Board will hold an inquiry on Feb. 6 into the application of the Council for sanction to a loan for electric lighting.

Sweden.—The Government have introduced a Bill into the Riksdag providing for a loan of £278,000 for the development of the telephonic service in Sweden.

Farnworth.—The District Council are contemplating an extension of their electricity works owing to an increasing demand for current from local clients.

Nuneaton.—Not content with the exorbitant charge of 3s. 6d. per 1,000ft. for the supply of gas, a further increase of 5 per cent. has been decided upon.

Westminster Electric Supply Corporation.—The Corporation recommend a dividend at the rate of 10 per cent. per annum for the half-year ended Dec. 31.

Holyhead.—The Local Government Board will hold an inquiry on Feb. 4 into the Council's application for sanction to borrow £3,000 for electric lighting purposes.

Chequerbent.—The experiment of generating their own current has proved eminently successful at the Hulton Colliery Co.'s Chequerbent and Atherton coal pits.

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Paris.—The French Minister of War proposes to purchase a piece of land near the Eiffel Tower, with a view to rendering possible wireless communication between Paris and New York.

Worcester.—An inquiry is to be held by the Local Government Board on Feb. 4 into the Council's application for sanction to borrow £10,000 for purposes of the electricity undertaking.

Stanley.—So bad were the complaints respecting the quality of gas at the last meeting of the District Council that a recommendation from the Lighting Committee to obtain a pressure gauge was adopted.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the four weeks ended Dec. 27, 1907, were 290,548, compared with 257,128 units in the corresponding four weeks of 1906.

Bedale.—The Rural District Council have received an application from the Postmaster-General seeking permission to erect telegraph poles on the road from Five-lane Ends, near Masham, and the Council have granted the necessary permission.

Stirling.—The engineer's report to the Corporation Electricity Committee showed that for the four weeks ending Dec. 21 49,115 units of electricity had been generated at the power station, as compared with 47,331 for the same period in 1906.

South Shields.—The Local Government Board have held an inquiry into the Corporation's application for sanction to borrow £7,052 for the provision of extra plant at the electricity works, and to carry out the necessary alterations to the buildings.

Heysham.—The District Council have instructed their clerk to write the Morecambe Council with reference to the poor lighting quality of gas supplied for public lighting, and asking them to afford the district a proper supply of gas for which they pay.

Newbury.—The Assessment Committee of the Guardians have had before them the question of the rating of the electric light station, and, believing they ought to have expert advice, have proposed as valuers Messrs. Hedley, of Sunderland, at a fee of 20 guineas.

Wisbech.—At the Guardians' meeting the master of the workhouse complained of the very bad quality of gas supplied to the house. In some of the rooms it was scarcely possible to see at all. The Board have decided to enter a strong complaint respecting the gas supply.

St. James's and Pall Mall Electric Light Co.—The directors of the St. James's and Pall Mall Electric Light Co. recommend a dividend on the ordinary shares of 5s. per share, making with the interim dividend paid a total distribution of 10 per cent. for the year.

City of Buenos Ayres Tramways (1904).—The directors of this company recommend for the year ended Dec. 31, 1907, a balance dividend of 1s. 3d. per share, and that the sum of £3,600 be transferred to the general amortisation fund, leaving £144 to be carried forward.

Germany.—The Imperial Minister of Post and Telegraphs on Tuesday introduced in the Reichstag a Bill for the regulation of wireless telegraphy, to compel shipping companies and owners of wireless stations on land to arrange for intercommunication without regard to the system used.

Morecambe.—On the 3rd inst. the borough accountant reported the receipt of a cheque value £295. 12s. 8d. from the Midland Railway Co., the sum the company agreed to contribute towards the cost of diverting the electric cables from under Moss-lane level crossing to over the Euston-grove bridge.

Rio de Janeiro Flour Mills.—The Rio de Janeiro Flour Mills and Granaries, of Rio and 48, Moorgate-street, E.C., are contemplating the adoption of electricity instead of steam in their important mills. The proposals are not yet ripe, but manufacturers of electric plant should keep this concern in view.

Werle.—The gas company have endeavoured to persuade the Parish Council to pay an increased charge for the supply of gas for public lighting. The charge now is 2s. 5d. for public lighting, and this was considered to be quite sufficient by a large public meeting, which refused to allow the extra charge to be levied.

Fulham.—The Electricity Committee are recommending the Borough Council to authorise a capital expenditure of £4,000 for the erection of a sub-station and necessary transformers and cable connections thereto in the Talgarth-road district, and that the borough electrical engineer be instructed to proceed with the work as soon as possible.

Oldham.—The fortnightly report of the engineer to the Corporation showed that the units sold for lighting and power during that period was 75,048, for traction 154,840, a total of 229,888, against 203,802 in the corresponding period of last year. The total equivalent of 8-c.p. lamps connected to date was 107,485, an increase in the fortnight of 391.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 31 a special settling day in the Canadian General Electric Co.'s interim certificates, fully and partly (£16) paid, 2,000,000dol. 7 per cent. cumulative preference stock in shares of 100dol. each; and Feb. 12 in the Pusing Bharu Tin Mines' 30,000 vendors' shares of £1 each, fully paid, Nos. 1 to 30,000.

Electricity to Candles.—Dr. Ridgeway, Bishop-designate of Chichester, has been remarking that when he takes up his abode in the episcopal palace in the Sussex city he will miss the electric light, with which he has worked for 25 years. The Bishop says he does not like gas, and that at Chichester he will have to use candles—if he can find good ones in these degenerate days.

Toronto.—Mr. Steele, president of the Toronto Chamber of Commerce, has agreed to head a movement, which is widely supported, having for its object the Government ownership of the electric power plant at Niagara. Mr. Steele and his supporters believe that the falls would be safeguarded by such an arrangement, and a better management of the plant in the public interest would result also.

Fife.—On the 23rd inst. a middle-aged miner named Alexander Combe met with his death in a remarkable manner in the underground workings of the Francis Pit of Lord Rosslyn's Dysart Collieries, Fifeshire. Combe was fastening a piece of corrugated iron on the box covering the electric cable when the nail he was using pierced the cable, and he received a shock which instantly killed him.

Durham.—The Finance Committee of the Guardians have considered a letter from the County of Durham Electrical Power Distribution Co., enclosing estimate as to lighting the workhouse with electric light, and have agreed to print the estimate and to supply a copy to each Guardian, together with a statement showing the cost of gas consumed at the workhouse during the past year.

Bury.—At the meeting of the Corporation Electricity Committee a letter was read from the Bury Chamber of Commerce asking for details of the scheme for building a new generating station. It was decided to supply the details and to inform the chamber that the Corporation could not say when the Local Government Board inquiry would be held, as there had been no application made for borrowing powers yet.

Ravensthorpe.—At a meeting of the Electric Lighting Committee complaint was made of the indifferent supply of electrical energy to consumers, and Mr. Mountain was instructed to see the Yorkshire Power Co. and report. It was resolved to lay electric cables from the sub-station to Calder-road and Queen-street end. Mr. Sam Lee was appointed inspector, and Mr. Stead to keep the electricity accounts.

Eastbourne.—The Telephone Co. are seeking permission from the Rural District Council to erect poles on the district roads in connection with the proposed extension of the telephone to Pevensey (where there will be an exchange) and Stone Cross. The Council have appointed four local members and the surveyor to meet the representative of the Telephone Co. with a view to arranging terms of settlement.

Bridgend.—The Cottage Homes Committee have reported to the Guardians that they have considered the question of adopting electricity for lighting purposes at the cottage homes, and have recommended the Board to request the Bridgend Council to arrange a more favourable graduated scale than that submitted for the lighting of the workhouse, infirmary, and cottage homes collectively. To this the Guardians have agreed.

East Riding.—At the last meeting of the County Council the clerk submitted a communication from the Newcastle Chamber of Commerce stating that the Postmaster-General had consented to receive a deputation on Tuesday, Feb. 11, with reference to the telephone rates, and it was resolved that Lord Wenlock be requested to represent the East Riding County Council on the deputation to the Postmaster-General with reference to telephone rates.

Bedford.—The annual dinner of the Bedford Trade Protection Society, held on the 23rd inst., was attended by the mayor (Mr. S. L. Kilpin), the high sheriff (Mr. Geoffrey Howard), the headmasters of the principal schools, and the leading tradesmen. It was urged that every effort should be made to bring the attractions of Bedford before the public during the holiday months. The mayor stated that a scheme was in hand to illuminate the riverside gardens by electric light.

Gillingham.—Mr. A. D. Chalmers, the borough electrical engineer, has submitted to the Education Committee an approximate inclusive price for installing the electric light in the following schools: Barnsole-road, 109 lights, £98; Richmond-road infants', 61 lights, £55; Richmond-road boys' and girls', 100 lights, £100; Byron-road, 92 lights, £83. The committee have decided that, in the interests of the health of the children, gas lighting should be abandoned and electricity introduced.

Slide-Rule Memento.—Messrs. Marples, Leach, and Co., of 6, Victoria-avenue, London, E.C., advise us that they have been so overwhelmed with inquiries for the little 6in. slide-rule memento that the stock which they had laid in to distribute as a New Year's gift has been entirely exhausted, although replenished three times. As there appears to be a demand for these little rules, Messrs. Marples, Leach, and Co. are willing to forward one of these to any of our readers sending 9d. in stamps.

Nottingham.—An alarming explosion took place at the house of Mr. Charles Hemingray, Independent-street, Radford. Noticing a smell of gas in one of the bedrooms, Mrs. Hemingray called her son-in-law, Mr. Harry Barker, and he went to look for the escape with a lighted candle. The result was disastrous to the house, although Mr. Barker escaped miraculously. The front of the building was wrecked, the windows being blown to the other side of the road, and the plaster shattered from the ceilings of all the downstairs rooms.

Kilkenny.—At the County Council meeting the secretary brought under the notice of the meeting the fact that the telephone trunk system was proposed to be established in Kilkenny. He wished to know would the Council approve of the project of being connected with the line. It would be very useful, and the cost would be only £5 a year. The Corporation and other public bodies had started the project. It would be very convenient for the officers of the Council if they had the telephone service. The Council approved.

Audley.—At the Council meeting an animated discussion took place with respect to the subject of the lighting of Talke village. Mr. Taylor characterised the lamps as being in a dirty, filthy condition, with no light in them. The Chairman said that a committee had recently interviewed the Kidsgrove Gaslight Co., who had pointed out many difficulties in connection with the supply for the village, and leakages made it utterly impossible to get a constant and good supply. The lamps were in a filthy condition from one end of the village to the other.

Tantalum Lamps.—Messrs. Siemens Bros. Dynamo Works are introducing a new type of tantalum lamp—namely, 16 c.p. for 100 to

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120 volt circuits. This lamp is not more fragile than the other types of tantalum lamps, and will burn in any position. Messrs. Siemens carry at present a small stock in London, which they are increasing with all speed to meet the enormous number of inquiries they have received for lamps of this type. They have also issued an opal tablet advertising tantalum lamps, which they will be pleased to supply on receipt of trade card.

Gloucester.—At the last Electricity Committee meeting the engineer reported that he had received an application for a supply of current for power and lighting purposes to the Co-operative Depôt, India-road, and that in order to furnish such supply it would be necessary to extend the main in Barton-street along India-road to such premises at an estimated cost of about £160. It was resolved that, subject to the co-operative society entering into an agreement to take current to the value of at least £40 per annum for three years, the Council be recommended to extend the main as requested.

Sedgefield.—With reference to the proposal of the Guardians to light the workhouse and the manor house with electricity supplied from the county asylum, the clerk has written to the Local Government Board giving the estimated cost of lighting by oil lamps and electricity, and has received a reply stating that, if the Guardians are able to submit a scheme for lighting these places with electric current obtained from a body that had power to supply it, they would be prepared to favourably consider the proposal. Ultimately the question of the method of lighting to be adopted was referred to a committee.

Anglo-American Telegraph Co.—The directors of the Anglo-American Telegraph Co. have resolved, after placing £20,000 to the credit of the renewal fund, to recommend the declaration of the following dividends: a balance dividend of £1. 5s. per cent. upon the ordinary consolidated stock for the year ended Dec. 31, 1907; a balance dividend of £1. 10s. per cent. upon the preferred stock for the year ended Dec. 31, 1907; a first and final dividend of £1 per cent. upon the deferred stock for the year ended Dec. 31, 1907—less income tax. After paying the foregoing dividends there will be a balance of about £2,400 to be carried forward.

Perth.—Correspondence and meetings have taken place between the Work and Paving Committee of the Town Council and the National Telephone Co., and a letter has been read from the company asking if the town was prepared to cancel their present agreement, whereby charges were to be made for calls. The committee, after considering the matter, agreed to instruct the town clerk to write to the company to the effect that the Council did not desire that the present agreement should be cancelled, but they wished a new agreement to be entered into between the town and the company of a supplementary nature, whereby the town would give the company facilities for extra wayleave on condition that this new agreement was entered into.

Dundee.—On behalf of the Dundee Harbour Trust objections have been lodged to the proposed new regulations issued by the Home Secretary for the generation, transformation, and distribution of electrical energy. These have been framed in terms of the Factory and Workshops Act, and an inquiry is to be held in London in March. It was stated at a committee meeting of the Harbour Trustees that, although at present they were not affected by the proposed regulations, they might come under their scope if they put in force their statutory rights to generate and distribute their own electricity. The objections were lodged to safeguard the rights of the trustees, and to assist the Town Council in their effort to have the regulations amended and made less burdensome.

Greystones.—Messrs. W. Coates and Son are submitting to the ratepayers of Greystones a scheme for the public and private lighting of Greystones by electricity, provided that suitable legal agreements can be made with the County and Rural District Councils. Messrs. Coates propose to employ suction-gas plant and to use metallic-filament lamps. It is interesting to note in this respect that the advent of the metallic-filament lamp makes it possible to reduce by one-half the size of the generating plant and mains over what was required even a year ago. It is estimated that the cost of providing a power station and all other works and expenses will amount to £3,000, and Messrs. Coates are appealing to the ratepayers and residents to subscribe to the formation of a small company.

Hull.—A letter was read at the meeting of the Corporation Telephones Committee from the Postmaster-General, giving sanction to certain alterations and extensions proposed with the object of improving intercommunication with National Telephone Co.'s subscribers. This will necessitate alterations on the switchboard and the rewiring of about 2,000 instruments at a cost of £800. Several members desired to know whether the expenditure would be justified, and the chairman replied that it was his desire to make the system as perfect as possible. Under the new scheme (which the company had approved) when intercommunication was desired it would be direct, and a call would not have to be passed from one operator to another. Also, subscribers would not be cut off in the middle of a conversation with the question "Have you finished?" The committee agreed to recommend the outlay.

Penybont.—At the meeting of the District Council a letter was read from the clerk to the Bridgend District Council, forwarding draft of the proposed agreement between the two Councils, safeguarding the interests of the Penybont Council. He pointed out that the Board of Trade were wishful to complete the proofs, and expressed a hope that the Penybont authority would expedite the matter as much as possible. The following resolution will be considered at the next meeting: "That this Council, pursuant to Section 1 of the Electric Lighting Act, 1883, do hereby give consent to the application made by the Urban District Council of Bridgend to the Board of Trade for the provisional order under the Electric Lighting Acts in respect of an extension of their existing area of supply, *inter alia*, to the parishes of Newcastle Higher, Newcastle Lower, St. Bride's Minor, Coity and Ewenny, and within the rural district of Penybont."

Ferndown.—At the meeting of the Rural District Council the surveyor reported that the National Telephone Co. had applied for the consent of the Council for the erection of a line of about 39 poles and stays on the road from West Moors Station to the junction of the County Council road at Ferndown, where it would run along the main road to Longham, for the purpose of extending the telephone system to Ferndown and Longham. The surveyor stated there could be no objection to consent being given on the usual terms—viz, a yearly payment of a wayleave of 1s. a pole to the Council—and that the poles be placed in positions satisfactory to the Council, and that all damage done to the surface of the roadsides in the erection of the poles be made good by the company, and that any reasonable expenses be paid in waiting upon the company's officials to point out the positions for erecting the poles and making good the roads. The Council agreed to the suggestions.

Beckenham.—At the last meeting of the Urban District Council the Electricity Committee reported that plans of a battery-house had been submitted by Messrs. Kincaid, Waller, Manville, and Dawson, and, subject to approval by the General Purposes Committee, the same were agreed to, and an order was given to advertise for tenders. A letter was also read from engineers covering a quotation by the General Electric Co. to provide and fix a direct-current armature to the No. 5 alternating set, including all necessary works in connection therewith, except foundations, for the sum of £415. Subject to the acceptance by the General Electric Co. of the necessary modification of dates in reference to the overhaul of the No. 6 engine and the return of No. 7, the committee recommended that this offer be accepted. The committee recommended that application be made to the Local Government Board for sanction to a loan of £465 to cover the cost of this new armature and of the necessary foundations. The report was adopted.

Richmond.—The electrical and trades' exhibition being held this week at Richmond is decidedly a step in the right direction, and the general success gives full warrant for urging publicity methods. The chief feature of the exhibition was, perhaps, the cookery section of the electrical exhibits. This being a branch of supply which of all things demands pushing and advertising. The Richmond (Surrey) Electric Light and Power Co.—who had already for some time past made a special feature of extending their supply for this purpose—co-operated in the exhibition in making the cookery demonstration of specially attractive character. The attention of existing consumers was called to the exhibit, and a very gratifying interest resulted. The lighting section, of course, included all the latest types of lamps, etc., the ammeter readings of the metallic-filament lamps attracting considerable interest on the part of the shrewder of the shopkeeping visitors.

Camberwell.—At the last meeting of the Borough Council the Finance Committee brought up a report regarding the proposal by the Board of Trade to dispense with its audit of electric lighting companies' accounts, and to accept in substitution the audit conducted by shareholders' auditors on behalf of the companies concerned. Camberwell is specially affected by this question, as there is included in its provisional order a special purchase clause enabling the authority to buy the company's undertaking at any time by paying such an amount as would be equal to a sum of £133 for every £100 properly expended on the undertaking and chargeable to the capital account. Representations have been made to the Board of Trade on the subject. The Council authorised the committee to take all necessary steps for the protection of the interests of Camberwell in connection with the audit of electric lighting companies' accounts, and also as to the form of accounts required, and gave them power to make representations to the Board of Trade.

Wireless Telephony.—The Danish wireless inventor, Mr. Valdemar Poulsen, is stated to be engaged in the completion, at Lyngby, five miles from Copenhagen, of a wireless telephone station, which is to be connected with the wireless station at Esbjerg. It is his intention to ultimately establish a wireless telephone between England and Denmark (Esbjerg). He does not intend to hurry, however, although his system of wireless telephony has already proved fully successful over long distances. The inventor attributes his success to new and improved microphones and other apparatus. The public will not be able to telephone or telegraph by these wireless inventions until every detail has been completed, and stations have been established all over the world. It is not intended to begin wireless telegraphing and telephoning between Denmark and England or America until it is quite possible to compete with the present cables. The inventor claims that his system of wireless telegraphy enables him to forward at least seven times as many words as by Mr. Marconi's system.

Middleton.—There was a special meeting of Middleton Parish Council on the 23rd inst. to further consider the question of the street-lighting. A letter was read from the gas company offering to supply gas to the meter lamps, the Council to supply meters. Another letter was read from Messrs. Cox Walkers and Co., Darlington, asking permission to tender for supplying the town with electric light. The consideration of the latter letter was left over, and the following resolution was passed: "That this Council acknowledge the receipt of the gas company's letter, and inform them that the Council must adhere to their offer of the 16th inst., to pay for four (or eight) additional test meters, and if it will meet the wishes of the gas company and have a tendency to help an amicable arrangement, a deputation of this Council will be glad to meet the gas directors and ask for a reply in due course." A deputation for this purpose was appointed, and another meeting will be held at which both systems of lighting will be discussed.

Whalley Bridge.—At a meeting of the Urban District Council, Mr. Exley made serious complaints against the gas the local company

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were supplying, and contended that the charges to consumers were excessive. He had heard that the New Mills Council were extending their mains to Furness Vale, and he suggested that the clerk write to the Council asking on what terms they would supply gas to Whalley Bridge. Mr. Ashton seconded. Mr. Carter disclaimed any personal interest, but asked if it would not be as well to give Whalley Gas Co. a chance. Let them write the company first and say if they could not have better treatment they should have to take other steps. Mr. Exley said he was the largest private consumer in the district and he had tried that. The Council were there for the benefit of the public, and if they could get better terms they were bound to do so. Mr. Downs thought if the Whalley Bridge Gas Co. were a little more enterprising, and did not confine their whole attention to dividend earning, they would be able to produce better and cheaper gas.

York.—The question of developing the commercial aspect of the York electricity department has for some time past engaged the attention of the Corporation Electricity Committee, especially in regard to the hiring of both arc and Osram lamps, at inclusive charges for current, maintenance, loan of wiring, and carrying out work on consumers' premises, on a system of deferred payments. The Streets and Buildings Committee having desired an improvement in the lighting of the Scarcroft and Bishopthorpe roads, the Electricity Committee instructed the city electrical engineer to report on the matter with a view to meeting the wishes of the Streets and Buildings Committee. He has done this, with the result that the committee directed him to change the lamps for others, whereby an increased light of about 25 per cent. over the previous lamps will be obtained, and to substitute an enclosed arc lamp at the corner of Bishopthorpe-road and New York-terrace, which will give an approximate increased light of 800 c.p. The additional charge for this increased lighting power will be £7. 2s. 6d. per annum.

Lyndhurst.—The clerk to the Parish Council has written to the postmaster at Southampton enclosing the resolution of the Council passed at the last meeting relative to Lyndhurst being included in the Southampton telephone area, instead of at Lymington, and the following reply has been received: "I beg to inform you that your letter respecting the question of the inclusion of Lyndhurst in the Southampton telephone area has been forwarded to the district manager of the National Telephone Co., Southampton." This was followed by a letter from the General Post Office, London, worded as follows: "With reference to your letter addressed to the postmaster of Southampton, relative to the arrangements for a telephone service at Lyndhurst, I am directed by the Postmaster-General to say that it is his intention, if adequate support is obtained, to provide Lyndhurst with a telephone service by means of a direct line from Southampton. Lyndhurst cannot, however, be included in the Southampton area, which has been assigned to the National Telephone Co. for the development of their system. It will accordingly be necessary to charge a trunk fee of 3d. in respect of every call between Lyndhurst and Southampton."

Stoke-on-Trent.—At a meeting of the Electric Lighting Committee of the Guardians, the master reported that during the year 1907 there had been a decrease of 537 tons in the consumption of fuel compared with 1906, but owing to the increased price the cost had gone up by the sum of £206, whereas if the cost had been the same as in the latter year a saving of £400 would have been effected. In 1906 the quantity used was 4,653 tons and the cost £1,674; in 1907 the quantity used was 4,116 tons and the cost £1,880. The committee called the attention of the Board to the great decrease in the consumption, which in a great measure had been caused by the various improvements in the machinery, reported from time to time, and also to the placing of the distribution of house fuel in charge of an officer, and to the fact that whilst there was an increase in the actual cost, that was a matter over which they had no control. Mr. Ball, in moving the adoption of the report, complimented the master and the engineer upon the saving in fuel. They could not, he remarked, help the increase in price; it would have been a serious matter if they had not been able to effect a saving.

Chester.—The Corporation Lighting Committee having passed a recommendation that application be made to the Local Government Board for sanction to borrow £28,000 for extensions to the electricity undertaking, they being of opinion that this sum would meet the requirements for the next five years, the Council have considered and agreed to the same; also to the sum of £2,500 for light and power installations for carrying out the purposes of Section 78 of the Chester Corporation Act, 1901. The following recommendation of the Lighting Committee has also been approved: "That from March 25, 1908, the following charges be made against the tramways undertaking for current supplied and the upkeep of the electrical equipment of the tramways—viz.: the sum of £982 per annum in respect of the interest and sinking fund charges and depreciation on the capital invested by the electricity undertaking on behalf of the tramways undertaking; a charge per Board of Trade unit supplied to tramways according to the actual cost to the electricity undertaking for the production of electrical energy per unit during the preceding year; a charge according to the actual cost to the electricity undertaking for time and materials in inspecting, repairing, and maintaining the electrical equipment of the tramways, plus 10 per cent., on such actual cost to cover the use of tools and supervision, and that all previous resolutions in connection with this matter be altered or aried accordingly."

Dublin.—The question of lighting the North Union Workhouse with electricity elicited a letter from the city electrical engineer as regards the comparative cost of gas and electricity. In an extract from the report, which was enclosed, Mr. Ruddle stated that he was informed that the total gas bill of the union was £1,000 per annum. Gas to the value of £130 was, however, used for cooking and heating purposes, and the cost of lighting was, therefore, £870 per annum. He believed the premises could be fitted up at a cost of £1,250, furnishing sufficient lamps to give an illumination of 50 per cent. greater power than the existing gas lighting. The annual capital charges upon this sum, taken at 7½ per cent., would amount to £94. He estimates the consumption of electricity would amount to 35,000 units per annum, which at 3d. per unit would amount to £440. A liberal allowance for renewal of lamps and general maintenance would be £105, making a total of £639 for the whole of the lighting, and effecting a saving of £231 per annum over the present gas bill. Even allowing for an increased allowance, for ample renewals and general maintenance, the total annual charges would not exceed £825, which would still show an annual saving over the present gas bill, and, as previously stated, give 50 per cent increased illumination in the premises. He thought, therefore, that the Guardians should have no hesitation in deciding to adopt the newer and healthier illuminant. It was decided to refer the matter to the committee which formerly had the matter in hand.

Hanley.—At the last Town Council meeting the monthly reports from the electricity department showed that in October 149,357 units were sold, against 113,005 in October, 1906. The total generated was respectively 174,110 and 136,144 units, the maximum loads 960 kw. and 835 kw. The coal consumption per unit was 8·01b., against 9·93lb. a year ago, and the works cost ·853d., compared with ·970d. per unit sold. In November 162,296 units were sold, against 144,399 in November, 1906. The total generated was respectively 183,326 and 162,699 units, the maximum loads 1,011 kw. and 894 kw. The coal consumption per unit was 8·23lb., against 8·35lb. a year ago, and the works cost ·720d., compared with ·709d. per unit sold. The Shelton Iron, Steel, and Coal Co. notified an advance in the price of manufacturing fuel of 6d. per ton, which was an all-round advance to buyers in the open market, and coincided with the advance on fuel under contract in accordance with the wages clause. In accordance with a resolution passed by the Municipal Electrical Association, the committee resolved to urge the Board of Trade to reintroduce the Electricity Supply Bill. The electrical engineer submitted a statement explaining the results for the first three months of 1907, being the interim period between the 1906 annual and the 1906-7 15 months' accounts, during which time it had been stated a loss was made upon the undertaking. The extra amount required to meet the sinking fund instalments covered the balance of two years' payments, and the accounts to the end of March, 1907, include all charges accrued to that date. Taking the proportion of sinking fund instalments for the three months, the surplus for that period was £778.

Kingston (Surrey).—At the last Town Council meeting the following important paragraph, which appeared in the minutes of the Lighting Committee, was considered: "The committee considered the report of the sub-committee in regard to the proposed application to the Local Government Board for sanction to a further loan, and resolved that the Council be recommended to make application to the Local Government Board for sanction to borrow the sum of £12,600, such amount being made up as follows—viz.: proposed new expenditure—engine-house, £800; mains, £3,210; services to consumers, £2,850; sub-stations, kiosks, and transformers, £2,230; disconnecting section pillars, £600; arc lighting, £300; incandescent electric lighting, £1,232; cost of loan, law charges, plans, etc., £288. 10s. 8d.; liabilities to Oct. 31, 1907, in excess of loans sanctioned, £1,089. 9s. 4d —total, £12,600." Councillor Sprunt, chairman of the committee, in moving the adoption of the recommendation, said the excess of expenditure over the loans sanctioned was due chiefly to the increased cost of copper, which rose from £56 to £120 a ton during the time the cables were being laid, but by a very careful study of the market they never paid more than £90 a ton. The £3,210 estimated for mains was to enable them to supply new customers, and their requirements in this direction were gauged by past experience. The whole of the proposed expenditure was absolutely necessary, and he reminded the Council that the figures were only estimates, and every item would have to come before the Council for approval before any expenditure was incurred. They had had a good deal to do with the gas company lately, and the sooner they got the whole of the public lighting into their own hands the better it would be for the town. The money would only be borrowed in instalments as it was required. Alderman Clarke seconded the motion, and said every item would be rigidly inquired into by the Local Government Board inspector, and it would be open to any ratepayer to attend the local inquiry. The motion was agreed to without further discussion.

TRACTION.

Haslingden.—The Haslingden and Accrington electric tramways departments have arrived at an understanding for through booking arrangements.

Southampton.—The Town Council are considering a proposal for the Tramway Committee to provide covers for the cars now running on some portions of the system.

Accrington.—Accrington Corporation has completed the conversion of its tramways, comprising 11¾ miles, to the electric system, and each section has received the sanction of the Board of Trade.

Farnworth.—It is expected, in response to local ratepayers' petitions, that the South Lancashire Tramways Co. will shortly inaugurate a regular service along the Long-causeway route.

Torquay.—Although the eight-mile system is not yet completed the demand for electric current for the trams amounted to between £300 and £400 a month. A new generating station will probably be needed shortly.

Ambleoote.—The Urban District Council have decided to again approach the tramways company with the object of inducing them to extend the 1d. fare, at present from Stourbridge to the bottom of Brettell-lane, to Dennis-park.

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Rowley.—The Urban District Council have directed their clerk to ask the Birmingham and Midland Tramway Co. to send representatives to confer with the committee respecting the ½d. fares for children and the necessity for more cars between Old Hill and Blackheath.

Dover.—In consequence of the falling off in the tramway revenue, the Tramways Committee, partly on the advice of the manager, and partly on their own initiative, have under consideration several important changes, some of which have already been adopted, and others are deferred, but will, it is expected, be soon in operation.

Coulsdon.—A poll of the parochial electors of Coulsdon resulted in a majority of 87 against the proposal to extend the tramways from the Croydon terminus at Purley to Whyteleafe and Smitham. The figures were: for, 288; against, 375. Only about 50 per cent. of the electors recorded their votes. At the Warlingham parish meeting there was a large majority in favour of the scheme, which is embodied in a parliamentary Bill.

Brentford.—The District Council have decided to offer no opposition to the London United Tramway Co.'s Bill, now before Parliament, for the construction of tramways over Kew Bridge to connect the Middlesex system of the company with the line from Kew to Richmond. Opposition to the Bill has, however, been lodged by the Middlesex County Council, which, with the Surrey Council, controls the bridge and its approaches.

Luton.—At the Council meeting the town clerk reported that he had received the informal approval of the Board of Trade to the lease of the Luton Corporation tramways to Messrs. J. G. White and Co. The town clerk was authorised, in due course, to make the necessary application to the Board of Trade to inspect the tramway system, and the question of making arrangements for the opening ceremony was, in the interim, left with the mayor and the chairman of the Tramways Committee.

Warrenpoint (co. Down).—It is stated on good authority in Warrenpoint that a company is about to be formed to purchase the present tramway from Warrenpoint to Rostrevor, and to continue it as an electric railway to Newcastle, the favourite watering place and golfing resort on the east coast. The proposed extension would open up a new line of country *via* Kilkeel and other seaside towns on the county Down coast. At present this route is largely served by long cars during the tourist months.

Ashton.—A serious collision occurred at Ashton on Friday night last. An electric car belonging to the Oldham, Ashton, and Hyde Tramway Co. was passing along Stockport-road when it collided with a lurry which was standing along with others in the roadway. The lurry caught the side of the car in such a manner that it stripped all the woodwork away, leaving the seats inside the car bare. Fortunately, there were only a few passengers in the car at the time, or something more serious might have happened owing to the falling splinters of wood. The driver of the car escaped without being injured.

Glasgow.—Under the Fatal Accidents Inquiry Acts an inquiry was held in Glasgow on the 23rd inst. into the circumstances attending the deaths of James Dolan, tramway motorman, and Robert Heggie, vanboy, as a result of the tramway smash on the 3rd inst. The evidence was largely a repetition of that given at the Board of Trade inquiry. At the close the verdict of the jury was that in their opinion there was not sufficient evidence to show how the car got beyond control, and it was their opinion that at the time of starting, the reversing handle not being in its proper place, the car should not have been sent on its journey.

Canada.—We understand that material progress is being made with the organisation of the English company which has been formed to develop Canada's electrical railways, and which undertakes to spend some £2,000,000 upon the work. The engineers are still engaged in making the necessary surveys, so that it will be some time before their reports are available. Among other projects, the company proposes to construct electric railways in the rural districts of Ontario, improve and develop certain existing water powers, and, more particularly, to lay down railway lines on the island of Montreal. It is also intended to take the Toronto street railway in hand and greatly improve it.

Morecambe.—At the last meeting of the Town Council the mayor reported that the public meeting on the 8th inst. had decided against the promotion of the Bill for the purchase and electrification of the tramways. Mr. Gorton said the opinion with regard to the public meeting was that there were too many non-ratepayers present. It was to be regretted that their fellow townsmen were not in the humour and not prepared to give even reasonable consideration to the information the speakers on behalf the Council were prepared to furnish. It might be some satisfaction to those who were really interested in Morecambe that the Council would do its duty without regard to the public meeting.

Belfast.—The Belfast Corporation's Bill for the purpose of purchasing the Whitewell and Cavehill Tramway at £60,000 came before Mr. Campion, one of the examiners of the Standing Order proofs, at the House of Commons on the 20th inst. After the usual formal evidence the examiner declared that the Standing Orders had been complied with, and the Bill will in due course come before the House. It is in connection with this Bill that a plebiscite of the ratepayers of the city is about to be taken, there being a good deal of local opposition to the acquirement of the tramway at the figure mentioned. However, it is pretty certain that the result will be in favour of the purchase of the tramway.

Wembley.—At the last Council meeting a letter was received from the Metropolitan Electric Tramways requesting the division of the rateable value of the power station and track—viz., £500—into two portions for general district rate purposes. The clerk also submitted a letter he had received suggesting, as a temporary measure, an assessment of the two properties, and the Finance Committee recommended that the depôt be assessed at £476, and the small portion of double track, measuring 1 furlong 5 chains, at £24, and that the clerk be instructed to inform the company that in fixing this assessment it must not be regarded as any precedent with regard to future rating of tramway lines. This was carried.

Chelsea.—The London County Council have written to the Borough Council informing them that they are advised they have no authority to make any contribution towards the heavy costs incurred by the Borough Council in the proceedings recently taken by them against the Underground Electric Railways Co. of London, in respect of an alleged smoke nuisance at the Lots-road generating station. It has been urged on behalf of the local body that the central authority should pay a substantial part of the costs, in view of the fact that the Chelsea Council were informed they would be made a defaulting authority, and that if they did not take action the London County Council would. In these circumstances, it was submitted, the Borough Council were forced to act.

Erith.—At the meeting of the Council Electricity and Tramways Committee the clerk reported that at the meeting of electors held in pursuance of the Borough Funds Acts, 1872 and 1903, on Jan. 7, the motion to approve the promotion of the Erith Tramways Bill in the next session of Parliament was rejected by a large majority, and that the decision of the meeting was final, unless a poll is demanded by the Council. The committee recommended, in view of the information received from the London County Council, that the contracts for the construction of the tramway from Wickham-lane, Plumstead, to Knee-hill, Abbey Wood had been let, and that the same would be completed at an early date, that the Bill be withdrawn. The recommendation was passed by the Council without discussion.

Cardiff.—The city treasurer and controller reported at the last meeting of the Tramway Committee that the amount provided in the estimates for the year ended March 31, 1908, for the maintenance and repairing of the permanent way was £5,000. The expenditure up to Dec. 31, 1907, already amounted to £5,099. 18s. 1d., including £1,105. 16s. 3d. for repairs to Ninian-road track. It did not include the cost of the overland route, and other plant purchased during the year amounting to £407, as that must be spread over a number of years and dealt with by a charge for depreciation in the ordinary way. The report was adopted. Mr. Ellis, the tramway manager, reported that the tramway receipts for the current year up to Saturday last were £2,691 in excess of the receipts for the same period last year.

Richmond.—To meet the wishes of the Town Council, the promoters of the West London, Barnes, and Richmond Tramways are prepared to forego the adoption of the overhead system of traction upon their proposed line in the Sheen-road, Richmond, and the Upper Richmond-road, Mortlake, though they are not ready to make the same concession in regard to the Lower Mortlake-road, where the overhead system was formerly sanctioned by the Town Council to the London United Tramways Co. Whatever may happen with regard to that, however, there will be no attempt made by them to introduce the overhead wires on the Upper-road. The class of car which these promoters have it in contemplation to adopt is a closed-in single-deck car, of appearance and arrangement familiar on most British tramways.

Leeds.—The result of the poll on the tramway proposals in the Corporation Bill will enable the measure to be proceeded with in the coming session of Parliament. The voters were called upon to say whether or not they approved of the projected extension of the tramways from Horsforth to Rawdon, Yeadon, and Guiseley, at an estimated expenditure of £90,000. The proposal met with the approval of a town's meeting, but Mr. Joseph Dransfield demanded a poll, and was afterwards successful in obtaining the requisite number of ratepayers to support him in that request. The figures of the poll were declared as follows: for the tramway scheme, 2,004; against, 1,055; majority in favour, 949. Out of 97,412 persons entitled to vote, only 3,675, or 3·77 per cent., went to the poll. There were 20 spoilt papers. The poll will cost the ratepayers about £600.

Lancaster.—At the last meeting of the Town Council the chairman of the Tramways Committee stated that there had been a decrease in receipts during the past six weeks of £42. At the same time there had been a decrease in expenses of £33. 1s. Mr. Heald, chairman of the Electricity Committee, said there was only one way of putting a stop to the increasing loss, and that was by giving someone the opportunity to acquire the Lancaster and Morecambe tramway system, and, if possible, the Morecambe tramway system. By joining the whole lot, including the Lancaster borough tramways, the thing might be made to pay. The chairman, replying to a long and animated discussion, said that the committee had already given serious consideration to the question of parting with the trams, but they must use a certain amount of discretion in withholding information from the Council.

Camber-on-Sea.—The Rye and Camber Tramways Co. have decided on an extension of the tramways for about half a mile along the shore to Camber, and the work, which has already been commenced, is proceeding apace. From the present terminus it is intended to run the line out on the shore for a distance of about 120 yards and then branch off to the eastward as far as a spot called Smugglers' Hole, where a small station will be erected. For a considerable distance the line will be laid on an embankment, which is being made, about 5ft. high, owing to the sea at high tide reaching this part. The extension will enable the public to get to the water expeditiously, and the ride *en route* will be especially enjoyable with a delightful sea breeze and the water at times alongside the line. It is expected that the work will be completed at Easter, when the line will be opened. By the making of the embankment several acres of land will be reclaimed from the sea.

Lewisham.—Ten members of the Lewisham Borough Council waited upon the London County Council Highways Committee on the

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23rd inst. with regard to the question of the Forest Hill tramways. For a long time Forest Hill residents have complained of the lack of cheap and easy travelling facilities to and from the City, and the deputation was the outcome of strong feeling on the subject. The deputation discussed the matter with the Highways Committee for nearly half an hour, and the committee promised to give the matter early consideration. Their attitude has been sympathetic, and it was only on a question as to the nature of the system to be employed that the committee had shown signs of disagreement. The County Council are in possession of parliamentary powers to construct lines which will link Forest Hill to the Lewisham High-road service, and also to the Dulwich tramways, and these are the sections which the deputation put before the committee as urgently requiring electrification.

Hull. — A deputation representative of the chief ratepayers and residents of Stoneferry have waited upon the Tramways Sub-Committee to urge the necessity for the inauguration of a tramway system to the district. Councillor Rains introduced the deputation, and it was explained that what they desired the Corporation to do was to bring the trams down to Stoneferry as early as possible, or to inaugurate a service of motor or horse 'buses until that was done. Mr. McIlwaine said that there was no necessity to pave the road with wood setts, as the granite was in good condition. He thought a single line of tramways might serve the narrow portion of Cleveland-street for the present. Other speakers followed, and Alderman Larard, in reply, said that the committee recognised the necessity for a service of trams to the district, but they were waiting until the land on either side of the road had been purchased. He had urged the other committees concerned to proceed with the matter as soon as possible.

Gloucester.—At the Council meeting the Chairman of the Light Railways Committee said he was sorry to inform the Council that the receipts for the past four weeks showed a decrease of £53. 13s. 6d. compared with the corresponding period of last year. The course had been adopted of not sending to the papers the full particulars showing the difference between the present and past receipts, the reason for which was that owing to the alteration of routes and other circumstances a comparison would be odious. The Press, however, felt it their duty, or something else, to give the comparisons every week, and while he did not grumble at this, he thought it would be more courteous for the Press to deal with the Corporation in a manner in which the latter required them to do. During last month tram receipts all over the country showed a decrease, owing to the frost, but this was not so noticeable in Gloucester as other places. In Cheltenham the receipts had gone down far more than at Gloucester. During the four weeks, however, they had saved in wages and current £19. 7s. 8d.

Southend.—At the Town Council meeting a letter was submitted from the Essex County Council granting the application of the Corporation for permission to lay a double line of railway in lieu of a single line in Leigh-road, opposite the Cricketers. The town clerk reported that he was arranging for the conveyance to the Corporation of the necessary land at the western corner of North-road, required to carry the proposed improvement into effect, and that the work could be commenced immediately upon completion of the documents. The town clerk reported that, in accordance with the instructions of the committee, he had informed the secretary of the United Methodist Free Church, Leigh-road, of the steps taken to minimise, as far as possible, the noise of the cars running past the church, and submitted letter from him, with copy of a letter he had received from the Middlesex County Council, as to their obligations under the light railways order in respect of the wood paving of the permanent way. The electrical engineer reported that such instructions had been given to the motormen as would ensure the slow running of the cars past the church during the hours of divine service.

Derby.—A collision occurred in Babington-lane on Tuesday afternoon between an Upper Dale-road electric tramcar and a dray belonging to the Mapperley Colliery Co. A considerable portion of the woodwork of the dray was smashed, and the front of the car was smashed and dinted. The car was travelling down the lane towards the town and the dray turned out of Gower-street just in front of the car, proceeding in the same direction The driver of the car scarcely had time to apply the brakes before he was in the back of the dray, and the latter crashed up against an electric lamp-post. Fortunately nothing very serious happened, and neither horse nor man was injured, but the traffic was delayed for some time before the dray could be cleared away. Even then a portion of the dray had to be further destroyed to enable its removal to be effected and the roads to be cleared. The work of completing the Nottingham-road tramway has been delayed by the frost, so that the expectation expressed at the Town Council meeting by Mr. Alderman Spriggs, that the route would be opened by the third week of January, has not been realised. We are informed that the line will be ready in about a fortnight's time.

Dumbartonshire.—Representatives from Messrs. J. G. White and Co., who have undertaken to construct and equip the new tramway system from Dalmuir to Balloch, are now in the district, and are busy arranging preliminaries previous to commencing the contract. The company expect to make a start with the actual work about the second week in February, and have stipulated in their agreement that the laying of the 13½ miles of single track shall be completed within six months. First of all, they are to open ground between the Dalreoch terminus of the Dumbarton tramways and Alexandria, and at this part of the route some of the rails have already been laid out on the road. If the weather is favourable, and the company able to make their customary progress of laying one mile of track per week, this section of the route will be open for traffic about the middle of April. After work has been thoroughly commenced on it, a start will also be made between Dumbarton and Dalmuir, so that without a doubt there should be inaugurated in the coming summer the long-anticipated tramway service from the city of Glasgow to the banks of Loch Lomond. The number of men who will be employed on each section is calculated at between 150 and 200. The cost of construction is put down at £144,000, and the scheme when completed will embrace Dumbarton burgh tramways, which have been laid down at a cost of something like £40,000. The whole will be the property of the Dumbarton Burgh and County Tramways Co., recently incorporated with a capital of £155,000.

Manchester.—Two deputations had interviews on the 28th inst. with the Tramways Committee of the Corporation. The first was headed by Miss Eva Gore-Booth, and was from the Manchester Women's Trades and Labour Council. They asked that consideration should be given to women going by car to and from their daily work. It was pointed out that there are several thousand women employed in Manchester to whom it would be a great advantage to have tickets at reduced fares for use morning and evening. At present working people's tickets are only available before seven o'clock in the morning. The deputation urged that it was a hardship on those women workers who leave home a little later than mill people, but are no better off as regards wages. They, therefore, asked that the time for the cheap tickets may be extended to nine o'clock. The chairman of the committee promised the deputation that their request shall be carefully considered. The second deputation came from the Amalgamated Tramway and Vehicle Workers. Councillor Jackson (Salford) stated that the object of the visit was to invite the committee's attention to the number of trolley boys, and to ask them to lay down a rule as to the relative proportions of boys and men employed in the tramway service. In this case also the chairman of the committee gave the deputation an assurance that the application will be duly considered. It was reported that the traffic receipts for last week amounted to £12,978. 19s. 1d., against £13,724. 13s. for the preceding week. The passengers numbered 2,633,332 last week. For the week which closed on Jan. 18 the number was 2,798,142.

Hanley.—At the last meeting of the Corporation it was stated that the Board of Trade had notified the Town Council that in connection with the North Staffordshire tramways they had consented to the use of electrical power in Hanley. They enclosed a portion of Colonel Druitt's report. Colonel Druitt reported that he had inspected the North Staffordshire tramways with reference to an application by the Potteries Electric Traction Co. for a renewal of the consent of the Board of Trade for these tramways to be worked by electric traction. He said that in Hanley two long portions had been entirely relaid as double line with heavy rails (100lb. to yard), and now the track in this borough on the original tramways was in good order. The state of these tramways was very much better than when he inspected them in March last year, and the company had done their best to get the track into good order as far as they could. They had spent over £20,000 on the renewal of their lines in this district since last year. They were also buying some new cars and repairing some of the old ones. The condition of the track of the old North Staffordshire tramways in Longton, Fenton, and Hanley was now satisfactory, and if a difference could be made between the tramways and these areas to those in Stoke and Burslem, he could recommend the Board of Trade to give a general consent to the tramways in Longton, Fenton, and Hanley being worked by electric traction. The Council resolved that the manager of the Potteries Electric Traction Co.'s attention be called to the complaint received with regard to drivers of tramcars not ringing their bells upon approaching principal street crossings in the borough. The town clerk submitted a letter from the solicitor to the Potteries Electric Traction Co. with draft order for which the company were applying to the Board of Trade concerning the construction of sidings the laying of lines, etc., and it was resolved that the town clerk be instructed to lodge an objection with the Board of Trade with a view to strengthening the position of the road authority in such circumstances.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Brussels.—The Belgian State Railways invite tenders for telegraph construction material. Tenders by Feb. 5.

Bourges.—Tenders are invited by the Military Authorities for one five-ton electrical crane. Tenders by Feb. 14.

Campina (Bucharest).—The Municipality invite tenders for the electric lighting of the town. Tenders by Feb. 9.

Melbourne.—Tenders are invited by the Postmaster-General for switchboards and telephone sets. Tenders by May 26.

Portsmouth.—Tenders are invited for the supply of coal at the power station. Tenders to the Town Clerk by Feb. 3.

Grenoble.—Tenders are invited for the construction of a tramway from Lyons to St. Jean de Bournay. Tenders by Feb. 1.

Sydney.—The Postmaster-General invites tenders for 33 switchboards for common-battery working. Tenders by March 4.

Edinburgh.—The Corporation invite tenders for an extension switchboard panel. Tenders to the Town Clerk by Feb. 10.

Oporto.—The Municipality invite tenders for the construction, maintenance, and working of tramways. Tenders by March 11.

Cologne.—The Prussian Government Railways invite tenders for the supply of telegraph construction material. Tenders by Feb. 6.

Wimbledon – Tenders are invited for the annual supply of flame arc lamp carbons to the Electricity Department. Tenders by Feb. 18.

Brazil.—The Government invite tenders for the installation of electric light and power supply in the city of Florianopolis. Tenders by March 5.

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Islington.—The Borough Council invite tenders for the supply of electrical and engineers' stores. Tenders by Feb. 18. See advertisement in last issue.

Croydon.—Tenders are invited for coal-conveying plant for the electricity works. Particulars from the Borough Electrical Engineer. Tenders by Feb. 10.

Cheltenham.—The Corporation invite tenders for the annual supply of stores, including electric lighting fittings and indiarubber goods. Tenders by Jan. 31.

Burnley.—The Guardians invite tenders for the supply of a booster to the electric lighting station at the union workhouse. Tenders by Feb. 12.

Hornsey.—The Borough Council invite tenders for the installation of electric light wiring and fittings in various public buildings. Tenders by Feb. 17.

Portsmouth.—Tenders are invited by the Tramways Committee for the supply of points, crossings, and junctions. Tenders to the Town Clerk by Feb. 3.

Norwich.—Tenders are invited for the supply of an electric motor and other apparatus. Particulars from Mr. A. E. Collins, city engineer. Tenders by Feb. 4.

Swansea.—The Corporation invite tenders for the supply of motors and starting switches during 12 months. Tenders to the Town Clerk by Feb. 21. See advertisement.

Blackburn.—The Electricity and Tramways Committee invite tenders for the annual supply of stores. Tenders by Feb. 15. Full particulars in advertisement columns.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Rawtenstall.—The Corporation invite tenders for the erection of generating station buildings and chimney stack at Hareholme. Tenders to the Town Clerk by Feb. 10.

Slough (Bucks).—The Urban District Council invite tenders for street lighting for one year. Tenders to Mr. G. H. Chardsley, clerk, 11, Mackenzie-street, Slough, by Feb. 6.

Salford.—The Tramways Committee invite tenders for the annual supply of stores, including electrical car accessories. Particulars from the General Manager. Tenders by Feb. 17.

Battersea.—The Borough Council invite tenders for the annual supply of various materials for the electricity department. Tenders to the Town Clerk by Feb. 18. See advertisement.

Gravesend.—The Electricity Committee invite tenders for the supply of 3,500 tons of rough small coal for the electricity works. Tenders to Mr. H. H. Brown, town clerk, by Feb 17.

Rathmines.—The Rathmines and Rathgar Urban District Council invite tenders for the annual supply of stores to the Electricity Department. Tenders to the Town Clerk by Feb. 13.

Belfast.—Tenders are invited by the Midland Railway Co. for the annual supply of stores, including telegraph material, switches, and crossings. Tenders to the Stores Superintendent by Feb. 4.

Brussels.—Tenders are invited for the construction of three electric railways. Particulars from the Société Nationale des Chemins de fer Vicinaux, 14, Rue de la Science. Tenders by Feb. 12.

Belfast.—The Belfast and co. Down Railway Co. invite tenders for the annual supply of stores, including switches and crossings. Tenders to the Secretary, Queen's Quay Terminus, by Feb. 10.

Leeds.—The Corporation invite tenders for steam, exhaust, overflow, and other pipes, valves, etc., in connection with a 3,000-kw. steam turbo-generator. Tenders to the Town Clerk by Feb. 10.

Hammersmith.—The Borough Council invite tenders for the annual supply of stores for the electricity department. Tenders to Mr. H. Thompson, town clerk, by Feb. 19. See advertisement.

Wallasey.—The Urban District Council invite tenders for the annual supply of stores for the Tramway Department. Particulars from the General Manager, Liscard, Cheshire. Tenders by Feb. 12.

Paris.—The Municipality invite tenders for centrifugal pumps to be driven by three-phase motors for the Clichy sewage pumping station. Particulars from the Clerk to the Municipality. Tenders by Feb. 18.

Hull.—Tenders are invited for the necessary electric light installation, fittings, and fans required at the Selby-street West School, now in course of erection, for the Education Committee. Tenders by Feb. 10.

Blackpool.—The Corporation invite tenders for the supply of uniforms and caps for the Tramways Department. Particulars from Mr. J. Lancaster, general manager, Tramway Office, Blundell-street, Blackpool.

West Ham.—The Corporation invite tenders for engine-room stores, indiarubber-covered wire, electric wiring materials and accessories. Particulars from the Borough Electrical Engineer. Tenders by Feb. 6.

Hampstead.—The Borough Council invite tenders for the supply of stores, including oils, for electric lighting station, tools, implements, and other electrical engineers' stores. Tenders to the Town Clerk by Feb. 13.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1.

St. Marylebone.—Tenders are invited for the removal of ashes and clinker from the electricity works for a period of 12 months. Specification from the Electrical Engineer. Tenders to the Town Clerk by Feb. 5. See advertisement.

East Ham.—The Corporation invite tenders for the installation of an approved generating plant with distributing pipes and radiators, and all other requisites, at the isolation hospital extensions. Tenders to the Town Clerk by Feb. 24.

Sydney.—The Postmaster-General invites tenders for cables and conductors, and 10 switchboards for 100 metallic circuits. Particulars from the Agent-General for New South Wales, 72, Victoria-street, Westminster. Tenders by Feb. 5.

Leeds.—Tenders are invited by the Tramways Committee for the annual supply of stores, including electrical sundries. Particulars from Mr. J. B. Hamilton, general manager, Tramways Office, City-square, Leeds. Tenders by Feb. 21.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1.

Wolverhampton.—The Tramways Committee invite tenders for the supply of clothing for the tramway employés. Particulars from Mr. W. A. Luntley, the general manager, at the Car Depôt, Cleveland-road, Wolverhampton. Tenders by Feb. 11.

Islington.—The Lighting Committee have been authorised to invite tenders for the carrying out of the work and for the supply of plant and machinery at the electric lighting station, pending the sanction to the borrowing of the sum of £23 304 being obtained.

Bristol.—Tenders are invited for the supply of cables and appliances for conveying electrical energy to the Avonmouth Docks, and for construction and maintenance for 12 months. Tenders to the Secretary of the Docks Committee, 19, Queen-square, Bristol, by Feb. 17.

Manchester.—The Tramways Committee invite tenders for the supply and delivery of one two-ton steam travelling crane. Particulars from Mr. J. M. McElroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by Feb. 17.

Belfast.—The Tramways and Electricity Committee invite tenders for the supply of low-tension insulated vulcanised bitumen cables during 12 months ending March 31, 1909. Tenders to Mr. T. W. Bloxam, city electrical engineer, by Feb. 25. See advertisement.

Sheffield.—The Tramways Committee invite tenders for the supply of stores—including electrical supplies and fittings, cable, car fittings, car lamps, wood slipper blocks, belting, and overhead line material—for 12 months ending March 25, 1909. Tenders by Feb. 10.

Portsmouth.—The Corporation Electricity Supply Department invite tenders for the annual supply of stores, including electrical goods, street work (laying cables, etc.). Particulars to be obtained at the Electric Lighting Station, Gunwharf-road, Portsmouth. Tenders by Feb. 12.

Birkenhead.—The Corporation invite tenders for the supply of stores at the generating stations and tramway depôts during the year ending March 31, 1909. Particulars from Mr. W. Wyld, borough electrical engineer and tramways manager. Tenders to the Town Clerk by Feb. 3.

Rawtenstall.—The Corporation invite tenders for the supply and erection of one balancing set, rotary transforming plant, and static transformers, feed pumps, boilers, condensers, circulating pumps, steam and water pipes, valves, etc., at the Electricity Works. Tenders to the Town Clerk by Feb. 7.

Wimbledon.—The Corporation invite tenders for one 1,000-kw. steam-driven turbo-alternator, with condensing plant, two water-tube boilers, economisers, pipe work and feed pump, high-tension main switchboard, and switchboard gallery. Particulars from the Borough Electrical Engineer. Tenders by Feb. 18.

Halifax.—Tenders are invited for the annual supply of stores for the Tramways and Electricity Departments, including lighting fittings, electrical accessories, copper strip, iron brake blocks, castings (malleable iron, cast iron, and brass), tubes and fittings, continuous-current meters, and overhead line material. Tenders by Feb. 12.

Adelaide.—Tenders are invited for the supply and delivery, c.i.f. Port Adelaide, of special work, points, and crossings for tramways. Specification, etc., from the Agent-General for South Australia, Threadneedle House, 28, Bishopsgate-street Within, London, E.C. Tenders to the Chairman, Municipal Tramways Trust, Adelaide, by Feb. 11.

Bermondsey.—The Borough Council invite tenders for the annual supply of stores to the electricity and destructor works, including arc lamp carbons and brushes, cable and jointing materials, conduits, electricity meters, demand indicators and main fuses, engine oils, meter boards, street frames and covers, and joint-boxes. Tenders to the Town Clerk by Feb. 17.

London.—The London County Council invite tenders for the manufacture, delivery, and laying of about five miles of low-tension lead-covered electric cable, and about two miles of telephone cables, etc., and the laying of stoneware cable ducts, building manholes, repaving, etc., for the reconstruction for electric traction of the Council's tramways in Caledonian-road and Seven Sisters-road. Tenders to the Clerk, County Hall, Spring gardens, S.W., by Feb. 4. See advertisement in last issue.

RESULTS OF TENDERS.

Edinburgh.—Messrs. T. and W. Smith, of Newcastle, have received the contract from the Edinburgh and District Tramways Co. for 600 tons of wire rope for use on their cable lines.

Accrington.—Messrs. Simpson Bros., of Hapton, have received the contract for the electric fittings, wiring, and switches for the new Carnegie library.

Stirling.—The Town Council have accepted the offer of the Tudor Co. to supply a completely new battery and to maintain it for a period

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of 10 years at £100. 10s. per annum. The tender of Johnston and Booth to supply 500 tons of coal for the power station, at 5s. 3d. per ton, has been accepted.

Belfast.—The Electricity Committee have accepted the tender of the Millfield Foundry for the supply of floor boxes and cable racks for £32. The tender of R. Craig and Sons has been accepted for the erection of an iron door and other contingent works at the electrical station for £21. 3s.

Cardiff.—The Electrical and Tramways Committee have accepted the tender of the British Insulated and Helsby Cables for high-tension cable at £593, and that of the British Westinghouse Co. for a 700-kw. motor-generator to be installed at the Hayes sub-station for the sum of £1,345. This new plant is required to supply current to the Great Western Railway and other consumers in the city.

London.—The London County Council have received the following tenders for the supply and delivery of about 500 tons of steel slot rails and 190 tons of conductor rails required for the reconstruction of the Caledonian-road and Seven Sisters-road tramways for electric conduit traction :

Frodingham Iron and Steel Co., near Doncaster*	£5,654	5	0
W. Scott and Co., Leeds	6,490	0	0
Steel, Peech, and Tozer, Sheffield (incomplete tender for slot rails only)	4,462	10	0

* Recommended for acceptance.

Stepney.—The Electricity Supply Committee have received the following tenders for the supply of 37 street boxes :

Universal Electrical Manufacturing Co.*	£62	11	3
British Insulated and Helsby Cables	63	10	0
Lucy and Co.	73	17	6
Henley's Telegraph Works Co.	85	2	6
Richmond and Co.	117	0	0
J. Every	120	17	6
Reason Manufacturing Co.	135	15	6
W. Cottis and Sons	143	19	0

* Recommended for acceptance.

OPENINGS FOR CONTRACTORS.

ABERAFESH—Elementary school, Montgomery Education Committee.

ABERDARE—Alterations at Trinity Chapel, new school hall, class-rooms, etc., Trustees.

ABERDEEN—Shops and dwellings (£2,000), Great Western-road, Mr. A. Robertson.

ABERDEEN—Three houses, Clifton-road, Mr. J. Shirras; additions to engineering premises, Urquhart-lane, Mr. C. Taggart; market building, Hutcheon-street, Aberdeen Hide, Skin, and Tallow Market Co.

AIRDRIE—New buildings, Chapelside School, School Board.

ANNFIELD PLAIN—Two houses, Northgate-street, Mr. J. J. Bulmer; 10 houses, Flint Hill, Mr. T. Reynoldson.

ARTINGTON—Elementary school, Surrey Education Committee.

ASHBY-DE LA-ZOUCH—Iron church, Mr. W. D. Bellasis.

ASHTON-IN-MAKERFIELD—Sanitary conveniences, showroom, Urban District Council.

ASH VALE—Elementary school (£4,220), Surrey Education Committee.

BACUP—Elementary school, Burnley-road, Education Committee.

BADSHOT LEA—Additions, Council school (£530), County Council.

BANGOR—Extensions, Council school (£2,000), Carnarvon Education Committee.

BANGOR—Higher-grade school, Carnarvon Education Committee.

BANTRY—Workmen's dwellings (£16,636), Rural District Council.

BARNELAKE POINT—Ice factory, Neyland Steam Trawling and Fishing Co.

BARNSBURY—Fire station, Caledonian-road, London County Council.

BARNSLEY—Y.M.C.A. hall and buildings, Eldon-street; two houses, Queen's-avenue, Mr. E. W. Dyson.

BECKENHAM—Six houses, Cromwell-road, Messrs. A. and R. Westerman.

BEDFORD—Church, Queen's-park, Ecclesiastical Commissioners.

BEDFORD—Two houses, Goldington-road, Mr. A. W. G. Prosser; 15 houses, Dudley-street, Mr. G. Williamson; house, Ampthill-road, Messrs. B. Litchfield and Son; vestry, St. Mary's Church, Rev. G. H. Pratt.

BEENHAM—Improvements to school buildings, Trustees.

BERMONDSEY, S.E.—Extensions to electricity undertaking (£2,154), Borough Council.

BETHNAL GREEN, N.E.—Shop, Russia-lane, Messrs. W. and F. Catmur.

BILSTON—Council school, Bull Hole's site, Education Committee.

BIRMINGHAM—Council school, Leigh-road, Education Committee.

BLACKHILL—Elementary school, Durham Education Committee.

BLOXWICH—Additions to Swann Inn, High-street, Bloxwich Brewery Co.; houses, Sandbank, Mr. T. Hughes.

BLYTH—Secondary school and pupil teachers' centre (£9,000), Education Committee.

BLYTH—General post office, H.M. Commissioners Public Works.

BOLTON—New premises, Messrs. Beaty Bros.; extensions at cotton mills, Messrs. Ainsworths, Barlow, and Jones.

BOLTON—New church, Chorley-road (St. Barnabas), Churchwardens.

BOLTON-LE-SANDS—Houses, Mr. Thompson.

BORRISOKANE—Workmen's dwellings (£37,801), Rural District Council.

BOSCOMBE—Mission hall, St. John's parish (£6,000).

BOURNEMOUTH—Additions to kiosk, Town Council.

BRADFORD—Bandstand, Lister Park, Corporation.

BRADFORD—Extensions, Bellevue Girls' Secondary School, Education Committee.

BRIDGNORTH—Secondary school, Salop Education Committee.

BRIGHOUSE—Electric transforming station, Perseverance Mills, Town Council.

BRISTOL—General post office, H.M. Commissioners of Public Works.

BRYNMENIN—Additions to stores, Abergawr Brewery.

BUCKLEBURY—Additions to Council school, Berkshire County Council.

BUCKLEY—Public hall, Orange Society.

BURNLEY—Booster at electricity station, Corporation.

BURPHAM—Elementary school (£1,132), Surrey Education Committee.

BURSLEM—Alterations to reading-room and free library, Wedgwood Institute, Town Council.

CARNARVON—Higher-grade school, Carnarvon Education Committee.

CASTLEBLANEY—Workmen's dwellings (£31,188), Rural District Council.

CASTLECOMER—Workmen's dwellings (£41,813), Rural District Council.

CHERTSEY—Elementary school, Surrey Education Committee.

CHESTER—Improvements at infirmary, Board of Guardians.

CHESTER—Asylum (£14,000), Town Council.

CHISLEHURST—Transmission station (£3,000), Chislehurst Electric Light Co.

CLAREMORRIS—Workmen's dwellings, Rural District Council.

CLAPHAM S.W.—Buildings, south side Clapham Common, Mr. E. J. Golds.

CLEATOR MOOR—St. Patrick's Club building, Messrs. Pickering and Crompton.

CLONEY GOWAN—Workmen's dwellings (£7,009), Rural District Council.

CLONMEL—Workmen's cottages (£16,560), No. 1 Rural District Council; workmen's cottages (£6,741), No. 2 Rural District Council.

COEDPENMAEN—Bethania Chapel, Mr. P. J. Jones.

COLERAINE—Scheme for labourers' cottages, Board of Guardians.

COMPTON—Alterations to Council school, Berkshire County Council.

CONGLETON—Public baths, Town Council.

CORK—Workmen's dwellings (£121.707), Rural District Council.

CROOK—Alterations, Council school, Education Committee.

CROSBY—Six houses and business premises, Mr. W. H. Buttrick.

CROSSMAGLEN—Workmen's dwellings (£19,057), Rural District Council.

CROYDON—Alterations at Waingate Infirmary, Guardians.

DAGENHAM—Additions to elementary schools (£650), Essex County Council.

DARLINGTON—Elementary school (£4,000), County Education Committee.

DEVIZES—Shops, Bishop Cannings, Mr. T. Stone.

DINAS POWIS—Elementary school, Glamorgan Education Committee.

DOLPHINHOLME—Alterations and additions to Fleece Inn, Mr. W. Mitchell.

DOVERCOURT—Congregational church, Cliff-road, Mr. H. H. Parker.

DUDLEY—Public library (£6,600), Town Council.

DUNDALK—Dwelling-house, Mr. J. M'Gahon.

EAST HAM—Generating plant, etc., isolation hospital, Town Council.

EASTHAMPSTEAD—Elementary school (£2,970), Berkshire County Council.

EAST ILSEY—Alterations to Council school, Berkshire County Council.

EDGWARE—Renovation of parish church, Churchwardens.

ERITH—Extensions, sanatorium (£3,600), Urban District Council.

FALMOUTH—Nine houses, Bar-road, Mr. A. Smith.

FARNWORTH—Refuse destructor, Corporation.

FERRYHILL—Twenty-three houses, Morgan's Gate, Mr. T. Golightly; 18 houses, Darlington-road, Mr. E. Robinson; three houses, Conyers-terrace, Mr. G. W. Lazenby; two houses, Chilton-buildings, Mr. S. Chapman.

FRASERBURGH—Higher-grade school, School Board.

FRIMLEY—Elementary school (£2,241), Surrey Education Committee.

GELLI—Alterations, Caersalem Wesleyan Chapel, Mr. W. D. Morgan.

GLENCULLEN—Workmen's dwellings, Rathdown Rural District Council.

GLOUCESTER—Extension of workhouse (£600), Board of Guardians.

GODALMING—Voluntary school, Board of Education.

GOLCAR—Two houses, Carr Top, Mr. Benjamin Whitwam; engine-house, Parkwood Mills, Messrs. John Broadbent and Son; 15 houses, Radcliffe-road, Messrs. A. and T. Haigh; dwelling-house, Co-operative Society.

GORTON—Wesleyan church, Trustees.

GRANGETOWN—Alterations, Council school, Bolckow-road, North Riding Education Committee.

HACKNEY, N.E.—Improvements, Tottenham-road School, London County Council.

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HADLEIGH—Elementary school, Education Committee.
HAGGERSTON—Elementary school, London County Council.
HALIFAX—Secondary school, West Riding Education Committee.
HAMMERSMITH, W.—Additions to Carlton Academy, Mr. W. F. Hurndall; six blocks of flats, west side Brook Green, Mr. F. W. Hingston.
HAMPSTEAD, N.W.—Extensions to electricity undertaking (£8,155), Borough Council.
HANHAM—Congregational church (£5,000), Trustees.
HARPUR HILL—Mission church, Ecclesiastical Commissioners.
HASTINGS—Extensions to infirmary, Town Council.
HEMSWORTH—Railway inn and hotel at South Kirkby, Rural District Council.
HENDON—Workmen's dwellings, Urban District Council.
HERTFORD—Municipal offices, Urban District Council.
HERTFORD—Corn Exchange alterations, Town Council.
HONLEY—Twenty-four houses, Newmill-road, Messrs. J. Sykes and Co.
HORNSEY—Workmen's dwellings (£39,690), Urban District Council.
HUDDERSFIELD—Sheds, offices, shops, etc., Colne-road, Mr. E. W. Lockwood.
HULL—Electric light installation, Selby-street School, Education Committee.
ILFORD—Public elementary school, Urban District Council.
ISLINGTON, N.—Additions, St. Mary Magdalene Schools, Managers.
KERSLEY—Mission church in connection with parish church, Ecclesiastical Commissioners.
KIDDERMINSTER—Eight houses, Offmore-road; three houses, Lea-street, Mr. Middleton.
KIDDERMINSTER—Additions to workhouse, Board of Guardians.
KILTIERNAN—Workmen's dwellings, Rathdown Rural District Council.
LEEDS—Lavatories, Corporation.
LEICESTER—Alterations, branch library, Clarendon-street, Corporation.
LEIGH-ON-SEA—Town hall, Town Council.
LEITH—Elementary school, Links-place, School Board.
LIVERPOOL—Baths, Queen's-drive, Walton, Corporation.
LLANDOVERY—Elementary school, Carmarthen Education Committee.
LLANFAIRFECHAN—Elementary school, Carnarvon Education Committee.
LONDON.—Extensions to laundry, North-Western Hospital (£655), Metropolitan Asylums Board.
LONDON, W.—Tea kiosk, Hyde Park, Office of Works.
LOOE—Public hall, Trustees, Constitutional Club.
LOUGH SWILLY—Barracks, Neds Point and Duncree Forts (£15,000), War Office.
MACROOM—Workmen's dwellings (£67,140), Rural District Council.
MAGOR—Elementary school, Monmouthshire Education Committee.
MAIDENHEAD—Secondary school, Berkshire Education Committee.
MANCHESTER—Y.M.C.A. buildings (£40,000), Messrs. Woodhouse, Corbett, and Dean.
MANCHESTER—Public conveniences, Delamere-street, Corporation.
MANCHESTER—Dwellings, Hulme, Sanitary Committee.
MANCHESTER—Dental hospital; additions to Owen's College, Oxford-road.
MANSTON—Detached house—Mr. F. Mitchell.
MARTON MOSS—Enlargement of elementary school, Rev. A. R. Burgess.
MATLOCK BATH—Extensions at the Royal Baths, Town Council.
MERTHYR—Additions, Mardy Hospital (£5,950), Town Council.
MICKLE TRAFFORD—Elementary school, Chester Education Committee.
MIDDLESEX—Extensions to Napsbury Asylum (£106,469), County Council.
MILNTHORPE—Enlargement of St. Thomas's School, County Education Committee.
MIRFIELD—Abattoir, Nab-lane, Mr. W. B. Mann; shop, Doctor-lane, Mr. F. Dyson.
NANTWICH—Chapel, Pilliory-street, Trustees, United Methodist Free Church.
NELSON—Conversion of fish market into municipal technical school, Education Committee.
NESTON—Council school, Education Committee.
NEW HAW—Elementary school. Surrey Education Committee.
NEWQUAY—Secondary school, Cornwall Education Committee.
NORTHFLEET—Seven houses, Mayfield-road, Messrs. Clements and Hotter.
NORTH SHORE—Sunday school, Wesleyan Trustees.
NORTHUMBERLAND—Social club, Togston-terrace, Building Committee.
NORTHUMBERLAND—Club buildings, Togston-terrace.
NORWICH—Additions, isolation hospital (£900), nurses' accommodation, Council.
NOTTINGHAM—Hippodrome (£30,000), Local Syndicate.
OGMORE VALE—Chapel, Trustees, Calvary Baptist Church.
OLDHAM—Mill, Mersey Spinning Co.
OLD TRIMDON—Three houses, Mr H. Brown.
ORPINGTON—Fire station, Bromley Rural District Council.
PADIHAM—Elementary school, Lancashire Education Committee.
PENMACHNO—Elementary school (£3,900), Board of Education.
PENTREUCHAF—Elementary school, Carnarvon Education Committee.
PENYCAE—Council school, Education Committee.
PETERHEAD—Higher-grade school, School Board.
PEWSEY—Tea rooms, Mr. A. Schmidt, Ludgershall.
POPLAR, E.—Divisional offices, London County Council.
RATHDRUM—Workmen's dwellings, Rural District Council.
RAWTENSTALL—Generating station buildings, Corporation.
ROTHERHAM—Elementary school, Southgrove Education Committee.
RUSHTON—Mill, Mutual Mill Building Co.
SADDLEWORTH—Mill buildings, J. Clare, Limited, Mr. Bradbury.
ST. DOGMAELS—Factory, Mr. T. L. Williams.
ST. LEONARDS—Fire station, Shepherd's-street (£1,295), Corporation.
ST. MARYLEBONE, W.—Additions to house, Messrs. Hudson and Hunt.
SALFORD—Council school, Pendleton, Education Committee.
SANDIACRE—Four pairs of villas, Stapleford and Sandiacre Co-operative Society.
SCARBOROUGH—Post office, Aberdeen-walk, H.M. Commissioners Public Works.
SKELMERSDALE—Two houses, Witham-road, Co-operative Society.
SOUTHWARK, S.E.—Building, Redeross-street, Mr. R. Plumbe.
SOWERBY BRIDGE—Secondary school, Messrs. Longbottom and Culpan.
STANHOPE—Additions and alterations to premises, Stanhope and Weardale Industrial and Provident Society.
STANWIX—Alterations, Council schools, Cumberland Education Committee.
STEPNEY, E.—Extensions to electricity undertaking (£22,000), Borough Council.
STEYNING—Six houses at Sompting, West Rural Council.
STIRLING—Alterations to premises, Forth-street, Messrs. Kemp and Co.; double villa and offices, Linden-avenue, Mr. R. Foster; double villa, Wester Livilands Estate, Mr. G. Owen.
STOKE NEWINGTON, N.—Electricity generating station (£3,700), Borough Council.
STRABANE—Technical schools, Education Committee.
STRABANE—Workmen's dwellings, Rural District Council.
STRETFORD—Extensions to electricity undertaking (£42,718), Urban District Council.
SUNDERLAND—Alterations and additions to premises, Messrs. Laing and Co.
SWALLOWFIELD—Elementary school (£3,600), Berkshire County Council.
SWANSEA—Asylum. Mr. E. T. Hine, architect.
TORQUAY—Council school, Education Committee.
TANDERAGEE—Workmen's cottages (£3,514), Rural District Council.
TAUNTON—Meters and cables, Corporation Electricity Works.
THAMES DITTON—Elementary school, Surrey Education Committee.
THROCKLEY—Forty-six cottages, Throckley Coal Co.
TODMORDEN—Hippodrome, Local Syndicate.
TROON—Extensions, Fullarton public schools (£9,360).
TWICKENHAM—Seven houses and shop, Colonial-avenue, Messrs. Loveless and Co.
WALSALL—Four houses, Birmingham-road, Mr. G. Haynes; two houses, Birmingham-road, Mr. F. Yardley; Pavilion, Bloxwich Hockey Club; workshop, Bridge-street, Walsall Co operative Society; offices, Green-lane Talbot Stead Tube Co.; house for electric light plant, Green-lane, Birchills Furnaces, Limited.
WALTON ON-THE-HILL—Elementary school, Surrey Education Committee.
WANDSWORTH, S.W.—Buildings, north side Eatonville-road, Mr. W. O. Poole.
WANTAGE—Alterations to Church school, Churchwardens.
WARE—Four houses, near Broxbourne Station, G.E.R. Co.
WATERFORD—Workmen's dwellings (£42,000), Rural District Council No. 1; ditto (£31,970), Rural District Council No. 2.
WESHAM—Vicarage, Wesham Cross, Churchwardens.
WEST ARDSLEY—Additions to property, Upper Green, Mr. Walter Foster.
WESTPORT—Workmen's dwellings, Rural District Council.
WHITCHURCH—Mental hospital, Local Government Board.
WHITEBROOK—Elementary school, Monmouthshire Education Committee.
WILTON-IN-CLEVELAND—Restoration of parish church.
WINDLESHAM—Alterations to Council schools, Town Council.
WINDSOR—Secondary school (£8,066), Berkshire Education Committee.
WOKING—Technical institute, Surrey Education Committee.
WOLVERTON—Church institute and Sunday school (£4,000).
WOODLEY—Alterations, elementary school, Ashton Education Committee.
WOOLWICH—Extensions to electricity undertaking (£3,000), Borough Council.
YARMOUTH—Mains and electricity stores (£571), Corporation.

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PROVISIONAL PATENTS, 1908.

JAN. 17.

5508A/07. **Connection system for dynamo-electric machines.** Benjamin Garver Lamme, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Section 91 of the Act, Aug. 2, 1906, being date of application in United States. An invention comprised in application No. 5508, dated March 7, 1907.) (Complete specification.)

1118. **Improved method of lighting miners' safety lamps by electricity.** William Patterson, 11, Victoria-place, Darlington, co. Durham.

1131. **Improvements in magnetic stands or holding appliances for tools or the like.** George Frederick Douglas Campbell and John Albert George Williams, trading as Campbell and Isherwood, 34, Castle-street, Liverpool. (Complete specification.)

1154. **Improvements in tiles, electric light casing, picture rails, and the like for fixing to or on a wall or partition.** Arthur John Hollick, Queen Anne's-chambers, Westminster.

1159. **Improvement in regulating apparatus for alternating-current circuits.** Wilbur Hayes Thompson, Westinghouse Building, Norfolk-street, London. (Date applied for under Section 91 of the Act, Feb. 2, 1907, being date of application in United States.) (Complete specification.)

1178. **Improvements in or relating to frictional blocks, such as brake blocks, electrical collector slippers, and the like.** Charles Christopher Woodman Simpson, 6, Lord-street, Liverpool.

JAN. 18.

1187. **Improvements in and relating to electric conductors and collectors for electric railways and tramways.** Robert Cleghorn Thomson, 96, Buchanan-street, Glasgow. (Donald Kempt, Argentine Republic.)

1203. **Improvements in connection with the telegraphic transmission of photographs and the like.** Frank Wyndham, 11, Grosvenor-road, Norwich.

1209. **Transmission and reproduction of pictorial representations by electrical agency.** John Joseph Pearson, 10, Jamaica-road, Bermondsey, London.

1221. **Improvements in trolleys or collectors for electric railways and tramways.** Henry James Tompkins, Queen Anne's-chambers, Westminster.

1239. **Improvements in suspending devices for electric conductors.** Ralph Layfatte Hoffman, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Oct. 8, 1907, being date of application in United States.) (Complete specification.)

1240. **Improvements in suspension devices for electric conductors.** Frank Guillot, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Oct. 10, 1907, being date of application in United States.) (Complete specification.)

1250. **Improvements in and relating to electrically-driven mining machines.** Peter Jensen, 77, Chancery-lane, London. (Joseph Andrew Jeffrey, United States.) (Complete specification.)

1252. **Improvements in electromagnetic devices for use on alternating-current circuits.** Michael Birt Field, and Ferranti, Limited, 18, Southampton-buildings, London.

1253. **Improvements in or relating to apparatus for producing and utilising electrical effluvia.** L on Gerard, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, April 19, 1907, being date of application in Belgium.) (Complete specification.)

1260. **Improvements in or connected with telegraphic codes.** John Boden Montgomery Thomson, 4, South-street, Finsbury, London.

JAN. 20.

1299. **Improvements in coincidence telemeters.** Otto Eppenstein, Jena, Germany.

1322. **Improvements in and connected with boxes for electric wiring.** Henry William Handcock, Alfred Herbert Dykes, and Robert Tweedy Smith, 34, High Holborn, London. (Complete specification.)

1333. **Improvements in telephonic receivers.** Arthur Harold Nicholson, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

1344. **Improved process for making electrolytic depositions of chromium.** Franz Salzer, 6, Lord-street, Liverpool. (Date applied for under Section 91 of the Act, Jan. 21, 1907, being date of application in Germany.) (Complete specification.)

JAN. 21.

1399. **Improvements relating to telegraphic apparatus.** Edwin Thorley Parker, 18, Southampton-buildings, London.

1401. **Improvements in the methods of insulating electrical conductors and in the method of supporting and jointing conductors.** Henry Hewson Brown, 38, Shaftesbury-road, Ravenscourt-park, London.

1429. **Improvements relating to the treatment of wood for use in electric batteries and electrolytic cells.** The Chloride Electrical Storage Company, Limited, and Benjamin Heap, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

1427. **Improvements in space telegraphy.** Lee de Forest, 322, High Holborn, London. (Date applied for under Section 91 of the Act, Jan. 29, 1907, being date of application in United States.) (Complete specification.)

1431. **Arrangements for producing little damped oscillations for wireless telegraphy.** William Phillips Thompson, 6, Lord street, Liverpool. (Ges. fur Drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

1450. **Improvements relating to the electrical operation of haulage and winding gear and the propulsion of vessels, road vehicles, and other bodies.** Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

1451. **Improvements in submarine signalling apparatus.** Josef Schiessler, 46, Lincoln's-inn-fields, London. (Complete specification.)

1453. **Improvements in gas-burners and electrical devices for controlling, igniting, and extinguishing the gas from a distance.** Henry Langdon Down and Telephos, Limited, 115, Cannon-street, London.

1469. **Improvements in methods of producing coherent conductors of refractory material.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

1470. **Improvements in electric furnaces.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company. United States.)

JAN. 22.

1491. **Improvements in and in the mode of manufacture of electrical resistances.** Percy Smith Brook and John Arthur Hirst, 34, Castle-street, Liverpool.

1502. **Improvements in electricity meters.** George Hookham and Chamberlain and Hookham, Limited, 4, New Bartholomew-street, Birmingham.

1503. **Improvements in electricity meters.** Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 4, New Bartholomew street, Birmingham.

1515. **Improved apparatus for wireless transmission and transmission by wires of photographs, drawings, and the like.** Ferdinand von Madaler, 61, Stanley-street, Battersea, London.

1532. **Improvements in apparatus for electric signalling.** Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Jan. 23, 1907, being date of application in Germany.) (Complete specification.)

1546. **Improvements relating to armature windings for commutator electric machines especially applicable to high-speed machines.** The Phœnix Dynamo Manufacturing Company, Limited, and Robert Pohl, 322, High Holborn, London.

1547. **Improvements in or relating to radio-telegraphy.** Heinrich Lange, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Jan. 22, 1907, being date of application in Germany.) (Complete specification.)

1549. **Improvements in heat accumulators.** The British Thomson-Houston Company, Limited, and Frederick Samuelson, 83, Cannon-street, London.

JAN. 23.

1563. **Electrical apparatus for raising and lowering one or more slides for theatrical effects, advertising, and signalling.** Robert Bright, jun., 13, Lonsdale-road, Sunderland.

1536. **Improvements in arc lamps.** Herbert Edmund Moul, 18, Kensington Court-place, London.

1613. **Improved apparatus for noting down telephone conversations and the like.** Otto Schmid, 6, Lord-street, Liverpool. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Feb. 6.)

1906.

22379. **Voltameters.** Hatfield.

25111. **Electrically-heated apparatus suitable for cooking, boiling, ironing, and other purposes.** Berry.

28628. **Electric switches.** Clark and Vlasto.

1907.

783. **Covering, arranging, and mounting electric conductors.** Calvert.

899. **Magnetic separators.** Hollidge.

919. **Electric clocks.** Parsons and Ball.

1003. **Auxiliary dynamo-electric machines for equalising the output of main dynamo-electric generators supplying energy to a fluctuating external load.** Lancashire Dynamo and Motor Co., Warburton, and Kelsall.

1099. **Electric switches.** British Thomson-Houston Company. (General Electric Company.)

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1099A. Electric switches. British Thomson-Houston Company. (General Electric Company.) (Date applied for under Rule 13, Jan. 15, 1907.)

1191. Electric circuit-closing devices. Stockall.

1195. Electrostatic measuring instruments. Hamilton.

1277. Electric switches. British Thomson-Houston Company. (General Electric Company.)

1279. Systems of electric motor control in which the characteristic of the main generator is varied, and apparatus therefor. British Thomson-Houston Company. (General Electric Company.)

1330. Apparatus for awakening persons by means of an electric shock. Hornung and Sperling.

1449. Braking of electrically-propelled vehicles. Fraser.

1499. Production of continuous electrical oscillations for therapeutic purposes and to the application of the same. Manders.

3432. Electric switches. Edgar and Edgar.

3833. Electric meters. British Thomson-Houston Company and Holden.

4031. Electric ignition apparatus of internal-combustion engines. Electric Ignition Co. and Hall.

4183. Protective devices for electrical apparatus. British Thomson-Houston Company. (General Electric Company.)

4782. Electric switches. Broadbent.

5424. Electric incandescent lamps of variable intensity and holders for the same. Dameseaux.

5593. Electrical switches. Bolton and Coventry Watch Movement Manufacturing Company.

6266. Commutation of dynamo-electric machines, electromotors, rotary transformers, and the like. British Electric Plant Company and Oelschlager.

7279. Electric arc lamps. Angold and Maxim Electrical Company.

7757. Process and apparatus for the electrolysis of alkali chlorides or the like. Billitzer.

9240. Electric time-pieces. Möller.

9337. Electrolytic electricity meters. North and Pohl.

9991. Multiple sockets for electric incandescent lamps. Elliot. (Date applied for under International Convention, May 18, 1906.)

10406. Junction boxes for electrical cables. W. T. Henley's Telegraph Works Company and Nichols.

10469. Electrical vapour apparatus. Hahn.

10786. Electrical signalling systems and apparatus therefor. British Thomson-Houston Company. (General Electric Company.)

11616. Electromagnetic counters. Fluegelman.

11717. Manufacture of incandescence electric lamp filaments of tungsten or alloys thereof. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, May 19, 1906.)

11823. Devices for amplifying variable electrical currents of telephonic or like character. Lake. (Stone.)

12356. Method of signalling by means of electric lights and apparatus therefor. Stepanow.

12531. Electric connectors or couplings. Turner.

12827. Means for governing engines. Marconi's Wireless Telegraph Company and Bangay.

15136. Contact breaker for electrical ignition apparatus for internal-combustion engines. Bosch.

15755. Ear-guard with holding attachment for telephone receivers. Anker.

16251. Insulating conduits for electric wires. Hinsky.

17079. Electric heating appliances for medical use. Gschwend.

17722. Electric controllers. British Thomson-Houston Company. (General Electric Company.)

18921. Electric telegraph apparatus. British Insulated and Helsby Cables, Limited, and Harrison.

19800. Dynamos especially applicable for exploding electric igniters. Lake. (Fabrik Elektrischer Zünder.)

20650. Electric furnaces. Hartenstein.

20948. Method for reducing disturbances in telephone and telegraph wires. Siemens Bros. Dynamo Works, Limited. (Siemens-Schuckertwerke Ges.)

21862. Armature for magneto-electric igniting apparatuses. Rickmann.

24028. Process for decarbonising tungsten filaments containing carbon or carbide. Wolfram Lampen Akt.-Ges. (Date applied for under International Convention, Aug 31, 1906.)

26130. Electric furnaces. Brewer. (Taylor.)

26846. Arc lamps. Allgemeine Elektricitats-Ges. (Date applied for under International Convention, Dec. 5, 1906.)

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Jan. 21, 1908, converted to gold, were £3 552; corresponding period 1907, £3,543; increase, £9. Aggregate from Jan. 1, 1908, £11,232; aggregate from Jan. 1, 1907, £11,251; increase, £31.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price.
	£	£
Alliance Electrical Co., 5 per cent Cum. Pref., Nos. 1-70 000	1 ..	⅛ ⅜
—— Ord., 1,125 000	1 ..	⅛ ¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1 125 000	1 ..	9/16 11/16
—— Ordinary Nos 1 125,0 0	1 ..	5/32 9/32
British Aluminium Co., Ordinary, 2 001 40 000	5 ..	3¾ 4¼
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4⅞ 5⅛
—— "A" 5 per cent. Cum. Pref., 1-20 000	5 ..	4¼ 4⅜
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 103
—— 5 per cent Loch Leven Den. (Reg.) Red., 1-3 000	100 ..	98 101
British Insulated and Helsby Cables Ord., 1-100 000	5 ..	6¼-7
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100 ..	102-103
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock Red.	100 ..	85-89
British Westinghouse Elec and Manuf. 6 per cent Pref., 27 001-375 000	3 ..	⅞-1
—— 4 per cent. Mortgage Debenture Stock	100 ..	40 50
Brush Electrical Engineering, Ordinary, Nos. 1 105 751	2 ..	0-½
—— Non Cum., 6 per cent., Pref.	2 ..	⅛-⅜
—— 4½ per cent 1st Debenture Stock	100 ..	81 86
—— 4½ per cent. 2nd Debenture Stock	100 ..	63-66
Callender's Cable, Debentures	100 ..	104-105
—— Ordinary	5 ..	9¼ 10¼
—— 5 per cent. Pref.	5 ..	5¼ 5⅝
Consolidated Electrical Co., Ordinary 1 110,000	1 ..	7/16 /16
Crompton and Co.	5 ..	1⅞ 2
—— 5 per cent Debentures	100 ..	95-96
Dick Kerr and Co., Ordinary 1 260 000	1 ..	1-1¼
—— 6 per cent. Cum. Pref., 1 30 000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock Red.	100 ..	99 102
Edison and Swan United, "A" Shares 1-9 #1	3 ..	⅞-1⅛
—— "A" Shares 01-017 13?	5 ..	1⅛-2⅛
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos 1 to 112 100	2 ..	5 16- /16
—— 7 per cent. Cumulative Pref.	2 ..	⅜-1⅞
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	65-69 x d
Electrolytic Alkali Co., Limited, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent 1st Mort. Deb. Stock Red.	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7 8¼
—— 4 per cent 1st Mort. Deb Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	⅜-⅝
—— ½ per cent. Debentures	100 ..	104½-106½
India Rubber, Gutta Percha, and Telegraph Works	10 ..	1 ½-15⅝
—— 4 per cent. Debentures	100 ..	85-100
National Electric Construction Co. 1-1 0 000	1 ..	⅛-⅜
Parker Thos., Limited, Ordinary	10 ..	10-10½
Pebles (Bruce) and Co., 6 per cent Cum. Pref., 20,001- 0.000	5 ..	—
Telegraph Construction and Maintenance	12 ..	28-31
—— 5 per cent Bonds	100 ..	102-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9

Electric Lighting and Supply.—

Name.	Amount paid.	Last price.
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10 000	5 ..	4⅜ 5⅛
Bournemouth and Poole Electricity	10 ..	1 ½ 11½
—— 4½ per cent. Cum Pref., 7 501-15 000	10 ..	10 1
—— 5 per cent. Cum Second Pref., 15 00.-22 500	10 ..	10¼ 1⅜
—— 4½ per cent. Debenture Stock Red	100 ..	99 02
Brentford (Kent) Electric Light and Power Co	5 ..	4⅜ 4¾
—— 4½ per cent. 1st Debenture Stock. Red.	100 ..	96-98
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	7-8
Calcutta Electric Supply Corp. Ordinary, Nos. 1-60 000	5 ..	7-7½
—— Nos. 8 ,000-100 000	5 ..	5⅜ 6⅜ xd
Camuridge Electric Supply Company £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	10 -.05
Central Electric Supply, 4 per cent. Guar Deb. Stock	100 ..	97-100
Charing Cross, West End, and City Electric Supply Ord., 1-80 000	5 ..	4¼-5
—— 4½ per cent. Cum Pref 1-80 000	5 ..	4¼ 5
—— 4 per cent. Debenture Stock. Red.	100 ..	97 1 0
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000 ..	5 ..	4¼-4⅜
—— ditto (Sub) 40,001-80 000	5 ..	3¼-4¼
Chelsea Electricity Supply	5 ..	3⅜ 4⅜
—— 4½ per cent Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 3-yr. Gold Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	10-11
—— 6 per cent Cumulative Pref	10 ..	11¼- ½
—— 5 per cent. Debenture Stock	100 ..	120-123
—— 4½ per cent 2nd Deb Stk Prov Certs (all pd.)	100 ..	97-100
City of Wellington Electric Light and Power Co., 6 per cent. Redeemable 1st Debs Red 1-1 630	50 ..	50-53
Corinth Light and Power Co., 1st Mt. 5 per cent. Bds., Red 1-1.000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50 000	5 ..	3¼-4¼
—— 5 per cent Preference 1-50,000	5 ..	4⅛-4⅝
County of London Elec Supply, Ordinary	10 ..	6¼-7¼
—— 6 per cent. Cum Pref.	10 ..	10¾-11¼
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100 ..	103-106
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	95-98
Edmundson's Electricity Corporation, Ordinary. 1-50 000	5 ..	3-3¼
—— 6 per cent. Cum Pref.	5 ..	3-3½
—— 4½ per cent First Mort. Deb	100 ..	76-80 xd
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 20-year Gold Bonds, 10,751-15 750	— ..	75-78 p.c.
Electric Lt & Traction Co. of Aust., 6 p.c. Cum Pf., 1-30,000	5 ..	2½-2¾
—— 5 per cent Debenture Stock, Red	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb Stock, Red	100 ..	92-95
Folkestone Electric Supply Ord., Nos 1-10 000	5 ..	4¼-5
—— 5 per cent. Cum Pref., Nos. 1-10 000	5 ..	5-5¼
—— 4½ per cent. First Deb Stock Red.	100 ..	94-97 xd
Hove Electric Lighting, Ord 1-15 000	5 ..	6¼-6½
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	98-101
Isle of Wight Elec. Lt and Pr., 4½ p.c. Deb. Stk., Red	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref 1-150 000	1 ..	⅛-¼
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½

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Name.	Amount paid. £	Last price. £
London Electric, Ordinary	5	1¼-1⅜
—— 6 per cent. Pref.	5	4⅞-5⅛
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	90-94
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.) all paid	100	92-95
Metropolitan Ordinary, 100 001- 00,000	5	6-6⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	102 06
—— 4½ per cent. Cum. Pref.	5	4⅞ 5⅛
—— 3½ per cent. Mortgage Debenture, Red	100	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000)	—	77-79 p.c.
Mexican Light and Power Co., Capital stock	$100	49¼-51¼
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	87¼-89½
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6¼-⅜
—— do., 57,010-75 000	5	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5	5-5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	5-5⅛
Notting Hill Electric Lighting	10	11¼-12¼
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5¼ 6
—— 4 per cent. Debenture Stock	100	93-95 xd
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	21/32-25 32
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	⅛-1
—— 5 per cent. Debenture Stock, Red	100	92-93
Rosario Electric Co 6 per cent Cum Pref., 1-20 000	5	4⅜ 5⅛
—— 6 per cent. Cum 2nd Pref., 1-15 000	5	4⅜-5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	—	100-102 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛-1⅛
—— 4 per cent. Debenture Stock	100	71-75
South London Ordinary	5	2½-3
South Metropolitan Electric Light and Power, Ord.	1	⅛-⅜
—— 7 per cent Cum Pref.	1	1⅛ 1⅜
—— 4½ per cent 1st Mort. Deb.	100	101 104
St. James's and Pall Mall, Ordinary, 101-20,080	5	7⅜ 8⅛
—— 7 per cent. Pref.	5	6¼-7¼
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30 007	5	1½ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	2-2½
Westminster, Ordinary	5	8¼-9⅛
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	5-5½

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260 007	5	5⅛-5⅛
—— 10 per cent. Non-Cum 2nd Pref., 260,008-280,007	5	7⅛-8⅛
—— Permanent 5 per cent Debenture stock, 1888	100	[128-131
Auckland Elec Trams, 5 p.c. 1s Mor. Deb. Stk, Red.	100	102-105
Barcelona Tramways, Ord., 1-20 000	10	—
—— 5 per cent. Cum. Pref shares, 1-10 000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	11/16 13/16
—— 5 per cent. Cum Pref. Shares, 1-75 000	1	13/16-15/16
Birmingham and Midland Trams., 4½ p.c 1st Db. Stk, Red.	100	93-96
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec. Supply and Trams Co, 6 per cent. Cum. Pref.	10	9⅛-10
—— 4½ per cent. Deb. Stock, Red.	100	93-95
Brisbane Tramway Invest., Ord., 1-75,000	5	2⅛ 2½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅜ 4⅝
—— 4½ per cent Deb. Stk, Red., Prov. Certs. all pd.	100	97 101
British Columbia Electric Railway Co., Ord Def.	100	125-128
—— Ord Pref.	100	105 109
—— 5 per cent. Cum. Perpetual Pref. Stock	100	100 104 xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40	100-105
—— 4½ per cent. Vancouver Power Deb.	100	99-102 xd
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10	1⅛-1⅜
—— 6 per cent. Cm Pf., 30 001-60 000	10	4¼ 4½
—— 5 per cent. Perpetual Debenture Stock	100	90-95
—— 4½ per cent 2nd Deb. Stock	100	68-73
Bueno Ayres and Belgrano Trams	5	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-4?,000	5	4⅜-5⅛
—— "B" 6 per cent Cm. Pf., 1-27 500	5	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c Deb. Stk., Red.	100	93-97
Buenos Ayres Gd Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	100-104
—— 6 per cent. Deb. Bonds, Red 1-2,275	100	100-104
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	90 93
Calcutta Tramways, Ord., Nos 1-137.610	5	6¼-7
—— 5 per cent. Cum. Pref., Nos. 1 30 000	5	4⅜-5⅜
—— 4½ per cent. 1st Deb. Stock Red	100	101 105
Cape Electric Tramways, Nos. 1-480,000	1	3 16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4¼-4⅜
—— 4 per cent 1st Mortgage Deb, 1-3 000 (1917)	100	86-99
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red 1985	100	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	91-95
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum Pref.	10	12⅝-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10	13-14
—— 6 per cent. Pref., Nos. within 1-60,000	10	12⅝-13⅜
—— 3½ per cent. Mort Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk, Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1 000	80 85 xd
Imperial Tramways Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	13-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60 000	5	⅞-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-⅛
—— 5 per cent "A" Deb. Stock	100	87-91
—— 6 per cent "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10- 0½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	92 95
—— £286 500 2nd Mort Deb. Stock	—	—
—— £83, 30 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	⅞-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425 553	1	13/16 15/16
—— 5 per cent. Mort Deb., 1-5,000 Red.	100	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7⅛-8⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	81-85
Madras Elec Trams. (1904) 5 per cent. Deb. Stk, Red.	100	95 98
Manila Elec. R.R. and Lighting Corp., 5 p.c 1st Lien and Coll Tr Sinking Fund Gold Bonds of 1953 Red. 1- ,635	$1 000	88-92
Manx Elec. Railway Co., 5½ p.c Cum Pref., 301-21 625 and 23,436 25 000	5	4½ 5
—— 4½ per cent 1st Mort. Deb Issue Red	100	94-98
Metropolitan Elec Trams., Defd., 1 000 001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref. 500,001 1 000 000	1	13/16- 15/16
—— 4½ per cent. Deb. Stock, Red.	100	93-96
Mexico Trams. Co, Gen. Cons 1st Mort 50-year 5 per cent. Gold Bonds	—	84-86 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 001-2 000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅜-9
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mrt. Deb. Stk.	100	99-103
Potteries Electric Traction, Ordinary 1-245 000	1	5/16-9/16
—— 5 per cent Cum Pref., 300 001 545 000	1	¼-⅜
—— 4½ per cent Debenture Stock	100	93-96
Provincial Tramways Co., Ordinary 1-24 912	10	4¼-5
—— 6 per cent. Cum. Pref., 1-10 000	10	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref., 1-30.000	5	5-5½
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	96-97
Sao Paulo Tramway, Light, and Power Co.	$100	117-121
—— 5 per cent. 1st Mort Deb., Red. 1929 1-11,000	$500	94-94½ p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum Pref., 19,571-169 570, Prov Certs.	1	⅞ 1⅛
—— 4 per cent. Deb Stock Red. 1 40	100	78-83
Sunderland District Electric Tramways. 5 p.c 1 t Mort. Debs., Red., 1-1 600	100	60-70
Yorkshire (West Riding) Elec Tram Co Ord., 70 001-110 000	5	1-1⅛
—— 6 per cent Cum Pref., 1-46,261	5	3⅛ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	67-68
—— 4 per cent. Pref.	100	84-86
—— " " deferred	100	4 -46
—— 4 p c Deb. Stock (Prov Script certs, fully paid)	100	100-103 xd
City and South London, Consolidated Ordinary	100	46-46
—— 4 per cent Debenture Stock	100	101-104
—— 5 per cent. Pref. Stock '91	100	116-119
—— " " " '96	100	114 117
—— " " " '01	100	113 116
—— " " " '03	100	110-113
Liverpool Overhead, 5 per cent. Pref	10	10-10¼
—— Ordinary, 1-50 000	10	3¼-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1 700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	—	36-40

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent Debs. Red., within 1-1,069	100	84-87
American Telephone and Telegraph Coll. t. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000	86-88
Anglo-American Telegraph Co. Ordinary	100	57-60
—— 6 per cent. Preferred Ordinary	100	101-103
—— Deferred Ordinary	100	16¼-17
Anglo-Portuguese Telephone Co., 5 per cent 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44 000	5	6⅜ 7⅛ xd
Commercial Cable Co., Stock, 500-year 4 p.c. Deb. Stk., Red.	100	84-85
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10	6½ 7⅛
—— 10 per cent Preference, 1-6 000	10	15⅞ 16⅜
Direct Spanish Telegraph Co., Ordinary	5	3¼ ⅜
—— 10 per cent Cum. Preference	5	8½ 9⅛
—— 4½ per cent Debs., 1 600	50	9 -101
Direct United States Cable Co.	20	13¾-14¼ xd
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200 Red.	100	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	99 102
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000 1913	25	99-101
Eastern Extension, Australasia and China, 1 300 000	10	12¼ 12⅝ xd
—— 4 per cent. Mort. Deb. Stock, Perp	100	01-104
Eastern Telegraph Co., Ordinary stock	100	130-135 xd
—— 3½ per cent. Preference stock	100	82-85 xd
—— 4 per cent. Mortgage Debenture Stock	100	99-102
Great Northern Telegraph Co. (of Copenhagen)	10	30-32
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1 200, Red.	100	99-101
Indo-European Telegraph Co.	25	52-55
Marconi's Wireless Telegraph Co., Nos 25? 128-284,190	1	9/16-11 16
Monte Video Telephone Co., Ordinary 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	⅛-1
National Telephone, Preferred	100	111-113
—— Deferred Stock	100	110-112
—— 6 per cent Cum. First Pref.	10	11-13
—— 6 per cent Cum. Second Pref.	10	10¼-12
—— 5 per cent Non Cum. Third Pref.	5	5 5/16-5 9/16
—— 3½ per cent Deb. Stock, Red.	100	97-99
—— 4 per cent Deb. Stock, Red.	100	99-101
Oriental Telephone and Electric Company	1	1 1/16 1 3/16
—— 6 per cent Cum Pref	1	1 1/16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Debs. Red., 1-1 000	100	98 101
United River Plate Tele. Co., Ordinary 1-100 000	5	6¼-7
—— 5 per cent Cum. Pref., 1-40 000	5	4⅞-5¼
—— 5 per cent. Debenture Stock, Red	100	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock. Red.	100	99-101
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-?0 000 and 53 001-53,008	2½	1¼-1⅜
—— 4 p.c. Debs., 1-1 500 guar. by Western Telegraph	100	98 101
West India and Panama Telegraph Co., Ordinary	10	13/32-17/32
—— 6 per cent. Cum. 1st Preference	10	7½-8
—— 6 per cent. Cum 2nd Preference	10	7½-8
—— 5 per cent. Debs., Red., 1-800	100	100-103
Western Telegraph Co., 1-207,950	10	12¼-13¼
—— 4 per cent. Debenture Stock, Red.	100	98-101

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Jan. 22	1,121	1,118	+ 3	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	Nov. 17	1,019	966	+ 53	− 176	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	Jan. 25	3 180	2,420	+ 760	+ 3,184	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 26	936	898	+ 18	− 16	23 53	23·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 18	6,290	5,220	+1,070	—	564	5½	,, 31	18,557	5,752,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 12	957	870	+ 87	+ 3,176	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 23	307	306	+ 1	—	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	− 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 603	—	7·786
Bolton Corporation	Jan. 26	1 874	1,845	+ 29	+ 5 953	42	42	March 31	111 294	21,410,690	2,411,969	1·14	11·03	2 649	6·12
Bournemouth Corporation	,, 22	1,276	1,186	+ 90	+ 1,642	23½	24½	,, 31	83,665	13,503,610	1,765,098	1·48	11 37	2 860	7·28
Bradford Corporation	,, 18	4,175	4 014	+ 161	+ 4,478	98	95	,, 31	232 427	46.728,977	5,167,26	1·193	10 78	2.421	—
Brighton Corporation	,, 26	635	598	+ 35	− 3,189	17·191	17·191	,, 31	50,652	10.769,310	1,798,205	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 24	4 615	4,598	+ 317	—	53½	51½	,, 31	265,769	56.902,257	6 178,886	—	—	—	—
Burnley Corporation	,, 25	1,169	1,085	+ 84	—	19½	19½	,, 31	62 699	11,967,4.8	1,205,830	1 31	12 48	5,825	8·21
Burton Corporation	,, 5	238	274	− 36	− 585	9⅞	8½	,, 31	15 576	3,383,527	421.317	1·07	8·87	1,718	6·14
Cardiff Corporation	,, 11	1,834	1,918	− 24	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1 04	9·74	3,266	6
Carlisle Tramways Company	,, 23	142	119	+ 23	+ 13	8·5	8·5	Dec. 31	10 254	2.790 699	350,417	—	—	—	7·96
Central London Railway	,, 25	6 277	6,466	− 189	− 737	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,357	5·22a
Charing X, Euston, & Hamp. Ry	,, 25	3,140	—	—	—	7⅜	6½	—	—	—	—	—	—	—	—
City and South London Railway	,, 26	3,507	3 203	+ 334	+ 1,620	9	6½	h June 30	82,455	10.048,780	—	—	—	—	—
Colchester Corporation	,, 22	153	158	− 5	—	8	8	* March 3	10,588	2 457,653	220,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 25	368	335	+ 17	− 173	15½	15½	Dec 31	25,032	5.966 364	891.9 8	—	6·74	—	4·78
Croydon Corporation	,, 24	1,115	—	—	—	12 c	12 c	March 3	62,065	13,514,9.8	1,102,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 24	†31	220	+ 11	− 58	7 23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	− 1,124	4½	4½	,, 31	12,468	3.178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Jan. 24	92	80	+ 12	− 1·h	6½	6½	—	—	—	—	—	—	—	—
Dublin U.T.	,, 24	4,618	4,314	+ 274	− 69	51½	48½	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 22	1,068	976	+ 92	+ 1,681	22	22	May 18	57.672	15.554 905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	,, 25	759	721	+ 38	+ 431	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3 636	7 14
Glasgow Corporation	,, 25	16,079	15 715	+ 364	+16,486h	177½	169	May 31	387.391	221,063,088	20,350,367	·95	10·47	5,035	5 21
Gloucester Corporation	,, 22	208	208	—	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6 94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 25	5,440	3,630	+1 810	+ 7,471	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77 996	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	,, 25	1,363	1,297	+ 66	+ 3 123	35½	35	,, 31	81,196	15 252,150	1 804 745	1·22	10 79	2 770	5 92
Hull Corporation	,, 25	2 305	2,151	+ 155	+ 6,041	26	26	,, 31	121,186	29,161,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 18	366	402	− 36	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 22	119	110	+ 9	+ 380	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	13,702	4,640,618	466,919	6·02	7 55	1 723	4 95
Lancashire United Tramways	,, 22	1,080	989	+ 91	+ 156	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 18	6,023	5 789	+ 234	+11,534	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10 69	3,352	5 58
Leicester Corporation	,, 25	1,901	1 820	+ 81	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 18	10,011	10,577	− 566	− 1,719	104	104	Dec. 31	563 793	122.094.528	12.115 934	1 108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 26	1,330	1,300	+ 30	− 152h	9 25	6 65	June 30	77 568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 11	28 855	26,983	+1,867	+20 655	98	98	March 31	1 178,014	314 227 090	30,130 297	1·05	10 98	—	8 56
Lowestoft Corporation	,, 11	144	150	− 6	+ 101	3½	—	Sept. 30	11 079	2,622,922	343,190	1·03	7 9	2,156	6 39
Maidstone Corporation	,, 23	143	72	+ 71	—	3½	2	March 31	5,913	1 186.566	157,050	1·14	8 6	2,856	6 2
Manchester Corporation	,, 25	12,984	12 535	+ 449	+633,747	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 25	8,911	7 991	+ 920	+ 3,451	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 26	15,170	15,0.4	+ 136	− 13	23½	23½	June 30	627,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 25	125	113	+ 12	− 32	2⅜	2⅜	March 31	7,709	2.035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 25	3,725	3,692	+ 33	+ 1,248	59⅛	57½	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·14
Newport (Mon.) Corporation	,, 18	561	541	+ 20	+ 2,054	14½	14½	,, 31	32,421	7,760,403	772 753	1 03	10 01	1.525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35⅔	35⅔	,, 25	94,948	18,647,731	1,818,444	1·19	12 53	2,603	7·239
Portsmouth Corporation	Jan. 18	1,470	1,416	+ 54	—	28½	28½	,, 31	98,911	21 668 825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	553	+ 9	− 788	13½	13½	,, 31	32,651	8,120 179	918 825	9·0	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749.202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	25,916	5,743,298	618,211	1 12	10 45	2,691	7·38
Salford Corporation	Jan. 20	4,241	4,356	− 125	+ 5,906	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78c	4·78c	Dec. 31	7,779	1,537 845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 26	5,180	4,915	+ 235	+11,197	65½	65⅔	March 25	276,907	73 966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 22	232	221	+ 11	+ 74	9	9	,, 31	20,076	4,431,928	390,578	1 07	12 33	3,165	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248 656	—	9 464	—	4·849
Sunderland Corporation	,, 12	1,129	1,239	− 110	− 1,378	20	20	,, 31	72,396	17.483 132	1,525,425	1·006	11·261	3,687	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	Jan. 16	161	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 25	686	675	+ 11	+ 625	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19.204	4,965 296	429 785	—	10 724	1 989	6·95
West Ham Corporation	,, 23	1,971	1,931	+ 40	+ 2,023	14·7	14·7	,, 31	122,881	35,002,836	2,556,854	789	10·96	4,407	6·79
Wolverhampton Corporation	,, 22	730	721	+ 9	+ 421	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·095

1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE

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WHAT IS ELECTRICITY?

This is the title of an article in the February *Grand* contributed by Dr. Gustave Le Bon. We have during the course of a rather lengthy student life seen many theories advanced as to what electricity is, but not one has stood the test of extended examination. Dr. Le Bon almost at the very beginning of his article advances a proposition to which as yet we cannot agree. He says: "Matter itself, it is now proved, must take its place in the cycle of things destined to perish." He gives no valid proof of this, and we are quite sure the dissociation of radium or any radioactive substance no more proves it than the separation of water into its constituents, oxygen and hydrogen. In fact, Dr. Le Bon does not believe his own statement. The idea that motion, and motion alone, was the be all of everything is not new; the concept that all masses were constituted by vortex motion has long been before the world, and years ago we heard how a very able theorist, fully imbued with the idea that vortex motion constituted matter, gave up the notion on the instant. He unfortunately knocked his "funny bone" against the jamb of a door when about to close the door, and believed in matter as well as motion ever after. The last paragraph of Dr. Le Bon's article reads thus: "The particles of dissociated matter appear to be composed of whirling vortices of ether, the immaterial substance with which space is filled. It is the vibrations of the ether that give rise to both heat and light, and it is described as immaterial because heat and light falling upon bodies in no way modify their weight." Earlier in the article it is stated that the older views about indestructibility of matter were held because sufficiently sensitive instruments of measurement were wanting. May not the new view of Dr. Le Bon be supplanted by some other theory when still more sensitive instruments are obtainable? But what is his theory? So far as we can understand, it is electricity is something which always accompanies the dissociation of matter, and that all electricity generated in the universe is obtained by such dissociation. His words are: "Electricity, whatever form it may take, has no other origin but this. The gigantic commercial dynamos, equally with the small experimental machines used in laboratories, serve to dissociate matter, and to do this alone. The electric current which provides us with light and transmits our thoughts through continents and oceans is produced by the dissociation of matter." There, we have tried to give Dr. Le Bon's views, but candidly confess we are as far off as we were before to the answer to the question he propounds and professes to answer. It does not tell us what electricity is to say it is the accompaniment of dissociation of matter. According to our learned doctor, there is no matter, only motion; if so, electricity must be motion, and nothing but motion. We are not combating the idea that electricity accompanies dissociation, only the view that that statement does not advance our knowledge of what electricity is. Very interesting are the investigations of Hertz, Lodge, J. J. Thomson, and others, but as yet we have to assume so much about all that concerns the hypothetical ether that it is too soon to speak positively about aught that concerns it. Dr. Le Bon has given considerable information to the non-scientific world in this article about the researches on radium and radioactive substances which will be of considerable educational value, while leaving us as you were in the answer to what is electricity? It is difficult to imagine that the time will ever come when it will be possible to really know the complete answer to "what is" in many directions. There is a generally accepted opinion that motion is

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degraded to give motion, but a moment's thought shows this to be incorrect. Then, again, matter may be almost infinitely reduced in weight or, shall we say, ponderability if velocity be proportionally increased to give the various effects known. Whether any value would accrue in practice if we could say what electricity is, is a question which can well be left till that time comes.

COMMONSENSE IN INDUSTRIAL AFFAIRS.

A plea for commonsense in the conduct of industrial affairs may seem a little out of date in an age in which conciliation is one of the dominating ideas, yet contemporary events demonstrate the necessity for such a plea. Many will doubtless remember the suggestion thrown out by a famous statesman some years ago that if the combatants in a war then raging would only meet in some half-way house or country inn to discuss their differences in a friendly spirit, a settlement would soon be reached, and some will probably wish that such a suggestion would be adopted in cases of industrial disputes. But the very simplicity of the step tends to disarm belief in it by those who enter into a conflict with an exaggerated idea of the righteousness of their own cause, and the pity is that such means are not resorted to until the parties have been put to much expense and suffering. A strike is now rampant in the shipbuilding industry on the North-East Coast. This is a matter which, it might be said, concerns primarily the conflicting parties, and is the business of the particular industry affected. But so close is the connection between the various industries that comprise the engineering world, that one cannot affect to remain indifferent to events that take place in the other. Moreover, a study of the circumstances out of which the shipbuilding strike has evolved may be of value as teaching us what to avoid, and what to adopt should similar circumstances befall us. According to accounts that have appeared in the local Press, it would seem that the differences between the employers and their men are so ridiculously slight that they could easily be overcome by the use of a little commonsense, and the appreciation by the men of their employers' difficulties. It is stated that the men were prepared—and offered—to accept a reduction in wages of one shilling per week at once and sixpence in May next. The employers had previously agreed to extend the sixpence reduction until March, but declined to go beyond that date. From the economic point of view, the position of the shipbuilding industry seems analogous to that of the electrical engineering industry, both suffering from lack of orders and dearness of raw materials. Obviously, it is most unwise for some leaders of trade unions to encourage the want of harmony between masters and men by making injudicious speeches—the result of ignorance or misinformation—instead of weighing their words carefully, and considering the results they are likely to produce at critical junctures, and attempting to understand the exact position of the masters. One would hardly question Sir C. Furness's faith in trade unionism, and when so staunch a supporter finds it necessary to warn the leaders of the movement of the folly and danger of their reckless policy, it will be admitted that something is wrong. In a letter to the *Times* Sir Christopher reveals the true state of the shipbuilding industry, and points to the injurious effect which the harassing policy of the workmen's leaders is having. But he adds that even if the dispute was immediately settled by the men's acquiescence, that would not bring orders for ships. "There must be," he says, "all-round reductions in the cost of materials. Copper, which has been abnormally high, is still at a high figure, tin, pig iron, coal, and the hundred and one commodities which go to comprise the building and equipment of steamers are at a level far above the average The whole trade of this country has suffered by the mad speculation of American financial operators, the result being evidenced by the fact that those who employ their lives to the creation of new industries and the development of established industries, which after all form the real backbone of this country in employing vast numbers of the population, have been taxed by a 7 per cent. bank rate which, if it had continued, would certainly have been disastrous and productive of lasting effects on the trade and commerce of this country." We know what these conditions mean to the electrical engineering industry. It is obvious that no industry situated in these circumstances can tolerate unsatisfactory relations between masters and men, and clear-sighted men on both sides must see that in disputes the simple expedient of a joint conference and the display of commonsense and forbearance are the only effective means of settlement.

LIGHTNING PROTECTION.

Mr. J. S. Peck touched upon a subject which has received comparatively little attention in Great Britain, when at the Institution last night he read an interesting paper on protective devices for high-tension transmission circuits. That this class of apparatus has not received in this country the consideration which it would apparently deserve is due to a variety of causes, all of which may have been urged with more or less reason in the earlier stages of electrical transmission, when there were very few high-tension transmission systems in existence, and when underground methods of transmission were adopted in the great majority of cases, and consequently not subject to lightning disturbances. Even at the present time there are very few systems in Great Britain working at pressures above eleven thousand volts. But it seems probable that voltages much higher than eleven thousand will be used in future, and that overhead transmission will come into more extensive use both for present voltages and for higher ones. Underground cable systems, again, are particularly subject to switching, grounding, short-circuiting, and other disturbances on account of their great static capacity as compared with overhead systems. Of course, climatic conditions have a great deal to do with the apparent lack of interest in the subject, and the fact that severe thunderstorms are of very rare occurrence is an important factor. Nevertheless, the anticipated extension of the use of high-tension overhead transmission renders further consideration of the subject by British engineers decidedly necessary. In America and on the Continent, where the conditions differ greatly from those in this country, the development of lightning protective devices have been carried to a high state of perfection, and Mr. Peck showed that, in addition to the development in this direction, much headway had been made in the study of the laws governing static disturbances. We turn naturally to America for knowledge concerning the problem, and the work of Wurts, Elihu Thomson, Steinmetz, and Thomas have enabled us to gain a clearer understanding of the difficult phenomena and how to deal with them. Mr. Peck has brought to notice the most important examples of the protective devices now in use, and has at the same time given a concise explanation of the simpler phenomena. He showed how static strains might be produced, and pointed out that they might appear as high pressure to earth or between wires or as a concentration of potential upon a portion of the circuit. To relieve the high pressure between line and

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ground or between wires, lightning arresters are used. To protect apparatus from concentration of potential, choke coils are placed in series with the apparatus to be protected or the turns nearest to the line are heavily insulated, or both choke coils and additional insulation may be employed. Lightning arresters usually consist of an air-grip in series with a current-limiting and an arc-suppressing device. The four types of lighting arresters in general use were described by Mr. Peck—the horn, the multi-gap, the water-jet, and the electrolytic, the latter being the last one to enter the commercial field. The time it has been in active service is short, but it has already proved effective, and the indications are, according to Mr. Peck, that it will afford greater protection that any other arrester yet produced.

ELECTRIFICATION OF RAILWAYS.—II.*

BY DR. GISBERT KAPP.

It has already been stated that the continuous-current system is the oldest and most generally used of the three systems described in the last lecture. Twenty years have passed since the first railway line was electrified in America, and a large amount of capital has since then been invested in electric traction in that country. The amount is much larger than what has been spent on electrification in Europe. Several of the electrical journals both here and abroad publish admirable statistics on central stations and electric tramways, but not on electrified main lines, so that I cannot put before you any definite figures as regards mileage of railways worked electrically; but to give you a general idea of the extent of electrification in America, I may quote a passage I have found in a lecture by Mr. Sprague, delivered in May last before the American Institute of Electrical Engineers. I give the passage verbatim, only changing dollars into pounds: "How much has been spent in steam railroad development it is impossible to tell, but that it is a stupendous amount, giving some suggestion of future capital demands, is evidenced by the fact that the total of the outstanding stock, bonds, and other obligations of the steam railroads in the United States now aggregates about 2,760 million pounds, while similar obligations of the electric railroads, which began their commercial expansion with the signing of the Richmond contract almost 20 years ago, exceed to-day 700 million pounds." The boundary line between the conception of a railway and that of a tramway is not always easy to draw, but, even allowing that some of the lines electrified in America would be called tramways here, there still remains an enormous amount of what may truly be termed "main-line" property to which electric traction has been applied within the last 20 years. I have quoted Mr. Sprague for two reasons: first, to show that if a country applies a new system of traction on so vast a scale it must have found that this new system is a commercial success; and, secondly, to show that the engineers having such unique opportunities of testing all their improvements on a large scale, may be trusted to have brought their work also to a high degree of technical perfection. Indeed, so strong was the lead that American engineers have taken from the first in continuous-current electrification that the few railways that have up to recently been electrified in this country, and are now working, were with one solitary exception either electrified by American firms or by home firms working to American standards.

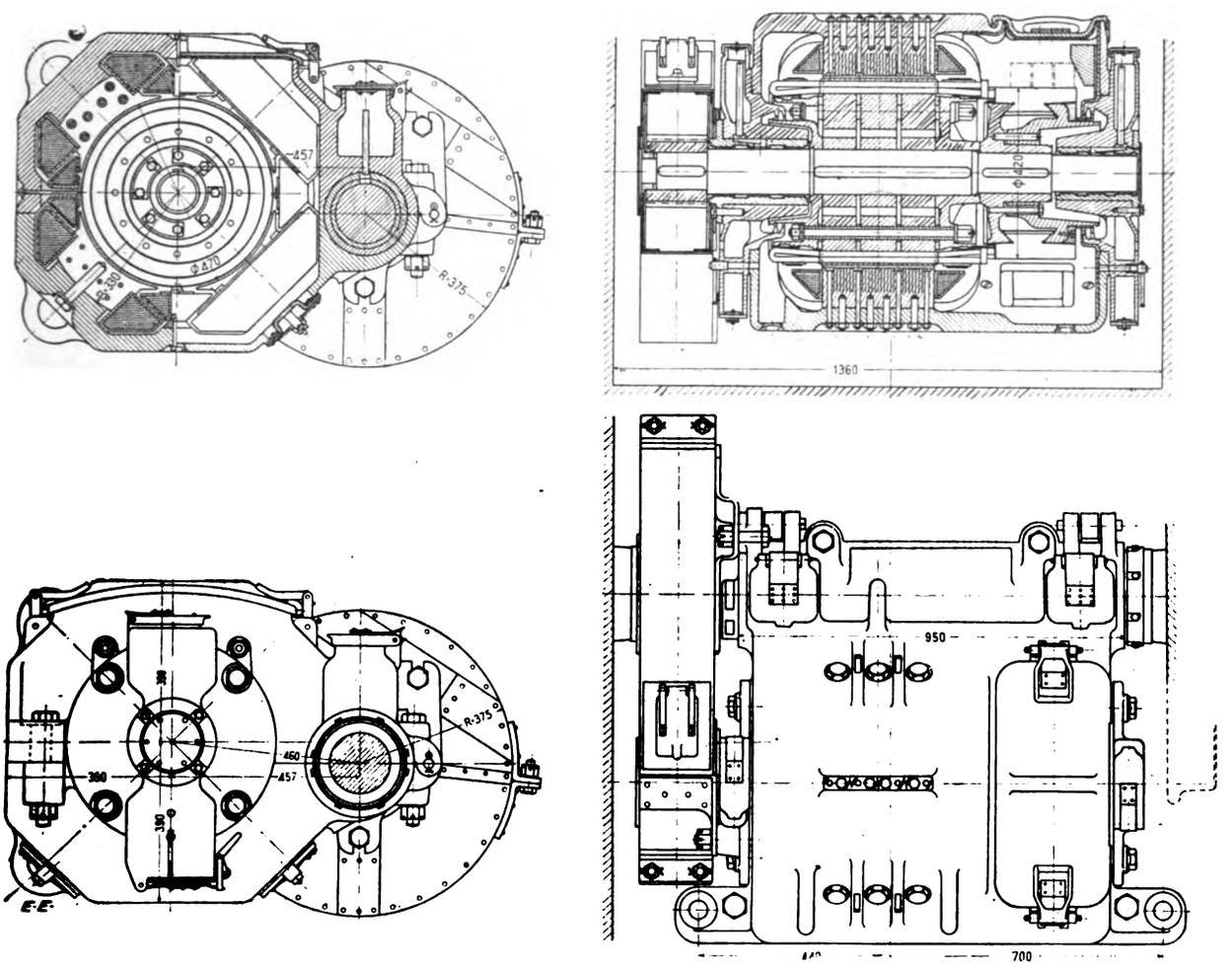

FIG. 29.—150-h.p. Motor for the Bonn-Cologne Railway by Siemens-Schuckertwerke.

On the continent of Europe the American influence was not so strong. Although one of the oldest lines—namely, that running from Milan to Gallerate and Porto Ceresio—was equipped by an American company, Continental engineers recognised from the first that the continuous-current system, no matter how perfect it be, would not meet all their requirements, and thus we see that so long as 10 years ago Messrs. Brown-Boveri introduced the three-phase system on the Gorner Grat Railway, and that some time after Messrs. Ganz and Co. introduced a

* Lecture delivered before the Royal Institution of Great Britain Saturday, Jan. 25.

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three-phase system on the Valtellina Railway. A little latter still we find German firms experimenting with the single-phase system, and now all the three systems have been taken up in Europe as well as in America. In the time at my disposal it will only be possible to give a few examples of the work done in the various directions, and I shall first draw your attention to some recent improvements in

THE CONTINUOUS-CURRENT SYSTEM.

One improvement—namely, the arrangement of the third rail with an under-running shoe—I have already mentioned. As regards the rolling-stock, some of the most important improvements are the use of commutating poles on geared motors, the gearless locomotive, and the use of higher pressure. Although modern motors run quite sparklessly when built for pressure up to about 750 volts, it is not easy to obtain satisfactory commutation with higher pressure unless a commutating field is provided. This may be done by commutating poles as shown. Fig. 29 is a drawing of the 130-h.p. motors built by Siemens-Schuckertwerke for the Bonn-Cologne Railway. This line is 18 miles long, and the maximum speed is 44 miles per hour. The trains are made up of four coaches, of which two are trailers, and the two motor coaches are each fitted with two of these motors

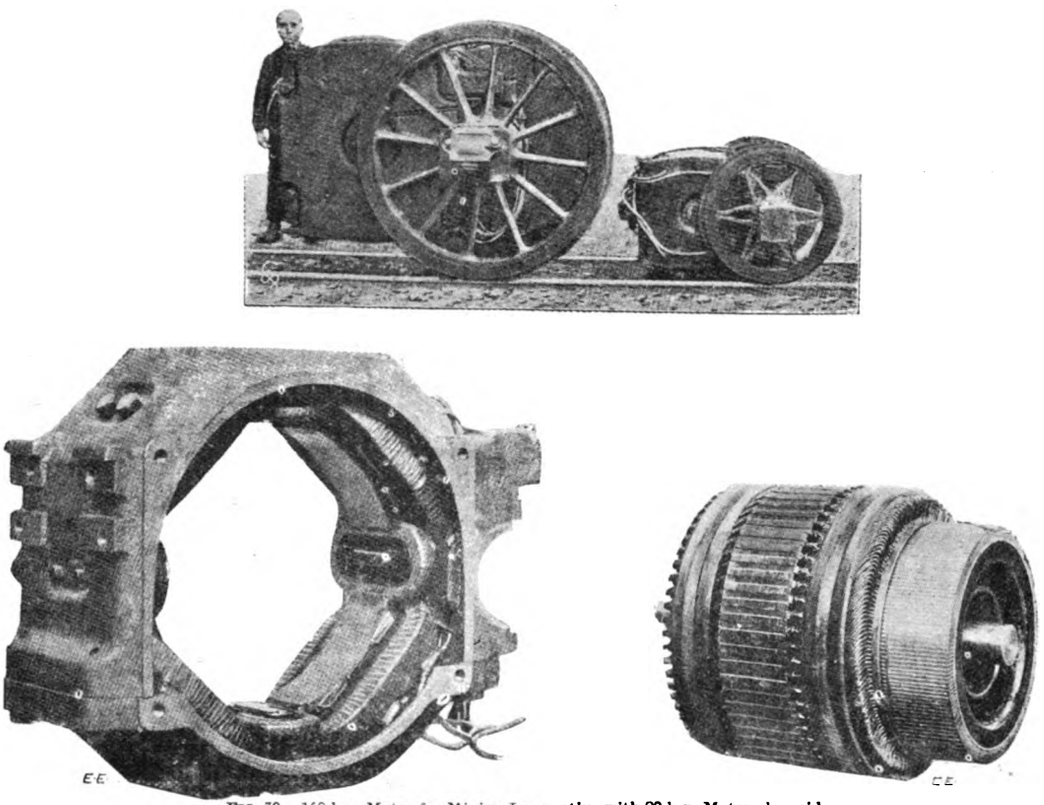

FIG. 30.—160-h p. Motor for Mining Locomotive with 20-h p. Motor alongside.

geared 1 to 3·1. The pressure on the trolley wire is 1,000 volts. Fig. 30 shows a motor of 160 h.p. for a mining locomotive with only 39½in. gauge put alongside a motor of 20 h.p. Here the pressure used is also 1,000 volts. A very remarkable type of locomotive is that built by the General Electric Company of America for the New York Central Railway (Figs. 31 and 32). It has four driving axles, with about 15 tons adhesive weight on each, the total weight being 85 tons. The axles are directly driven, and the leading feature of the design is that there is no rigid connection between the armature and the field system. The armature is carried on the driving axle, and the field is suspended from the frame, and thus participates in the

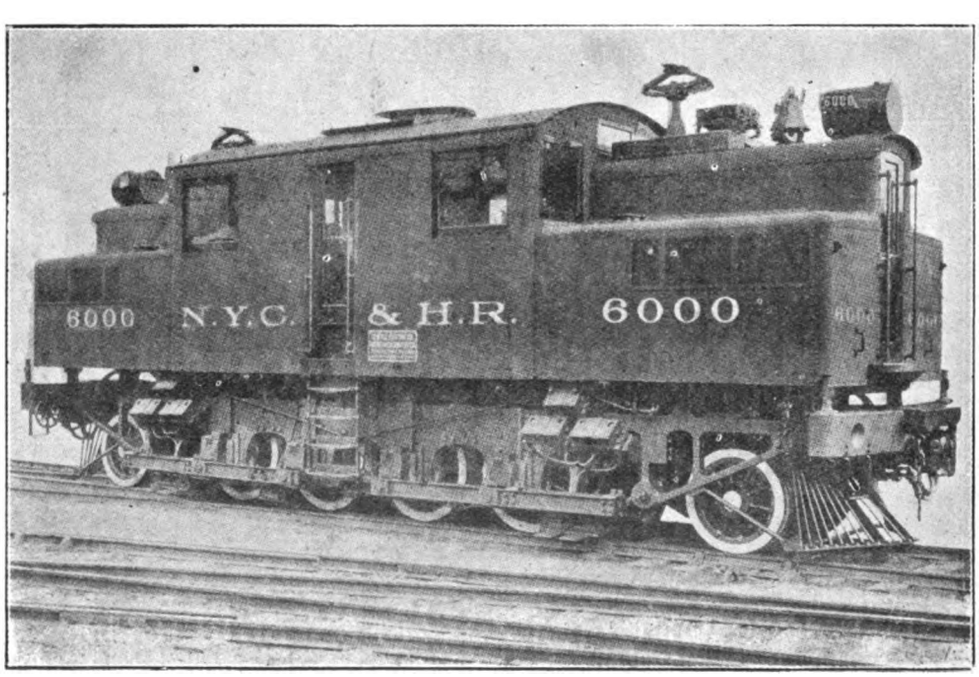

FIG. 31.—95-ton Electric Locomotive for New York Central Railroad.

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up-and-down motion permitted by the springs. The pole-faces are almost flat, and the air-space is very large. The field systems of the four motors are, magnetically speaking, in series, the frame and a heavy yoke bar completing the magnetic circuit. The motors having only two poles and the maximum 4,300 amperes. The current is collected by four shoes on each side attached to longitudinal channel iron. Two further collectors are placed on the roof. These can be raised by air pressure into contact with overhead conductors fixed in the yards, where the third

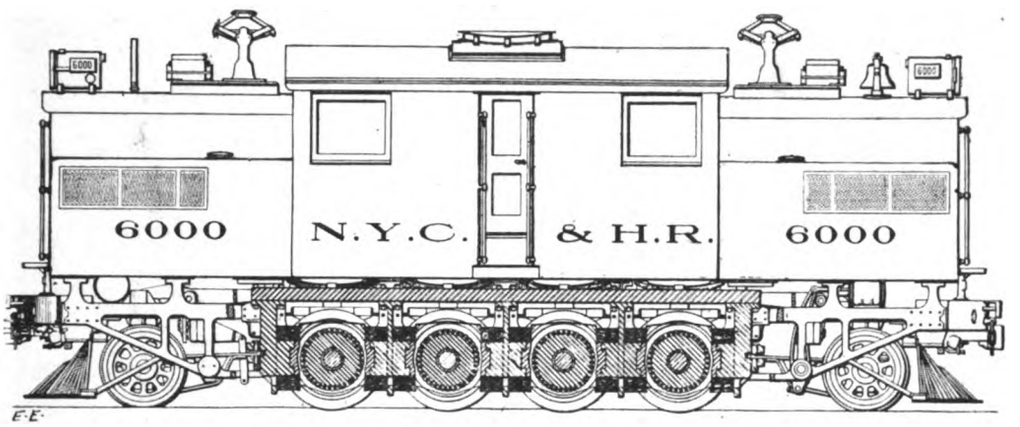

FIG 32.—Section of the Locomotive, showing special arrangement of Motors.

are specially adapted for high pressure; they could be worked at 1,000 volts, although 650 volts is the pressure adopted. The brushes are carried by the frame, and the collection is said to be perfect, notwithstanding the fact that the elasticity of the brush gear has to compensate for the relative motion between frame and armature. At the usual one-hour rating the motors develop 2,200 h.p., but rail would be objectionable. As illustrating the power of these engines, Mr. Sprague has recorded a case where a heavy steam train on going out of New York came to a standstill in a tunnel owing to a defect in its locomotive. An electric train following behind coupled on and pushed the whole load, amounting to about 900 tons, up a grade of 1·02 per cent. to the next station.

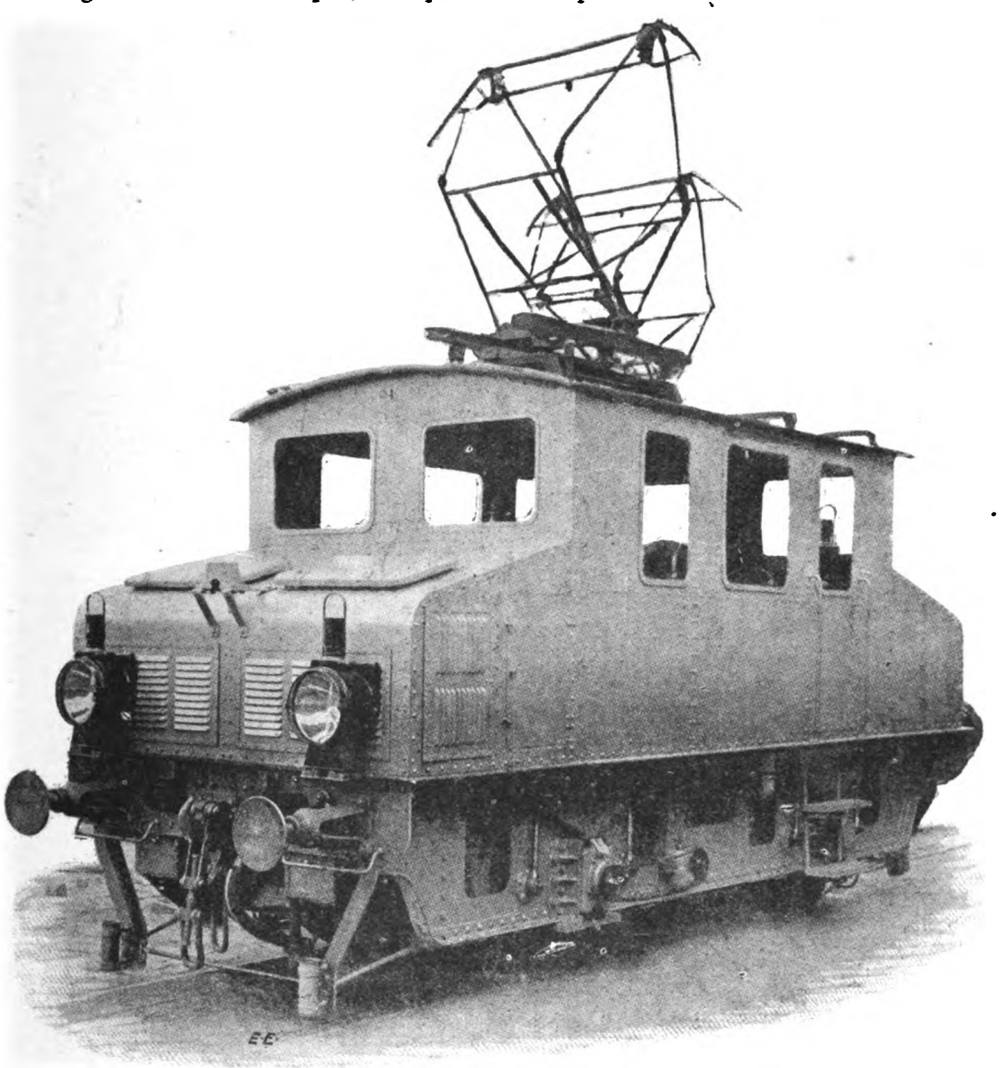

FIG. 33.—Krizik Locomotive, built for the Vienna Town Railway. 3,000 volts direct current.

for a short time as much as 3,000 h.p. can be obtained The maximum drawbar pull is 15 tons, and the speed with a train of 440 tons is 60 miles per hour. The steam locomotives which these engines have displaced weighed with tender 143 tons, and the maximum drawbar pull was 11½ tons. The normal full-load current is 3,050 amperes,

Whatever be the system of supply adopted, high voltage in the working conductor is desirable. The higher the pressure the farther apart may be the feeding points, the smaller will be the loss of power in the conductor, and the more easily can the current be taken off by the sliding contact. With continuous-current motors

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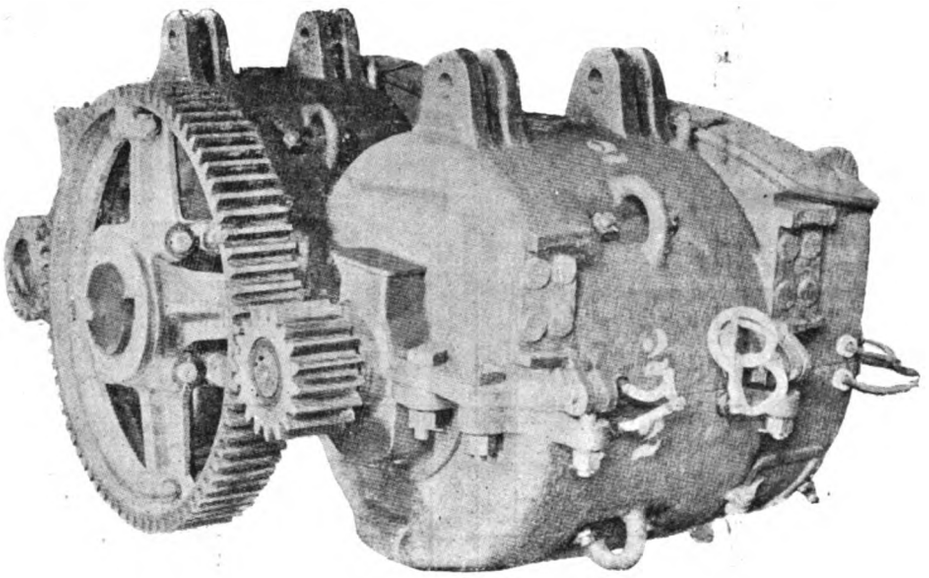

FIG. 34.—View of Two 750-volt Motors driving the same Gear Wheel for the Krizik Locomotive.

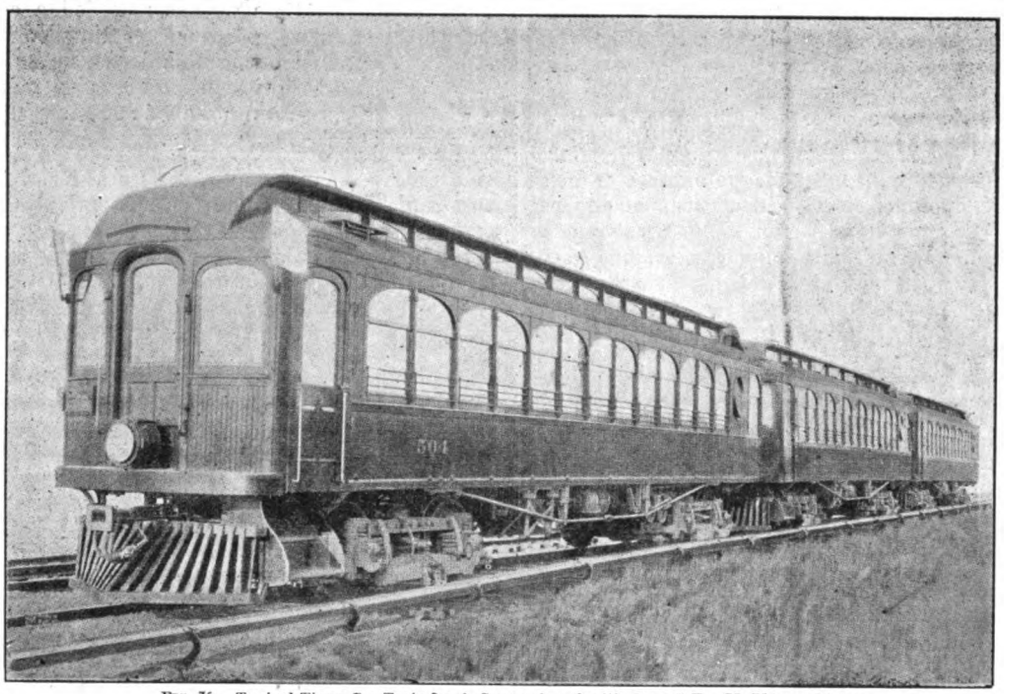

FIG. 36.—Typical Three-Car Train, each Car equipped with Four G.E.—73 (75 h.p.) Motors.

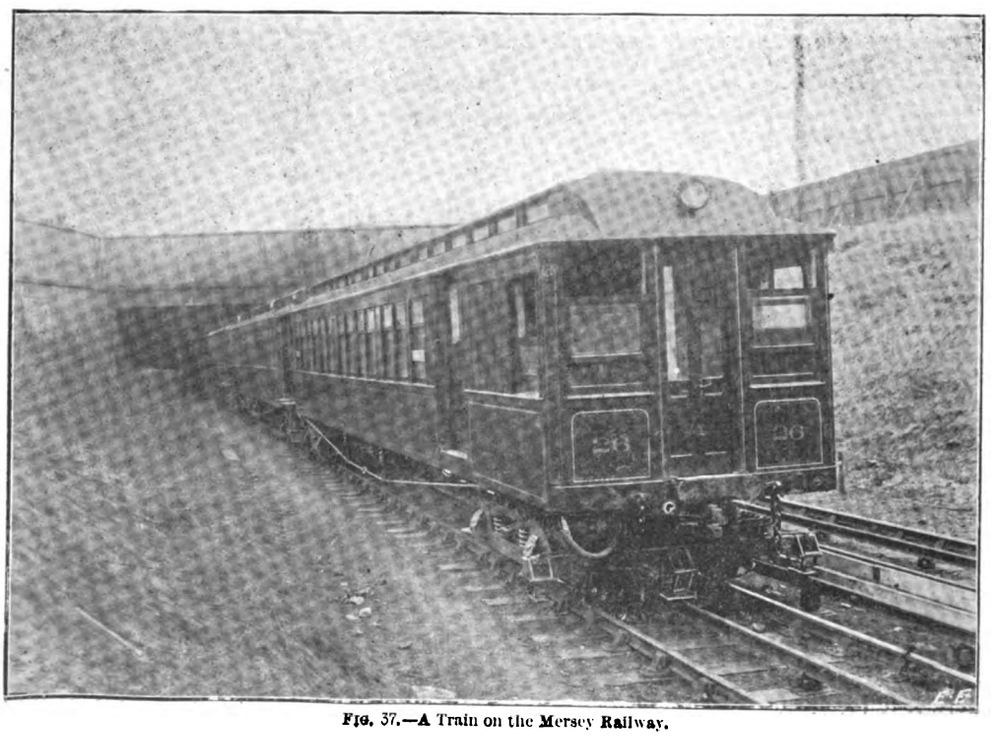

FIG. 37.—A Train on the Mersey Railway.

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of moderate size (such as required for tube and town lines), experience points to 500, or at the most 750 volts, as a safe working limit; and in exceptional cases, if the motors are large and commutating poles are used, 1,000 volts, but if a higher pressure is desired motors must be put in series. This has been done for the first time on the City and South London Railway running from Clapham, *vid* London Bridge, to Islington. The motors on this line are constructed for a working pressure of 500 volts. The trolley wires of the up-and-

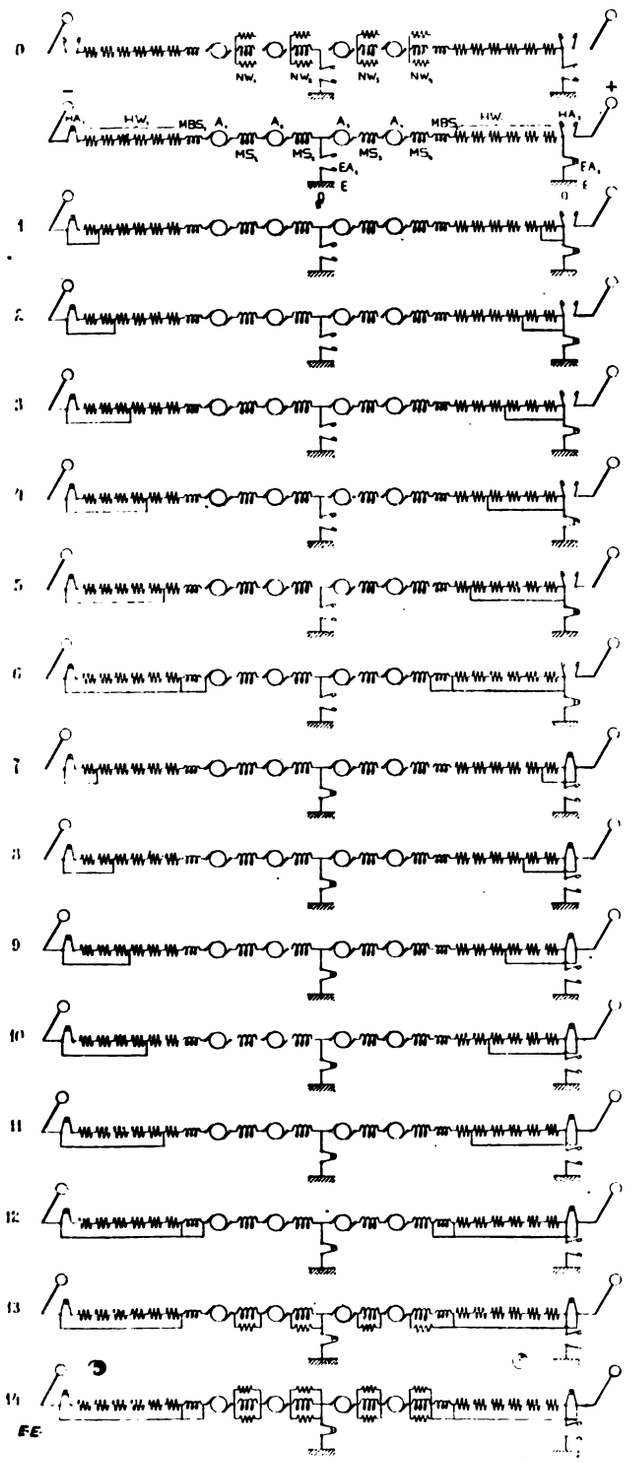

FIG. 35.—Controller Diagram for the Krizik Locomotive.

down line form the outer conductors of a three-wire system, the rails forming the middle wire. Thus, cars running on the up line get current from a positive conductor and cars running on the down line from a negative, the over-all working pressure as supplied from the power-house at Stockwell being 1,000 volts, whilst each car only gets 500 volts. This system does well enough for a town railway where the number of trains running on either side is fairly constant, and only a small part of the current has to go through the rails back to the power-house. This unbalanced portion is further provided for by three storage batteries at Stockwell, London Bridge, and Islington acting as buffers and shortening the path of the out-of-balance current. The system would not do on long main lines, because the return current would have to flow over long sections of rail, and thus the very essence of the three-wire system would be lost. This difficulty has been successfully overcome by Mr. Krizik, a Bohemian engineer, in the line he built to connect Tabor with Bechyne, in Bohemia. The line, which was opened for traffic in June, 1903, is only 15 miles long, and was worked with a pressure of 1,500 volts, but it is now being extended to 28 miles, whilst the pressure is raised to 3,000 volts.

In the Krizik system the three-wire principle is also carried out, not as between two trains, but as between two groups of motors on the same train. There are two trolley wires, one 1,500 volts above and the other 1,500 volts below earth potential, and normally the rails carry no current. At starting, on crossings and in the event of one side of the system failing, the rails carry the return current in the same way as in other continuous-current lines, but the trolley has the higher pressure of 1,500 volts. Owing to the high pressure the third rail can be replaced

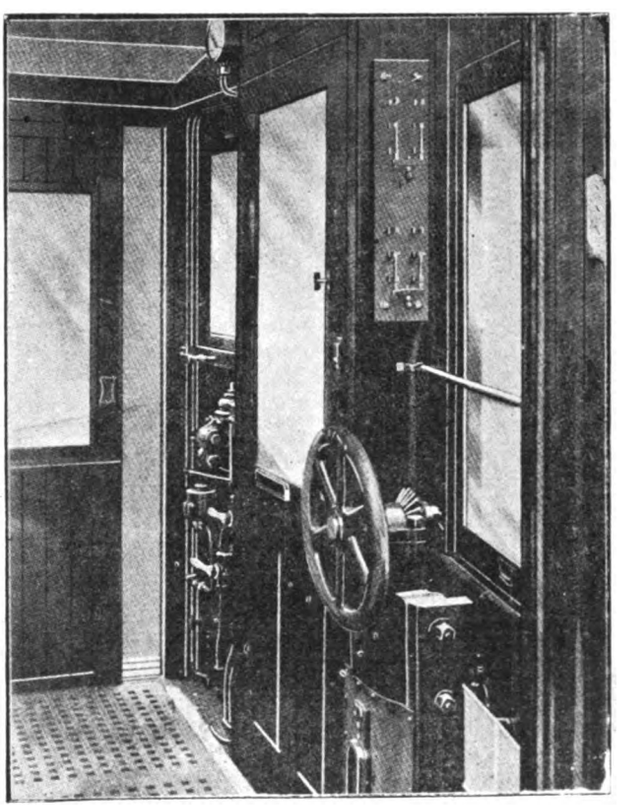

FIG. 39.—Interior of Motorman's Compartment (Westinghouse).

by overhead trolley wires, the current being taken off by pantograph collectors as shown in Fig. 33, which represents a Krizik locomotive built for the Vienna Town Railway and now being used on experimental runs on that line. The overhead wires are fixed 17ft. above rail level and 4ft. 8in. apart. The wire is of figure 8 profile and 115 square millimetres cross-section. Thanks to the high pressure, only two feeding points are required on the whole system, the drop of pressure at intermediate points being estimated at only 3 per cent. The locomotive weighs 29 tons and has two driving axles, each fitted with a pair of 750 volt motors. The motors are suspended in the usual way and gear both into the same toothed wheel, keyed on to the driving axle (Fig. 34). One such group forms a unit, taking current from one side of the three-wire system. The two units are permanently coupled in series, so that four 750 volt motors are permanently in series. At starting, or when going over crossings, the negative trolley alone is switched in, the earth connection being made beyond the fourth motor. In this case the pressure per motor is only 375 volts, and the starting is effected in the usual way by first inserting and then gradually withdrawing resistances. The current returns through the rails.

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At full speed the positive trolley is also switched in, and the earth connection is transferred to the middle point between the two groups of motors. Fig. 35 shows the sequence of connections from start to full speed, a special controller being used for the purpose. I am informed by Mr. Krizik that competitive trials between his system and the single-phase system are now in progress on the Vienna Town Railway, but that as yet no decision has been arrived at which system shall be taken. Meanwhile, it is interesting to note that by the use of commutating poles in combination with twin motors on the Krizik three-wire system, a main line can be electrified with 4,000-volt continuous current—that is, eight times the pressure customary hitherto.

by static transformers and rotary converters to 600-volt continuous current, and supplied to the trains (Fig. 36) through third rail. The express trains make the run between the two terminal towns in exactly an hour, or at a speed of 44 miles per hour. After leaving the main track the train runs on branch roads through the town, giving what Americans call a door-to-door service in the manner of a tramway. The slow trains run at 24 miles per hour.

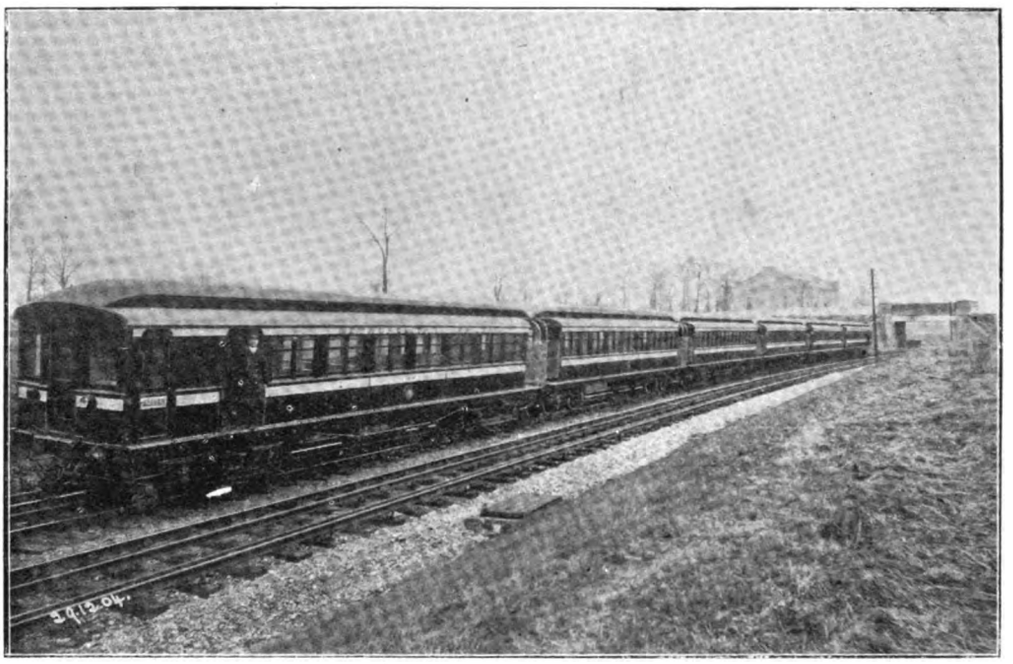

FIG. 38.—A Six-Coach Metropolitan Train.

The accompanying illustrations show similar work in this country. Fig. 37 shows a train on the Mersey Tunnel line, which was electrified by the British Westinghouse Company, and started running on May 3, 1903. Fig. 38 is one of the six-coach trains on the Metropolitan Railway,

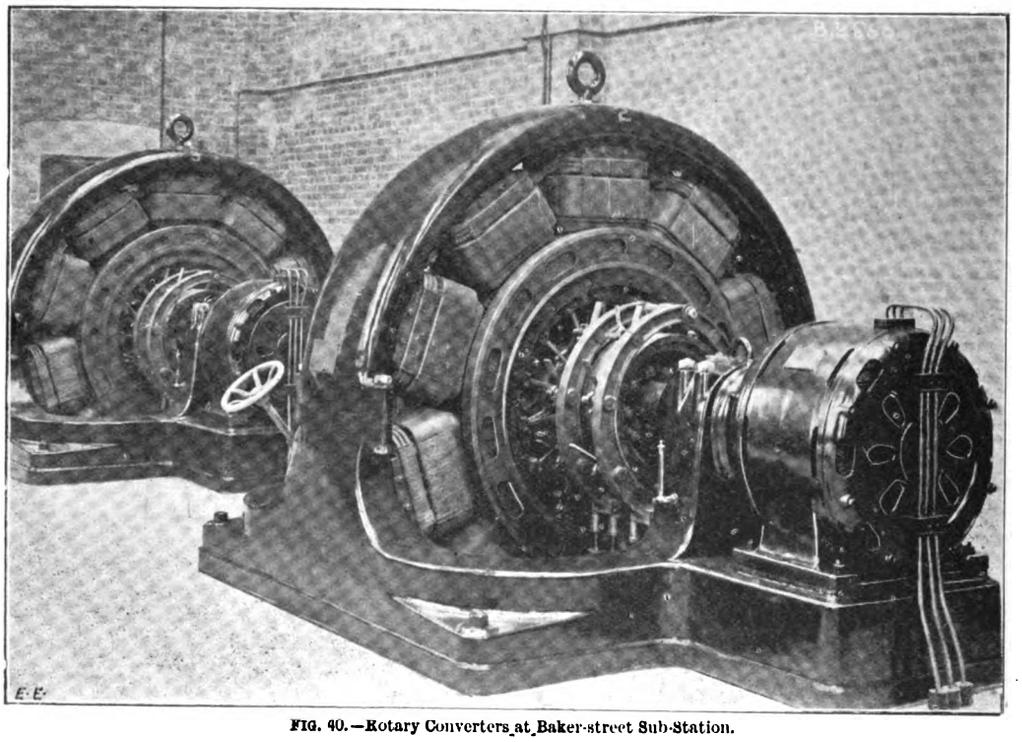

FIG. 40.—Rotary Converters at Baker-street Sub-Station.

As a typical example of main-line electrification in America we may take the line between Utica and Syracuse—44 miles, mostly double track, but in parts treble and quadruple track. The line was electrified by the General Electric Company of America. The power is brought by a three-phase 60,000-volt transmission line to four sub-stations along the railway, where it is converted also electrified by the British Westinghouse Company. The trains are worked on the multiple-unit system by a master controller in the driver's stand (Fig. 39). The current is supplied by third rail outside the track, the shoes being attached to the first and last coach, so that on crossings, where the third rail must be interrupted (the ends being connected by underground cables technically

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termed "jumpers"), the supply of current to the train as a whole is never cut off. There is a fourth rail between the track for the return, which is necessary when large currents are needed to prevent interference with the telephone service. The continuous current is produced by rotary converters in sub-stations (Fig. 40), which receive power in the shape of three-phase current at 33 frequency, and 11,000 volts pressure from the Neasden power-house, where four 5,000-h.p. Parsons-Westinghouse steam-turbines are installed.

(To be continued.)

STANDARD PERFORMANCES OF ELECTRICAL MACHINERY.*

BY DR. RUDOLPH GOLDSCHMIDT, ASSOCIATE-MEMBER.

(Continued from page 157.)

ALTERNATORS.

The task of developing standard efficiencies for alternators is a very difficult one, as the law fixing the size of the machine is very complicated if the number of poles and the diameter are small. We can speak of the "output" of the field and the "output" of the armature separately. Our output formula, K W at 1,000 = 0·165 × A W × F, refers to the armature only. Now, if we wish to make a good machine with not too much voltage drop, the A W of the field must be a multiple of the A W of the armature, say three or four times as much. The flux in the field

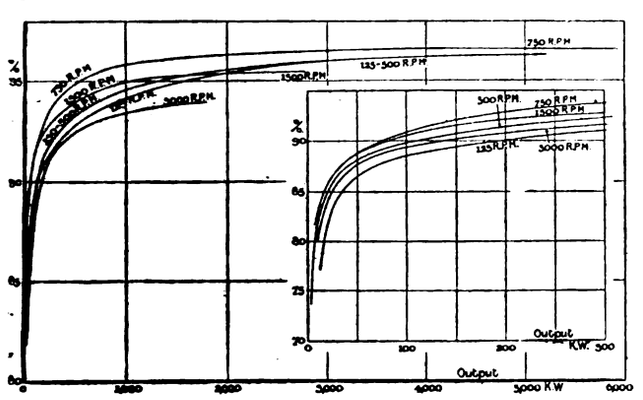

FIG. 11.—2- and 3-phase Alternator Efficiencies, 50 ∼

exceeds that in the armature by the amount of the leakage flux. Consequently, the "output" of the field must be considerably more than that of the armature. As the field in the case of modern alternators is generally inside the armature, its mean diameter is smaller than that of the latter. Consequently, it is often a difficult matter to provide room for sufficient A W and F, and the output of the whole machine has to be reduced. I should say that with machines below 5ft. or 6ft. in diameter and a moderate number of poles this difficulty is always experienced. In such cases the output of a certain size of machine may be considerably increased by the admission of a higher voltage drop or by compounding.

On account of these difficulties I decided not to reproduce here the curves for the detail losses of alternators, as they would have been too numerous, but to give the results only. Figs. 11 and 12 show the efficiencies of medium-volt polyphase alternators for 50 and 25 ∼ respectively, the power factor being unity. The falling off of the efficiency with very high speeds due to the friction and core loss will also be noticed here. In comparing alternating-current with direct-current machines, large alternators are found to be slightly more efficient than large direct-current machines on account of the commutator losses of the latter, but the reverse is the case with small machines where only small currents have to be dealt with on the commutators and where the alternators require considerable excitation. To find the efficiency of single-phase alternators it must be remembered that the output of a certain machine as a polyphase alternator is about 50 per cent. more than as a single-phase one. The losses of the latter may, therefore, be taken as those of a 50 per cent. larger polyphase machine. If we wish to know the efficiency of a 50-∼, 1,000-kw. alternator, running at 250 revolutions, we pick out from Fig. 11 the efficiency for 1·5 × 1,000 = 1,500 kw., polyphase, 250 revolutions = 95 per cent. The losses are $\frac{1}{0·95} - 1 = 5·2$ per cent. of 1,500 kw. = 1·5 × 5·2 = 7·8 per cent. of 1,000 kw. Therefore, as 1,000 kw. single-phase alternator, the machine has $\frac{1}{1·078} = 92·7$ per cent. efficiency.

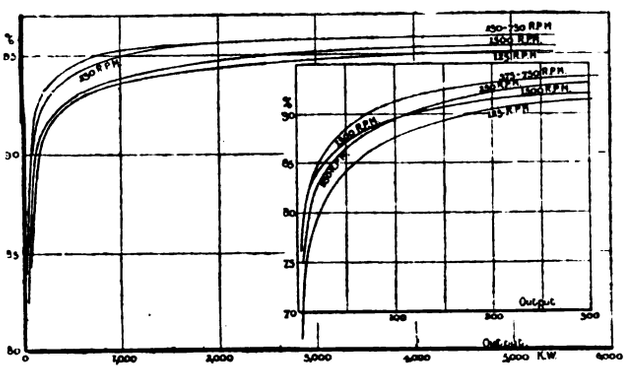

FIG. 12.—2- and 3-phase Alternator Efficiencies, 25 ∼.

Generally speaking, if g is the efficiency of the 50 per cent. larger polyphase alternator, the efficiency of the single-phase machine is

$$g_1 = \frac{g}{1·5 - \frac{g}{2}}$$

If the power factor is 0·85, the output of a certain machine is reduced 15 per cent.—actually the output of the armature only—while the excitation losses rise. It may, therefore, be stated approximately as

$$g_{0·85} = \frac{g}{1·3 - 0·3 \times g}.$$

I have pointed out what great influence on the size of machine the permissible voltage drop has. Therefore it is advisable not to specify it higher than can be helped. As a rule one finds about 7½ per cent. drop specified with a power factor of 1, and 23 per cent. with a power factor of 0·85. Calling the excitation watts with this drop (23 per cent.) 1, and plotting a curve "exciting watts as function of the drop," the curve Fig. 13 is obtained. I have

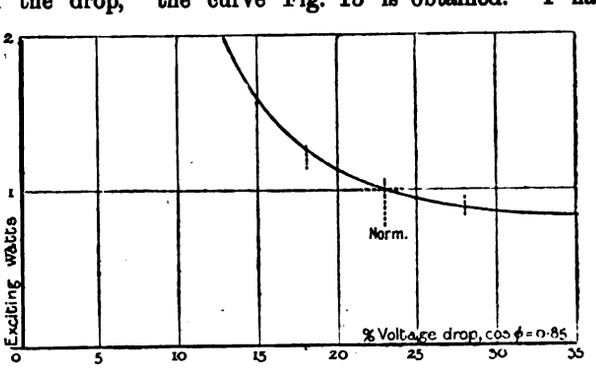

FIG. 13.—Voltage Drop of Alternators.

marked 23 per cent. as normal. If 5 per cent. less drop is required—that is, 18 per cent.—the exciting watts would go up 25 per cent., whilst an increase of 5 per cent. to 28 per cent. drop only alters the watts 12 per cent. A voltage drop of 23 per cent., therefore, appears to be very well chosen.

INDUCTION MOTORS.

The Efficiency.—The design of induction motors is far more definite than that of alternators, so that I may venture to reproduce a curve for the normal flux as a function of the "power" horse-power at 1,000 in Fig. 14. The overload capacity is the chief determining factor for these fluxes. In our case they refer to machines for about 125 per cent. overload capacity. With large and high-speed machines this figure is somewhat higher, owing to

* Paper read before the Institution of Electrical Engineers.

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the fact that considerations of economy become important when A W and F are chosen. The percentage core loss and copper loss for different powers are shown in Figs. 15 and 16. In induction motors the percentage core loss is also independent of the speed, and of the periodicity, if plotted separately for different numbers of poles. Three curves have been drawn: for 2 poles, 16 poles, and 48 poles. For any intermediate number the method of interpolation may be used. For instance, if it is desired

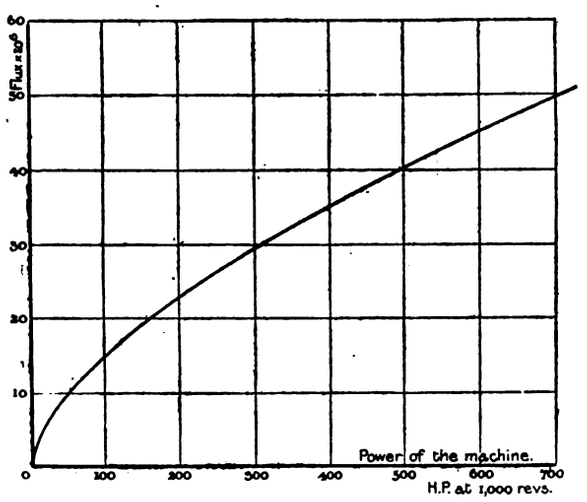

FIG. 14.—Induction Motors. Fluxes.

to find the percentage core loss of a 50-~, 500-h.p., 500-revolution (synchronous) motor, we have

$$\text{Power} = 500 \times \frac{1,000}{500} = 1,000 \text{ h.p. at } 1,000.$$

$$\text{Number of poles} = 120 \times \frac{50}{500} = 12.$$

From Fig. 15: Core loss with 2 poles, 1·4 per cent.; with 4 poles, 2·1 per cent.; consequently with 12 poles, 1·9 per

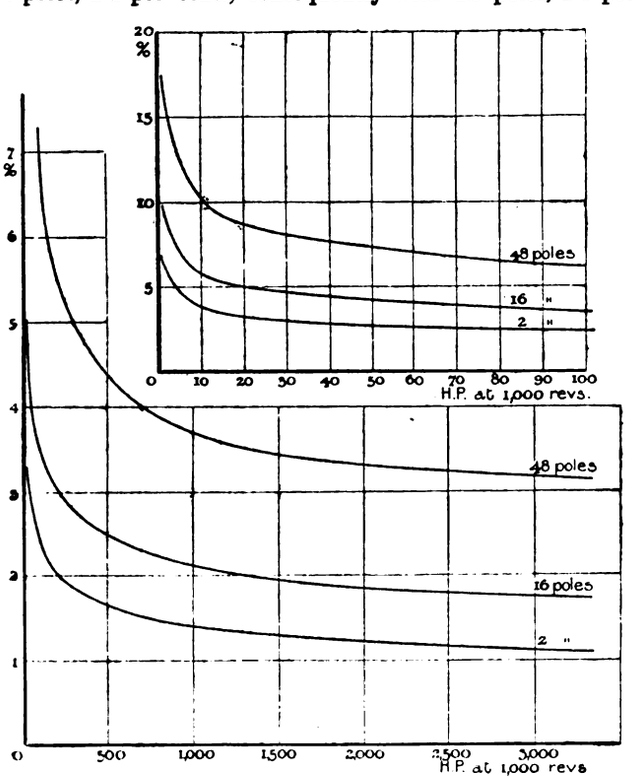

FIG. 15.—Core Loss of Induction Motors.

cent. The copper losses have been plotted for four poles and 50 ~ only. Here it has to be borne in mind that the percentage copper loss increases as the square root of the number of poles, and in proportion to the periodicity. The reason for this is that with an increasing number of poles the output falls proportionately, but the mean length of turn is reduced as the length of the end connections decreases. With different frequencies the copper losses remain constant, whilst the output falls with the periods. If it is desired to know the copper loss of an eight-pole machine for 25 ~ (375 r.p.m.), having a "power" of 100 h.p. at 1,000, it will be seen, from Fig. 16, that for 54 ~ and four poles it is 2·7 per cent.; consequently in our case it amounts to

$$2 \cdot 7 \times \sqrt{\frac{8}{4}} \times \frac{50}{25} = 7 \cdot 6 \text{ per cent.}$$

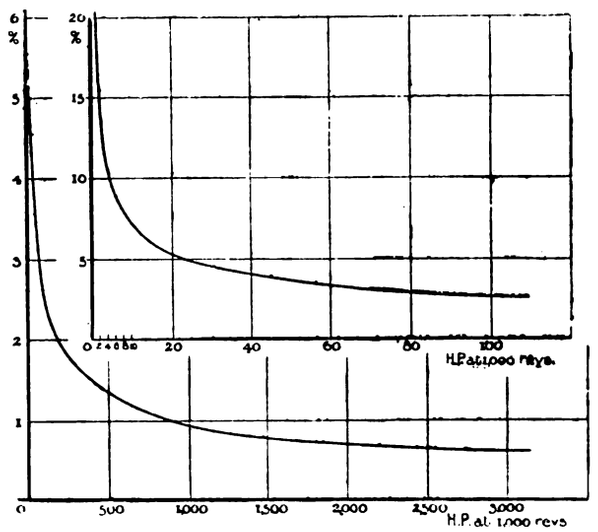

FIG. 16.—Copper Loss of 4-pole Induction Motors.

This copper loss is the stator and rotor loss combined. With moderately good machines about 44 per cent. of the copper losses are in the stator, 56 per cent. in the rotor, so that the rotor losses in our case are 7·6 × 0·45 = 3·4 per cent. of the output of the machine, unless a squirrel-cage rotor with specially high resistance is employed. This 3·4 per cent. may be called the natural rotor losses, or, what is practically the same, the natural slip. With squirrel-cage machines it is about 20 per cent. less than this amount, which refers to wound rotors. For obtaining high starting torque this slip can be artificially increased by the use of end rings of high-resistance metal in the rotor. I shall refer to this in the section on starting.

Figs. 17 and 18 show the complete efficiency curves for 50 and 25 ~ for polyphase machines. Fig. 19 gives the efficiency of single-phase induction motors for 50 and 100 ~.

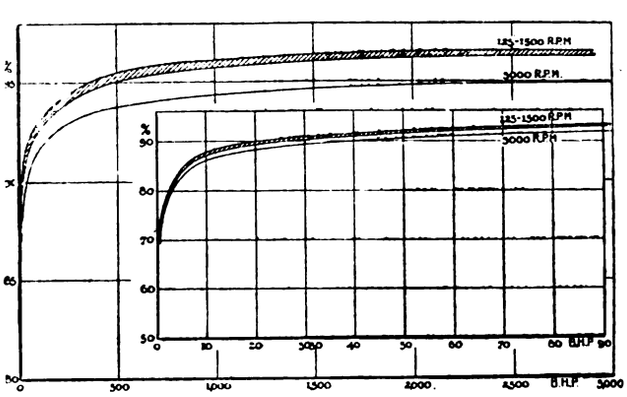

FIG. 17.—Efficiency of 50-~ Induction Motors, Polyphase.

In these curves the most striking feature is the fact that the efficiency is almost independent of the speed. It has been possible to show a narrow shaded area within which the efficiencies fall for any speed between 125 r.p.m. and 1,500 r.p.m. Since the percentage core loss falls, and that of the copper and friction loss rises as the speed goes up, the total losses remain nearly constant for a certain output. A comparison will show that the difference between the efficiencies of direct-current machines and alternating-current induction motors is not considerable. Single-phase motors naturally are considerably worse than both (Fig. 19).

The Power Factor.—In saying that the efficiencies of direct-current and induction motors are practically identical, we have to restrict this to the real efficiency, the apparent efficiencies naturally being much worse with the latter class of machines. It is often important to know clearly before-

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hand what the power factor is likely to be before deciding on the speed, as a few revolutions may often convert a bad motor into a moderately good one. It is hardly practicable to draw a great number of power-factor curves which might enable one to read off the figures at a glance, as there are too many items influencing the power factor—namely, the size of machine, expressed by the "power" horse-power at 1,000, the number of poles, and the overload capacity. The air-gap also influences the power factor, but, as hitherto, this detail of design is taken account of in determining the "size," that is, the power of the machine. Instead of a great number of curves for cos ϕ we use the two Figs. 20 and 21. It is well known that the power factor of an induction motor greatly depends on the leakage of the machine, this leakage being smaller the smaller the air-gap,

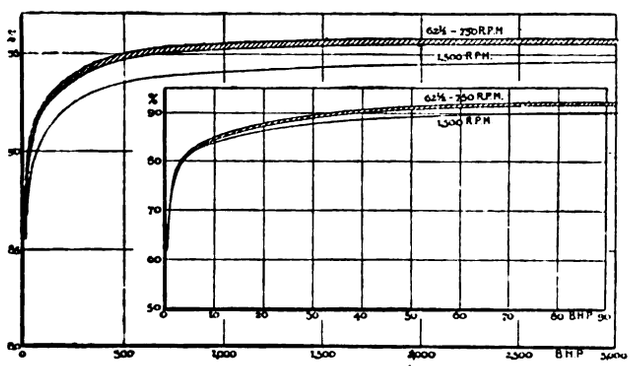

FIG 18.—Efficiency of 25-~ Induction Motors, Polyphase

the larger the diameter, and the lower the number of poles. Apart from this latter item the leakage only depends on details of design, so that a factor which is an expression for the tendency to admit leakage can be plotted as a function of the "power" of the machine. We call this factor the "*coefficient of lag*" A.* All details of design have been crammed into this coefficient, and it has been so selected that if multiplied by the number of poles Heyland's leakage factor appears. The meaning of A can be easily understood by studying the treatises by Behrend, Hobart, S. P. Thompson, and others, on induction motors.

Fig. 20 shows the coefficient of lag A dependent on the "power" horse power at 1,000 for three-phase motors with squirrel-cage rotors, whilst Fig. 21 directly gives the power factor at normal load for different overload capacities,

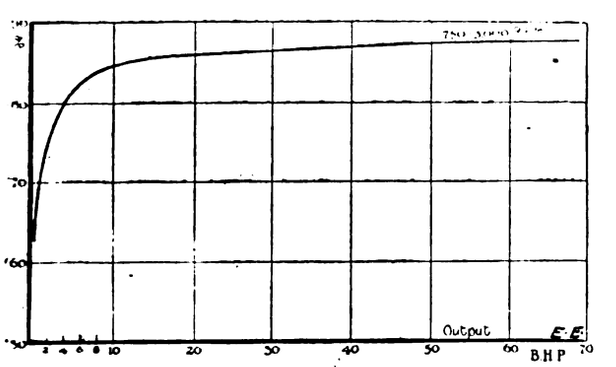

FIG 19.—Efficiency of 50- and 100-~ Induction Motors, Single-phase

dependent on the product "A × number of poles." If it is desired to know the power factor of a 20-h.p., 500-revolution, 50-~, three-phase motor, having, say, 125 per cent. overload capacity—that is, a machine with $120 \times \frac{50}{500}$ = 12 poles = p, and a "power" of $20 \times \frac{1,000}{500}$ = 40 h.p. at 1,000—we pick out from Fig. 20 A = 0·0082; A × p = 0·0082 × 12 = 0·099. From Fig 21 for this [A × p] and 125 per cent. overload capacity the power factor = 83½ per cent. If an overload capacity of 350 per cent. were required, the power factor would have been reduced to 73 per cent. The coefficient of lag A in Fig. 20, referring to three-phase squirrel-cage motors, is smaller than with any other class of motor, so that three-phase squirrel-cage machines have the highest possible power factor. A has to be multiplied

* I have to thank Mr. F. C. Aldous, of Manchester, for this term.

by the following constants: with two-phase machines by 1·4, with one-phase machines by 2·1. In all cases where the rotor is a wound one the coefficient of lag increases another 20 per cent. The motor in the above-mentioned example, having as three-phase squirrel-cage machine an A = 0·0082, would as two-phase slip-ring motor have an A = 0·0082 × 1·4 × 1·2 = 0·0168. A × p = 0·0168 × 12 = 0·20. With 120 per cent. overload capacity the power factor works out at 69½ per cent., compared with 83½ per cent. as a three-phase squirrel-cage machine. I should call this an almost impossible machine, as the wattless component of the current is larger than the watt component, and the no-load current will not differ very greatly from that at full load. I have drawn a

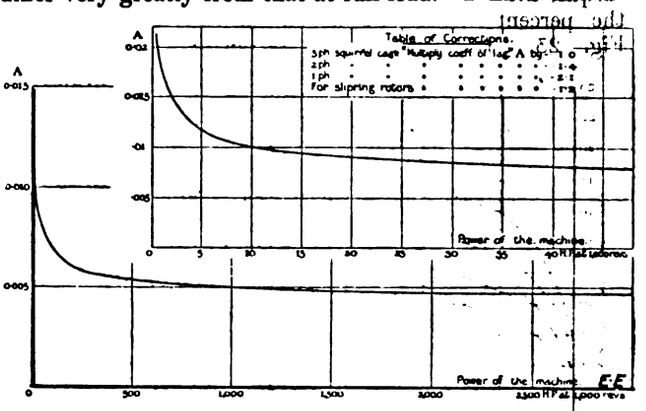

FIG 20.—Coefficient of Lag of Induction Motors.

line in Fig. 21 which represents the line of desirable practical limits, which only in exceptional cases ought to be exceeded. To make this still clearer the chart (Fig. 22) has been added, giving the highest number of poles a motor ought to be built for, the overload capacity being 125 per cent. in the case of polyphase and 60 per cent. with single-phase machines. From this chart it will be seen that a 20-h.p. motor as three-phase squirrel-cage machine ought not to have more than 16 poles, as three-phase slip-ring not more than 14 poles, as one or two phase squirrel-cage not more than 12 poles, as one or two phase slip-ring not more than 10 poles. This is rather hard on single-phase 100-~ motors, but these are trouble-

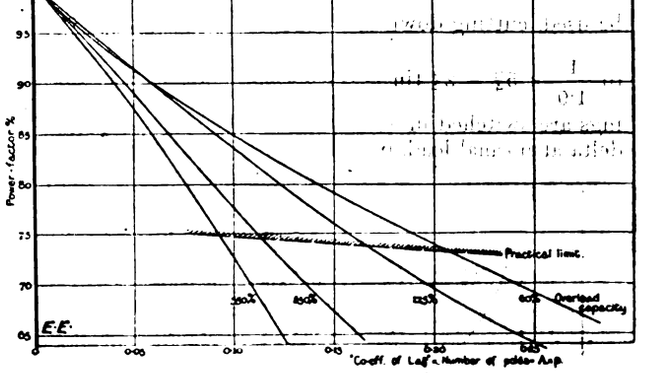

FIG 21.—Power Factors of Induction Motors.

some machines in many other respects. They can, however, be built if one is cautious in the selection of speeds. By building specially narrow 100-~ motors the performance may be slightly improved. It is necessary to point out that, when finding the coefficient of lag for single-phase motors from Fig. 20, this is to be taken at an abscissa for 50 per cent. larger output, as the "size" of a single-phase machine is 50 per cent. larger than the corresponding three-phase one.

The Starting of Polyphase Squirrel-Cage Motors.—The starting performance of a slip-ring motor where resistance is inserted in the rotor is too well known to be mentioned here, and it does not offer any special points which depend on size or design. The starting of squirrel-cage motors, however, often causes uncertainty as to the current consumption and the torque obtainable. We have to distinguish between machines being thrown straight on to the line and those started by means of a starting transformer,

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which reduces the voltage on the motor terminals. If thrown straight on to the line, the current taken by the motor depends on the overload capacity it has been designed for, the current being larger the stronger the motor. Fig. 23 shows in a curve the approximate ratio $\frac{\text{starting current}}{\text{normal current}}$ dependent on the overload capacity. With very bad machines this ratio is somewhat smaller than that given here, due to the high no-load current. It will be noticed that with 125 per cent. overload capacity the starting current is about five times the normal current. If we wish to obtain a starting torque equal to the running torque, the rotor must have its resistance adjusted to give the percentage of slip as shown by the Curve II. in Fig. 23. In some cases, especially with American

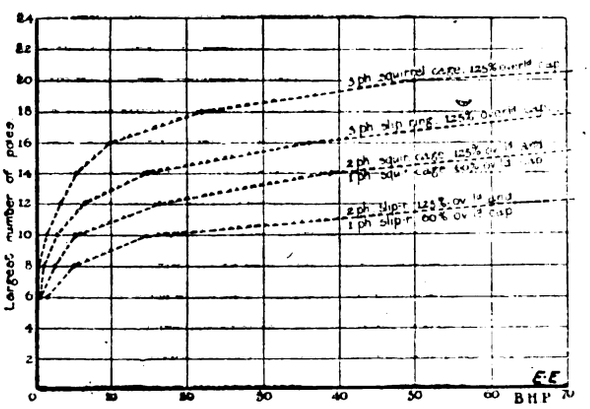
Largest number of poles
3 ph squirrel cage, 125% overload cap
3 ph slip ring, 125% overload cap
2 ph squirrel cage, 125% overload cap
2 ph slip, 125% overload cap
1 ph slip, 60% overload cap
BHP
E·E

FIG. 22.—Limit Number of Poles of Induction Motors.

machines, a good efficiency is not regarded as of great importance compared with good starting qualities. Also, short-circuit rings of the squirrel-cage are made of very high-resistance metal, and slips of 6 and, with small machines, even 10 and 12 per cent. are considered quite permissible. In this case very high starting torques can be obtained. Curve III. shows about the highest starting torque practicable. For instance, a machine with 150 per cent. overload capacity, having a starting current of $5\frac{3}{4}$ times the normal, can be expected to develop about 1·9 times the normal torque at starting. If in this case the normal torque is required a starting transformer can be used, cutting down the starting current in the ratio $\frac{1}{1{\cdot}9}$ to $\frac{1}{1{\cdot}9} \times 5\frac{3}{4} = 2\frac{3}{4}$ times the normal. Very often the windings are switched in star connection at starting, being in delta at normal load, in order to reduce the starting current.

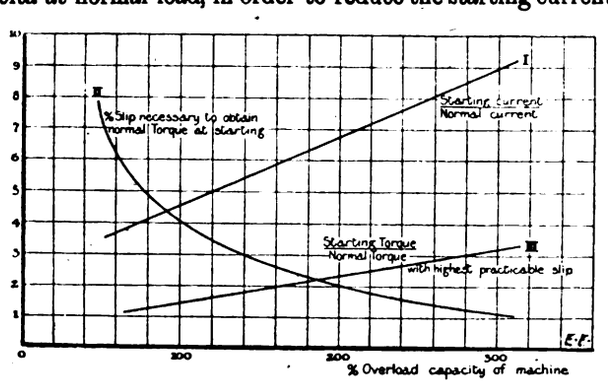
% Slip necessary to obtain normal Torque at starting
Starting current / Normal current
Starting Torque / Normal Torque
with highest practicable slip
% Overload capacity of machine
E·E

FIG. 23.—Starting of Squirrel-cage Motors, Polyphase.

Then the starting currents are reduced, together with the torques, to one-third of the figures given in Fig. 23. A motor having 200 per cent. overload capacity, the starting current being $6\frac{3}{4}$ and the starting torque $2\frac{1}{4}$ times the normal, would, in the star-delta method of starting, develop a torque of $1/3 \times 2\frac{1}{4} = \frac{3}{4}$ normal torque, and would consume $1/3 \times 6\frac{3}{4} = 2\frac{1}{4}$ times normal current.

Starting of Single-Phase Motors.—Single-phase induction motors with slip-rings are, as a rule, started with choking coils, and squirrel-cage machines with resistances as a means of splitting the phase. Only rarely are condensers employed. Whatever means are used for phase splitting, certain practical limits are encountered which without very much difficulty may also be followed up theoretically. I have given in Fig. 24 the starting current of single-phase motors as a multiple of the normal for different starting torques, the overload capacity being assumed to be about 75 per cent.

Maximum Voltage.—Before concluding the section on induction motors I should like to allude to a question often

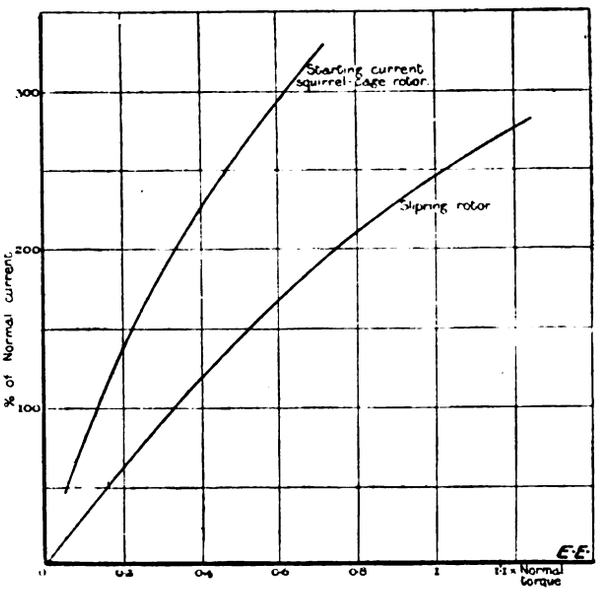

FIG. 24.—Starting Current of Single-phase Motors

asked, What is the maximum voltage for which a motor can conveniently be built? When ought a transformer to be used with the motor? This naturally depends very much on the design. Often the end brackets are too tight to take high voltage end connections, and questions of detail of design have to be taken account of. If this is not the case, I may say that the voltage of an induction motor ought not to be so high that with large machines the current falls below $2\frac{1}{2}$ amperes, and with small machines below $1\frac{1}{2}$ amperes.

(To be continued.)

ELECTRIC ILLUMINATION.*

BY J. CAMERON RENNIE.

A paper on this subject divides itself naturally into two parts—the production of light and the distribution of light. The first of these is a purely practical matter, an exact science with an obvious goal, which is the transformation of electrical energy into luminous radiation. We can consider and compare the various attempts to reach this goal, but cannot determine theoretically the route to be followed, nor, indeed, apply any theory whatsoever to the question. The improved sources of light must be discovered, not invented.

In the second case, however, the distribution of light, we have certain fundamental laws which must be obeyed; and from them we can deduce the best methods of distribution. It must be remembered that in dealing with the problem of illumination the ultimate judge is the human eye. It would, therefore, be wise to study the physiology of the eye with regard to light more closely than it has been studied up to the present. The two main facts to be considered are: (1) that the eye is liable to fatigue, and (2) that it adjusts itself as far as possible to its surroundings. The first of these is two well known to need explanation, the fatigue usually being proportional to the brilliance of the light to which the eye is subjected. The second fact explains the function of the eyelids and iris. If the intensity of illumination is too high the iris closes, thereby reducing the intensity of light on the retina to the normal amount.

It is obvious, therefore, that if there is in the range of vision a brilliant luminous spot, such as a naked arc, the

* Abstract of paper read before the Northampton Institute Engineering Society, Jan. 24.

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iris will adjust itself by closing till the brightness of the image of this spot on the retina does not exceed the normal. The remainder of the field of vision is made correspondingly dimmer, hence objects, other than the luminous spot, are not seen so easily as they should be. This fact has been recognised in a slight degree by the use of frosted and obscured shades. Unfortunately, many investigators are busy proving how wasteful it is to use these, a common statement being that 50 per cent. of the light is wasted. Whether that is so or not does not matter in the slightest degree. If by the use of obscured shades visual discrimination is improved, that is all that is required.

This leads to the conclusion that all the published figures and curves of the illumination in streets, buildings, etc., are quite valueless for comparative purposes. One street might be found to have double the illumination of another street and yet for ordinary use be much worse lighted. To have any real value the intrinsic brilliance of the source must be included in the statement, as that alone determines the action of the iris, which in turn fixes the discriminating power of the eye, whereby in turn the perfection of the distribution of light is judged.

LIVERPOOL ELECTRICITY SUPPLY.

There has during the past few months been a great deal of correspondence in the Liverpool papers respecting the electricity supply undertaking, and one or two circulars have been distributed depreciating the generating stations, the engineering skill of the head officials, and the capacity of the Tramways and Electric Light and Power Committee. It is a curious fact that two members of the Council, Mr. Alfred Gates and Mr. W. B. Stoddart, should put their names to the pamphlet which we have before us, and which contains what, in our opinion, are unfounded charges against the engineers and the contractors to the Corporation. On looking through the list of committees we find that neither of these gentlemen is on the Electricity Committee, but they must have spent a great deal of time in investigating electrical matters. The old proverb which states that "It is an ill bird that fouls his own nest" would seem to apply in this case. In view of the attention the matter has attracted, we thought it of interest to go to Liverpool and see at Lister-drive the Westinghouse turbines over which so much has been written. The matter was brought to a head by the following four resolutions, which appear in the agenda for the Council meeting on Wednesday last:

2. By Councillor Gates: That a special commission of inquiry be appointed by the Council to investigate and report on the Westinghouse turbine engines at Lister-drive—their cost and working—with authority to obtain independent expert opinion, if thought necessary.
3. By Councillor Gates: That the Council sanction the printing, in full, of the shorthand notes taken at the recent Local Government Board inquiry as to the Tramway and Electric Power and Lighting Committee's application for power to borrow £200,000, and that a copy be sent to each member of the Council.
9. By Councillor W. B. Stoddart: That a special committee be appointed to inquire into the following thefts from Lister-drive station—cable from battery-room; theft of a tarpaulin from L. and N.W. Railway; theft of pages from a Corporation book *re* turbines and other matters.
10. By Councillor W. B. Stoddart: That a special committee be appointed to inquire into the following matters—workmen's wages, promotions, suspensions, overtime, fines, etc., at Lister-drive station.

The first question, as to the Westinghouse turbines at Lister-drive, has been reported upon by Mr. A. Bromley Holmes, the consulting engineer to the Corporation, and Mr. A. Clough, the electrical engineer. The report shows that four turbines have been supplied by the Westinghouse Company, and that these have not yet fulfilled the guarantees as to steam consumption contained in the contract. Messrs. Gates and Stoddart in their widely-circulated pamphlet quote from the engineers' report the following sentences: "The estimated steam consumption named in their tender (the Westinghouse Company's) was somewhat lower (about 6 per cent.) than they were able to secure in actual operation." Messrs. Gates and Stoddart comment on this in the following way, which may be intelligible to them, but is not to us: "The 6 per cent. estimated excess steam consumption is, in practice, from 20 to 25 per cent., for which the Corporation have to pay." Why Messrs. Gates and Stoddart should increase the 6 per cent. extra steam found on trial under practical running conditions in Lister-drive to 25 per cent., we cannot tell.

Again, as to the ultimate efficiency of these Westinghouse turbines the engineers report that: "So far as the limited time the turbines have been in use enables the engineers to express an opinion, they feel confident that when all the machines have been adjusted to the same conditions as the one accepted in September last year the four sets of plant may be considered generally satisfactory, and will show a considerable saving in fuel as compared with the plant of smaller output hitherto installed in the power stations." Messrs. Gates and Stoddart, commenting on this, say: "If two to four years is a limited time, what are we to conclude as to a reasonable time? Again, we would point out our inability to discover this efficient engine. As to the four sets being considered generally satisfactory, we unhesitatingly say that if the engineers consider them so we, after making many inquiries, are of opinion that from a ratepayer's standpoint they are a failure, and have been a most expensive experiment conducted by a private firm at the expense of the ratepayers of Liverpool."

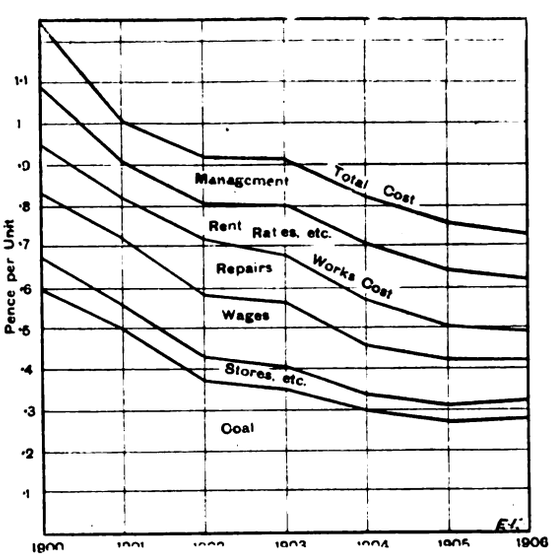

FIG. 1.—Curves showing the Costs per Unit Sold in the Liverpool Corporation Electricity Works for the Last Seven Years.

From the directory and inquiries in Liverpool we gather that Mr. Alfred Gates is an oil merchant and Mr. W. B. Stoddart a wholesale tobacco dealer. We should, therefore, be inclined to place their opinion, so unhesitatingly given, somewhat lower than that of two qualified engineers. From our inspection of the plant and from a perusal of the above reports we think the facts can be plainly stated as follows:

1. The Westinghouse turbines have not fulfilled their guarantees in steam consumption, and hence the company has still to receive the final payments under the contract.
2. The Westinghouse Company admit this, and have undertaken to supply new rotors for the turbines, which will bring them up to the specification and increase their output.
3. This and all the experimental work on their turbines has been willingly done at the contractors' expense, who have loyally abided by their contract in spite of the financial loss incurred by so doing.
4. In the meanwhile these four turbines have been at the service of the Corporation, and have been regularly run to supply load as required. The usual percentage of spare plant enables the Westinghouse Company to work on one turbine without endangering the continuity of the supply. We saw three of the sets at work on Tuesday. In our opinion the statements made above, that these turbines are "a failure" and "an expensive experiment conducted by a private firm at the expense of the ratepayers" of Liverpool, are both unjustified and untrue.

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In order to see how the department for the supply of electricity in Liverpool has been conducted we have looked up the financial records during the past three years as given in the tables of our contemporary, the *Electrical Times* Such cold figures are, we think, more reliable in estimating the value of the work done by engineers and the committee than any opinion formed by non-technical men. Fig. 1 shows how the total cost per unit is built up for each year from 1900 to 1906. The fall in the cost of coal per unit has been regular until the last year, and it must be remembered that a rise in the price of coal can easily counterbalance a decrease in the quantity used per unit.

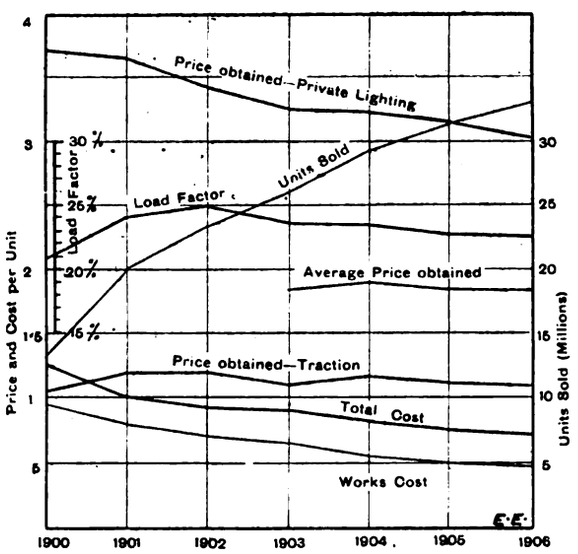


FIG. 2.—Progress Diagram of the Liverpool Electricity Supply Undertaking.

If there was such an increase in the steam consumption of these turbines as 25 per cent. over the guaranteed figures it would be shown in the lower curve. Fig. 2 is a progress diagram for the same period. It indicates how the price charged for private lighting has been decreased, and how the units sold have increased from about 13 million in 1900 to over 33 million in 1906. Fig. 3 shows how the total income has been divided each year. These curves will appeal to engineers, and we trust that even the Liverpool ratepayers will appreciate what has been done.

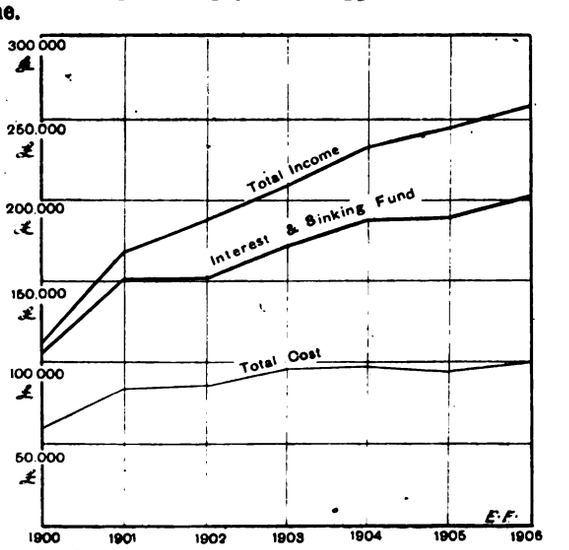


FIG. 3.—Income and Costs Curves for the Liverpool Corporation Electricity Works.

The resolutions above referred to were not reached at the meeting of the Council, but the following report from the *Liverpool Courier* indicates that Mr. Gates goes so far as to oppose the spending of more money on the undertaking. This opposition at the last inquiry did not convince Mr. Ross Hooper, the Local Government Board inspector, and nearly all of the loan then applied for has been granted.

On the proceedings of the Tramway Committee,

Mr. GATES objected to the committee spending £50,000 upon new machinery for 1909 unless they were prepared to admit that the present machinery was defective. He moved an amendment that the item of £50,000 be deleted from the report and estimates.

Mr. PATTERSON seconded.

Sir CHARLES PETRIE said it would be a very dangerous proceeding of the Council to take the opinion of certain members as against that of the committee and its officials.

Mr. STODDART said that not only the members of the Council, but the Local Government Board inspector had censured the committee. He (Mr. Stoddart) had gathered a lot of facts which Sir Charles Petrie should see when the right time came.

Mr. SKELTON did not know whether Mr. Stoddart and Mr. Gates were right or not on this question, but, at any rate, these two gentlemen had convinced many people in the city that there was something wrong. He complained that the committee had not acted with that openness to supply the representatives of the city with information which they ought to have done. He hoped, however, Mr. Gates would withdraw his proposition.

Alderman F. SMITH defended what the committee had done, and in view of the new principle adopted by the Local Government Board as to sanctioning the borrowing of loans, he thought that what they were asking for now was quite reasonable, in order that the building might be gone on with in the summer. He referred to the statement of Mr. Stoddart at the Local Government Board inquiry, and which made him positively shudder when he read it. Mr. Stoddart's words to the inspector were: "I am only here for information; I am not opposing. I am only here for information I have not been able to get, and I am pleased to say, sir, that through your efforts to-day I have learned more to-day than I have learned on the committee or on the Council."

Mr. STODDART: Every word of it is true.

Alderman SMITH: I believe it. I would be sorry, indeed, to know no more about the matter than by industrious application in a committee-room where a Local Government Board inspector was making an inquiry for three hours. Alderman Smith was remarking that they were having the Westinghouse engines put right, when

Mr. SKELTON asked: Why do you try to lead the Liberal party?

Alderman SMITH: I am not leading the Liberal party, nor do I intend to hound after Councillor Skelton.

In the course of his speech Alderman Smith was continually subjected to interruption from the Liberal side, which led the

LORD MAYOR to remark: I regret all these interruptions.

Alderman SMITH: I cannot expect anything else, because this is not so much against the undertaking as it is levelled against me. If my duty to my party conflicts with my duty to the city, I have got one line to take—I shall go to the work I have got in hand.

The voting then took place, the amendment being defeated by 77 votes to 10, a result which was received with laughter.

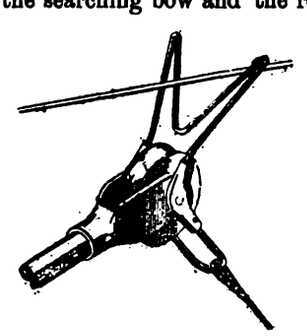
Sir CHARLES PETRIE: So much for amateur engineering.

The business of the Tramways Committee was not concluded when the Council rose.

We insert the asides, as we believe they show quite as much as the speech that the matter is not an impersonal one. The majority of 77 to 10 is a compliment to the engineers, and shows that they have the confidence of the Council.

TROLLEY LINE SEARCHING DEVICE.

A simple device for trolley line searching has been recently patented in America, and is shown below. It consists of an elbow casting attached to the trolley pole end, and into which the searching bow and the rope attachment



fit. The device is operated by pulling the trolley rope until the trolley wire lies between the horns of the bow, so that when the bow is lowered again the trolley wire falls into the groove of the trolley wheel with certainty. The wearing parts, such as the wire bow, can be readily replaced.

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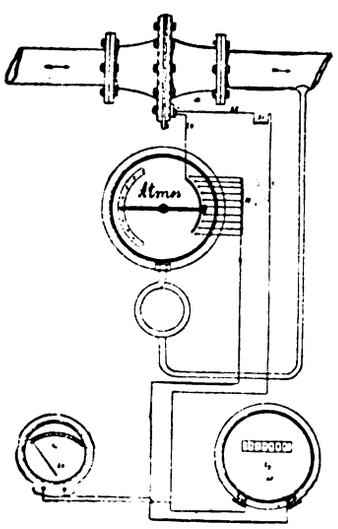
AN ELECTRICAL METHOD OF MEASURING STEAM CONSUMPTION CONTINUOUSLY.

A German patent has recently been taken out by Herr P. Weller for a steam consumption meter, consisting of a small alternator whose magnet wheel is built into the steam-piping, and is rotated by means of turbine blades fitted to its periphery The voltage so generated in the alternator armature indicates directly on the scale of a voltmeter or frequency meter the pounds of steam consumed per hour, or a continuous record can be taken by means of a train of wheels. In order to correct for



variations in steam pressure, the resistance in the voltmeter circuit is varied automatically by the action of the pressure gauge somewhat as shown above.

SURFACE-CONTACT TRACTION.

Those who follow the progress of electrical traction must be aware of the attention which is being given to the question of developing surface-contact traction, and to the more or less successful attempts now being made to overcome the imperfections which experience has brought to light. Tramway engineers have in the past viewed with little favour the proposals for propelling tramcars by means of electrical energy collected from studs placed along the surface of the track, and surface contact has in consequence made comparatively small headway. Moreover, a commercial system was not introduced into this country until the boom in electrical tramway enterprise was beginning to show signs of expending itself, and had left the overhead trolley and conduit systems firmly established in the favour of tramway engineers. But it is safe to predict that the future will see a more general extension of the application of surface contact to electrical traction, and that the former prejudice will break away in face of the engineering developments which are calculated to render that method more suited to modern requirements. An ingenious system of surface-contact traction is being brought forward which promises certain distinct advantages. It is the invention of Mr. David Suchostawer, of Vienna, and we understand that a company is now in course of formation, under the title of the S.P (Suchostawer Patents) Syndicate, Limited, to take over the system. It is not yet possible to give a detailed description of this system, but we have before us a report from Mr. H. M. Sayers, M.I.E.E, who has examined Mr. Suchostawer's invention and has expressed himself very favourably thereon. The chief features of the system in favour of which Mr. Sayers has pronounced are: (1) safety; (2) reliability; (3) low cost of construction; and (4) low working costs. The cost of track work has been reduced to a minimum owing to the fact that the stud seating and the line wire are but a few inches below the surface, so that no special excavation is necessary to accommodate them, the excavation for the tramway structure sufficing. To guard against the danger of "live" studs, there is employed a gravity pull off and a complete leakage trap. Mr. Sayers expresses the opinion that the system covered by this invention will find ready application to tramways in many places in which overhead wires are objected to. The directors of the company are Mr. S. A. Lehmann, Mr. C. S. Drummond (formerly director of the British Electric Traction Company). and Mr. E A. Phippen. The consulting engineer to the company is Mr. Henry M. Sayers, M.I.E.E.

OFFICIAL REPORT ON THE HAMPSTEAD ELECTRIC RAILWAY COLLISION.

The official report of Major J. W. Pringle on the collision which occurred on Oct. 26 last between two electric passenger trains at West Hampstead Station on the Metropolitan Railway was issued on Saturday last by the Board of Trade. It will be remembered that the 7.37 a.m. down train from Baker-street to Willesden Green was standing at the platform waiting for the signal to proceed. The following down train—7.41 a.m. ex Baker-street to Neasden—was admitted into the station under all proper signals, and struck the rear of the standing train. Three passengers were killed and 25 others complained of minor injuries or of the effects of shock. The motorman of the colliding train sustained more serious injuries, and was long detained in hospital.

The arrangement of the lines, etc., at West Hampstead is shown on the accompanying plan. The signal box is placed at the east end of the platform, and between the up and down lines. The railway is equipped with the block system of electric lock-and-block signalling devised by Mr. Spagnoletti. Dealing with the down line only, between Finchley-road and Kilburn Stations, there are in the signal box at West Hampstead three movable dial or disc instruments in use for working the traffic, in addition to the bell instruments. One of these, A, is known as the down disc instrument to Finchley-road, and deals with the section of the line between the starting signal at Finchley-road and the home signal at West Hampstead. This section of road is controlled by the mutual co-operation of the two signalmen at Finchley-road and West Hampstead. The disc readings in this instrument, A, are three in number: (1) "Train on line," on a red disc; (2) "Line clear," on a white disc; (3) neutral, half red, half white disc. The readings are duplicated in a similar instrument, A^1, in Finchley-road signal box. The second, B, is known as the down "additional" disc instrument, and deals with that section of the line between the down home and down starting signals at West Hampstead. The signalman at West Hampstead has sole control over this section of road. There are only two portions of the disc in this instrument—viz., "Train on line" and "Line clear." The third, C, known as the down disc instrument to Kilburn, refers to the line between the down starting signals at West Hampstead and Kilburn. Again, two signalmen—*i.e.*, at West Hampstead and Kilburn—are mutually responsible for the working of this section, and an instrument, C^1, at Kilburn duplicates the instrument, C, at West Hampstead. The normal position of all these instruments is with the disc showing "Line clear."

The method of signalling is as follows: F, H, and K represent the signalmen at the three stations. F signals a train on the bell instrument to H, in accordance with the bell code, and unpegs the white key of his instrument A^1. If the line is clear, H acknowledges the bell signal by repetition, presses down the red key of his instrument A, and lowers his down home signal. He releases the lock of this signal lever by pressing down the key of his instrument B. The action of pressing down the red key of instrument A electrically releases the lock on the starting signal at F, and causes the "Train on line" red disc to appear on both the instruments A and A^1. F then lowers his starting signal and replaces it to danger when the train has operated a treadle in advance of it. F's starting signal now remains locked until it is again released by H. When the train has passed over the treadle 167 yards in front of the down home signal at H, the disc of the instrument A will be released, and, simultaneously with that of A^1, will swing into the neutral position. H then rings "Line clear" on his bell instrument to F. F acknowledges this bell signal by repetition, and pegs the white key on his instrument A^1 to "Line clear." This causes "Line clear" to show on the disc of instrument A also. H replaces his down home signal to danger, and signals the train to K, who releases the starting signal at H in the same manner as was done by H for F. At this moment the disc of instrument B will be showing "Train on line," and so long as it remains in this position H cannot, in normal working, again lower his down home signal to allow a train from F to enter the station. When the train has left H, and passes over a treadle 103 yards in advance of the down starting signal,

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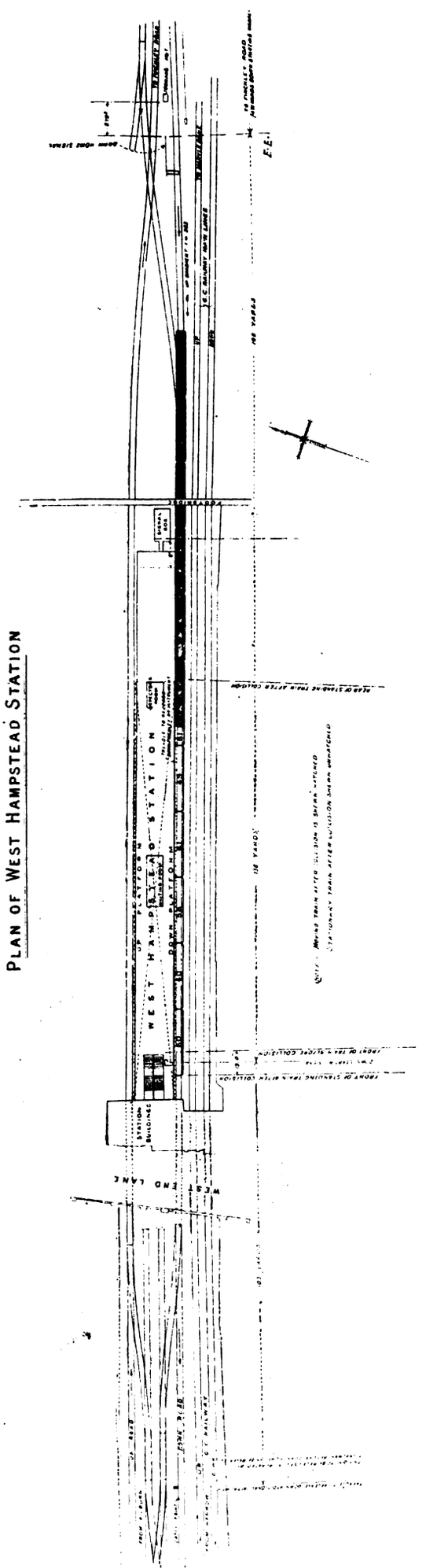

PLAN OF WEST HAMPSTEAD STATION

the "Train on line" disc in B is electrically released, and the disc "Line clear" is automatically displayed. Signalman H can then, by pressing down the key of his instrument B, release the lock on his down home signal. Shortly, the electrical interlocking ensures that the passage of a train over a treadle in front of the home signal at West Hampstead releases the instrument A. This release allows the signalman at West Hampstead to free the lever working the down starting signal at Finchley-road. Again, the passage of a train over a treadle in front of the down starting signal at West Hampstead releases the disc instrument B, which permits the signalman at West Hampstead to free the lever working his own down home signal. It must be noted that the disc instrument B is only released if the treadle in front of the down starting signal is operated whilst the starting signal lever is in the safety position. If the signal lever is at danger when the treadle contact is made, the instrument B will not be released. Lock indicators are provided in the signal box behind each signal lever which is electrically controlled. These visually indicate whether the lock is "on" or "off." In case of a failure of the electrical releasing arrangements, or when a train arrives at the station, but does not proceed further, it is necessary to provide means whereby the signalman can release his disc instruments and his lever locks. For this purpose there are fixed in the signal box a number of small release boxes with glass fronts. These contain release springs, which when operated by hand release the disc instruments.

Major Pringle states that it is a complicated case, and it is made more difficult by much conflict of evidence on material points. He examines the statements of the men at some length, and says that, after carefully weighing all the evidence and taking into consideration all the possibilities of failure in the signalling arrangements, he has formed the following conclusions: (1) That the first (Willesden Green) train was not, on arrival at West Hampstead, put into block to Kilburn, and that the starting signal was consequently not lowered. The result was that the train was kept standing at the platform for five or six minutes before the collision happened. (2) That, in all probability, owing to the thick fog, the train, as it stood at the platform, was out of sight of the signalman, but nothing was done in accordance with the company's rules to remind him of the position of the train. (3) That the electrical and mechanical signalling arrangements were in working order, and that it was not possible, with proper usage, and in accordance with the regulations, to lower the down home and distant signals for the second (Neasden) train to enter the station until the first train had left the station.

He finds, therefore, that the collision was caused by forgetfulness in the first instance, and subsequently by some illegal manipulation of the electrical instruments or locking on the part of Signalman Hollis. He must bear the full responsibility for his conduct. On the morning in question he arrived three-quarters of an hour late for duty, after 16 hours' rest, and had been at work for about an hour when the collision took place. He has been employed by the company for about 18 years, first as signal-box boy, and afterwards (since 1892) as signalman, and there is no serious entry in his record sheet during the last three years. Further, he finds that the collision might, in all probability, have been prevented if Motorman Spittle and Guard Sills had carried out general rule No. 55 (*a*), which is applicable on the company's system to trains standing within station limits. To some extent responsibility falls upon these men for not carrying out this rule. Station Foreman Fitch failed to act in accordance with Rule 61 (A) and appoint a ground fog signalman, or detail one of the station staff to assist Hollis. It is evident he has not properly supervised the manner in which the signalmen perform their duties, or observed the company's rules regarding the use of the release key boxes. Signalman Boggis was wrong in accepting a train when he thought it had been improperly signalled. But having regard to the time the signal was received—*i.e.*, after the collision, as the evidence shows—this error was not a contributory cause of the accident.

It is generally recognised that an automatic system of signalling is best adapted for a railway where block sections are very short, and traffic of high frequency. The company's system of "lock-and-block" signalling has done excellent service in the past. This is proved by the fact that, from the opening of the railway in 1863 until the date of this unfortunate collision, some 3,000 millions of passengers have been carried without the loss of one life in a train accident. The maximum number of trains dealt with during the winter at West Hampstead in one signalman's tour of duty—eight hours—is 226, an average of 28·25 per hour. During the summer months the average is sometimes as high as 36 per hour. Having regard to the number of movements involved in passing so large a traffic on the "lock-and-block" system a machine-like regularity of action is necessary, which can best be supplied by an automatic method of working. The company have for some time past been experimenting with a system of train-controlled signalling with a view to adopting it on their lines. But every detail must be thoroughly proved by long and continuous tests under working conditions before the method can be accepted. Some time, therefore, must elapse before any complete change in the signalling arrangements can be carried out.

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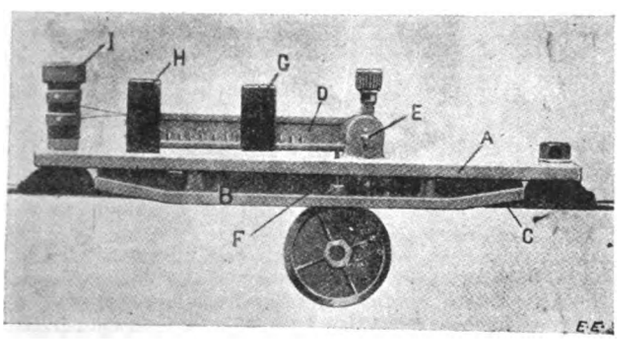
TRADE NOTES AND NOVELTIES.

Traction Specialities.

The Consolidated Accessories Company, 27, Clement's-lane, London, E.C., who have been appointed selling agents for Geo. Green and Co.'s traction specialities, draw attention to a trolley-tension indicator which has been designed to enable motormen on returning to the depot to note the trolley tension with facility, and to record it in the signing-off book as a matter of daily routine. The arrangement, as will be seen on reference to the illustration, consists of two half-ears supporting between them a cast plate, A. To the side of this plate is hinged an inclined cast plate, B, which has a groove, C, running parallel with the trolley wire throughout its length for the purpose of engaging with one of the flanges of the trolley wheel. The two ends of this plate gradually incline upwards, so that the trolley wheel rides quite smoothly from the wire on to the plate. On the top of the plate, A, is a lever, D, working on the fulcrum, E, consisting of a hardened knife-edge. Attached to the lever just above the knife-edge is a small lubricator, which with but occasional attention is sufficient to keep the knife-edge and its bearing thoroughly oiled, to the exclusion of damp and rust. The lever has connection with plate B by means of the pin, F, so that any motion of the plate B is freely transmitted to the lever, causing it to lift about 1in. as a maximum. The lever is fitted with two movable weights, G and H. The weight G is free to be moved over that half of the scale in its neighbourhood, and, according to the position it is fixed relatively to same, exerts a downward pressure on the hinged plate, through the medium of the pin, F, varying from 15lb. to 25lb. The second weight H is not fixed to the lever, but is slotted out so that the lever can be moved from its slightly inclined position, shown in the sketch, to a horizontal one, before it begins to engage with this weight and lift same. According to the relative position of this weight on the scale, some 2lb. to 5lb.

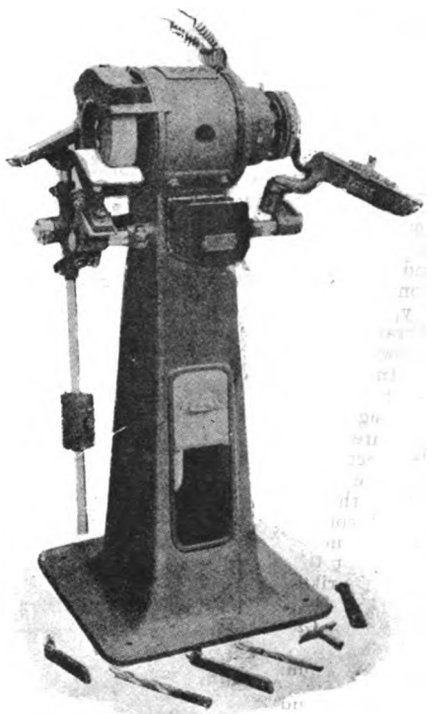


Trolley Tension Indicator (Consolidated Accessories Co.).

pressure can be exerted on the plate B. The two scales are marked directly in pounds for convenience in setting the weights to whatever the requirements may be. Assuming that the first weight is set at 20lb., if the trolley tension is less than this the lever will not move, and, if equal, it will be moved to a horizontal position and there retained, as the second weight has now engaged with the lever and is ready to exert its weight on same. If this second weight is set to give 4lb., then, if the trolley tension exceeds 24lb., the lever will be further moved upwards, lifting the second weight with it. It will be seen, therefore, that the minimum tension can be varied between 15lb. and 25lb., and the maximum tension between 15 + 2 = 17lb., and 25 + 5 = 30lb. Experiments have been made in regular service to see what variation between minimum and maximum tension can be worked in practice, and it has been found that this can be 3lb. The closeness with which the minimum and maximum tension can be worked depends, of course, upon the design of the trolley and its sensitiveness. I is an insulator having two contact pieces attached to same, and positioned so as to make contact with two springs fixed to the end of the lever. The first movement of the lever causes contact to be made, lighting up a green lamp, and the second movement a red lamp. No lamps alight indicates that the tension is insufficient, a green lamp only that the tension is correct, and a red and green lamp that there is too much tension.

Workshop Specialities.

Among the interesting engineering specialities which have been introduced by Messrs. Michael Pal and Co., engineers, Parliament-mansions, Victoria-street, London, S.W., is an electric tool grinding and polishing machine which grinds twist drills up to 1¼in., or up to 2in. The motor is fitted with emery wheels of a special construction, and all tools can be ground by the use of several toolholders supplied with the machine. A novel construction in this machine is the pendulum swinging holder, which allows a steady universal movement to be given to the tool whilst grinding. Various electric motors and dynamos have been placed upon the market. These are made in four shapes: (1) water or air tight; (2) totally enclosed; (3) ventilated enclosed; and (4) protected type. The alternating-current motors are made either with short-circuited rotors up to 15 b.h.p., or slip-ring rotors combined with short-circuiting arrangement. Some useful oil-saving and waste-cleaning plants

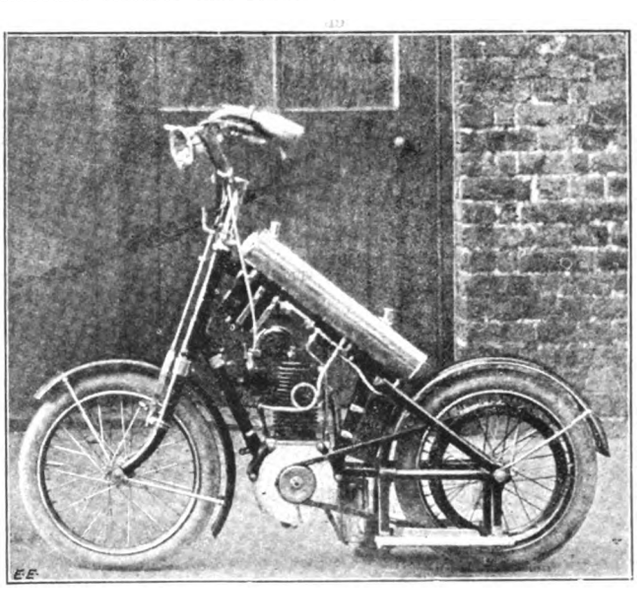


Tool Grinding and Polishing Machine.—Michael Pal and Co.

have also been introduced, and seem well designed for effecting economies in workshops.

Motor Cycle.

Messrs. Johnson and Phillips, Limited, Charlton, Kent, have recently made and placed upon the market a motor cycle which embodies features that render it of interest to those of our



"Max" Motor Cycle.—Johnson and Phillips.

readers who have to traverse a wide area in carrying out inspection work. The "Max" motor cycle, by which name the machine is known, is of very low weight, and this adds to the general economy of the machine in the way of tyre upkeep, petrol consumption, etc., and, owing to the special design, which is fitted with foot-plates and a collapsable seat if required, the space necessary for storing is very small. As will be seen from the illustration, the "Max" motor is not intended for touring work, and is, therefore, free from all the gearing and consequent friction which are inseparable with change-speed mechanism. It seems eminently suitable for inspection work, where a number of stoppages are necessary in a short distance.

Electric Signs.

A line of inexpensive electric signs is being introduced by the Technical Art Company, Emerson-chambers, Newcastle-on-

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Tyne. A feature of these signs is their Duplex effect, first one half of the message appearing, then the second. Thus a question and answer can be given on one and the same sign. In connection with the Duplex and other signs brought out by this company, it is worth mentioning that a specially-devised switching arrangement for giving cyclic operations (at what is claimed a lower cost than a motor drive) is employed very effectively. In addition to the Duplex flashing cone sign, the Technical Art Company have introduced automatic thermo-electric cone signs. With one of these signs only one 50-c.p. lamp is required for a display of 314 square inches. The problem of electric sign work is receiving a great amount of attention at the present time, and gives promise of a hopeful future. From the engineering point of view, the work has developed to a considerable extent, but at the same time good artistic effect has not been neglected. The signs introduced by the Technical Art Company, judged by the illustrations which we have seen, strike us as having been developed from the advertising rather than from the engineering point of view.

Catalogues, Lists, etc.

The bright little publication of the Simplex Company, *Installation News*, commences its second year with the issue of the January number. The articles and notes are presented in an attractive form, and are sure to interest contractors. We have also received a leaflet dealing with "Simplex" metallic-filament electric lamps, and brass adaptors for use on circuits over 130 volts with these lamps.

The Sun Electrical Company, Limited, 118 and 120, Charing Cross-road, London, W.C., have issued a catalogue (Section O) of electric signs and flashers, in which a great variety of effective advertising signs are illustrated.

A mailing card has reached us from the Kevan Electric Company, Limited, 88, Charing Cross-road, relating to "Kevan" electric lamps. These cards have been designed, printed, and dispatched by the Morgan Reeve Company, 12, Newgate-street, London, E.C., and is being circularised throughout the electric and hardware trades.

A catalogue of electrical testing instruments has been issued by Mr. Robert W. Paul, Newton-avenue Works, New Southgate, London, N. This catalogue has been entirely revised and brought up to date by the inclusion of descriptions of the most recent designs of electrical instruments.

Messrs. Morris and Lister, Carlton Works, Coventry, are sending out copies of their revised list dealing with their 1908 pattern of eddy-current testing brake.

INSTITUTION AND TECHNICAL SOCIETY NOTES.

Royal Institution.

A general monthly meeting of the members of the Royal Institution was held on Monday afternoon (the 3rd inst.), Sir James Crichton-Browne, treasurer and vice-president, in the chair. Lord Ellenborough and Mr. Alfred Moseley, C.M.G., were elected members. The honorary secretary reported the decease of the Right Hon. Lord Kelvin, O.M., G.C.V.O., P.C., D.C.L., LL.D., D.Sc., F.R.S., Grand Officer of the Legion of Honour, Chancellor of the University of Glasgow, on Dec. 17, 1907, and the following resolution was passed: "That the managers of the Royal Institution of Great Britain desire to record at this, their first meeting subsequent to his death, their sense of the great loss sustained by the institution and by science in the decease of Lord Kelvin." Lord Kelvin became a member of the Royal Institution in 1886. He gave his first lecture at the Royal Institution at the time when Faraday was engaged in his epoch-making researches on electricity and magnetism; and between the years 1856 and 1900 Lord Kelvin delivered a course of lectures on the electric telegraph in 1863, and no less than nine Friday evening discourses on the following subjects: "The Origin and Transformations of Motive Power" (1856), "Atmospheric Electricity" (1860), "Tides" (1875), "Effects of Stress on Magnetisation of Iron, Nickel, and Cobalt" (1878), "The Sorting Demon of Maxwell" (1879), "Elasticity viewed as possibly a Mode of Motion" (1881), "Isoperimetrical Problems" (1893), "Contact Electricity of Metals" (1897), Nineteenth-Century Clouds over the Dynamical Theory of Heat and Light" (1900). On the occasion of the celebration of the jubilee of his appointment to the chair of natural philosophy in the University of Glasgow, an address of congratulation was presented to Lord Kelvin on behalf of the members of the Royal Institution, expressing their high appreciation of the conspicuous services rendered by him in the extension and diffusion of scientific knowledge. When Lord Kelvin resigned his professorship and came to reside in London he took much interest in the Royal Institution, and became a manager in 1892. The managers desire to offer on behalf of the members of the Royal Institution the expression of the most sincere sympathy with Lady Kelvin and the family in their bereavement.

The special thanks of the members were returned to Dr. W. J. Russell, F.R.S., for his donation of £100 to the general fund, and to Mr. Charles Hawksley for his donation of £100 (in commemoration of the hundredth anniversary of the birth, on July 12, 1807, of Thomas Hawksley, F.R.S., civil engineer) to the fund for the promotion of experimental research at low temperatures. Letters were read from Prof. A. Haller, Prof. L. Troost, and Prof. W. Spring, acknowledging their election as hon. members of the Royal Institution. The chairman announced that the managers had appointed Dr. Kenneth Robert Hay, M.B. (Cambridge), medical officer to the Royal Institution in succession to the late Dr. Woodhouse Braine, who held the appointment for 36 years.

Iron and Steel Institute.

The annual general meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George-street, London, S.W., on Thursday and Friday, May 14 and 15, 1908. The annual dinner will be held—under the presidency of Sir Hugh Bell, Bart.—in the Grand Hall of the Hotel Cecil, on Thursday, May 14. The autumn meeting will be held in Middlesbrough on Sept. 29 and following days. The council will shortly proceed to award Carnegie research scholarships, and candidates must apply before Feb. 29. The awards will be announced at the general meeting. In order to be included in the voting list at the general meeting, applications from candidates for membership of the institute must be received at the office of the institute not later than Tuesday, March 24.

FORTHCOMING EVENTS.

Friday, Feb. 7.

Institution of Civil Engineers (Students' Section).—At 8 p.m., "Electric Hardening and Annealing Furnaces," by Mr. P. T. Steinthal.

Junior Institution of Engineers.—At 8 p.m., at the Royal United Service Institution, Whitehall, "Aerial Navigation," by Mr. Herbert Chatley.

Northampton Institute Engineering Society.—"Some Problems of Electric Railway Operations," by Mr. E. V. Pannell.

Saturday, Feb. 8.

Junior Institution of Engineers.—At 6.30 for 7 p.m., dinner at the Hotel Cecil.

Institution of Electrical Engineers (Manchester Students' Section).—Visit to the Lister-drive generating station of the Liverpool Corporation.

Tuesday, Feb. 11.

Liverpool and District Electrical Association.—At 8 p.m., at Common Hall, Hackins Hey, Dale-street, discussion on "Fuel Economy in Steam Generating Plants."

Physical Society.—At 7 p.m., dinner at Hotel Cecil.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., at the Municipal School of Technology, Whitworth-street, "Electrical Driving of Textile Mills," by Mr. W. Hanna.

Institution of Civil Engineers.—At 8 p.m., meeting.

Institution of Electrical Engineers (Glasgow Local Section).—At 8 p.m., at 207, Bath-street, discussion on Mr. Snell's paper on "The Cost of Electric Power for Industrial Purposes."

Wednesday, Feb. 12.

Institution of Electrical Engineers (Birmingham Local Section).—At 7.30 p.m., at the University, "Experimental Determination of the Losses in Pole Shoes due to the Armature Teeth," by Messrs. T. F. Wall and S. P. Smith; and "The "Reluctance of the Air-Gap in Dynamo Machines," by Mr. T. F. Wall.

Institution of Electrical Engineers (London Students' Section). At 7.30 p.m., at 92, Victoria-street, S.W., "Train Lighting," by Mr. G. H. Nelson.

Association of Engineers-in-Charge.—At 8 p.m., at St. Bride's Institute, Fleet-street, "Superheated Steam," by Mr. T. Sudgen.

Junior Institution of Engineers.—At 8 p.m., at Architectural Association, 12, Tufton-street, Westminster, joint meeting with the Discussion Section of Architectural Association. Paper: "Suggestions as to how the Architect and Engineer may combine," by Mr. Percy J. Waldram, F.S.I.

Thursday, Feb. 13.

Rugby Engineering Society.—At 8 p.m., "Mechanically-Propelled Commercial Vehicles, with special reference to the Petrol-Electric System," by Mr. Bernard Hopps.

Friday, Feb. 14.

Physical Society of London.—At 8 p.m., annual meeting in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington.

Saturday, Feb. 15.

Institution of Electrical Engineers (Students' Section).—At 10.30 a.m., visit to the National Physical Laboratory.

General Electric Company.—At 6.30 p.m., dinner at the Trocadero.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE STAFF OF SMALL CENTRAL STATIONS.

SIR,—I should like to state my views on the above article by "Central Station Man" in your issue of the 3rd inst. I am a station man myself, actually engaged in electricity supply. I do not know whether the writer of the above article is engaged in electricity supply, but if he is I consider he is one of those "amateur" type of engineers of which we know there are a large number in the business at the present time. He is the sort of man who would depend on his fitter rather than trust himself, owing to his want of knowledge on both the technical and commercial side of the business.

He is also one of those men who are the ruination of the profession. Talking of apprentices, he says: "The lads are quite easy to get hold of, as many of the brightest and best lads of the community are anxious to get into electrical engineering work, *and a fresh one should be taken on every six months to keep the supply up*, as it is a moral certainty that the apprentices will take the first opportunity of bettering their experiences as soon as they have got their feet on the first rung of the ladder." Just so. What really happens is that as soon as these lads have learnt a little and ask for more money, they have to "get"; they then flood the market and keep down salaries. This is the sort of thing many of our badly-managed small stations and some of our big power companies are doing at the present time. Very few of these lads get on, but it is from this few that I should say the writer of the article himself has sprung. I think the sooner assistant engineers in electricity supply form a professional union and take this matter, with others, in hand the better.

I do not think much of either apprentices or premium pupils. My experience shows me that the best youths to get are "improvers"—youths who are really fond of the work, and have spent about five years in good engineering works, building and repairing steam or gas engines and dynamo machinery and switchgear, etc. They should have attended evening classes at a good technical school during the time they are going through the works. These are the boys to get hold of. They can do repairs to the engines, piping, dynamos, or switchgear, or anything you put them to, and when you cannot afford to pay them more money you can safely recommend them to a better job, knowing they will become a credit to the profession. They should be taken on trial for about a month, and when engaged it should be insisted on that they stay 12 months.

With regard to the fitter-driver, I cannot agree on this point. It is this which makes me think the writer of the article has no practical knowledge. A small station requires much more attention to pressure regulation than a large one, especially a new station just starting up, as it is absolutely necessary that there shall be no complaints about bad light or bad pressure. Instead of this fitter-driver, get a good chief assistant engineer, with mechanical and electrical training, of course Such a man can be got at £2. 5s. per week, rising to £2. 15s. in two annual increases of 5s. per week. This assistant will be in charge in the engine-room every weekday during the peak, say from 5 p.m. to 8 p.m. or thereabouts; he will also attend to mains matters and test meters and supervise repairs. There should be three of the above-referred-to improvers. One will take the evening shift from 4 p.m. to 12 or 1 a.m, as necessary; another will take from 7 or 8 a.m. to 4 p.m., later in summer or earlier in winter as necessary. Both these men can attend to the engines and switchboard easily. The improver on the 8 to 4 p.m. shift will do engine and switchgear repairs and maintenance, such as gland packing, etc. There should be a labourer on from 7 a.m. to 6 p.m. to grease and help in the engine-room. There will be two stokers, one for morning and the other for evening shift; the morning stoker can often help in the engine-room also. The third improver will attend to mains work and meter fixing, etc., and he will also have a labourer to help him, and who can be lent to the engine-room sometimes. This improver will be under the supervision of the chief assistant, like the others. If the undertaking is municipal, then one young shorthand-typist clerk is quite enough; he will also act as storekeeper. Possibly a female might do here, but it might interfere with the young men in the engine-room. If the job is a company, then a secretary will be necessary in addition. He will act as chief accountant.

Last, but not least, we come to the chief himself. He, of course, must be a good mechanical and electrical engineer, and, in my opinion, must also be a bit of a civil engineers. He will attend to the canvassing and fixing up of agreements with consumers—in fact, deal with the consumers in general. Both he and the chief assistant must be men who will not mind working 10 to 12 hours per day, though this will not by any means be necessary every day. The chief should be a good steady-going married man, if possible to get him.

In giving the above I have supposed the works to be equipped with the best kind of plant, which in this instance would, in my opinion, be enclosed high-speed forced-lubrication reciprocating engines condensing into surface or jet condensers, depending on the water supply, and Lancashire boilers and shunt generators, which must have excellent regulating qualities. There must be a *large* battery, not a country house battery such as one sees in so many small stations; it is a great mistake to put in a small potty battery. All plant should be of reputed make.—Yours, etc.,

ELECTRICITY SUPPLY.

THREE-PHASE TO SINGLE-PHASE CONVERSION.

SIR,—In concluding this discussion I would point out that Mr. K. Faye-Hansen has made no attempt to disprove my argument, which is, that unbalancing is due to variations of flux produced by the pulsating armature reaction. His theory appears to be that unbalancing is due to inductive drop, but no explanation is offered in proof of this, and I fail to see why the drops in the three phases should be unequal, if the flux can be kept constant. But with any ordinary machine a single-phase load must cause the flux to vary during the cycle, thus unbalancing the three-phase side, and this effect will take place with any single-phase load, however small. It is interesting to note that the tests confirm on this point also.

As no objection is raised against the induction regulator

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method, it may be taken that Mr. Faye-Hansen admits this to be a satisfactory solution. This, of course, makes it possible to use an ordinary rotary. Mr. K. Faye-Hansen's contention that the scarcity of polyphase to single-phase converters is due to technical unsoundness scarcely bears examination, for if the demand for such plant is as great as he supposes, why are there no examples of the motor-generators to which he pins his faith?—Yours, etc.,

J. MESSENT.

TELEPHONE PROGRESS ON THE CONTINENT.

SIR,—There has recently been much discussion of what is known as the measured-rate tariff for telephone service, and a few months ago a statement went the round of the Press to the effect that in Germany, Belgium, and France telephone rates for unlimited service were materially lower than those in force in this country. Also, there have been efforts to discredit the technical policy of the National Telephone Company and the Post Office in the important matter of the adoption of the central-battery system of working large telephone exchanges.

I have just returned from a tour on the Continent devoted exclusively—barring one week in the Engadine, devoted exclusively to more alluring affairs—to the study of telephone conditions. I visited Antwerp, Brussels, Rotterdam, The Hague, Amsterdam, Hamburg, Berlin, Vienna, Munich, and Paris, and in each place conferred with the principal telephone authorities, visited the chief exchanges, and was made fully acquainted with recent progress and future plans, both technical and administrative. Well, everywhere I find that measured rates and central-battery equipment are the order of the day. I talked with, perhaps, 50 telephone officials, administrators, engineers, and executives, ranging from an under-secretary of State down to an exchange manager, and among them all—Belgian, Dutch, German, Austrian, and French—there was no difference of opinion as to the correctness of the measured-rate tariff for telephone service and as to the efficiency of the central-battery system of working large telephone exchanges.

Practice is following precept with more or less rapidity. Germany, which contains about half the total telephones in use on the Continent, is about to abolish the unlimited rate entirely, and in a short time all telephone subscribers in the German Empire will pay for their service at measured rates. An interesting detail is that in the new German tariff the lowest rate at which calls will be sold to the large user is exactly the same as the corresponding figure in the National Telephone Company's tariff—viz., ·48d. per call. Austria abolished unlimited rates last year, and all Austrian telephone subscribers now pay measured rates. There was much opposition to the new tariff, especially from the large users in Vienna, but commonsense has prevailed, and the Austrian administration is now enjoying a rapid increase of subscribers, particularly among private houses and small users generally, owing to the much more elastic tariff which the measured-rate scheme provides.

In Belgium a measured-rate tariff is under discussion, and the responsible minister has announced that a new scale of telephone rates will shortly be introduced. In France the leading officials of the Telegraph Department have long been convinced of the correctness of the measured-rate principle, and a committee is about to be appointed to prepare a new tariff.

Therefore, whereas it has recently been represented in the British Press that telephone service is supplied in the principal Continental countries at absurdly low figures for unlimited service, the facts are that measured rates are either actually in force or about to be adopted. And when a change of this sort is made by a Government administration on the Continent it is not done in the gradual and genial way adopted here by the National Telephone Company and the Post Office, who allow old subscribers to retain their existing arrangements until convinced of the superiority of newer methods. The Continental subscriber finds his contract changed for him, whether he likes it or not.

As with measured rates, so with the central-battery system. This would hardly be worth mention were it not for the efforts of those connected with the defunct municipal telephone movement to discredit modern telephone work, for among serious telephone engineers there is no difference of opinion as to the superior efficiency of central-battery working. Everywhere on the Continent new central-battery exchanges are coming into use, and old local battery systems are being abandoned and replaced by central-battery plants. The reconstruction of the Berlin system with central-battery plant for 100,000 lines is nearly complete, similar work at Hamburg is in course of execution, while many of the smaller systems in Germany have already been converted. In Belgium, Holland, and Austria new exchanges are all central battery, and old ones are gradually being rebuilt on the same lines, while the French administration is now engaged in converting the entire Paris system to central-battery working.

The extent to which both the administrative and the technical conditions of the telephone business on the Continent have been misrepresented by contributors to the Press, and the general interest in the "telephone question" at the present time, are my excuse for the length of this letter.—Yours, etc.,

HERBERT LAWS WEBB.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.

The following is a list of the members of the British Electrotechnical Committee as reappointed by the Institution of Electrical Engineers for the year 1908: Sir John Gavey, C.B. (president), Colonel R. E Crompton, C.B., Mr. W. Duddell, F.R.S., Mr. Kenelm Edgcumbe, Dr. Gisbert Kapp, Dr. R. T. Glazebrook, F.R.S., Mr. R. Kaye Gray, Mr. Robert Hammond, Colonel H. C. L. Holden, F.R.S., Mr. T. Mather, Mr. H. W. Miller, Prof. J. Perry, Sir Wm. H. Preece, K.C.B., F.R.S., the Right Hon. Lord Rayleigh, O.M., F.R.S., Mr. Alex. Siemens, Mr. C. P. Sparks, Mr. J. Swinburne, F.R.S., Prof. S. P. Thompson, F.R.S., Mr. A. P. Trotter, Mr. E. B. Vignoles, Mr. C. H. Wordingham, Mr. G. C. Lloyd (hon. secretary), Mr. C. le Maistre (secretary).

We understand that the committee is about to take up the question of "symbols," and a sub-committee has been appointed and is in process of formation to deal with the matter with a view to international agreement.

WEST HAM CORPORATION ELECTRICITY SUPPLY.

Staff Dinner.

On Thursday, Jan. 30, we were invited to attend the second annual dinner of the staff of the West Ham Corporation electricity department. The invitation was a personal one from Mr. A. Hugh Seabrook, the energetic engineer controlling this undertaking, and we were pleased to note that his staff was larger in numbers than that we met last year, and that each member of it was permeated by his enthusiasm and energy.

The dinner was held in the Restaurant Frascati, and was presided over by Mr. Seabrook.

Mr. W. FLETCHER, of the Co-operative Wholesale Society, proposed the toast of "The Mayor and Corporation of West Ham," and, speaking as one of the largest consumers, said West Ham was in an admirable position for supplying factories with electrical energy. The C.W.S. flour mill at Silvertown was being driven solely by electricty. [We understand that the consumption of this society is likely to reach 6,000,000 units per annum.]

The DEPUTY-MAYOR, in responding, expressed the Council's pride and confidence in their electrical engineer and his staff.

Alderman LITTLER, chairman of the department, proposed "The Electricity Department." He said that since they last met round the festive board there had been several changes in the personnel of the staff, and he was pleased to record that that reorganisation was complete. Every department had been thoroughly gone through by their chief, who had brought them into a good state of business efficiency. That had been accomplished to the credit of Mr. Seabrook and of the committee who entrusted him with the work. He expressed regret at the death of Mr. F. E. Harris, the loss of whom in the prime of life was a matter of real regret not only to them, but to all who valued a fearless, capable, and energetic municipal officer. They welcomed that evening the new members of the staff—Mr. Lloyd

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Jones (station superintendent), Mr. Mackensie (station foreman), Mr. Toombs (chief of stores), and others; and he congratulated Mr. Gilbert on his promotion to mains superintendent and Mr. Farndon to assistant sales manager. He outlined the work of the department and indicated its future prospects. Manufacturers, said Aldermen Littler, knew that they were not dependent upon one line between the generating station and their factories, so that there was no possibility of failure of supply. West Ham offered exceptional facilities as a manufacturing centre, and he wanted manufacturers to recognise it. The electricity department were prepared to assist in making the borough one of the most favourable manufacturing centres in the South of England. The Council's smoke and nuisance by-laws were reasonably interpreted, and they tried to make the life of the manufacturer as easy as they possibly could, with proper consideration for the health of the district. They were not going to worry the manufacturers by dreadfully irritating restrictions. They boasted that their generating station was the most advantageously situated of any in the South of England, and they could generate electricity at a figure which would bear favourable comparison with any of the more favoured towns in the North, where coal cost from 3s. to 5s. a ton less.

Mr. A. Hugh Seabrook responded, and in doing so placed on record his high appreciation of the way in which the staff worked. The result of a test by a laboratory of the difference in cost between gas with the incandescent burner and electricity with the Osram lamp (the price of gas being 2s. 6d. per 1,000ft. and electricity 3½d. per unit) was that the cost came out the same. But 2s. 6d. per 1,000ft. for gas was a lower price than obtained in London and 3½d. per unit was a higher price than obtained on the average in London, so the result of the test proved what his department had announced again and again, that electricity is cheaper than gas.

Mr. W. A. Gilbert, in a neat speech, proposed "The Visitors," for whom Alderman L. W. Spratt responded.

An excellent musical programme was carried out under the direction of Mr. W. H. Collings.

PUBLICATIONS RECEIVED.

"Wireless Telephony," by Ernst Ruhmer. Translated from the German by Dr. James Erskine-Murray (London: Crosby Lockwood and Son, 7, Stationers' Hall-court, Ludgate-hill). Price 10s. 6d. net.

"The Hughes and Baudot Telegraphs," by Arthur Crotch (London: S. Rentell and Co., Limited, 36, Maiden-lane, Strand, W.C.). 1s. 6d. net.

"Whittaker's Arithmetic of Electrical Engineering" (London: Whittaker and Co., 2, White Hart-street, Paternoster-square, E.C.). 1s. net.

"Engineering Workshop Practice," by Charles C. Allan (London: Methuen and Co., 36, Essex-street, Strand, W.C.). Price 3s. 6d.

Junior Institution of Engineers (London). *Journal and Record of Transactions*, vol. xvii.

British Weights and Measures Association (London). *Official Report and Journal.*

"Les Decouvertes Modernes en Physique," by O. Manville, D.ès.Sc. (Paris: Librairie Scientifique A. Hermann, 6, Rue de la Sorbonne). Price 5fr.

APPOINTMENTS VACANT.

Assistant Distribution Engineer, Woolwich Borough Council. Salary £90 per annum, rising by annual increments of £10 to £140 per annum. Applications by Feb. 17. See advertisement.

Assistant Manager, Harland and Wolff, Belfast, electrical department. See advertisement in last issue.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, Feb. 15.

Monday, Feb. 10.—"A" Coy.—Infantry drill, 6 p.m.
Technical drill, 7 p.m.

Tuesday, Feb. 11.—"B" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

Wednesday, Feb. 12.—"A" Badge examination, 6 p.m.

Thursday, Feb. 13.—"C" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

Friday, Feb. 14.—"D" Coy.—Infantry drill, 6 p.m.
Technical drill, 7 p.m.

(Signed) J. H. S. Phillips, Captain,
Acting Adjutant.

THE B.I. HANDBOOK.

This handbook has been issued by the British Insulated and Helsby Cables, Limited, of Prescot, Lancashire (price 7s. 6d.). Though the information it contains is to some extent descriptive of the principal manufactures of that company, there is also to be found a considerable amount of general information which is likely to be of use to electrical engineers. Much hitherto unpublished information of a technical nature is given, and although some of the matter is already public property, or is to be consulted in the various handbooks published, its appearance here in so handy and concise a form cannot fail to be appreciated. The numerous tables and formulæ relating to melting points of metals and alloys, conductivity of metals, generation of electrical energy and transmission, breaking stresses for poles and stay wires, electrostatic capacity in cables, illumination, etc., will be found very useful, whilst, apart from the purely technical information, there is a digest of the Patents and Designs Act, 1907, a scale of the fees on instruments for obtaining patents and renewals, and other matter which will be helpful to the inventor, the station engineer, and the contractor. It is inevitable that in a work of this kind some references to the articles manufactured by the company should be made, but the balance as between information of general technical interest and of personal character has been very fairly maintained. Who, for instance, will not be interested in the section dealing with feeder pillars for lighting and power distribution, wherein are described some types of transformer kiosks? In view of the interest now centreing upon the cost of electrical power transmission, and the evidence which has been tendered respecting the effectiveness and economy of above-ground sub-stations in the form of transformer kiosks, a description of the "Prescot" type deserves to be carefully considered. Electricity is playing such an important part in the difficult operation of the welding of metals, and so satisfactory have been some of the results of this process, that a study of the methods and machines by which these have been brought about will repay our readers. The electric welding outfit as supplied by the British Insulated and Helsby Cables, Limited, consists of a generator, switchboard, cable, transformer, clamps, operating lever, and automatic switch. A description of these parts, together with the details of the sizes required for various purposes, is given in the handbook. It is not difficult to find in this handbook particulars relating to the company's manufactures, or any general technical information required, since the two are separately indexed, and for convenience and utility this is a book which may be confidently recommended.

PERSONAL.

The Nelson (B.C.) Corporation have appointed Mr. R. A. Brown, of Calgary, as city electrician.

Sir Wm. E. Clegg ex-Lord Mayor of Sheffield, will be the guest of the evening at a house dinner of the Municipal and County Club, Whitehall-court, to be held on Feb. 28.

Mr. H. S. May, the resident engineer in the Blackpool Corporation tramways department, has been appointed rolling-stock superintendent under the London County Council.

According to the *London Gazette*, the partnership between A. Bennetts and W. Baker, electric lighting engineers 3, Mulgrave-road, Sutton, has been dissolved by mutual consent.

We are informed that Mr. N. C. Rowan is leaving the Sheffield Corporation tramways to take up an appointment under the Cleveland and Durham Electric Power, Limited, of Middlesbrough.

The Eccles Electricity Committee have recommended the Town Council to increase the salaries of Mr. Frank Clark, chief clerk; Mr. E. J. Ward, senior shift engineer; and Mr. C. W. Marsland, shift engineer.

The Radcliffe Electric Power Co. held their first annual dinner and smoking concert at the Boar's Head Hotel, Bury, last week. Mr. C. D. Taite, chief engineering manager, presided, and a very enjoyable evening was spent.

The employés of the Swansea Improvements and Tramways Co. have presented Mr. David James, the general manager, with a handsome gold watch, suitably inscribed, as a token of the esteem in which he is held by them.

Mr. Edw. J. Hogan, who has been identified with the Sunbeam Lamp Co. since its inception, has now severed his connection, and is opening offices in Charing Cross-road, where he is representing several manufacturing firms.

We regret to announce the death of Sir Henry Whatley Tyler, deputy-chairman of the Great Eastern Railway, chairman of the Westinghouse Brake Co., Rhymney Iron Co., the Peruvian Corporation, and connected with other commercial concerns, a former president of the Grand Trunk Railway of Canada, and chief inspector of the Board of Trade for railways.

The Crewe electrical and signal department staff of the London and North-Western Railway held their second annual dinner at the Royal Hotel last week. Mr. J. T. Roberts, assistant signal superintendent of the department, presided, supported by Messrs. Michod and Bean, respectively telegraph and electrical assistants, and altogether the function was a great success.

We regret to announce the death, at the early age of 37 years, of

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Mr. John Woodside, A.M.I.C.E., of Belfast. He carried out many important installations, including those of the Belfast and Sheffield Hippodromes, Purdysburn Asylum, and numerous mills and factories in the North of Ireland, and at the time of his death he had the lighting of Portrush and the Abbey Sanatorium, Whiteabbey, in hand.

Mr. E. Sidgwick, of Stalybridge, has been recommended by the Rochdale Tramways Committee to the vacant position of car-shed superintendent in succession to Mr. J. W. Galloway. Mr. Sidgwick has for the last five years been an erecting engineer and inspector of tramway work for the British Westinghouse Electric and Manufacturing Co., of Trafford Park, Manchester. In this capacity he has been engaged on tramway work in various parts of the country.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Bolton.—The Tramways Committee are taking up the track in Leelane and Victoria-road, Horwich.

Sherbroke (Ontario).—Plans are being prepared for an electric light and power plant for the city.

Newcastle Emlyn.—The Urban District Council have under consideration a proposal to establish a municipal electricity plant.

Olavarria (South America).—A local company is being formed in order to erect and equip an electric lighting and power station.

Wingham (Ontario).—The Town Council have authorised the expenditure of 25.000dol. for repairs to the hydro-electric power plant.

Farnworth.—The South Lancashire Tramways Co. have opened a parcel-carrying service here and on the other parts of their extensive system.

Pembrokeshire.—The County Council have decided to have telephones installed in all the county offices. The cost is estimated at £50.

Barnstaple.—The Town Council have decided to heat the guildhall by electric radiators, as recommended by their electrical engineer.

Houghton.—The Rural District Council have passed plans for the erection of a sub-station at Philadelphia for the Durham Collieries Electric Power Co.

Londonderry.—The Corporation Electricity Committee are formulating a scheme to install electricity as the illuminant for the remaining gas lamps in the district.

Hanley.—The Local Government Board will hold an inquiry on Feb. 18 into the application of the Council for sanction to borrow £18 000 for electric lighting purposes.

Heywood.—The Council are recommended by the Electricity Committee to make the necessary arrangements in order to spend £8,000 to provide additional extensions at the electricity works.

Dundalk.—A public meeting has been held at which a resolution was passed empowering the Urban District Council to promote a Bill to Parliament in order to carry out an electricity scheme.

Farnworth.—The District Council, owing to increased demands for electricity from the public, are proposing to enlarge their works or obtaining supplies from the Lancashire Electric Power Co.

Wireless Telegraphy.—The Marconi Wireless Telegraph Co. are now accepting messages from the public for transmission between London and Montreal. The charge is 7½d. a word, inclusive of land rates.

Montevideo.—The Montevideo Telephone Co. have purchased a central site in Montevideo for the sum of 25.000dol. A large building will be erected on the site for the purpose of a central station and offices.

Vale of Rheidol Light Railway Co.—After providing for the debit balance of £406 brought forward and meeting prior charges, there remains £800, and a dividend at the rate of 2½ per cent. per annum is proposed.

Porthcawl.—The manager of the gasworks was "gassed" while assisting at the tapping of a gas-main recently. A medical man was called in and artificial respiration was resorted to. We are glad the manager recovered

Gas-Engine First Aid.—Gas poisoning from gas-engines has become so common that German authorities urge that cylinders of oxygen be kept near, and that engineers be taught to apply inhalations to resuscitate victims.

Stone.—At the last meeting of the Urban District Council the inspector reported finding many gas lamps out owing to low pressure. Strong criticisms were passed, and it was stated that the gas in the town was poor and dirty.

Vancouver.—Steam power has been abandoned in the shops of the Canadian Pacific Railway and electric power installed instead. The demand is nominally for 225 h.p., furnished by motors ranging from 75 h.p. down to 5 h.p.

St. Petersburg.—Heissler's telephone manufactory has been destroyed by fire. Twenty thousand telephone instruments, which were intended for the telephone service of the city, have been destroyed. The loss is very considerable.

Buxton.—Applications have been made by the residents in Temple-road and by the Buxton Gardens Co. to the Urban District Council for extensions of the electricity mains in order to supply their premises. The Council have agreed subject to certain conditions.

Edmonton (Alberta).—Work on the new power station will be commenced early in the spring. The machinery is due to arrive in June, and every effort will be made to have the building ready for its reception. A gas-producer plant will be installed, as being the cheapest method of supplying power for generating electricity.

Burnley.—The Town Council are recommended by the Electricity Committee to purchase a 750 kw. steam generator at a cost of £6,835 and a motor-driven centrifugal pump at a cost of £265, these purchases being necessary on account of the growing demand for current.

Eastbourne.—A conference has been held with the rating surveyor and the clerk to the Assessment Committee in respect to the assessment of the Council electricity undertaking, at which it was agreed that it should be increased from the present assessable value of £1,420 to £3,020.

Bedale.—The Postmaster-General has asked the permission of the Rural Council to erect telegraph poles at Five Lanes End, near Masham, and this has been granted, subject to the approval of the surveyor and to the liability of the poles being removed at any time when the Council might think fit.

Sunderland.—The Sunderland Forge and Engineering Co. have presented to the physics and electrical engineering department of the technical college an automatic safety motor starter, a set of 12 controller resistances, and samples of finished insulating materials used in dynamo construction.

Accrington.—The Haslingden Corporation have notified the Accrington Town Council of their intention to commence the reconstruction and electrification of the tramways within their borough on April 1. The Council have agreed to permit steam cars to be run on their loop line until that date.

Thirsk.—The Rural District Council have received a communication from the Post Office Telegraphs Department giving notice of their intention to open up the road from Boroughbridge to Thirsk and Stockton, through the Thirsk rural district area, for the purpose of laying underground telegraphs.

Torquay.—With the running of the projected trams along Torbay-road the Council will be faced with the necessity of providing further plant in connection with the electricity supply. A scheme for the erection of a new station at Upton, to cost between £17,000 and £20,000, is under consideration.

Worcester.—It is proposed to extend the Council electricity main to Shrub Hill railway station, by agreement with the railway companies. The Electricity Committee are asking the Corporation to make provision for the purchase of new plant for the Hylton-road station, to cost £123, £2,262, and £925.

Attercliffe.—A resident the other night noticed the usual offensive smell given off by gas in his house, although no gas was laid on at his premises. Shortly after a gas flame appeared, rising from the floor in front of the fire. Assistance was obtained when a break in the main outside the house was found, and the gas had made its way into the house.

Croydon.—The Croydon and Southern Districts Tramways Bill is to be strenuously opposed by the Croydon Borough Council. The promoters seek power to run their cars between Purley and Norbury, which is the principal section of the Croydon system. The main object of the Bill is the construction of new lines between Purley, Whyteleafe, and Smitham.

Denmark.—The Danish Government has given some attention to the matter of securing electrical energy from windmills with the view of increasing the efficiency of the great number of windmills in that country. Nearly 30,000dol. have been appropriated, and an experimental station established at Askoc. A great deal of valuable information has been accumulated.

Lochmaben.—The almost prohibitive price of coal gas at Lochmaben has raised the question of adopting another method of lighting for the burgh. The matter has been under discussion by the Town Council, and it has been remitted to a committee to report on the best method of lighting, embracing petrol gas, oil gas, electric light, and also on modernising the present coal plant.

Stock Exchange.—The Stock Exchange Committee has appointed Feb. 12 a special settling day in Sempam Tin Mines' 30,000 vendors' shares of £1 each, fully paid, Nos. 8 to 30,007; and Feb. 19 in London Asiatic Rubber and Produce Co.'s 26 500 shares of £1, 15s. paid, Nos. 1 to 26 500; and Zinc Corporation's 108,142 preference shares of £1 each, fully paid, Nos. 500,001 to 608,142.

Islington.—The Lighting Committee are reporting to the Council that during the 11 weeks ended Jan. 11, 1908, the premises of 56 additional consumers were connected to the mains, additions to existing installations were made in 26 cases, reductions in two cases, and 30 consumers were disconnected. The result is a net increase in the maximum supply of the equivalent of 9,799 8-c.p. lamps.

California.—California has the world-wide reputation of fatherin the most daring engineering projects in the world in the way of electrical generation and transmission. The record power transmission is that of the Kern River plant in Southern California, where 25 000 h.p. is sent 117 miles at a pressure of 85,000 volts. Extensions of this plant are contemplated, which will increase the horse-power to 65,000.

Pontardulais.—Of such bad quality is the gas supplied, that the Pontardulais and Hendy Councils have held a joint meeting to deal with complaints regarding the supply. After a long discussion the clerk was instructed to write to the gas company complaining of the illuminating quality of the gas for street-lighting. There appears to be an opening here for the establishment of an electric supply company.

Loughborough.—The Town Council have decided to apply to the Local Government Board for sanction to borrow a further £5,000 for capital expenditure on the electricity undertaking. There is no scheme on foot now, but the borrowing powers of the Council are exhausted, and as cable extensions and other small items of capital

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expenditure are gradually cropping up, it has been found necessary to have further power to borrow as required.

Montrose.—The Harbour Committee have reported to Montrose Harbour Board that after due consideration they had made the necessary arrangements with the North of Scotland Electric Lighting Co. to light by electricity the inside of the transit shed, the fish quay, and the deep-water wharf. The committee also instructed the clerk to intimate to the Montrose Gas Co. that the lighting by gas of the places would be discontinued at March 31 next.

Rochdale.—The Corporation Electricity Committee are recommending that tenders be invited for the supply of condensing plant and pipework. They have also considered the question of giving a supply of electricity for power and lighting purposes to Messrs. Sidebottom's mill in Woodbine-street. They have instructed the electrical engineer to communicate with the firm, stating that they do not see their way to go to the expense of laying the necessary cables.

Middlesex.—On the recommendation of its Parliamentary Committee the County Council have decided to oppose both the London and District Electricity Supply Bill (1908) and the London Electric Supply Bill (1908), the first on the ground that its provisions, so far as it affects Middlesex, are not necessary, owing to the districts concerned being already catered for by other companies; and the second, because it contains several clauses which may affect county interests.

London's Tramway Link.—Before the end of April passengers will be able to travel through by tramway from Highbury to almost any part of South London. The extension of the Aldwych tube to the Victoria-embankment is practically completed, all the boring work being done, while the finishing touches are being given to the walls by bricklayers and plasterers. Only single-decked cars will be able to pass through the tubes, however, and a large number of these vehicles is now on order.

Colne.—A special report was presented to the Town Council at the last meeting by the electrical engineer upon the necessity of purchasing an additional feeder for supplying electricity to the centre of the town, and it was resolved that application be made to the Local Government Board to sanction borrowing powers to the extent of £1,670 for the installation of a high-tension cable, etc., and that application be made also for additional loans of £1,000 for extensions to mains, and £1,500 for the hiring of motors. To this the Council agreed.

Glasgow.—An explosion of gas occurred on the 30th in a tenement at 295, Main-street, Bridgeton, Glasgow. A quantity of gas escaped through the gas-pipe leading to one of the dwelling-houses, which accumulated under the floor. An explosion followed, with the result that about 4ft. of the flooring was torn up and part of the ceiling, measuring about 10ft. by 7ft., of the public-house of Mr. James Kemp, 293, Main-street, which is situated immediately underneath, was knocked down. Fortunately no person was injured.

Glasgow.—The Electricity Committee have purchased from the proprietor of Pollok estate a plot of ground in Haggs-road, lying between Ellangowan-road and Ravenshall-road, extending to 2,050 square yards, at the price of 10s. per square yard, for the purpose of erecting a transformer station, from which it is proposed to supply the districts of Craigton, Dumbreck, Crossmyloof, and Pollokshaws, subject to the condition that the Corporation shall pay the cost of construction of roads, sewers, ash footpaths, and lamps, at the rate of £1 per running foot of frontage.

Edinburgh.—The proposal to construct a new roadway from the car terminus at Murrayfield, Edinburgh, to the exhibition grounds at Saughton Park is under consideration by a sub-committee of the Streets and Buildings Committee of the Edinburgh Town Council. The roadway has been commenced, for building operations have been begun, and it is proposed to carry the roadway on to Saughton. The cost would be about £3,000, and this amount will be recovered from the landowners as the ground is built upon. The Exhibition Committee and the Tramway Committee have agreed to subscribe, the former £450, the latter £250 towards the cost.

Cheltenham.—The monthly report of the electrical engineer to the Corporation committee showed that there were 953 consumers, with the equivalent of 63,190 8-c.p. lamps connected to the private supply mains, the corresponding figures for last year being 909 and 60,648 respectively. The committee considered the question of the application of the surplus upon the revenue account for the year ended March 31, 1907—viz., £3,872. 11s. 6d.—and resolved that £2,000 be placed to a reserve fund and invested, and £1,600 to a reserve for renewals fund, and the balance carried forward.

Cannock.—At the last meeting of the Urban District Council the clerk stated that the deed of transfer with respect to the Council's provisional order for electric lighting had been completed and signed, and the purchase money paid to him. He had received a cheque from the solicitor now acting for the syndicate on behalf of the Shropshire Power Co. for £460, which had been paid into a special account. That £450 would be sufficient not only to recoup the Council the cost of obtaining the order and the deposit paid to the Board of Trade, but all the clerk's costs of the transfer to the Shropshire Co.

Ormskirk.—At a meeting of the Urban District Council a letter from the Board of Trade was read. This pointed out that the Ormskirk Electric Lighting Order, 1900, did not contain any provision enabling the Council to transfer their powers thereunder, and that the Board were not prepared to approve of arrangement which involved a divestiture by the Council of any of their legal powers and obligations, and adding that unless the Council could satisfy the Board that they intended to exercise the powers under the order themselves the Board considered that the order should not be allowed to remain any longer in force.

National Telephone Co.—The directors have resolved, subject to final audit, to recommend at the forthcoming general meeting of shareholders the following dividends for the half-year ending Dec. 31, 1907, after payment of the dividends on the preference shares: at the rate of 6 per cent. per annum on the preferred stock and at the rate of 6 per cent. per annum on the deferred stock, less income tax in all cases, carrying £145,000 to reserve and about £10,000 forward. The transfer books of the company will be closed from the 7th to the 20th prox., both days inclusive, and the dividend warrants will be posted on the latter date.

Clacton.—At a special meeting of the Urban District Council the Electricity Committee presented a special report recommending the expenditure of £4,000 for additional electrical generating plant, etc., required to meet the increased demand for electric current next season. It was proposed to run the new engine on producer gas, which the engineer stated would cost for fuel 50 per cent less than the town gas used at present at a cost of 2s. per 1,000 cubic feet. Last summer the existing plant of 200 kw. capacity was at times overloaded with 215 kw. The Council agreed to visit the works and have the matter thoroughly explained to them before taking action.

Halifax.—The annual meeting of the Halifax Chamber of Trade was held on the 3rd inst. at the Mechanics' Institute, Mr. J. Walker Clark presiding. The chairman, in moving the adoption of the report, referred to the question of telephone rates. He said the National Chamber of Trade was joining the deputation to the Postmaster-General, and their representative would support the following points—viz., an inclusive charge, a minimum rental charge, with a message rate at a very much lower figure than that proposed, and the administration of the telephones by local authorities, it being alleged that the trunk service now under the control of the Government was the least efficient part of the system. The report was adopted.

Greystones (co. Dublin).—A meeting of the ratepayers of this township was held on the evening of the 1st inst. for the purpose of considering three scheme of lighting for the town. Mr. A. M. Archer, J.P., presided. The schemes included an electric lighting one by Messrs. William Coates and Co., Belfast and Dublin, a coal-gas scheme by a London firm, and an improvement on the present oil-lamp system. Messrs. Coates's scheme included 70 standards with two lamps on each for public lighting, plant would be laid down for supplying 4,000 units for private lighting, and the cost would be about £3,000. It was decided to approve of the electric lighting scheme, and to oppose the gas Bill which is being promoted in Parliament.

Cardiff.—The telephone as a means of communication continues to grow in favour with the public, and to meet the increasing demand at Cardiff docks the National Telephone Co. has opened six additional call offices, each of which can be used for Cardiff district calls on payment of 1d. The new call offices are situated in the following places: west side of West Dock Lock; west side of East Dock Lock; south end Commercial Dry Dock; east side, south end Roath Dock; east side, north end of Wharf-road East, near Tyndall-street entrance; and east side of Queen Alexandra Dock. The Cardiff area includes all subscribers in the following places outside Cardiff: Bonvilstone, Dinas Powis, Llandaff, Llanishen, Penarth, Radyr, St. Mellon's, Taff's Well, and Whitchurch.

Finchley.—Mr. H. Ross Hooper has held an inquiry on behalf of the Local Government Board at Finchley into the application of the District Council for sanction to borrow a further sum of £22,000 for the extension of the electric lighting undertaking. Mr. E. H. Lister, the clerk to the Council, stated that the growth of Finchley during the last few years had been phenomenal. The number of new houses had varied between 400 and 600 a year, most of which were wired during erection for electric light. Notwithstanding that the undertaking had already been hampered by two serious fires—one at the boiler-house and the other in the offices—the financial result of the scheme had been satisfactory, a profit of £227 being made in the first complete year's working. There was no opposition to the application.

Knaresborough.—The Harrogate Gas Co. are protesting against the action of the Knaresborough Rural District Council in supporting the Harrogate Corporation in seeking powers from the Board of Trade to extend the area for the supply of electricity to the whole district within the area covered by the administration of the Rural District Council. It appears that at the present time the Harrogate Corporation have no power to supply their light to Bilton, Pannal, and Starbeck, but the gas company have powers for those portions of their area. Consequently, if anyone requires electric light in Pannal they cannot have it because the gas company hold the monopoly. The Corporation are going to the Board of Trade to see if they will allow them to supply the electric light in those places which at present they were unable to do. What have the gas company to fear?

Crewkerne.—The Light Railway Commissioners have held an inquiry relative to the application to construct a proposed light railway between Crewkerne and Martock. Mr. Garland opened the case for the promoters and, in reply to the chairman's observation that there was no evidence as to the financial prospects, said they could not approach the public for subscriptions until an order had been obtained. The sum of £500 had been guaranteed for the preliminary expenses. Mr. Hutchinson suggested that the inquiry be adjourned in order that the promoters might ascertain what financial assistance might be obtained. His client, Mr. Peters, had no wish to be vindictive in the matter, but he was bound to look after his own estate. Mr. Garland accepted the suggestion, and the inquiry was adjourned, the Chairman remarking that the Commissioners were satisfied with the local requirements, and that it would be to the benefit of the district.

Greetland.—Some time ago the District Council approached the Elland Council asking on what terms they would supply electricity to the Greetland authority. Negotiations were opened, but these have not been carried forward. At Monday's meeting of the District Council Councillor W. Shackleton asked why the question had not been carried forward, and pressed the chairman of the committee to fix a night for

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the full consideration of the subject. The Chairman said there had been no dilatoriness on the part of the committee, and a night would be fixed for consideration of the subject which would meet the convenience of the members. There had been several applications for the use of the electrical illuminant, and as the Council cannot afford to lay down an installation of its own, it is desirable that arrangements should be made for a supply from the Eland Council. We understand that the latter authority are prepared to allow Greatland to obtain the current through meter at their new boundary.

Stoke-on-Trent.—At the meeting of the Town Council the Electricity and Destructor Committee reported that they had considered a special report by the electrical engineer on the present and probable future demand for electricity showing that the generating plant would shortly require extending. They recommended that that report be adopted and the plant extended accordingly, and that application be made to the Local Government Board for sanction to borrow £5,965, the estimated amount required to carry out the work. The committee also recommended that the town clerk be instructed to write to the Board of Trade on the subject of amending the Electric Lighting Acts by giving increased facilities to local authorities. In reply to questions, Alderman Robinson said they had reached the limit of the producing capacity of the present plant, and they were not only faced with the prospect of an increased demand both for lighting and motive power, but they had undertaken to supply electricity in the Fenton district. The recommendations of the committee were adopted.

Rossendale.—For two or three days the houses and works in Rossendale have been made almost unbearable by an obnoxious gas. The odour was first noticeable on Sunday, and the services at both St. James's Church, Waterfoot, and St. John's Church, Bacup, were disturbed, several members of the congregations having, through faintness, to be carried out. On Monday morning when the mill operatives went to work they found the sheds almost insufferable because of the nauseating smell. At a Stacksteads mill a number of weavers had to leave their looms, and at Messrs. Hargreaves' reed and heald works, Bacup, three or four employés were overcome. Many complaints were made to the sanitary inspector, and the matter was investigated by Dr. Brown, the medical officer of health, who found that sulphur compounds had in some way got into the mains from the gasworks and were being discharged through the burners. Those who were fortunate enough to use electricity were, of course, free from the poisoning effects of the ancient and dangerous system of lighting.

Hammersmith.—The Electricity and Lighting Committee reported to the Borough Council at the last meeting that they had under consideration reports by the electrical engineer upon immediate extensions of plant, etc., and future developments at the Council's generating station, rendered necessary to enable the Council to supply consumers, over and above those already contracted for, without undue risk. The engineer pointed out that during the last six months the applications for current represent a record increase over any previous period, and already the maximum demand this winter had increased by 370 kw. over the maximum recorded last year. The estimated cost of the works above is as follows: generating station, increase of boiler capacity, £4,400; ditto, main switchboard, £1,000; sub station, Hammersmith-road, £283; station transformers, £570; extension of mains, £1,899; consumers' services to March, 1909, £4,038—total, £12,190. The committee approved the engineer's report, and recommended that the several works suggested in the report should be carried out in accordance with the estimates submitted. The recommendation was agreed to by the Council.

Bury.—At the last meeting of the Electricity Committee of the Town Council estimates of the proposed new electricity generating station at Chamber Hall were considered. The electricity engineer, Mr. S J. Watson, submitted figures based on a plant of (1) 2,000 kw., (2) 3,000 kw., and (3) 4,000 kw. The estimated cost for land, building, sidings, and plant were (1) £39 881, (2) £18,155, and (3) £55,720; for connecting mains with the existing works, £6 300 for either scheme. There was also an item of £10,000 for transformers and high-tension mains when applications for a supply of current in large quantities were made, and this sum would also be applicable to either of the schemes. The average cost per kilowatt, based on the capacity of the power station, was submitted by Mr. Watson. These were: No. 1 plant, £19·9 per kilowatt; No. 2 plant, £16·05 per kilowatt; and No. 3 plant, £13·9 per kilowatt. Mr. Watson reported that the larger scheme was the most economical. The committee considered the whole schemes, and decided that they would recommend the Council to apply for borrowing powers for £72,000. Tenders were opened for the construction of the large chimney at the works, and, subject to the Local Government Board sanctioning the scheme, it was decided to give the contract to Mr. Cammack Dennis, of Bury.

Wednesbury.—At the next meeting of the Town Council part of the business will relate to the difficulty which has arisen between the Corporation and the Midland Electric Co. with regard to the supply of electricity in the borough. The Light and Water Committee will report that, at the request of the Board of Trade, a meeting was held at the offices of the Board on the 7th ult. between representatives of the company and of the Corporation to see whether it was not possible for some new arrangement to be made for the supply of energy in bulk by the company to the Corporation. The terms submitted by the company at the meeting, and further terms since obtained from them, have been carefully considered by the committee, and they are of opinion they would not enable the Corporation to carry on their undertaking except at a loss. The committee have since received a notice from the company of their intention to terminate on March 31 next their agreement for the supply of electricity in bulk to the Corporation; also a further notice of their intention to break up all the principal streets of the town in pursuance of the powers alleged to be contained in their provisional order. Notice of the Corporation's disapproval of the company's proposed action has been served on the company.

Ashton.—On Saturday evening the Ashton Urban District Council inaugurated a new enterprise in their district by the adoption of electric lighting for part of it—namely, Liverpool-road. Members and officials of the Council assembled at Juddfield Brow, from which point the lighting commences, and the ceremony of switching on the light was performed, amidst cheering, by Mr. J. Hamilton, chairman of the Council, who expressed the wish that the new undertaking of the Council might prove successful. The cost of the work is about £300. There are 64 poles erected in connection with the installation, placed a distance of 40 yards apart. Every alternative pole is used for lighting, and there are on each pole two lamps of 25 c.p. each. The lamps are each fitted with two short iron brackets having watertight fittings, with clear globes. The lamps are wired in series, and connected through a fuse to the wires, properly enclosed in tubing. The electric lighting is carried through about 200 yards of the district of the Haydock Council. The Ashton Council obtained the concession of an electric lighting order from the Board of Trade in July, 1901, and have now for the first time availed themselves of the powers thus derived. The electricity is obtained from the St. Helens Corporation.

Redditch.—Mr. W. O. E. Meade-King held an inquiry on behalf of the Local Government Board on Wednesday last into an application by the Redditch Urban District Council to borrow £1,500 for the purpose of the electric lighting undertaking. On behalf of the Council, Mr. G. W. Hobson (clerk) stated that, acting on the suggestion of the Local Government Board, the Council had decided to extend the application for the loan from £500 to £1,500—£1,000 for cables and £500 for meters—which it was anticipated would meet the requirements for the next three years. The period asked for the loan was 20 years. The population of the urban district at the last census was 13 493, and was now estimated to be 15,500. The assessable value was £46,413 18s. 10d., and the rateable value £55,248. 16s. 5d. The balance of outstanding loans under the Sanitary Acts was £18,385. 13s. 10d, and under other Acts £34,594. The general district rate was 3s. 6d. in the £, the poor rate for the urban district 2s. 8d., and for Feckenham urban 4s. The Inspector asked if the undertaking was remunerative. Mr. Hobson replied it was not yet self-supporting, but the financial position had improved. In 1905 there was a net loss, after payments in respect of sinking fund contributions and interest, of £621; in 1906 of £632; and in 1907 of £488. The contribution from the rates to assist the undertaking in the current year was £600, compared with £1,000 a few years ago.

Wrexham.—At a meeting of the Electricity Supply Committee the electrical engineer submitted his monthly report, including the following statement: connections and supply—used for tramways, 13,434 units December, 1907, against 15,652 units December, 1906; used for lighting, etc., 51,717 units, as against 53,275 units; total units generated, 65,181, as against 68,927; new consumers connected, 6. The electrical engineer also reported that, having arranged with the Great Western Railway Co. to supply electrical energy for the purposes of new luggage lifts at the Wrexham railway station, he was in negotiation with them for a supply of energy for lighting the station and goods yard; and he recommended that, in the event of terms being arranged, the Corporation lay, at their own cost, a cable from the Regent-street end of the railway station approach to the luggage lifts, at an estimated cost of £100, subject to the company granting the necessary wayleaves over their property for the laying of such cable, and for any extensions thereof, which may be required for the purpose of supplying the premises now occupied by Messrs. Powell Bros and Whitaker and Messrs. W. Thomas and Son. It was resolved that the Great Western Railway Co. be informed that the Corporation are prepared to supply them with electricity upon the following terms, subject to the company entering into an agreement satisfactory to the town clerk—namely: for an annual consumption of 15,000 units or under, £165; for each unit and above 15,000 units, when the consumption does not exceed 20,000 units per annum, 2½d.; for each unit over and above 20,000 per annum, 2d. That, in the event of the company taking a supply of electrical energy upon the foregoing terms, the Corporation lay a cable for the purpose named, at an estimated cost of £100. This report was adopted by the committee.

Aberdeen.—In accordance with the remit from the Aberdeen Town Council, Mr. J. A. Bell, Corporation electrical engineer, has prepared a report of the capital sum expended by the Deeside and District Electric Supply Co. upon their undertaking, and the annual net profits earned by the company, without allowing for depreciation, sinking, or reserve funds. The nominal capital of the company was £10,000, and the price paid by the company in December, 1905, to Messrs. Lowdon Bros. for the undertaking was £7,500. After that the company put in plant to the value of £1,712. In October, 1905, the undertaking was valued at £7,800. Since that time the plant above referred to had been put in, and a workmen's cottage erected at a cost of £330, making a total of £9,842. The valuation Mr. Bell made for the Corporation of the undertaking as a going concern was £6,137, which, however, did not include anything for the cost of the company's provisional order, or the flotation of the company, amounting to £667, or for goodwill, etc. Regarding the company's profit for the year ended December, 1906, it was £283. 3s. 9d., from which was deducted interest £51, and proportion of preliminary expenses £36. 7s. 8d., leaving £192. 16s. 1d. as the net profit for the year. The units sold for the year ended December, 1907, show a 10·4 per cent. increase over the preceding year. The undertaking, as taken over by the Corporation, had 141 consumers, and already nine applications have been received for supply off the existing cables. All the main cables are in excellent condition, and of sufficient capacity for a very considerable increase in the number of consumers. Dr. Gordon, town clerk, reporting as to how far it is compulsory upon the Corporation to carry out the provisions of the Aberdeen Corporation Electricity Act of last year, says that under the Act the Corporation are required to lay down within two years from the passing of the Act suitable

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and efficient distributing mains for the purpose of general supply in the areas defined in the Act. Default or delay in laying down the compulsory distributing mains would make the Corporation liable for each default to a penalty not exceeding £5 each day during which the default continues.

Aston.—The Electric Supply Committee in their report to the Town Council state that the sale of current during the past month shows the following increases over last year: lighting, 14,841 units; power, 40,743; traction, 9,070. The total sale was 291,032 units. The committee have for some time had under consideration the necessity of extending the works and plant. The committee have in commission 2,150 kw. of plant for normal full-load working, and 2,650 kw. to meet a peak of two hours' duration. The total lighting and power connections at Dec. 31, 1906, were 52,551 equivalent 8-c.p. lamps, and the maximum demand upon the plant supplying these lamps was 925 kw. The lighting and power connections made from that date to Dec. 31, 1907, are 36,097 equivalent 8-c.p. lamps, making a total of connections to this date 88,598 equivalent 8-c.p. lamps, or an increase of 68·5 per cent. The maximum demand (sustained) upon the plant to meet this load has been 1,500 kw. The committee have applications in hand for 24,315 equivalent 8-c.p. lamps, which brings the total at March 31, 1908, to 112 913 equivalent 8-c.p. lamps, or an increase from Dec. 31, 1906, of 114 per cent. In considering the possible maximum demand the committee have taken the actual figures obtained in December, 1906, and on the same basis find that the maximum demand which will be made upon the plant during the winter of 1908 from the existing connections and applications, and not considering any further increase, will be about 1,925 kw. To meet this anticipated demand the Council have 1,750 kw. of plant full-load capacity, and 2,200 kw. overload capacity. From these figures it will be seen that it is not only necessary that extensions should be made, but that they must be commenced immediately. The committee accordingly recommend the installation of one 2,000-kw. turbo-generator, three-phase, 6,600 volts, 50 periods per second, complete with condenser, air and circulating pumps, etc., this unit to be contained in an extension built on the end of the existing engine-house, space being left in the floor for the reception of a further unit of similar capacity; and two 400-kw. and one 300-kw. motor-generators placed in the existing engine-house, or a small extension if necessary, to be used for converting the alternating current to continuous current, or *vice versa*, as required. The approximate cost of these works, with extra boilers, coal storage, switchgear, etc., is put down at £33,000. Of this amount the Council have already obtained the Local Government Board's sanction to £5,000 on the buildings, £1,687 on one boiler, £1,100 on coal bunkers, making the total sanctioned £7,787, leaving a balance of £25,213, to which the sanction of the Local Government Board will be required. The adoption of this scheme would increase the station capacity to 4,150 kw. full-load running. By the installation of two 400-kw. and one 300-kw. motor-generators, 1,100 kw. will be added to direct-current plant, thereby increasing the capacity to 3,250 kw., leaving 1,000-kw. alternating-current supply available for direct supply to power users on the outskirts of the district. Further, it will shortly be necessary to supplement the feeder to Six Ways and Villa ward, owing to increased lighting and power connections. This can be done at much less cost by running an alternating-current feeder to a small sub-station, and there installing the two rotary converters and switchgear already installed at the station for the Erdington supply. These machines would efficiently convert the alternating current to direct current, and would maintain a steady pressure throughout the district with the minimum of loss.

TRACTION.

Ilford.—At a special meeting of the ratepayers' association it was decided to ask the Urban Council to proceed with the laying of the Cranbrook-road tramways.

Madras Electric Tramways (1904).—The receipts for the fortnight ending Jan. 31, 1908, totalled Rs.19,961, being an increase of 13·3 per cent. over the corresponding month of 1907.

Brisbane Electric Tramways Investment Co.—Traffic receipts of the Brisbane tramways for the month ended Jan. 31 amounted to £14,340; corresponding week last year, £12,465 — increase, £1,875.

Leith.—At a meeting of the Town Council on Feb. 4, a motion not to proceed further with the proposed extension of tramways under the provisional order now being promoted by them was defeated by a large majority.

Gorton.—The Finance Committee of the Manchester Corporation are recommending the City Council to authorise the immediate advance of £11,350 for tramway purposes to the Gorton District Council at £3. 15s. per cent.

Russia.—The British commercial agent at Vladivostok reports that the contract for the construction of electric tramways on the overhead system and for the electric lighting of that town has been given to a German firm. The cost of the work is to be about £158,000, and it is to be finished by July 1, 1909.

Buenos Ayres and Belgrano Electric Tramway Co.—Receipts for the week ending Jan. 28, 1908, converted to gold were £3,376; corresponding period 1907 were £3,462—decrease, £86. Aggregate from Jan. 1, 1908, £14,658; aggregate from Jan. 1, 1907, £14,713—decrease, £55.

Light Railways Act, 1896.—The Board of Trade have recently confirmed the following order made by the Light Railways Commissioners: London and North-Western Railway (Dyserth and Newmarket Light Railway) Order, 1908, authorising the construction of a light railway in the county of Flint, from Dyserth to Newmarket.

Darlaston.—The question of the increased fare charged to children by the Birmingham and Midland Tramways Co. has been brought before the General Purposes Committee of the District Council, and they have referred the same to the Association of Midland Local Authorities to see what united steps can be taken to get the fares reduced.

London, W.—The construction of the new London County Council tramways from Harrow-road to Putney Bridge has commenced, and the laying of the ducts is nearly finished. The trams will pass through Wood lane, past the Franco-British Exhibition, Shepherd's Bush-green, Hammersmith-broadway, and Fulham Palace-road. The line is to be opened in May.

Bournemouth.—At the annual dinner of the Westbourne Literary and Debating Society, Councillor R. V. Banks, chairman of the Corporation Tramways Committee, stated that £25,000 had been realised on profits from the tramways since their inception, and that they had repaid on capital account about £60,000. The undertaking also contributed a sum of £2,000 yearly to the borough rates.

Little Lever.—At a meeting of the Council's Tramways Committee the desirability of providing a system of tramways for Little Lever was considered, and also a statement by the clerk of an interview he had had with the manager of the Bury Corporation tramways. It was, therefore, resolved that an interview be arranged between the committee and representatives of the Bury Tramways Committee to discuss the question.

Liversedge.—The District Council have decided to protest against the proposal of the local tramway company to allow their powers to lapse so far as the making of a line between Hightown and Cleckheaton is concerned, and that, if arrangements could be made with the Cleckheaton Council, a joint deputation should interview the Board of Trade on the subject, with a view to the making of the line in accordance with the original undertaking.

Derby.—In their report to the Town Council the Tramways Committee state that under the provisions of the contract the time for the completion of the Ashbourne-road and Uttoxeter-road tramways was extended by the borough surveyor to Oct. 24, 1907. As the works were not completed until Nov. 28, 1907, the penalties amounted to £1,465, which sum has been deducted from an instalment due to the contractors, Messrs. R. W. Blackwell and Co.

Sunderland.—The Corporation Tramways Committee are to give £4,288 of the profits for the present year to the relief of the rates. Despite the great trade depression, the receipts from fares only show a decrease of £2,000, the total being £70,000. The wages bill was £13,000, and current expenses ran to £12,800. Interest on loans accounted for £8,500, and repayment of loans £9,300; £6,200 is put to the reserve and renewals fund. Last year these figures were about the same, but the amount given to the relief of the rates was £7,100.

Southport.—The conference between the Southport Corporation Tramways Committee and a deputation of tramway employés has had a happy ending. The committee have now agreed to the following rates of pay: motormen, probationary six months 5½d. per hour, then 6d. per hour for three years, after the expiration of which the men will receive a rise of ½d. per hour; conductors, probationary six months 4½d. per hour, subsequent three years 5d. per hour, and after the expiration of three years 5½d. per hour. The committee have further agreed to abolish the stripes system, and have also decided to recommend the six days' holiday each year. The result of the conference has given the greatest satisfaction to the men.

Campbeltown and Machrihanish Railway.—A meeting of the shareholders of the Campbeltown and Machrihanish Light Railway was held on the 27th ult. in the offices of the company, 150, St. Vincent-street, Glasgow, for the purpose of considering the draft order to amend the company's borrowing powers, for which application had been made to the Light Railway Commissioners. Under the draft order, Section 53 of the order of 1905, referring to borrowing powers, is amended to read and have effect as if the sum thereby authorised to be borrowed by the company were £8,500 instead of £2,000, whilst other clauses affect the application of borrowed money, the making up of accounts, etc. The order was approved of.

Dunfermline.—We understand that Mr. George Balfour has obtained the controlling interest in the Dunfermline tramways scheme, for which parliamentary powers were recently acquired, and that the construction of the lines will be taken in hand some time during the coming summer. The tramways will run through Dunfermline and Crossgates to Cowdenbeath, where one line will branch off to Lochgelly and the other to Kelty. There will also be a branch line from Dunfermline to Townhill. The total length of track is about 15 miles, of which it is intended to construct about 11 miles at present. The line will be partly single and partly double. The portion to be meantime built will require a capital expenditure of about £150,000, and this part of the work should occupy about five or six months in construction. The current will be purchased from the Fife Electric Power Co.

Morley.—At a meeting of the Morley Town Council the mayor moved that, subject to the necessary agreement being completed in a satisfactory form, the Council decide to exercise their rights to purchase the light railways to be constructed in the borough of Morley. He explained the advantages which would accrue to the public—viz., that the Corporation would receive £3,000 a year by purchasing from the company, which would already had powers to construct the tramways; that if the Corporation were to buy the company were bound to take the undertaking on a lease for 28 years, and that the company were bound to hand over the tramways in a good working condition at the end of that period. So that in 28 years the tramways would become the property of the Corporation without any further payment. Further, they would receive £3,114. 10s. per annum in reduction of the rates. A lengthy and somewhat animated discussion took place, and ultimately the resolution was carried by 15 votes to 13.

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Chorlton-cum-Hardy.—It was suggested at a meeting of the Chorlton-cum-Hardy Ratepayers' Association on Wednesday last that the Tramways Committee should be asked to extend the 1d. stage from Chorlton to Alexandra-road and to the Stretford-road end of Chorlton road. This would enable Chorlton people to get to the city by any of the routes for 2d. instead of 2½d., which is the charge by some routes at present. A resolution in favour of the suggestion was adopted. Several members suggested that in order to obviate the delay in travelling along the single line with loops in Upper Chorlton-road, the Tramways Committee should be asked to lay a double line of track by Seymour-grove to Old Trafford Bar, which was the most direct route to the city. It was said that the Stretford Urban Council blocked the way to the carrying out of that project. The association decided to ask the Tramways Committee to resume negotiations for the laying of lines along Seymour-grove, and it was also resolved to request the Stretford Urban Council, in the public interest, to do all they could to facilitate the scheme.

Wandsworth.—At the last meeting of the Borough Council the General Purposes Committee made several recommendations relating to the proposals contained in the London County Council Tramways Bill. The chief of these were: That before the proposed tramway to form a junction between the existing tramways in High-street and Mitcham-road at the north-eastern side of the Broadway was constructed, the road there should be widened so as to provide a space of 9ft. 6in. between the kerb and the tramway rail, and a footpath of not less than 9ft. in width. That the proposed tramway from the existing terminus at Streatham along Streatham High-road to the county boundary at the River Graveney should be a double line throughout, and the whole of it constructed on the underground system. That the proposal to use overhead electrical traction for the proposed tramway over Putney Bridge into Lower Richmond-road should be objected to. That the widenings at Streatham High-road proposed by the Bill were not sufficient; that the proposal to widen the road in certain places by reducing the width of the footpath should be objected to, and that provision should be made in the Bill for a contribution by the County Council to the cost of the paving works which will be rendered necessary by the proposed widenings and construction of the tramways; and that any necessary alterations in the gradient of the road be made at the expense of the London County Council. The committee suggested that they should be authorised to present a petition embodying these recommendations against the Bill. The recommendations were agreed to.

Newcastle.—A meeting of the Tramways Committee of the Newcastle Corporation was held on the 30th ult., when a deputation of workmen representing the Walker shipyards, shopmen's union, and builders' labourers waited upon the committee, and urged that the ½d. workmen's fares in the morning should be rearranged, and that the present system of workmen's coupons was expensive and involved a very great hardship to many thousands of workmen. The chairman thanked the deputation for their attendance, and stated that the matters they had mentioned would receive most careful consideration. The committee, however, had already arranged that the coupon tickets, which were issued at 22 for 1s., could be used on any of the cars in the morning up till 8 o'clock, from noon until 2 o'clock, and from 4.30 to 7 at night, which was a very great advantage to the workmen. In cases where the whole of the tickets were not used, they would be accepted by the conductors at the face value, the men paying the difference between that and the ordinary fares. If all the coupons issued for a week were not used, there was no objection to them being used as part of the requirements for the following week. The committee intimated that they would consider the advisability of making an alteration with respect to workmen's tickets in cases of workmen earning over 25s. per week and also in cases of women earning over 15s. per week. The city engineer was authorised to complete the connection between New Market-street and Pilgrim-street, and to lay new crossings and points already sanctioned by the committee and Council. It was agreed to run all the cars in connection with the Royal Show at ordinary fares, and to grant as many facilities as possible.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Accrington.—Tenders are invited for the supply of a cooling tower in connection with the new 2,000-kw. plant.

Bremerhaven.—Tenders are invited by the Harbour Authorities for 27 electric cranes. Tenders by March 2.

Manchester.—Tenders are invited for the supply of four water-tube boilers and accessories. Tenders by Feb. 25.

Bourges.—Tenders are invited by the Military Authorities for one five-ton electrical crane. Tenders by Feb. 14.

Campina (Bucharest).—The Municipality invite tenders for the electric lighting of the town. Tenders by Feb. 9.

Salford.—The Corporation invite tenders for the installation of electric light at the car depôt. Tenders by Feb. 17.

Salford.—The Tramways Department invite tenders for electrical and mechanical car accessories. Tenders by Feb. 17.

Islington.—The Borough Council invite tenders for the supply of electrical and engineers' stores. Tenders by Feb. 18.

Melbourne.—Tenders are invited by the Postmaster-General for switchboards and telephone sets. Tenders by May 26.

Sydney.—The Postmaster-General invites tenders for 33 switchboards for common-battery working. Tenders by March 4.

Edinburgh.—The Corporation invite tenders for an extension switchboard panel. Tenders to the Town Clerk by Feb. 10.

Oporto.—The Municipality invite tenders for the construction, maintenance, and working of tramways. Tenders by March 11.

Wimbledon.—Tenders are invited for the annual supply of cables and conduits for the Electricity Department. Tenders by Feb. 18.

Wimbledon.—Tenders are invited for the annual supply of flame arc lamp carbons to the Electricity Department. Tenders by Feb. 18.

Remscheid.—The Municipality invite tenders for high-pressure turbines and turbo pumps in connection with the waterworks. Tenders by Feb. 15.

Brazil.—The Government invite tenders for the installation of electric light and power supply in the city of Florianopolis. Tenders by March 5.

Croydon.—Tenders are invited for coal-conveying plant for the electricity works. Particulars from the Borough Electrical Engineer. Tenders by Feb. 10.

Burnley.—The Guardians invite tenders for the supply of a booster to the electric lighting station at the union workhouse. Tenders by Feb. 12.

Hornsey.—The Borough Council invite tenders for the installation of electric light wiring and fittings in various public buildings. Tenders by Feb. 17.

Blackburn.—The Electricity and Tramways Committee invite tenders for the annual supply of stores. Tenders by Feb. 15. See advertisement in last issue.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Rawtenstall.—The Corporation invite tenders for the erection of generating station buildings and chimney stack at Hareholme. Tenders to the Town Clerk by Feb. 10.

Ilford.—The Urban District Council invite tenders for one 1,000-kw. steam dynamo and one water-tube boiler and accessories. Tenders by Feb. 25. See advertisement.

Salford.—The Tramways Committee invite tenders for the annual supply of stores, including electrical car accessories. Particulars from the General Manager. Tenders by Feb. 17.

Swansea.—The Corporation invite tenders for the supply of motors and starting switches during 12 months. Tenders to the Town Clerk by Feb. 21. See advertisement in last issue.

Stockton-on-Tees.—The District Fund, Gas, and Electricity Committees invite tenders for the annual supply of stores. Tenders to the Town Clerk by Feb. 17. See advertisement.

Handsworth.—The Urban District Council invite tenders for 315-kw. engine and dynamo and switchgear, and feed pump, economiser, and pipework. Tenders by March 4.

Gravesend.—The Electricity Committee invite tenders for the supply of 3,500 tons of rough small coal for the electricity works. Tenders to Mr. H. H. Brown, town clerk, by Feb 17.

Rathmines.—The Rathmines and Rathgar Urban District Council invite tenders for the annual supply of stores to the Electricity Department. Tenders to the Town Clerk by Feb. 13.

Kilkenny.—Tenders are invited for the erection of an electric power-house at the asylum, for the Committee of the Kilkenny District Asylum. Tenders to Mr. M. J. Hogan, clerk, by Feb. 17.

Belfast.—The Belfast and co. Down Railway Co. invite tenders for the annual supply of stores, including switches and crossings. Tenders to the Secretary, Queen's Quay Terminus, by Feb. 10.

Leeds.—The Corporation invite tenders for steam, exhaust, overflow, and other pipes, valves, etc., in connection with a 3,000-kw. steam turbo-generator. Tenders to the Town Clerk by Feb. 10.

Battersea.—The Borough Council invite tenders for the annual supply of various materials for the electricity department. Tenders to the Town Clerk by Feb. 18. See advertisement in last issue.

Wallasey.—The Urban District Council invite tenders for the annual supply of stores for the Tramway Department. Particulars from the General Manager, Liscard, Cheshire. Tenders by Feb. 12.

Paris. The Municipality invite tenders for centrifugal pumps to be driven by three-phase motors for the Clichy sewage pumping station. Particulars from the Clerk to the Municipality. Tenders by Feb. 18.

Salford.—The Tramways Committee invite tenders for the supply of uniform clothing for the tramway employes for the year ending March 31, 1909. Tenders to Mr. L. O. Evans, town clerk, by Feb. 17.

Hammersmith.—The Borough Council invite tenders for the annual supply of stores for the electricity department. Tenders to Mr. H. Thompson, town clerk, by Feb. 19. See advertisement in last issue.

Hull.—Tenders are invited for the necessary electric light installation, fittings, and fans required at the Selby-street West School, now in course of erection, for the Education Committee. Tenders by Feb. 10.

Portsmouth.—The Tramways Committee invite tenders for the supply of uniforms for inspectors, timekeepers, motormen, and conductors, etc. Particulars from the General Manager. Tenders by Feb. 17.

Birmingham.—The Tramways Committee invite tenders for the supply of uniform caps for inspectors, motormen, and conductors. Particulars from Mr. Alfred Baker, general tramway manager. Tenders by Feb. 11.

Hampstead.—The Borough Council invite tenders for the supply of stores, including oils, for electric lighting station, tools, implements, and other electrical engineers' stores. Tenders to the Town Clerk by Feb. 13.

Buenos Ayres.—Tenders are invited for the construction of underground electric tramways. Particulars from the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London. Tenders by June 1.

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Barking.—The Urban District Council invite tenders for the annual supply of stores for the electricity and tramways departments. Particulars from the Engineer at the electricity works. Tenders to the Clerk by Feb. 25.

Aston Manor.—The Corporation invite tenders for one 2,000-kw. turbo-alternator, complete with condenser, air, and circulating pumps, etc. Tenders to the Chairman of the Electricity Committee by Feb. 17. See advertisement.

East Ham.—The Corporation invite tenders for the installation of an approved generating plant with distributing pipes and radiators, and all other requisites, at the isolation hospital extensions. Tenders to the Town Clerk by Feb. 24.

Rawtenstall.—The Corporation invite tenders for the supply and erection of one overhead travelling crane, and of a battery of accumulators, automatic reversible booster, etc. Tenders to the Town Clerk by Feb. 21. See advertisement.

Leeds.—Tenders are invited by the Tramways Committee for the annual supply of stores, including electrical sundries. Particulars from Mr. J. B. Hamilton, general manager, Tramways Office, City-square, Leeds. Tenders by Feb. 21.

Buenos Ayres.—Tenders are invited for (1) the construction of and (2) the concession to work the two principal sections of the underground electric railway. Particulars from the Argentine Legation, 12, Rue van Moer, Brussels. Tenders by May 1.

Islington.—The Lighting Committee invite tenders for the supply of one 500-kw. steam turbine, condensing plant, switchgear, alternator, exciter, etc., and also for water-tube boilers and coal-conveying plant for the electricity works. Tenders by Feb. 25.

Wolverhampton.—The Tramways Committee invite tenders for the supply of clothing for the tramway employés. Particulars from Mr. W. A. Luntley, the general manager, at the Car Depôt, Cleveland-road, Wolverhampton. Tenders by Feb. 11.

Rio de Janeiro.—Tenders are invited by the Secretary of the Estrada de Ferro Central do Brazil, at Rio de Janeiro, for the supply of rails and accessories. A deposit of 2,000 milreis (about £132) will be required to qualify any tender. Tenders by Feb. 28.

Manchester.—The Tramways Committee invite tenders for the supply and delivery of one two-ton steam travelling crane. Particulars from Mr. J. M. McElroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by Feb. 17.

Bristol.—Tenders are invited for the supply of cables and appliances for conveying electrical energy to the Avonmouth Docks, and for construction and maintenance for 12 months. Tenders to the Secretary of the Docks Committee, 19, Queen-square, Bristol, by Feb. 17.

Sheffield.—The Tramways Committee invite tenders for the supply of stores—including electrical supplies and fittings, cable, car fittings, car lamps, wood slipper blocks, belting, and overhead line material—for 12 months ending March 25, 1909. Tenders by Feb. 10.

Belfast.—The Tramways and Electricity Committee invite tenders for the supply of low-tension insulated vulcanised bitumen cables during 12 months ending March 31, 1909. Tenders to Mr. T. W. Bloxam, city electrical engineer, by Feb. 25. See advertisement in last issue.

Portsmouth.—The Corporation Electricity Supply Department invite tenders for the annual supply of stores, including electrical goods, street work (laying cables, etc.). Particulars to be obtained at the Electric Lighting Station, Gunwharf-road, Portsmouth. Tenders by Feb. 12.

Nottingham.—Tenders are invited by the Tramways Committee for the supply of the various articles of clothing required for the motormen, conductors, and inspectors for ensuing year. Particulars from the General Manager, Corporation Tramways. Tenders to the Town Clerk by Feb. 10.

Wimbledon.—The Corporation invite tenders for one 1,000-kw. steam-driven turbo-alternator, with condensing plant, two water-tube boilers, economisers, pipe work and feed pump, high-tension main switchboard, and switchboard gallery. Particulars from the Borough Electrical Engineer. Tenders by Feb. 18.

Castleres.—The Rural District Council invite tenders for suction gas plants, gas-engines, dynamos, battery, switchgear, overhead distribution lines, arc lamps, and service connections, in connection with the electric lighting scheme for the town of Ballaghaderreen. Tenders to Mr. P. A. Flanagan, clerk of the Council, by Feb. 22.

Halifax.—Tenders are invited for the annual supply of stores for the Tramways and Electricity Departments, including lighting fittings, electrical accessories, copper strip, iron brake blocks, castings (malleable iron, cast iron, and brass), tubes and fittings, continuous-current meters, and overhead line material. Tenders by Feb. 12.

Brussels.—Tenders are invited for the construction of local electric railways between Namur and Jambes, Namur and Saint-Servais, and between Namur and Wépion (La Pairelle). The work is estimated to cost 90,837fr. (about £3,633); a deposit of 9,000fr. (about £360) will be required to qualify a tender. Tenders to the Director-General, Société Nationale des Chemins de Fer Vicinaux, rue de la Science 14, Brussels, by Feb. 11.

Bermondsey.—The Borough Council invite tenders for the annual supply of stores to the electricity and destructor works, including arc lamp carbons and brushes, cable and jointing materials, conduits, electricity meters, demand indicators and main fuses, engine oils, meter boards, street frames and covers, and joint-boxes. Tenders to the Town Clerk by Feb. 17.

RESULTS OF TENDERS.

Ilford.—The Electricity Committee have accepted the tender of W. T. Henley's Telegraph Works Co., at £1,130, for the supply of feeder cable.

Hanley.—Messrs. Chas. Pullan have received the contract from Lipton, Limited, for lighting their new premises at Hanley. Arc and Osram lamps will be used.

Bermondsey.—The Electricity and Street-Lighting Committee have accepted the tender of Grover and Sons for the supply of one pair of 7ft. wheels for a cable drum at £16. 10s.

Rochdale.—The Electricity Committee recommend the acceptance of the tender of the General Electric Co. for the supply of a generator, and that of Browett, Lindley, and Co. for the engine.

London, W.—The tender of Galbraith Bros. has been accepted for the erection of the Western district parcel office and Mayfair telephone exchange, for H.M. Office of Works, for the sum of £12 298.

Herts.—The County Council have accepted the tender of Dick, Kerr, and Co., at £4,175. 13s. 6d., for the construction of the light railways from the Middlesex county boundary to a point 80 yards south of the Queen Eleanor's Cross at Waltham Cross.

Belfast.—The City Council have adopted the recommendation of the Electricity Committee, and have accepted the tender of Dick, Kerr, and Co. for the construction of the electric tramway and collateral works on the co. Down side of the harbour, for the sum of £17,232. 18s.

Glasgow.—The Electricity Committee recommend the acceptance of the tender of Willans and Robinson, amounting to £32,043, for two 4,000-kw. steam turbines and "Contraflo" condensers with Dick, Kerr, and Co.'s alternators as additional plant required for next winter at the Port-Dundas and St. Andrew's Cross stations.

Lambeth.—Messrs. Strode have received a contract to wire and fix electric light fittings in the Council chamber and ante-room of the new town hall at a cost of £23. 10s. The Council have also placed an order with the General Electric Co. for the supply of 1,000 Osram lamps for £150, and have accepted the tender of Maple and Co. for making, supplying, and fixing of office and other joinery fittings, required in accordance with specification, for the sum of £1,028. 15s.

Hull.—The Corporation Tramways Committee have accepted the tender of Siemens Bros. for a generator, £793, and a spare armature, £362, for the power station; that of J. H. Fenwick, of Hull, amounting to £7,084. 18s. 2d., for the erection of a new car-shed on the Cottingham-road (the brickwork), and the tender of Keay and Co., of Birmingham, £1,391. 17s. 8d., for the roofing. The contract for the terra-cotta work has been let to the Hathern Station Brick and Tile Co., £380. 8s. 11d.

Gloucester.—The Light Railways Committee have accepted the following tenders, among others, for the annual supply of stores to the tramways department: L. Andrews and Co., micanite plate, red fibre sheet, asbestos sheet, Baker's fluid; Anglo-Russian Oil Co., light car oil, paraffin; Anti Attrition Metal Co., anti-friction metal; British Insulated and Helsby Cables, cables; Brown-Bayley's Steelworks, car wheel tyres; J. M. Butt and Co., brake blocks; Gloucester Iron and Metal Co., sheet copper, sheet brass; Henley's Telegraph Works Co., Para strip; Jennings and Guilding, screws (iron and brass), cotter pins, iron washers, rivets, etc.; Ruberoid Co., press-pahn, P and B insulating tape, P and B electrical compound; J. Yates and Co., picks, hand hammer shafts, drills.

"Aron" Taximeters.—We learn that the General Electric Co. have just received through the Federation of Associated London Cab Proprietors a contract for the supply of 1,000 taximeters for horse-drawn cabs, and during the present month a number of these instruments will be seen on vehicles plying for hire on the London streets. This taximeter is made by the manufacturers of the well-known electricity meter of the same name, and has been approved by Scotland Yard besides passing the severe tests of the National Physical Laboratory. The General Electric Co. have also received a number of orders for these taximeters from other cab proprietors in London and the provinces, and altogether expect an extremely busy year in this new line of manufacture. Special arrangements have been made at the company's works at Southwark, Hammersmith, and Kilburn for the fixing and adjusting of the instruments.

Fleetwood (Lancs.).—The tender of Allmark and Gill, Blackpool, at £123. 10s., has been accepted for providing and fixing Beeston's boiler and radiator, etc., in the Primitive Methodist new Sunday school, Fleetwood; and the following tenders have been received for lighting the new school:

Fielding and Co., Birley-street, Blackpool (accepted)	£50	10	0
Morrison and Roebuck, Blackpool	58	0	0
Rothwell Bros., Great Harwood	59	0	0
Marsden and Co., Blackpool	61	0	0
Fleetwood Electric Light Co., Fleetwood	63	14	0
A. Leake and Co., St. Annes	69	14	0
C. Riley and Co., Fleetwood	73	14	0
Wilkins Bros., Whitechapel, Liverpool	79	0	0
Allmark and Gill, Blackpool	87	0	0

London.—The London County Council have received the following tenders for the roadwork, etc., in connection with the reconstruction of tramways in Caledonian-road and Seven Sisters-road:

Dick, Kerr, and Co., London, E.C.*	£53,516	15	10
R. W. Blackwell and Co., Westminster	55,013	5	10
W. Manders, Leyton	56,684	7	4
J. G. White and Co., London, E.C.	58,249	14	3
J. Mowlem and Co., Westminster	59,007	0	0
E. Nuttall and Co., Manchester	59,917	1	2
W. Underwood and Bro., Dukinfield	61,240	14	0
W. Griffiths and Co., London, E.C.	62,041	16	7
W. Muirhead and Co., London, E.C.	62,110	11	2
National Electric Construction Co., Westminster	64,993	11	2
G. Law, Kidderminster	68,489	0	0

* Recommended for acceptance.

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OPENINGS FOR CONTRACTORS.

ABERTILLERY—Extensions to electricity undertaking, Town Council.
ACTON—Extension, Central Council school, Education Committee.
ADWICK-LE-STREET—Elementary school, West Riding Education Committee.
ASHTON—Elementary school, Education Committee.
ASTLEY GREEN—Artisans' cottages, Mr. Cross, Peel Hall.
ATHLONE—Sanatorium, County Hospital Board.
AUDLEY—Elementary school, Education Committee.
BACUP—Elementary school, Education Committee.
BALLYMENA—Public abattoir (£1,500), Urban District Council.
BARNSTAPLE—Six houses, Grenville-avenue, Mr. J. Wakeley; 10 houses, Charles-street, Mr. E. Karslake; two houses, Yeo Vale-road, H. Harris; two houses, Kingsley-avenue, Mr. J. Hill.
BATH—Rebuilding premises, Northumberland-place, Messrs. Cates and Stoffell.
BECKENHAM—Battery-house, electricity department, Urban District Council.
BELMONT (SURREY)—Bacteriological laboratory, Metropolitan Asylums Board.
BELPER—Post office, Urban District Council.
BENFIELDSIDE—Elementary school, Durham County Council.
BINGLEY—Training college, West Riding Education Committee.
BISPHAM—Additions to houses, Warbreck-drive, Mr. Roebuck; additions to Norbreck Hall, Mr. Hurdman.
BLACKBURN—Alterations, Mayson-street school, Education Committee.
BLACKBURN—Two schools, Education Committee.
BLAGDON—Church (£12,000), Ecclesiastical Commissioners.
BOLTON—Alterations, St. George's Church, Churchwardens.
BOLTON—Rebuilding Prince of Wales's Inn, New Bury, Messrs. J. G. Swales and Co.
BOLTON—Extensions, municipal electricity works.
BRADFORD—Pavilions, Horton and Wibsey Parks, Corporation.
BRISLINGTON—Parochial hall, Churchwardens.
BRIXTON, S.W.—Buildings, west side of Brixton-hill and north side of Cornwall-road.
BROADSTAIRS—Addition, Seapoint, Miss Kent; rebuilding 26, High-street, Mr. Marsh; lock-up shop, Nelson, Mr. E. Brown; stable and stores, Ranelagh-grove, Mr. H. Sackett.
BROWLEY—Elementary school, Education Committee.
BUDE—Elementary school, Cornwall Education Committee.
BUSHBURY LANE (STAFFS)—Elementary school, Education Committee.
BUSHEY—Public offices (£3,350), Urban District Council.
BUTT LANE—Elementary school, Staffs Education Committee.
BUXTON—Mortuary (£300), Urban District Council.
CAMBRIDGE—School of arts and crafts, County Education Committee.
CASTLEFORD—Secondary school, West Riding Education Committee.
CHELMSFORD—Baptist church, schoolroom (£7,000), Trustees.
CHELTENHAM—Additions to Holy Trinity School, Education Committee.
CHESILBORNE—Elementary school, Dorset Education Committee.
CHESTER—Extensions electricity undertaking (£28,000), Corporation.
CHESTER-LE-STREET—Secondary school, Durham County Council.
CHOPWELL—Elementary school, Durham County Council.
CIRENCESTER—Caretaker's house, Mr D. G. Bingham, Urban District Council.
CLEADON—Elementary school, Durham County Council.
CLEETHORPES—Elementary school (£4,300), Lindsey County Council.
COCKBROOK—Church, Ecclesiastical Commissioners.
COEDPENMAEN—Chapel, Trustees Welsh Church.
CONNONLEY—Alterations to school, Keighley Education Committee.
CORWEN—Minister's house (£480), Mr. G. Lewis, Shrewsbury.
COVENTRY—Works at county hall (£3,385), Warwickshire County Council.
CRAMLINGTON—Mortuary chapel, Urban District Council.
CROWMARSH—Elementary school, Oxfordshire Education Committee.
CRYNANT—Villa. Mr. J. Cook Rees, architect, Neath.
DORCHESTER—Alterations, boys' school, Colliton-street. Mr. J. Feacey, architect.
DOVER—Alterations, Castlemount College, Brothers of Christian Schools.
DUNDEE—Workshops, etc., Broughty Ferry-road, Messrs. Imrie and Summers.
DUNSHAUGHLIN—Workmen's dwellings, Rural District Council.
DURHAM JOHNSTON—Extensions to school, Durham County Council.
EARBY—Elementary school, West Riding Education Committee.
EASTLEIGH—Church (£8,000); parochial hall (£2,100); club (£500).
EASTWOOD—Elementary school (£8,000), Notts Education Committee.
ECCLESTON—Elementary school, Lancs. Education Committee.
EDMONTON—Technical school, Middlesex Education Committee.
EDWINSTOWE—Alterations to Wesleyan chapel.
ELLESMERE PORT—Public library, Town Council.
EPWORTH—Alterations, school, Lindsey County Council.
FALKIRK—Extensions to borough buildings (£4,000), Town Council.
FARNWORTH—Extension, electricity works, District Council.
FARNWORTH—Extensions, Dake Spinning Mill, Larkhill; secondary school, Education Committee.
FATFIELD—Elementary school, Education Committee.
FENNY STRATFORD—Additions, St. Martin's Church, Churchwardens.
FISHPONDS (BRISTOL)—Church, Ecclesiastical Commissioners.
FLAXTON—Two villas, Malton-road, Mr. J. H. Johnson.
FOLESHILL—Chapel and caretaker's house (£4,000), Rural District Council.
FOLKESTONE—Elementary schools (£8,000), Education Committee.
FULHAM, S.W.—Sub-station, Borough Council.
GAINSBOROUGH—Refuse destructor, Town Council.
GLOUCESTER—Extensions, electricity mains, Co-operative depôt, India-road (£160).
GOSPORT—Enlargement, secondary school (£3,500), County Council.
GOVAN—Workhouse at Merryflatts, Guardians.
GRANGETOWN—Alterations to school, North Riding County Education Committee.
GREAT CORNARD—Elementary school, West Suffolk Education Committee.
GREENWICH—Refreshment-room, lavatory, private offices, at Borough Hall, Town Council; additions to Delta Metal Works, Tunnel-avenue.
HAMMERSMITH, W.—Baths and wash-houses, Borough Council.
HANLEY—Extensions to electricity undertaking (£18,000), Tow Council.
HARLOW (ESSEX)—Police station, Commissioners of Public Works.
HARWOOD-IN-TEESDALE—Elementary school, Durham County Council.
HAWARTON HILL—Elementary school, Durham County Council.
HEANOR—Elementary school, Education Committee.
HEATH TOWN—Manual training centre, Staffordshire Education Committee.
HENGOED—Additions to Council school, Glamorgan County Council.
HEXHAM—Secondary school (£12,000), Northumberland Education Committee.
HEYSHAM—Houses, Middleton-road, Mr. J. Harrison.
HIGHGATE, N.—Hall and classrooms (£2,000).
HILL END—Alterations, Hill End Asylum (£10,000), Herts County Council.
HODDESDON—Elementary school, Herts County Council.
HONLEY—Twenty-four houses, Newmill-road, Messrs. Joseph Sykes and Co.
HUDDERSFIELD—Additions to Moldgreen Council schools, Education Committee.
HULL—Twelve houses, Haltemprice-street, Mr. F. Beilby; seven houses, Perth-street, Mr. J. Osborne; four houses, Beverley-road, Mr. F. West; four houses, Cottingham-road, Messrs. Lison and Harris; 16 houses, Brecon-street, Mr. A. Needler; four houses, Cottingham-road, Mr. R. Foster; two houses, Portobello-street, Mr. W. Pickering; seed-crushing mills, Morley-street, Messrs. Wray, Sanderson, and Son; iron building, Bellamy-street, Mr. W. F. Cowx; alterations to 38, Hessle-road, Messrs. Lipton, Limited; alterations to premises, Alfred Gelder-street, Messrs. W. A. Massey and Co.; additions, Chanterlands-avenue, National Radiator Co.; vestry, St. George's-road, Trustees of Church of St. John the Baptist; warehouse, Lockwood-street, Messrs. Robinson and Co.; shops, Waterworks-street, etc., Hull Corporation.
HULL—Rewiring 2,000 instruments (£800), National Telephone Co.'s premises.
ILFORD—Extensions, infectious diseases hospital, Urban District Council.
IMMINGHAM DOCK—Temporary school (£250), Lindsey County Council.
INCE—Houses, Wray-street, Mr. W. Bithell; five houses, Bird-street, Mr. H. Dickinson; institute, Westwood-lane, St. Mary's Churchwardens.
ISLINGTON, N.—Machinery and plant, Islington Borough Council.
JARROW—Secondary school, Education Committee.
JERSEY—Post office, Commissioners of Public Works.
KENSINGTON, W.—Public conveniences, Ladbroke-grove, Borough Council.
KERSLEY—Secondary school, Education Committee.
KILKENNY—Electric power house, District Asylum Board.
KING'S LYNN—Motor garage, Globe Hotel.
KINGSTON—Theatre of varieties, Local Syndicate.
KINGSTON (SURREY)—Electricity undertaking (£12,600), Town Council.
KIRKHAM—Steam fire-engine, Urban District Council.
LAMBETH S.E.—Public conveniences, Waterloo Station, Borough Council.
LANCASTER—St. Peter's School, Rev. D. Billington; six dwelling-houses, Mr. W. Jackson; storage shed, Lancaster Agricultural Society; 20 cottages, Mr. R. L. Dilworth; four dwelling-houses, Mr. W. C. Halliday; 20 dwelling-houses, Mr. W. Mashiter; dwelling-house, warehouse, alterations, etc., Mr. James Wilson.

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LEEDS—Institute, Hunslet-road, Congregational Trustees.
LEICESTER—Fruit shed, Midland Railway Co.
LEOMINSTER—Secondary school, Hertfordshire County Council.
LEVENSHULME—Municipal milkshops, Urban District Council.
LEXDEN—Alterations to workhouse, Board of Guardians.
LITTLE HULTON—Secondary school, Education Committee.
LLANELLY—New Y.M.C.A. buildings (£3,600).
LONGWOOD—Dwelling-house, Longwood-road. Mr. J. Ainley, architect.
LOTHERSDALE—Alterations to elementary school, Education Committee.
LOUGHOR—Electric plants, Broad Oak Colliery.
LOWER HOPTON—Six dwelling-houses, Mr. Fergus Barrowclough.
MAESTEG—Alterations to 1, Picton-street, Mr. Thomas Rees; additions to 86, Picton-street, Mr. Howell Thomas; alterations to the Horse and Groom Hotel, Commercial-street, Mr. M. D. Thomas; alterations to 100, Picton-street, Messrs. Thos. Rees and Sons; house and shop, Caerau-road, Messrs. B. Jones and Co.; science rooms, Plasnewydd School, Education Committee.
MANCHESTER—Offices, Oxford-street, Refuge Assurance Co.
MANCHESTER—Buildings, Palatine Bank.
MARSHCHAPEL—Alterations, school, Lindsey County Council.
MEDLAR-WITH-WESHAM—Elementary school, Lancs. Education Committee.
METHIL—Sixty-eight houses, North British Railway Co.
MEXBOROUGH—Fire station, Town Council.
MIDDLETON—Ambulance station, Corporation.
MOIRA—Thirty-three houses, Mr. S. McIlwaine; 17 houses, Mr. G. Patton.
MORLEY—Alterations at mill premises, Messrs. David Bradley.
MORPETH — Elementary school, Northumberland Education Committee.
NEWINGTON, S.E.—Special school, Beresford-street (£4,950), London County Council.
NEW ROMNEY—Lifeboat house, National Lifeboat Institution.
NEWTONHEAD—Extensions, school, Education Committee.
NORTHALLERTON—Police buildings, Town Council; elementary school, Education Committee.
NORTHAMPTON—Elementary school, Town Council.
NORTH BRANCEPETH—Elementary school, Durham County Council.
OLDHAM—Cotton mill at Hollins, Devon Spinning Co.
PARTICK—Church (£6,000), Trustees.
PENGE—House, North Surrey District School, Mr. C. A. Sharp.
PERTH—Extensions (£1,950), Academy buildings.
PHILADELPHIA—Sub-station, Durham Collieries Electric Power Co.
PITLOCHRY — Alterations, mansion house, Croftinloan. Messrs. Leonard and Morris, architects.
PONTYPRIDD — Storerooms at Llwynypia workhouse, Board of Guardians.
PONTYCYMMER—Elementary school, Glamorgan County Council.
PORTSMOUTH — Soldiers' and sailors' home (£18,000), Wesleyan Trustees.
PUDSEY—Secondary school, Education Committee.
RADCLIFFE—Shops and public offices, Urban District Council.
REDDITCH — Extensions to electricity undertaking (£500), Town Council.
RETTENDON—Alterations to tower of church (£230), Churchwardens.
RICHMOND—Forty houses, Dancer-road, etc., Town Council.
ROCHDALE—Parish church (£10,000), Ecclesiastical Commissioners.
ROLLESTON—Elementary school, Education Committee.
ROTHESAY—Church, Trustees U.F.C.
RYHOPE—Elementary school, Durham County Council.
ST. ALBANS—Higher-grade school (£8,000), Education Authorities.
ST. ANNES—Elementary school, Lancs. Education Committee.
ST. AUSTELL—Public conveniences, Market-place.
ST. GEORGE-IN-THE-EAST—Manual training college, etc., Berner-street.
ST. PANCRAS, N.W.—Extensions, Midland Grand Hotel, Euston-road, Mr. Bancroft, architect; clubroom, Gloucester-road, Mr. Pitch, architect; buildings, Tottenham Court-road, Whitfield-place, Fitzroy-court, and Warren-street, St. Pancras, Messrs. Seth Smith and Monro.
SALFORD—Electric light installation, car depot, Corporation.
SCUNTHORPE —Temporary school (£500), Lindsey County Council.
SETTLE—Alterations, Golden Lion Hotel, Proprietors.
SHEFFIELD—Extending Sheffield Courthouse, Corporation.
SHEFFIELD—Improvements to elementary school (£3,075), Staffs County Council.
SHEFFIELD—Extension to engineering workshop, University.
SHERBURN—Elementary school, Durham County Council.
SHREWSBURY—Pavilion, Shrewsbury Bowling Club.
SHORT HEATH—Elementary school (£3,270), Staffs County Council.
SHREWSBURY—Pavilion, Shrewsbury Bowling Club.
SILKSWORTH—Elementary school, Durham County Council.
SITTINGBOURNE—Elementary school, Kent Education Committee.
SKEGNESS—Elementary school (£3,000), Lindsey County Council.
SKEGNESS—Hydropathic establishment, Seacroft Golf Links, Board of Directors.
SLINGSBY—Additions, school (£100), Managers.
SOUTHAMPTON — Additions to grammar school, West Marland, Governors.
SOUTH BANK—Elementary school (£11,200), North Riding County Council.
SOUTHEND-ON-SEA—Elementary school, Chalkwell Hall, Education Committee.
SOUTHEND—Dust destructor (£11,000), Town Council.
SOUTH HETTON—Elementary school, Durham County Council.
SOUTHSEA—Important additions, Queen's Hotel, Managers.
SOUTH SHIELDS—Plant, electricity works (£7,052), Corporation.
SOWERBY BRIDGE—Secondary school (£8,000), Education Committee.
SPENNYMOOR—Higher elementary school and pupil teachers' centre, Education Authority.
STANGHOW LANE—Alterations, school (£700), North Riding County Council.
STEAMHILL (CORK)—Sanatorium (£12,000), Cork Hospital Board.
STEETON—Elementary school, Keighley Education Committee; seven houses, Mr. W. Bailey, Bradford.
STOKE—Post office, Messrs. Meiklejohn and Son.
STONE—Laboratory, grammar school, Governors.
SUTTON COLDFIELD—Free library (£3,500), Town Council.
SWAFFHAM—Alterations at union workhouse, Guardians
SWANSEA—Alterations, 32, Gower-street, Works Committee.
TANTOBIE—Workmen's club and institute. Mr. T. E. Taylor, architect.
THURLSTON—Council rooms (£1,000), Urban District Council.
TORQUAY—Post office, Commissioners of Public Works.
TRALEE—Electric cranes, Harbour Commissioners.
TYLDESLEY-WITH-SHAKERLEY—Elementary school, Lancs. Education Committee.
TYNEMOUTH—Street lighting, Town Council; police dwellings, site at Chirton, Town Council.
USWORTH—Houses (£12,000). Messrs. Brown and Spain, architects.
WALTON—Additions, maternity hospital, West Derby Guardians.
WANDSWORTH, S.W.—Elementary school, Hotham-road (£12,929), London County Council.
WARE—Enlarging grammar school (£4,000), Herts Education Committee.
WARRINGTON—Factory. Mr. A. J. Howcroft, Oldham, architect.
WATERHEAD—Cotton mill, Orme Mill, Limited.
WESTMINSTER, S.W.—Post office, Commissioners of Public Works; alterations to premises, Connaught-street, Messrs. Pearcy, Tansley, and Co.
WHITBY—Temporary secondary school (£950), North Riding County Council.
WHITECHAPEL, E.—Training centre, etc., London County Council.
WIMBORNE—St. Giles Church, restoration, Churchwardens.
WINCHESTER—Grand stand, Winchester Pageant Committee.
WISSAGE—Children's homes (£5 48 0), Guardians.
WOLSINGHAM—Elementary school, Durham County Council.
WOLSTANTON—Fire station, Town Council; rate collector's office, etc.
WORLE—Elementary school, Somerset Education Committee.
WORSLEY—Secondary school, Education Committee.
YORK — Twenty-eight houses, Curzon-terrace, and motor-house, Granville-terrace, Mr. C. Martin; additions, premises, St. Leonards, Messrs. Shann and Metcalfe.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN RAILWAY.

The half-yearly general meeting of the Company was held on the 28th ult., Sir Charles McLaren, Bart., M.P., being in the chair.

The report of the Metropolitan Railway Co. for the half-year ended Dec. 31 last states that the total receipts for the half-year (deducting this Company's proportion of the revenue of the City lines and extensions) have been £347,651, and the expenses £191,959, leaving a profit of £155,692. Compared with the corresponding half-year of 1906 the receipts show an increase of £3,775, and the expenses a decrease of £5,914. The net revenue account, after providing for the interest upon the debenture stocks and other fixed charges, and the dividend upon the preference stocks, and placing £6,000 to the depreciation fund, shows a balance of £19,845 available for dividend upon the ordinary stock. The directors accordingly recommend a dividend upon the ordinary stock for the past half-year at the rate of 10s. per cent. per annum, and to carry forward £5,515. The Surplus Lands Committee announce that the dividend on the surplus lands stock for the past half-year will be at the rate of £2. 15s. per cent. per annum. The directors call attention to the fact that this is the first occasion since the agreement with the Great Central Co. came into force that it has been possible to make a comparison in the accounts with the corresponding half-year, and they are glad to be able to show both an increase in the receipts, which has been continuous throughout the half-year, and a reduction in the expenditure. The extra revenue

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has been earned in spite of very keen competition. To meet this competition a largely-increased service of trains has been run, the electrical working now in full operation having rendered this extra service possible without materially adding to the expenses. A conference was formed a short time ago of representatives of the various passenger-carrying companies in London with a view to limiting competition, adjusting fares, arranging through bookings, etc. It is hoped in this way to help the interests of the companies concerned, and, at the same time, to give increased travelling facilities to the public. All the electric underground lines likely to be made are now open, and it is possible to gauge the effect they may have upon this Company by diversion of traffic. On certain routes the loss has been considerable, but the extra accommodation which all these lines afford has induced a large increase in the travelling habit of the people of London, which will, no doubt, further grow, and the directors have every reason to think that any loss incurred on particular routes will soon be balanced by gains in other directions. The result on the traffic of the electrification of the Hammersmith and City line and its extension to Addison-road has been satisfactory, and an appreciable increase is shown in the business in consequence. In conjunction with the Great Western Co., who are partners in the line, it has been arranged to build a special station where the railway abuts on the site of the Franco-British Exhibition, with an entrance directly into the exhibition grounds. From this it is expected that a large business will result during the ensuing summer. The directors regret that during the half-year two accidents have happened—one at West Hampstead and the other at Farringdon-street. To meet the expenses arising from them it is proposed to take £4,500 from the reserve fund.

The CHAIRMAN, in moving the adoption of the report and accounts, said it would be observed there was an increase in the receipts of £3,775, and this was exclusive of their proportion of the receipts from the joint line which they now shared with the Great Central Co. Dealing with the causes that had contributed to the decreases in number of passengers and revenue, he said the multiplication of tubes in London, having only one class of car, tended to discourage the habit of paying a higher fare on those lines, such as the Metropolitan, where more than one class of accommodation was still provided. So far as the second-class was concerned, this Company's electric trains made no provision for that class of passenger, and by far the larger number of those who formerly travelled second class now availed themselves of the equally good accommodation which was supplied in their third-class cars, and this had led to a loss of revenue. Again, the fact that they had found it necessary to increase a number of their fares, which experience had taught them were too low, had tended to discourage their first-class traffic. The little second-class traffic they now had was carried in the trains of other companies, and not in their own. With regard to the third-class, the increase in fares had helped them materially in the past half-year, but they had felt very seriously the effects of new competition, notably from the Great Northern and Piccadilly and the City and South London Railways, as well as the London County Council electric tramways, the receipts at one station alone—namely, King's Cross—having fallen several thousand pounds, but at their other stations on the Circle and the St. John's Wood line there had been most satisfactory increases, which had more than compensated for this loss. Turning to the expenditure side of the account, maintenance of permanent way, works, and stations showed a saving of £1,982, while locomotive and generating expenses had increased by £4,754, which was partly due to an addition of 351,000 train miles run, but more particularly to the high prices ruling for coal, and under this head alone there had been an increase for the half-year of £4,188. Carriage and wagon repairs showed a decline of £1,766, and traffic expenses were practically the same as the corresponding half-year, although they had run a much larger train mileage. General charges were £1,073 more, and law expenses £544 down. Rates and taxes showed a decrease on comparison of £4,513. The balance of account for working trains for other companies showed an increased credit of £4,427, a portion of which was due to their having made an arrangement with the District Co. to provide the whole of the Inner Circle train service with their own stock instead of the District trains working over the Metropolitan line. They were thus able to reduce their net expenditure by £5,915, and he was pleased to tell them that the percentage of expenses to receipts had been brought down from 62·19 per cent. to 59·76 per cent., a saving of 2 43 per cent. The result of these figures was that they were able to increase the amount taken to the net revenue account by £9,690. They received £823 more from the joint circle City lines, and from the joint line beyond Harrow an additional sum of nearly £6,000. This satisfactory outcome of the joint arrangement was due both to development of traffic and a saving in working expenses. A less agreeable feature was the increase of £5 776 in their payments of bankers' and general interest. Referring to the competition which they had to face from tubes, motor omnibuses, and the electric trams, the Chairman said the facilities for travel in and about London had increased enormously within the last few years, and there was no doubt that for the time being the supply of such facilities had outrun the demand. Referring to the London passenger traffic conference, which was composed of the passenger-carrying companies in London, he said that with so many interests involved the proceedings of the conference must necessarily be somewhat slow, but so far they had every reason to be satisfied with the progress that had been made, and they felt sure that a great deal more was to be done by the various companies co-operating together for the common good rather than by a system of wasteful competition such as they had had in the past. His attention had been called to a criticism of their accounts which appeared in the Press last week. Special reference was there made to two items in their general balance-sheet—namely, "arrears of Government duty suspense account £50,000," and "reconstruction of stations suspense account £31,157." With regard to the £50,000, that represented an amount which they had to find over 20 years ago to meet a claim from the Government for arrears of passenger duty, and to raise the sum they issued £50,000 terminable debenture stock under parliamentary powers obtained in their Act of 1883. They provided for the payment of that money by taking £1,000 out of revenue every year, and they would find the accumulation of those sums in an item on the other side in the general balance-sheet, amounting now to £22 282. With regard to the second item—namely, £31.157 for reconstruction of stations—that represented their share of the money spent on what was practically a rebuilding of the joint stations at High-street, Kensington, Gloucester-road, and South Kensington. Those who used those stations were, no doubt, aware of the very great improvement that had been made, and by the rearrangement made of the properties in front of the stations a very considerable increase in revenue from rents was being derived. High-street, Kensington, was the only station yet completed, but when the others were finished the rents they would receive would pay a very handsome return on the whole of their outlay. In the meantime, they were writing off the cost of the works out of each half-year's revenue. He regretted the dividend they were declaring was so small, and in concluding he said their electrical plant was now running very well, and the high standard of efficiency to which their electrical working had attained would enable them now to give the public greatly improved facilities and a better train service, while the additional cost would be scarcely appreciable.

Sir WILLIAM BIRT seconded the resolution, which was carried unanimously.

YORKSHIRE ELECTRIC POWER.

The report of the Yorkshire Electric Power Co. for the half-year ended Dec. 31 last, to be submitted to the meeting at Leeds on the 18th inst., shows a steady and progressive improvement in the Company's business. The profit on revenue account for the half-year amounts to £836, as against a loss of £403 for the preceding half year. After payment of mortgage interest the net revenue account shows a loss on the half-year of £139, as against a loss of £1,211 for the half-year ended June 30. 1907. The loss made in the half-year occurred during the earlier part of that period; during the last three months the receipts have not only met all current expenses, but have been more than sufficient to cover mortgage interest in addition. The demand for energy from the Company's mains is steadily increasing, thereby reducing the average cost of production for each unit, and thus substantially improving the position of the undertaking. The directors anticipate with confidence profitable and continuous progress of the Company's business for the yea 1908. Up to Dec. 31 last agreements had been entered into with consumers for a total of 5,548 kw. (7,437 h.p), being an increase of 2 426 kw. (3,252 h.p.) during the six months, which is a considerably larger increase than in any previous half-year. Amongst these new agreements is one with the British Carbide Factories, who have leased for a number of years a portion of the Company's land in close proximity to the generating station and are now erecting buildings thereon in which calcium carbide will be manufactured on a large scale for the first time in Great Britain. They have contracted to take their supply of current from the Company, and will be important consumers. As the Company has now reached the position of meeting expenditure out of revenue, the directors suggest that in future the general custom of electrical and industrial companies shall be followed and the report and statement of accounts issued to shareholders yearly instead of half-yearly as hitherto. A resolution to this effect will be submitted for the consideration of shareholders at the meeting in February. The directors regret that Mr. W. P. J. Fawcus has found it necessary, owing to continued absence abroad, to retire from the position on the Board which he has held from the beginning of the Company.

BLACKPOOL AND FLEETWOOD TRAMROAD.

The report of the Blackpool and Fleetwood Tramroad Co. for the half-year ended Dec. 31 last states that, including the sum brought forward, the balance of profit, after providing for debenture interest, is £12,537, and the directors recommend a dividend at the rate of 9 per cent. per annum, writing off £2,500 to depreciation reserve and £878 to general reserve account, leaving £2,408 to be carried forward. The number of passengers carried during the half year was 1,799,442. The receipts from all sources amounted to £23,869.

LIVERPOOL OVERHEAD RAILWAY.

The report of the Liverpool Overhead Railway Co. for the half-year ended Dec. 31 last, to be submitted at the meeting at Liverpool on the 11th inst., states that the gross revenue receipts amount to £41,136 and the working expenses to £32,154. The directors recommend the declaration of a dividend at the rate of ½ per cent. per annum on the ordinary shares (less income tax), leaving £4,178 to be carried forward.

ANGLO-AMERICAN TELEGRAPH.

The report of the Anglo-American Telegraph Co. for the six months ended Dec. 31 last states that the total receipts from July 1 to Dec. 31, 1907, including the balance of £24,142 brought forward, amounted to £235,935. The traffic receipts show a decrease of £7,798, as compared with the half-year ended Dec. 31, 1906. The working expenses of the half-year, as shown by the revenue account, amounted to £73,456, being a decrease of £3 049 as compared with the corresponding period of 1906. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £20.000 to the renewal fund, leaving a balance of £142,478. Quarterly interim dividends of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock

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were paid on Nov. 1 last, absorbing £52,500, leaving a balance of £89.978, out of which the directors recommend final dividends of £1. 5s. per cent. on the ordinary stock, £1. 10s. per cent. on the preferred stock. and £1 per cent. on the deferred stock, amounting together to £87.500, making a total distribution for the year ended Dec. 31, 1907, of £3. 10s. per cent. on the ordinary stock, £6 per cent. on the preferred stock, and £1 per cent. on the deferred stock. The balance of £2,478 will be carried forward. The renewal fund has been debited with £90,000 as a provision on account of depreciation of the securities. and this sum has been deducted from the cost of "sundry securities" in the balance-sheet and carried to a depreciation account.

CENTRAL LONDON RAILWAY.

The report of the Central London Railway Co. for the half-year ended Dec. 31 last, to be submitted at the meeting on the 5th prox., states that the capital expended during the half-year amounted to £19,482. The chief items are for the additional generating plant at the power-house and the new line at Shepherd's Bush. Compared with the corresponding period in 1906, there has been a decrease of £18,508 in the revenue receipts and of £5 152 in the working expenses; rates and taxes have decreased by £168. The available balance is £69,620. The number of passengers carried during the half-year amounted to 16,646,620, compared with 20,721,508. The decrease in the number of ordinary passengers carried during the half-year is 3,710 636 and of workmen 364,252, the total decrease being 4,074,888, or 19·67 per cent., compared with the corresponding period. A modified system of fares was adopted from July 1 last. An arrangement, subject to one month's notice, has been entered into with the omnibus companies, in accordance with which they reduced the length of their penny fare sections on the route of the Central London Railway, the latter retaining the minimum fare of 2d. The new fares came into operation on Dec. 15 last. The average receipt per passenger for the half year is 2 01d., as compared with 1·84d. in the half-year ended December, 1906. The cost per passenger is 1·28d. as compared with 1·09d. in the corresponding period. Continued attention has been given to the reduction of the working expenditure to lessen, as far as possible, the loss resulting from the diversion of traffic by omnibus and other surface competition, as well as from the opening and development of other tube railways; and with the same view, improvements in the working and controlling of the trains have been adopted. After providing for interest on the debenture stock and other payments, the net revenue. including £25 891 brought in from previous half-year, shows a balance of £70.750. The directors recommend the declaration of the following dividends: On the undivided ordinary stock at the rate of 3 per cent. per annum for the half-year; on the preferred ordinary stock, at the rate of 4 per cent. per annum for the half-year; on the deferred ordinary stock, at the rate of 2 per cent. per annum for the whole year. After providing for these payments there remains a balance of £20,218. The directors recommend that of this balance £10,000 be credited to the reserve fund, the £10,218 remaining to be carried forward. The directors also propose that the outstanding accounts for parliamentary expenses incurred in the promotion of the Company's Bills in the sessions 1901 to 1905 be now cleared, and that the amount. £25 366, be charged to the reserve fund, leaving a credit balance of £72,880 at that account. The locomotive account placed in suspense in 1903, pending the sale of the materials of the superseded engines, is now closed. and the balance of £66.590 has been retransferred to the capital account. The line from Shepherd's Bush Station to the depôt is in course of construction, and is to be completed in time for the opening of the Franco-British Exhibition in May next. A new station is being provided, immediately opposite the entrance to the exhibition.

POWER-GAS CORPORATION.

The report of the Power Gas Corporation for the year ended Sept. 30 last, to be submitted to the meeting on the 12th inst., states that the year's trading of Ashmore, Benson, Pease, and Co. shows a profit of £591, after contributing £3,500 for interest to the Corporation on its advances. The works have been fairly well employed during the year, and are busy at the present time. As intimated in the previous report, the A.B.P. Accumulator Co., whose business was formerly carried on as a department of the Stockton works, but which it had been found impossible to carry on at a profit, has now been liquidated voluntarily, involving a net loss of £16,822, which has been temporarily placed to a suspense account in the books of Ashmore, Benson, Pease, and Co. The directors have recently had the land, buildings, plant, and machinery of Ashmore, Benson, Pease and Co. revalued, and they find that certain items have considerably depreciated in value chiefly owing to the extensive alterations and additions made from time to time in the remodelling of the works. They believe that it will be a sound policy to write these down to their true value. The majority of the holders of the deferred shares have agreed on certain terms that the whole of the loss should be written off their shares. This course involves some alteration of the Company's articles of association, and the directors draw attention to the proposed resolution the passing of which will enable a resolution to be submitted at a subsequent meeting, whereby the capital credited as fully paid on the deferred shares would be reduced by an amount corresponding to the losses which have to be provided for. Several Mond gas installations, including repeat orders, have been completed and set to work during the past year. The directors regret, however, that the volume of power-gas business in this country has only been small, although satisfactory progress has been made in the sale of the Company's plant abroad. Various negotiations are in progress for the installation of the Company's systems of gas production. Mention may be made of the Langwith By-Product Co., recently formed by this Company in conjunction with the Sheepbridge Coal and Iron Co., to install a large Mond ammonia recovery installation at the Langwith Colliery. This contract was not concluded in time to reap any benefit in this year's accounts. A contract for a large Mond gas installation which was entered into some time ago with Kosmoid, Limited, of Dumbarton, but which was never completed owing to the financial difficulties of that firm, has resulted in a bad debt of £2.305 in this year's accounts. In consequence of the unsatisfactory results of the year's trading the directors have decided to waive their fees for the year. The balance-sheet now presented shows a balance to credit of profit and loss account of £253, which the directors propose to carry forward to next account. In their report the auditors state that "the property account of the Company appears in the balance-sheet at cost without depreciation. The investment in and advances to Ashmore, Benson, Pease, and Co. are taken at cost without depreciation. The buildings, plant, and machinery of Ashmore, Benson, Pease, and Co. have been recently revalued, and the loss shown thereby, together with other items of loss, chiefly resulting from the liquidation of the 'A.B.P.' Accumulator Co., referred to in our last report, the directors propose to deal with by a reduction of capital. The investments in other companies are taken at face value, but for these the market price, where available, is considerably less than face value. The estimate of profits on contracts partly executed, as in former years, has been made by officials of the Company."

NEW COMPANIES REGISTERED.

Harpenden (Selangor) Rubber Co.—Registered Jan. 18. Capital, £30,000 in £1 shares. Objects: to acquire Harpenden Estate, Kapar, Selangor, with other assets, undertaking, and liabilities of a company incorporated in Ceylon under same title. No initial public issue. Registered office: 20, Eastcheap, E.C.

Mercedes Electric Manufacturing Co., Limited.—Registered Jan. 25 by R. C. Leach, 10, Serjeant's-inn, E.C. Capital, £50,000 in £1 shares. Objects: to carry on the business of manufacturers of motors, motorcars, cycles, and other vehicles of all kinds, whether driven by electrical or other power, etc, and to adopt an agreement with Mercedes Mixte, Limited. No initial public issue. Registered office: 11A, Regent-street, S.W.

Langkat Sumatra Rubber Co., Limited.—Registered by Stibbard Gibson and Co., 21, Leadenhall street, E.C. Capital, £75 000 in £1 shares. Objects: to acquire three estates in Upper Langkat, Sumatra, known as Blankahan, Blankahan "A," and Soengei Roean; to adopt an agreement with the Rubber Estate Agency; to acquire estates, plantations, and lands, producing or likely to produce rubber, coffee, cocoa, and other produce, etc. Registered office: Mincing-lane House, Eastcheap, E.C.

"Z" Electric Lamp Manufacturing Co., Limited.—Registered Jan. 25 by Bird and Bird 5 Gray's-inn-square, W.C. Capital, £150 000 in £1 shares. Objects: to acquire the business of the "Z" Electric Lamp Syndicate and that of the Albion Electric Lamp Works, which the said syndicate has contracted to purchase; to adopt an agreement with the said syndicate, W. L. Pakenham (as trustee for the holders of the "A" shares therein), and H. F. Brown (as trustee for the holders of the "B" shares therein); and to carry on the business of manufacturers of incandescent lamps and the component parts thereof, makers of and dealers in electrical apparatus, fittings, and plant, etc. No initial public issue. Registered office: Orient House, New Broad-street, E.C.

Liens Registered.

Mexican Rubber Co., Limited.—Issue on Jan. 7 of £1,000 6 per cent. debentures, part of series created Dec. 10, 1907, to secure £3,000. Charged on the company's undertaking and property, present and future. No trustees. Total amount previously issued of same series, £1,750.

Lowden Electric Lamp Co, Limited (Acton Green).—A debenture, dated Dec. 18, 1907, to secure £350, charged on the company's undertaking, including uncalled and unpaid capital, has been registered. Holders: British Westinghouse Electric and Manufacturing Co., 2, Norfolk-street, W.C.

Westminster Engineering Co., Limited.—Issue on Dec. 14 of £600 5 per cent. debentures, part of series created Aug. 25, 1900, to secure £4 000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £3,400.

Newcastle-upon-Tyne Electric Supply Co, Limited.—A 5 per cent. third mortgage debenture, dated Jan. 2, 1908 to secure £300,000. has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital. Holders: Lloyds Bank, Newcastle-on-Tyne.

New System Private Telephone Co., Limited (London).—Particulars of £3,000 debentures created by resolution of Jan. 7, 1908, have been filed pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: the company's undertaking and property, present and future, including uncalled capital (if any), but excluding royalties, moneys paid or payable, and shares allotted or allotable under all and other benefits of an agreement dated April 7, 1903, and a supplemental agreement dated Dec. 10, 1904, whereby the company granted licences to the Yorkshire Private Telephone Co. to use Patent No. 28.612 of 1896. No trustees. An issue on even date of £2,000 debentures, part of above series, has also been registered.

Egyptian Delta Light Railways, Limited.—Issue on Jan 17 of £25,000 4 per cent. debentures, part of series created by resolutions of March 25, 1897, June 19, 1900, Feb. 23 and May 31, 1904, and

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July 23 and Nov. 10, 1907, to secuee in all £505,000. Property charged: shares, debentures, securities, railways, undertaking, and other assets owned by the company, present and future (subject as to the property purchased from La Compagne des Chemins de fer Economiques de l'Est Egyptien to £242,180 3½ per cent. debentures, and as to property acquired from the Metropolitan and Cairo Helouan Railway Soci-té Anonyme to £E96,000 4 per cent. debentures. Trustees: Sir Gerald Fitzgerald, K.C.M.G., 18, Cadogan-gardens, S.W., and Sir John R. Heron-Maxwell, Bart., 9, Wilbraham-place, London. Total amount previously issued of same series, £480,000.

Lancashire Light Railways Co., Limited.—A mortgage, dated Jan. 1, 1908, to secure £2,000 (supplemental to and transferring the charge created by an indenture dated June 29, 1907, covering £6,000, and securing a further £3,000), has been registered. Property charged: all moneys due or to become due under a working agreement with the St. Helens and District Tramways Co.; all moneys, shares, securities, or other consideration to which the company may become entitled as the purchase money in respect of any sale of its railway property or undertaking, or part thereof; the company's railway and any extension thereof, with all tolls, rates, and charges for the time being, authorised to be demanded or charged in respect thereof, and the company's undertaking and property, present and future, including uncalled capital (subject, as regards railway, etc., to any working agreement). Holders: Lancashire United Tramways, Atherton.

LEGAL INTELLIGENCE.

HEATH v. THE CORPORATION OF BRIGHTON.

Nuisance from Generating Station.

This case occupied the attention of Mr. Justice Joyce in the Chancery Division of the High Court of Justice for a number of days. From the facts, as set forth in the *Times*, it appears that the plaintiffs were the incumbent and the trustees of the church of SS. Mary and Mary Magdalene at Brighton. Annexed to the church there were buildings which were used for the purposes of Sunday schools, classes, a working-men's club, and meetings of various kinds in connection with the parish. The church was capable of holding about 300 people, and the congregation was drawn from the surrounding district, which was chiefly occupied by poor people. In 1891 the defendants, the Corporation, erected upon land acquired by them under the Brighton Electric Lighting Order, 1883, and in close proximity to the church, a quantity of machinery for generating electricity. In 1905, for the purposes of their tramway and electric lighting system, the Corporation erected a new generating station at Southwick, outside the borough, and connected it with their existing works, which were at the same time extended, machinery being added for transforming and transmitting currents of electricity. The plaintiffs alleged that, in consequence of this extension of the works, the defendants had, since March, 1906, caused, and were still causing, a nuisance to the plaintiffs by noise. By reason of such noise it was alleged that the incumbent and his congregation were inconvenienced and disturbed, not only in the church but in the adjoining buildings, where is was difficult, and at times impossible, to hold classes and meetings as had been done before. The plaintiffs accordingly claimed an injunction restraining the defendants from so using their machinery as to cause nuisance and annoyance to the plaintiffs and other persons using the church or any of the buildings in question. The defendants denied that they were causing a nuisance to the plaintiffs. They alleged that their machinery was of the best and most smoothly working modern type, and was adequately housed in a building specially designed and suitable for the purpose, and that in most parts of the church it was impossible to hear any sound at all from the works, and in other parts of the church and classrooms any sound from the works amounted at most to a faint hum or buzz which could only be detected in the absence of all other sounds, and did not at any time amount to a nuisance or even to any appreciable inconvenience. They further relied on the statutory powers given to them by the Brighton Corporation Act, 1900, and also on the fact that they as a public authority were exercising such powers and performing their duties with relation to the public supply of electricity in a reasonable and proper manner and according to the best and most approved methods.

The case occupied the attention of the Court for several days, a large number of witnesses being examined on either side. It appeared from the evidence that the noise complained of was a humming or buzzing sound of a peculiarly varying and elusive nature, being experienced in different degrees of intensity at different times and in different parts of the building. The incumbent, the Rev. Edward Heath, in describing the effect of it upon himself, said that when he was preaching it was impossible to think over what he was going to say, and he had for some time past been compelled to disuse the pulpit and preach from the floor of the church. There was the usual conflict of evidence in such cases, the plaintiffs' witnesses asserting that the noise was distressing and annoying to them, while many of the defendants' witnesses declared that they could only hear it by listening very intently for it.

At the conclusion of the evidence, and after hearing the address of counsel, his Lordship reserved his judgment.

TRAMWAY COMPANY'S REPAIRS.

In the King's Bench Division of the High Court of Justice on Monday, Feb. 3, Mr. Justice Phillimore and Mr. Justice Walton, sitting as a divisional court, had before them the case of West *v.* the Bristol Tramways Co. on defendants' appeal from the decision of Judge Castle, sitting in the Tolzey Court. Mr. Clavell Salter, K.C., and Mr. Vachell appeared for the appellant company, and Mr. Inskip represented the respondent.

PLAINTIFF, a market gardener, of Bristol, complained that by reason of the defendant company having paved the roadway opposite his garden with wood blocks treated with creosote his plants had been injured, and he brought his action against the defendant for a nuisance. The case was twice before the learned Recorder of Bristol and a special jury. On the first occasion the jury failed to agree, and on the second judgment was entered on their finding for the plaintiff. The defendant company now appealed, pleading that they were protected in what they had done by their statute, and submitted on this ground, and on also the findings of the jury, that judgment should have been given in their favour.

Mr. CLAVELL SALTER, K.C., in support of the appeal, pointed out that Parliament had imposed upon the defendant company the obligation of maintaining a portion of the roadway, and they had at all times to execute the repairs under stringent and mandatory orders. They were, in fact, in a quasi public position, and were made responsible for the middle part of the roadway as if they were a highway authority. He submitted, first, that they could not be liable in an action for doing what they were told to do by Parliament, and, secondly, that on the finding of the jury as to the reasonable necessity of what they had done they were entitled to judgment.

Mr. INSKIP submitted that, while it was the duty of the company to pave the roadway, they were not entitled to use a chemical preparation, the fumes of which injured the property of others.

Mr. Justice PHILLIMORE, in giving judgment, said in his opinion the appeal must be dismissed. No doubt the tramway company was ordered to keep in repair a portion of the highway, and to do it by using wood paving, but the Act did not state that they were to use wood blocks treated with creosote. The plaintiff was, therefore, entitled to recover in respect of any damage he had suffered in consequence of the action of the company.

Mr. Justice WALTON concurred, and the appeal was dismissed with costs accordingly.

Leave to further appeal was granted on the defendant company consenting not to ask for costs of going to the Court of Appeal in the event of succeeding in that court.

PLACING OF TELEGRAPHIC WIRES.

Iron v. Wooden Poles.

On Tuesday in the King's Bench Division of the High Court, Mr. Justice A. T. Lawrence, the Hon. A. E. Gathorne-Hardy, and Sir James Woodhouse, sitting as the Railway and Canal Commission, had before them the case of the Postmaster-General *v.* the Metropolitan Borough of Woolwich, which came up on an appeal from the award of the stipendiary magistrate for the Woolwich district.

On April 4 last the Postmaster-General gave notice in writing asking the consent of the defendants to the placing of certain overhead telegraphic wires in certain streets of the borough. The Council failed to give their consent within the required 21 days, and thereupon a difference arose between the Postmaster-General and the Borough Council, and in pursuance of the Telegraph Act, 1878, the matter was referred to Mr. Arthur Hutton, stipendary magistrate for the district. After hearing the case on July 2, 1907, he made an order that the Postmaster-General should be at liberty to place and maintain overhead telegraphic lines as specified in the notice, and he also made an award that the wires should be placed overhead in certain places and underground in other places. The Postmaster-General was, however, dissatisfied with the award of the magistrate so far as it ordered that certain telegraph wires should be attached to iron posts, and so far as it related to the placing of the wires underground in certain parts of the borough.

The Borough Council contended that by placing the wires underground within portions of the district the amenities of those districts as residential areas and their rateable values would be preserved, and there would be no obstruction. In reference to the placing of wires overhead, they presented similar considerations in contending that iron poles were more sightly.

Sir ROBERT HUNTER, for the Postmaster-General, in presenting the case, explained that these wires were to be put up to connect alarms with fire brigade stations, but ultimately, no doubt, they would be used for telephone purposes. He estimated that if the work was done in the manner he contended it ought to be done, there would be a difference of £220 from the way the defendants contended the work should be carried out.

Mr. M. F. ROBERTS, assistant engineer-in-chief, G.P.O., and an electrical engineer, gave evidence as to the advantages to be gained by having the work done according to the Postmaster-General's idea and the saving of cost.

Mr. ALFRED CONLER, an architect and surveyor, deposed to the houses in the areas to which the Borough Council raised objection to the Postmaster-General's proposals being composed of from four to seven rooms, more than one family generally residing in one house.

Mr. THOMAS EDWARD DUCKE, estate agent, said that iron poles did not deteriorate the selling value of the property.

Mr. JAMES R. DICKSON, borough engineer, Woolwich (called for the Borough Council), gave evidence as to the lasting value of an iron pole over that of a wooden pole. He had been at the laying of miles of electric wires both in Woolwich and in Shoreditch, and he was of opinion that if the present work was carried out according to the Postmaster-General's idea it would affect certain residential areas.

Mr. DONALD DUNWOODY said he did think the Borough Council were unreasonable in their demands.

The hearing was continued on Wednesday, when counsel and Sir Robert Hunter having addressed the Court, the Commission reserved judgment.

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SUPPLYING ELECTRIC LIGHT.

Bourne and Hollingsworth v. the Marylebone Borough Council.

This case came before Mr. Justice Ridley and a special jury, and was an action by the plaintiffs, drapers of Oxford-street, against the defendants for damages for alleged breach of contract.

Plaintiffs' case was that by a contract made between the plaintiffs and the defendants the latter agreed to supply electric light to the plaintiffs for their new premises in Berners-street. Plaintiffs contended that it was an express term of the contract that the supply of the light should be at the rate of 240 volts, and that the supply should be given to the Berners-street premises by the first week in September, 1905, when an autumn sale was to take place. The contract was partly in writing and partly verbal, interviews having taken place in May and September, 1905, between Mr. Hollingsworth and Mr. F. A. Wilkinson and Mr. A. Wright on behalf of the defendants. All the lamps were prepared on the premises, but the defendants broke their contract and did not supply the light by Sept. 25. The light was not supplied until Oct. 9, 1905. By a verbal contract made on Sept. 22 it was agreed that if the plaintiffs would adapt their premises so as to receive a temporary supply of light at the rate of 200 volts instead of 240 volts the light would be furnished within two days from Sept. 22. Plaintiffs accordingly employed Messrs. Bros, who adapted the premises, but the light was not supplied within the specified time.

Defendants' case was that neither Mr. Wright nor Mr. Wilkinson had any authority from the defendants to enter into any of the alleged contracts, and that neither of the alleged contracts were under the seal of the Corporation.

Mr. Lush, K.C., and Mr. J. D. Crawford appeared for the plaintiffs and Mr. Shearman, K.C., and Mr. McCarder for the defendants.

In the result the jury returned a verdict for the plaintiffs on all points, but the case stood down for legal arguments as to the liability of the defendants.

COMPANY'S WINDING-UP.

In the Liverpool County Court on Friday last application was made under the Companies Act to Judge Shand for a temporary stay of all proceedings under the order made last July for the winding-up of the Patent Exploitation of Liverpool.

Counsel for the contributories, creditors, and the liquidator said the interests of the petitioning creditors, the Electrical Power Storage Co., of London, had been sold to Mr. W. P. Thompson, the promoter, who was also the largest shareholder and largest creditor of the Patent Exploitation. The action of the company against Siemens Bros. and Co., which went to the House of Lords, had now been determined, and damages, after inquiry, had been fixed and agreed at £5,000. This sum would be coming in shortly to Mr. W. P. Thompson, to whom the damages had previously been assigned by the company. It was Mr. Thompson's intention to pay off all the claims against the company and then apply to the Court to annul the winding-up order.

The petitioning creditors wrote through their solicitors that they were no longer interested in the proceedings, and the Official Receiver, one of the joint liquidators, offered no objection to the application.

His Honour granted a stay of all proceedings for one month.

CROWSON v. METROPOLITAN RAILWAY CO.

At the Marylebone County Court Mrs. Florence Crowson sued the Metropolitan Railway Co. for damages in respect of serious injury to one of her fingers, caused by one of the vestibule sliding doors. She said that she was alighting from a train at Sloane-square recently, when, by reason of the brakes being suddenly released, she was thrown violently forward. To save herself from being thrown on to the platform she caught hold of the door, and thus sustained her injuries.

The guard said that both the plaintiff and her husband were on the platform of the train before it stopped. The gentleman squeezed through the door, and was on the station platform before the train stopped. The lady was following when she met with her injury.

Counsel for the defendants said the company did everything in their power to guard against accidents by the provision of straps, etc. There must be the jerk complained of occasionally on 'buses, tramcars, and other vehicles.

The Judge said he could not help plaintiff. She had no right to be on the platform of the train before it came to a standstill. He gave judgment for the defendants.

PROVISIONAL PATENTS, 1908.

JAN. 24.

1670. **Electric current generators and motive power machine.** Walter Shelverton Frost 135, High-street, Homerton, London.

1696. **Improvements in means or apparatus for heating by electricity.** Leopold Aron Frank, 1, Great James-street, Bedford-row, London.

1709. **Improvements in and relating to collecting rings for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Jakob E. Noeggerath, United States.)

JAN. 25.

1719. **Improved "magnetic" shuttle-operating mechanisms for looms.** John Thom., jun., and Co. and Robert MacPhail, 100, Wellington-street, Glasgow.

1734. **Improvements in electric battery sub-stations fed from alternating-current systems.** Alfred Mills Taylor, 12, Ashfield-road, King's Heath, Worcester.

1751. **Improvements in or relating to vehicles propelled by a combination of electrical and mechanical power.** Willis Nelson Stewart, Edward Brice Killen, and Frank Harris, 52, Queen Victoria-street, London.

1754. **Improvements relating to the recuperation of electric energy for projectors and the like.** Amédée Lertourné, Birkbeck Bank-chambers, Holborn, London. (Date applied for under Section 91 of the Act, Feb. 11, 1907, being date of application in France.) (Complete specification.)

1770. **Improvements in dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JAN. 27.

1791. **Improved propeller for use in ships, aeroplanes, flying machines, or steerable balloons driven by steam, oil, electricity, or other means.** Osmond Watkins and Arthur Johnson, The Highlands, Broomy Hill, Hereford.

1797. **Improved portable or pocket apparatus for wireless telegraphy.** Ferdinand von Madaler, 61, Stanley-street, Battersea, London.

1832. **Improvements in and relating to dynamo-electric machines.** Siemens Bros. Dynamo Works, Limited, and Moritz Schenkel, Queen Anne's-chambers, Westminster. (Complete specification.)

1848. **New or improved apparatus for alternative wireless telegraphy and telephony.** Josef Schiessler, 46, Lincoln's-inn-fields, London. (Complete specification.)

1850. **Improvements in or connected with electric relays.** Eustace James Mullett, 173, Fleet-street, London.

JAN. 28.

1862. **Apparatus for the production of an electric glow in an exhausted vessel, and modification of the said glow by means of a magnetic field.** Frederick John Jervis-Smith, Battramsley House, Lymington, Hants.

1877. **Improvements in electrolysis of liquids.** Arthur Alexander Govan, 53, Bothwell-street, Glasgow.

1947. **Improvements in or relating to machines or apparatus for reproducing in ordinary characters telegraphic or other messages or intelligence in the form of perforations in a tape.** Frederick George Creed and William Arthur Coulson, 46, Lincoln's-inn-fields, London.

1948. **Improvements in and relating to electric motor-control systems.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

1949. **Improvements in and relating to commutators for dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

1950. **Improvements in gravity switches as applied to telephones and the like.** John Edward Kingsbury, 24, Southampton-buildings, London. (Bell Telephone Manufacturing Company, Belgium.)

JAN. 29.

1984. **Improvements relating to electric ignition apparatus for internal-combustion engines.** The Electric Ignition Company, Limited, and Frederick Harold Hall, 24, Temple-row, Birmingham.

2074. **Improvements in electrically-controlled lifts, hoists, cranes, and the like.** Eugene Chaudoir, 173, Fleet-street, London.

2082. **Improvements in current collectors for use in electric traction systems** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JAN. 30.

2085. **Electrically-operated railway switch points and signals.** Arthur Henry Johnson, "Wanganni," Ashdown-road, Epsom, Surrey.

2088. **Improvements in or relating to electrical ignition apparatus.** Tom Welsh, 122, George-street, Edinburgh.

2094. **Improvements in devices for giving visual and oral warning of the leakage of electric currents.** Edward May Munro and Brecknell, Munro, and Rogers, Limited, Finsbury-pavement House, London.

2103. **Improvements in or relating to electric lamps.** Cutler, Wardle, and Co., Limited, and Walter Wardle, 55, Market-street, Manchester.

2120. **Improvements in arc lamps.** Alfred Harold Greening and Charles Petitjean, 15, Clifford's-inn, London.

2127. **Improvements in electrically-operated whistles.** Benjamin Joseph Barnard Miles, 23, Southampton-buildings, London. (The Signal and Control Company, United States.) (Complete specification.)

2153. **Improvements in incandescent electric lamp caps and couplings.** William Woodyer Buckton, 72, Victoria-street, London.

2159. **Improvements in and connected with electric motors.** Arthur James Page and Harold English Harrison, 4, South-street, Finsbury, London.

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2163. Improvements in hauling gear for electric hauling machines. Mark Archer, 31, Bedford-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Feb. 13.)

1906.

23926. Electrolytic cells. Hatfield.

23916. Dynamo-electric machines for maintaining a constant or practically constant electromotive force under variations of speed specially applicable to train-lighting. Mackie.

24084. Magnetic compasses. Smith.

28724. Mechanical cars for carrying overhead transmission cables for electrical traction purposes. Oliver.

1907.

1197. Treatment of boron. British Thomson-Houston Company. (General Electric Company.)

1264. Manufacture of electrical accumulators. Miura.

1356. Devices for regulating pressure of alternating-current generators. Ganz und Co. Eisengiesserei und Maschinen-fabriks Akt.-Ges. (Date applied for under International Convention, Jan. 19, 1906.)

1517. Construction of choking coils for alternating-current testing. Morcom and Walshe.

1713. Electric fusible cut-outs. Eckstein and Heap.

1759. Radio-telegraphy. Raymond-Barker and Amalgamated Radio-Telegraph Company.

1781. Magnetic clutches. Ravenshaw, Middleton, and Townsend.

2138. Brush-holders for dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

2417A. Electric ignition switches. Chambers and Bennett. (Date applied for under Rule 13, Jan. 31, 1907.)

2459. Dynamo-electric machines. Walker.

2815. Safety terminals for electric accumulators and other appliances for use in mines or otherwise. Best.

2937. Apparatus for making and breaking the current on electrically-fired internal-explosion engines and the like. Chambers and Bennett.

3254. Time switches for electric circuits, and more particularly for use with electric lights. Venner and Griesbach.

3915. Electrical heating apparatus. Reynolds.

4182. Protective devices for electric circuits. British Thomson-Houston Company. (General Electric Company.)

4574. Secondary batteries. Oppermann.

4738. Electric rock drills and the like. Allgemeine Elektricitäts Ges. (Date applied for under International Convention, Feb. 27, 1906.)

5066. Electric couplings or connections. Hann, Ingle, and Drake and Gorham, Limited.

5334. Method of producing undamped electrical oscillations. Eisenstein.

5575. Manufacture of electric conductors suitable for use as incandescing bodies in electric lamps. British Thomson-Houston Company. (General Electric Company.)

6057. Overhead conductors for electric tramways and the like. Bill.

6242. Systems of electrical distribution employing vapour rectifying devices. British Thomson-Houston Company. (General Electric Company.)

6716. Dynamo-electric machines or motors. Siemens Bros. Dynamo Works and Wilson.

6929. Electric telegraphy. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, March 22, 1906.)

7785. Duplexing telegraph lines. Kitsee.

8240. Sockets or holders for incandescent electric lamps. Damseaux.

9851. Maximum demand electric indicators. British Thomson-Houston Company. (General Electric Company.)

10007. Method of and means for altering the working speed of polyphase motors. Siemens Bros. Dynamo Works and Poynder.

11072. Plates for electrical accumulators. Margulis.

11673. Commutators for electrical machines. Von Ammon.

13175. Electric selecting apparatus for telephones and the like. Watkins, Bolster, and Goodsell.

14221. Electric fuses for use in blasting and the like. Malson.

17947. Automatic electrical gong-ringing device for electrical street railway cars. Fallek

19626. Electrical locking apparatus for railway signalling. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

20947. Method of inserting former-wound coils of flat copper into the slotted iron cores of electrical machines. Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.)

23641. Electric light pendants. Hanwell.

5402. Telegraph sounders. Whitney. (Date applied for under International Convention, Nov. 15, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.		Last price.
	£		£
Alliance Electrical Co., 5 per cent Cum. Pref., Nos. 1-70 000	1	..	⅛-⅜
—— Ord., 1,125 000	1	..	⅛-¼
Aron Electricity Meter. 6 p.c Cum. Pref. Shares, 1-125 000	1	..	11/16-13/16
—— Ordinary Nos. 1 12),000	1	..	5/32 9/32
British Aluminium Co., Ordinary, 2 001 40 000	5	..	5¼-4⅝
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4⅜ 5¼
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4⅜-4⅝
—— 4 per cent. Funding certificates, 1-20 000	5	..	3⅜ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100 103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	99 99 xd
British Insulated and Helsby Cables Ord., 1-100 000	5	..	6-7⅛
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅛-6
—— 4½ per cent. Mortgage Debentures	100	..	103-103
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	85 89
British Westinghouse Elec. and Manuf. 6 per cent Pref., 275 001-375 000	3	..	⅛-1
—— 4 per cent. Mortgage Debenture Stock	100	..	40-45
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2	..	0-½
—— Non. Cum., 6 per cent., Pref.	2	..	½-⅝
—— 4½ per cent 1st Debenture Stock	100	..	82 85
—— 4½ per cent. 2nd Debenture Stock	100	..	63-66
Callender's Cable, Debentures	100	..	105-107
—— Ordinary	5	..	9⅜ 10¼
—— 5 per cent. Pref.	5	..	5¼ 5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-7/16
Crompton and Co.	3	..	1⅜ 2
—— 5 per cent Debentures	100	..	93-96
Dick Kerr and Co., Ordinary, 1 260 000	1	..	1-1¼
—— 6 per cent. Cum. Pref., 1-305 000	1	..	1-1¼
—— 4½ per cent. Debenture Stock Red.	100	..	99-102
Edison and Swan United, "A" Shares, 1-9 261	5	..	⅝-1⅛
—— "A" Shares 01-017.139	5	..	1⅛-2⅛
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112 100	2	..	5/16-7/16
—— 7 per cent. Cumulative Pref.	2	..	⅜-1⅛
—— 4 per cent. Perp. 1st Mort. Deb	100	..	65-69
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red.	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅞-8⅛
—— 4 per cent. 1st Mort. Deb. Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	4⅞-5⅛
—— 4½ per cent. Debentures	100	..	105-107
India Rubber, Gutta Percha, and Telegraph Works	10	..	14⅜-15⅝
—— 4 per cent. Debentures	100	..	98-100
National Electric Construction Co., 1-170,000	1	..	⅛-⅜
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	29-31
—— 5 per cent. Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9

Electric Lighting and Supply.—

Name.	Amount paid.		Last price
	£		£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4⅝-5⅛
Bournemouth and Poole, Ordinary	10	..	10¼ 11½
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	10- 1
—— 6 per cent. Cum second Pref., 15 001-22,500	10	..	10¼ 1⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	100- 03
Bromley (Kent) Electric Light and Power Co	5	..	4⅝-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-98
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	7-7⅛
—— Nos. 80,000-100.000	5	..	5⅜-6⅜ xd
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	10 -105
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	4⅛-5
—— 4½ per cent. Cum Pref., 1-80,000	5	..	4⅛-5
—— 4 per cent. Debenture Stock, Red.	100	..	97-100
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5	..	4¼-4⅜
—— ditto (1903) 40,001-80 000	5	..	3¼-4¼
Chelsea Electricity Supply	5	..	3⅛-4⅛
—— 4½ per cent. Debentures	100	..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref	10	..	11½-12½
—— 5 per cent. Debenture Stock	100	..	120-123
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs (all pd.)	100	..	98-101
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. stl. 5 per cent. Bds., Red. 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50 000	5	..	3⅛-4⅛
—— 5 per cent. Preference 1-50,000	5	..	4⅛-4⅞
County of London Elec. Supply, Ordinary	10	..	7-⅞
—— 6 per cent. Cum Pref.	10	..	11-11½
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	105-108
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	99-99
Edmundson's Electricity Corporation, Ordinary, 1-50 000	5	..	⅜-⅞
—— 6 per cent. Cum Pref.	5	..	⅜-1⅛
—— 4½ per cent First Mort. Deb.	100	..	70-80
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	—	..	75-78 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cum Pf., 1-30,000	5	..	2⅛-2⅜
—— 5 per cent Debenture Stock, Red	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	..	92-95
Folkestone Electric Supply Ord., Nos. 1-10 000	5	..	4⅜-4⅝
—— 5 per cent. Cum Pref., Nos. 1-10 000	5	..	5-5⅛
—— 4½ per cent. First Deb. Stock Red.	100	..	94-97
Hove Electric Lighting, Ord. 1-13 000	5	..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	98-101
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150,000	1	..	9/16 11/16
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10¼

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1¼-1⅝
—— 6 per cent. Pref.	5 ..	4⅝-5¼
—— 4 per cent 1st Mortgage Debenture Stock, Red	100 ..	91-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. stock, Red (Prov. Certs), all paid	100 ..	92-95
Metropolitan Ordinary, 100,001-.00,000	5 ..	6-6¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	102-106
—— 4½ per cent. Cum. Pref.	5 ..	4⅝-5⅜
—— 3½ per cent. Mortgage Debenture, Red	100 ..	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($10), D 1-3,000 ($500), M 1 4,400 ($1,000)	— ..	77-79 p.c.
Mexican Light and Power Co., Capital stock	$100 ..	55-57
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	87-89 xd
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	— ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	6¼-6⅜
—— do., 57,010-75,000	5 ..	6¼-6⅜
—— do., 75,001-87,500 (issued at 22 prem., 16s. paid	5 ..	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5-5¼
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5 ..	5-5¼
Notting Hill Electric Lighting	10 ..	11½ 12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅜-6¼
—— 4 per cent. Debenture Stock	100 ..	93-96
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1 ..	13/16-15 16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red	100 ..	96-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5 ..	4⅜ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15,000	5 ..	4⅜-5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co, 5 p.c. Cons. 1st Mt. Bds.	— ..	101-103 p.c.
Smithfield Markets electric supply, Ord., 1-12,000	5 ..	¼-½
—— 4 per cent. Debenture Stock	100 ..	70-74 xd
South London, Ordinary	5 ..	2½-3
South Metropolitan Electric Light and Power, Ord.	1 ..	⅛-¼
—— 7 per cent Cum Pref.	1 ..	1⅛-1¼
—— 4½ per cent 1st Mort. Deb.	100 ..	101 104
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7⅜ 8⅜
—— 7 per cent. Pref.	5 ..	6½-7⅛
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric supply Co., Ordinary, 8-30,007	5 ..	1½ 2½
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	2-2½
Westminster, Ordinary	5 ..	8-9
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	5-5½

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5 ..	6-6¼
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007 ..	5 ..	⅜ 1/16-⅝ 5/16
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	129-131
Auckland Elec Trams, 5 p.c. 1s Mor. Deb. Stk, Red.	100 ..	102-105
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref shares, 1-10,000	10 ..	—
—— 5 per cent Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	11/16 13/16
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1 ..	13/16-15/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk, Red.	100 ..	93-96
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 1⅝
Bombay Elec. Supply and Trams Co, 6 per cent. Cum. Pref.	10 ..	9⅜-9⅝ xd
—— 4½ per cent. Deb. Stock, Red.	100 ..	95-97
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3¼ 3⅜
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜ 4⅝
—— 4½ per cent Deb. Stk., Red., Prov Certs. all pd.	100 ..	97-101
British Columbia Electric Railway Co., Ord Def.	100 ..	127-130
—— Ord. Pref.	100 ..	106 110
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	103-106
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	100-103
—— 4½ per cent. Vancouver Power Deb.	100 ..	99-102
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10 ..	1⅛-1⅜
—— 6 per cent. Cm Pf., 30001-60 000	10 ..	4⅝ 5⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	93-97
—— 4½ per cent 2nd Deb. Stock	100 ..	70-74
Buenos Ayres and Belgrano Trams	5 ..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-4 ,000	5 ..	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27 500	5 ..	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110-116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c Deb. Stk., Red.	100 ..	96-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	100-104
Buenos Ayres Lacroze Trams. Co., Stg. 6 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90-93
Calcutta Tramways, Ord., Nos 1-137,610	5 ..	6⅜-6½
—— 5 per cent. Cum. Pref., Nos. 1 30 000	5 ..	4⅜ 5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	101 105
Cape Electric Tramways, Nos. 1-480,000	1 ..	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4¼-4⅜
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	96-99
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5¼-5½
—— 4 per cent. Deb. Stock, Red 1985	100 ..	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	91-96
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10 ..	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12⅜-13⅜
—— 3½ per cent. Mort Debs., 1-3,000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk, Red.	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6857	$1,000 ..	80-85
Imperial Tramways Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60.000	5 ..	⅞-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	92-95
—— £296,500 2nd Mort. Deb. Stock	— ..	—
—— £83,'30 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	⅞-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1 ..	13/16-1 1/16
—— 5 per cent. Mort Deb., 1-5,000 Red	100 ..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7⅛-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	81-85

Name.	Amount paid.	Last price.
	£	£
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red. 1-1,635	$1,000 ..	88-92
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25 000	5 ..	4½ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100 ..	96-98
Metropolitan Elec Trams., Defd., 1 000,001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref., 500,001 1 000 000	1 ..	13/16- 5/16
—— 4½ per cent. Deb. Stock, Red.	100 ..	94-97
Mexico Trams. Co, Gen. Cons. 1st Mort 50-year 5 per cent. Gold Bonds	— ..	85-87 p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100 ..	100-102 xd
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74,000	5 ..	⅜-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	98-103
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	¼-⅜
—— 5 per cent. Cum Pref., 300,001-545 000	1 ..	¼-⅜
—— 4½ per cent Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary, 1-24 912	10 ..	4½-5
—— 6 per cent. Cum. Pref., 1-10,000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5-5¼
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	96½-97½
Sao Paulo Tramway, Light, and Power Co.	$100 ..	120-124
—— 5 per cent. 1st Mort Deb, Red. 1929, 1-11,000	$500 ..	94-96 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169 570, Prov. Certs.	1 ..	⅞-1¼ xd
—— 4 per cent. Deb St ck, Red. 1 40	100 ..	78 82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs, Red., 1-1 600	100 ..	60-70
Yorkshire (West Riding) Elec Tram. Co, Ord., 70 001-110,000	5 ..	1-1¼
—— 6 per cent Cum Pref., 1-46,261	5 ..	3¼ 3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	66-68
—— 4 per cent. Pref.	100 ..	84-86
—— " " deferred	100 ..	44-46
—— 4 p c Deb. Stock (Prov. Script Certs, fully paid)	100 ..	100-103
City and South London, Consolidated Ordinary	100 ..	40-42
—— 4 per cent Debenture Stock	100 ..	101-104
—— 5 per cent. Pref. Stock '91	100 ..	116-119
—— " " " '96	100 ..	114-117
—— " " " '01	100 ..	113 116
—— " " " '03	100 ..	110-113
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10¼
—— Ordinary, 1-50 000	10 ..	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red, 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	— ..	36-40

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent Debs., Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000 ..	86-88
Anglo-American Telegraph Co., Ordinary	100 ..	57-60
—— 6 per cent. Preferred Ordinary	100 ..	101¼-103½
—— Deferred Ordinary	100 ..	16¼-16⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co., 1-44.000	5 ..	6⅜-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	86-88
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10 ..	6½-7½
—— 10 per cent Preference, 1-6 000	10 ..	15⅜ 16⅜
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-3½
—— 10 per cent. Cum. Preference	5 ..	8¼ 9¼
—— 4½ per cent. Debs, 1 600	50 ..	98-102
Direct United States Cable Co	20 ..	13⅜-14⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	97-100 xd
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	99-101
Eastern Extension, Australasia and China, 1-300 000	10 ..	12⅜ 12⅝ xd
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	101-104
Eastern Telegraph Co., Ordinary Stock	100 ..	130-135
—— 3½ per cent. Preference stock	100 ..	86-87
—— 4 per cent. Mortgage Debenture Stock	100 ..	10 -103
Great Northern Telegraph Co. (of Copenhagen)	10 ..	33-35
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs, within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	53-56
Marconi's Wireless Telegraph Co, Nos. 256,128-384,190	1 ..	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	1-1
National Telephone, Preferred	100 ..	111-113
—— Deferred stock	100 ..	110-112
—— 6 per cent Cum. First Pref.	10 ..	11-13
—— 6 per cent Cu m. Second Pref.	10 ..	10¼-12¼
—— 5 per cent Non Cum. Third Pref.	5 ..	5⅜-5½
—— 5½ per cent. Deb. Stock, Red.	100 ..	97-99
—— 4 per cent Deb. Stock, Red.	100 ..	98¼-10 ⅛
Oriental Telephone and Electric Company	1 ..	1 1/16-1 3/16
—— 6 per cent. Cum. Pref	1 ..	1 1/16-1 3/16
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100 ..	98-101
United River Plate Tele. Co., Ordinary, 1-100 000	5 ..	6¼-7
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅜-5¼
—— 5 per cent. Debenture Stock, Red.	100 ..	—
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	98-102
West African Telegraph Co.	10 ..	10-10½
West Coast of America, 1-30 000 and 53 001-53,008	2½ ..	1⅝-1¾
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	98 101
West India and Panama Telegraph Co., Ordinary	10 ..	⅛-⅜
—— 6 per cent. Cum. 1st Preference	10 ..	7⅜-8¼
—— 6 per cent. Cum. 2nd Preference	10 ..	7⅜-8¼
—— 5 per cent. Debs., Red., 1-800	100 ..	100-103
Western Telegraph Co., 1-207,980	10 ..	12¼-13¼
—— 4 per cent. Debenture Stock, Red.	100	98-101

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Jan. 29	1,113	1,102	+ 11	- 1,310h	27½	27½	May 31	72,605	17,676,000	1,529,682	0 98	11·39	4,987	6·34
Ayr Corporation	Nov. 17	1,019	966	+ 53	- 176	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5 35
Baker Street and Waterloo Ry.	Feb. 1	3,185	2,340	+ 845	+ 4,029	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 2	963	914	+ 49	+ 35	23·53	24·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	Jan. 25	6,118	4,976	+1,141	—	56½	54½	,, 31	18,557	5,252,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 22	857	870	+ 17	+ 3,176	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 20	281	295	- 14	- 1,248	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	Feb. 2	2,029	1,957	+ 72	+ 6,025	42	42	March 31	111 294	25,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	Jan. 29	1,243	1,094	+ 149	+ 1,791	29¼	24½	,, 31	85,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 25	3 832	3 840	+ 52	+ 4,530	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	Feb. 2	645	626	+ 19	- 3,170	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	Jan. 31	4,504	4,371	+ 133	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	Feb. 1	1,103	1,050	+ 53	—	19½	19½	,, 31	62,699	11,967,458	1,205,830	1·31	12 48	5,825	8·21
Burton Corporation	Jan. 5	238	274	- 36	- 585	9½	8½	,, 31	15,576	3,383,527	421,317	·07	8·87	1,768	6·14
Cardiff Corporation	,, 11	1,894	1,918	- 24	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	Feb. 1	154	133	+ 21	+ 34	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 1	6 201	6,406	- 205	- 912	6	6	,, 31	349,298	43,057,997	1,279 698a	1·85	62 29a	55,357	35·22a
Charing X, Euston, & Hamp. Ry.	,, 1	3,170	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 2	3,272	3 085	+ 287	+ 1,907	9	6¼	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	Jan. 29	146	138	+ 8	--	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 30	379	383	- 4	- 182	15½	15½	Dec 31	25,032	5,966 364	891 9 8	—	6·74	—	4·78
Croydon Corporation	,, 31	1 200	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502 408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 31	222	212	+ 10	- 43	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1,124	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Jan. 31	89	87	+ 2	- 11h	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 31	4 550	4,400	+ 150	+ 133	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 29	1,058	951	+ 107	+ 1,789	22	22	May 15	57,672	15,554 905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	Feb. 1	820	758	+ 62	+ 402	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 1	16,219	15,601	+ 618	+17,103h	177½	169	May 31	387,381	224,063,088	20,350 367	·95	0·47	5,035	5 21
Gloucester Corporation	Jan. 29	205	202	+ 3	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6 94	1,002	5·1
G.N., Piccadilly and Brompton.	Feb. 1	5 590	—	—	—	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,996	18,899,242	1,624,275	—	1·52	—	8·65
Huddersfield Corporation	,, 1	1,390	1,309	+ 81	+ 3,201	35½	35	,, 31	81,196	15 252,150	1 804,745	1·22	0 79	2,770	5·92
Hull Corporation	,, 1	2,401	2,234	+ 167	+ 6,207	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	Jan. 25	352	363	- 11	—	10½	10½	,, 31	26,489	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 29	121	109	+ 12	+ 391	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	—	—	—	—	—	7½	7½	May 15	13,702	4,640,618	466,919	·672	7 55	1 723	4 95
Lancashire United Tramways	,, 29	1,039	934	+ 105	+ 280	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 25	5,746	5,593	+ 148	+11,790	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10 69	3,352	5 58
Leicester Corporation	,, 25	1,901	1,820	+ 81	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 18	10,011	10,577	- 566	- 1,719	104	104	Dec. 31	563.793	122,094,528	12,115 934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	Feb. 2	1,3 8	1,3 2	+ 56	- 76h	9 25	6·65	June 30	77,568	10,957,148	1,102 809	—	—	—	—
London County Council	Jan. 18	23,6 7	26,567	+3,070	+213,725	98	98	March 31	1378,014	314,227 090	30,130 297	1·05	10 98	—	8 56
Lowestoft Corporation	,, 11	144	150	- 6	+ 101	3½	—	Sept. 30	11,079	2,672 922	343,190	1·03	7 9	2,156	6·39
Maidstone Corporation	Feb. 3	144	69	+ 75	—	3¼	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 1	13,561	12 586	+ 995	+ 42 636	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 1	9,157	7,917	+ 1,210	+ 4 661	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 2	15,099	14 885	+ 214	+ 201	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 1	119	118	+ 1	- 32	2¾	2¾	March 31	7,709	2 035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 1	3,839	3,808	+ 31	+ 1,329	59⅛	57¼	,, 31	210,491	45 5 6 468	4,263,174	1·11	11·85	3,560	6·14
Newport (Mon) Corporation	Jan. 25	543	524	+ 19	+ 2.074	14½	14½	,, 31	32,421	7,760 403	772 753	1 03	10 01	1.525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35¼	35¼	,, 25	94,948	18,647,731	1,818,444	1 19	12·53	2,603	7·209
Portsmouth Corporation	Jan. 18	1,470	1,4 6	+ 54	—	28½	28½	,, 31	98,911	21 658 825	2 199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,651	8,120 179	918 825	9 3	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	25,916	5,745,298	618,211	1 12	10 45	2,691	7·38
Salford Corporation	Jan. 27	4,021	3,841	+ 180	+ 5,961	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78c	4·78c	Dec. 31	7,779	1.537.845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	Feb. 2	5,253	5,037	+ 216	+11,413	65½	65¾	March 25	276,907	73 966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	—	—	—	—	—	18	18	,, 31	49,185	9 437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	Jan. 29	253	201	+ 32	+ 106	9	9	,, 31	20,076	4,431.728	390,578	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248 656	—	9 464	—	4·849
Sunderland Corporation	Feb. 2	1,087	1,178	- 91	- 1,702	20	20	,, 31	72,396	17,483 132	1 535,425	1·006	11·261	3,687	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,675,221	221,417	·8	9 94	1,968	7·79
Torquay Tramways	Jan. 30	160	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	Feb. 1	701	680	+ 21	+ 644	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·5
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19.204	4,965 296	429 785	—	10 724	1.989	6·95
West Ham Corporation	Jan. 30	2,110	2,237	- 127	+ 1,982	14·7	14 7	,, 31	172,881	35,502 836	2,556,854	789	10 96	4,407	6·79
Wolverhampton Corporation	,, 29	738	705	+ 33	+ 455	20	20	,, 31	43,823	9.276,023	966,133	—	10 886	2,159	6·095

1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TELEPHONIC MATTERS.

The recent tendency to make some alteration in the method of charging for telephone services, as indicated by a letter in our last issue, is not to be allowed to proceed without adverse criticism. On Tuesday one of the largest and most influential deputations that ever visited a minister waited on the Postmaster-General in order to put their views before him. An almost equal large preliminary meeting had been held the previous afternoon to discuss the matter and to elect speakers for the deputation. Four questions were selected upon which to dilate: (1) measured rates, (2) flat rates, (3) payments for junction calls, and (4) future policy. We shall not enter into detail on each of these points, but will at once say the deputation ought to have made its arguments much stronger, and the Postmaster-General's reply was feeble in the extreme. The broad argument of those responsible for the new device, measured as against a flat rate, is that it is the only just and honest method of paying for services rendered. They assume that a subscriber who initiates two calls ought to pay double as much as the subscriber who initiates one call, inferring, though carefully abstaining from saying so, that the prime cost of two calls to the seller is twice that of one; and it is just in this inference that the whole justness of the case topples to pieces. In ordinary business transactions flat rates prevail more largely than measured rates. The bookseller does not make his unit the cost of one book, nor does any business man dealing in things the reproduction of which is much less costly than the production of the original. The bookseller, for example, assumes the sale of a thousand books, and makes his unit the cost of that thousand. If the measured-rate system in telephony is to prove acceptable, the unit from which the rate is to be deduced must be something other than unit message. The Postmaster-General did not say that some such system as that of the bookseller was employed when obtaining the charges per measured rates. He rather dwelt upon the wholly fallacious argument that a busy line might get its messages through at one fifth of a penny each, while a smaller user on the flat rate paid one penny per message. We quite agree in getting uniformity of charge, but such uniformity must be based on costs, and it is absolutely wrong to indicate or leave to be inferred that in such cases one man is paying for the other. Take the operator. She can deal with an average number of messages per working day, say five hundred messages. Her wages are the same, her environments are the same, whether only ten or the whole five hundred messages are dealt with; hence in that case the units of measurement are wages and five hundred messages. Again, any one line and instruments cost the same whether used infrequently or frequently to a limit; hence costs per message are not proportional to number of messages unless the unit of measurement is the limit, or, if we may coin an expression, an average limit. As a matter of fact, a flat rate must be and is obtained by averaging after this manner; hence is in a way a measured rate. No human method is perfect, but there certainly is no valid reason for making changes which a large number of users show would be costly. There is no getting away from the fact—the finances of the National Telephone Company prove it up to the hilt—that the system hitherto in vogue has paid, and paid well. The only logical reason for change is to get more out of the subscribing public, and the subscribing public think and, indeed, can prove that it is paying already far too high a price for services rendered. If the Postmaster-General can show that the new departure will lower the payments by sub-

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scribers, they will not be unwilling to give it the greatest consideration. He dismissed the idea of another committee to inquire as premature, but, again, we disagree. The cost of installation of small and large exchanges is now fairly well standardised; the average usage per line is fairly well known; and comparisons could be made where the conditions of working vary, so that the question of cost could be thrashed out to the lowest decimal point, and the validity of change in charging better understood. No one on Tuesday objected to a measured rate if the measured rate was so adjusted as to make telephony cheaper rather than dearer.

THE LEEDS TRAMWAY RESERVE FUND.

In our leading article for Dec. 6, 1907, we referred to the Leeds Corporation mismanagement. Quoting from the balance-sheet of the tramway department for the year ending March 31, 1907, we showed that not only had there been no addition to the reserve fund during the year, but that £85,000 had been abstracted from this fund for the relief of rates. Our statement then made caused considerable stir in Leeds, and has raised the question of the city's financial stability. Sir John Ward, the chairman of the Tramways Committee, explained in a letter to the local papers that he was not in favour of this depletion of the reserve fund which had been done by the Finance Committee. Why he allowed this large sum to be taken from the reserve for which he, as chairman, was directly responsible is not clear. At the meeting of the Leeds City Council last week the whole question came up for discussion, and Alderman Portway moved the following resolution: "That a committee be appointed to consider the question as to what amount of reserve funds should be provided in addition to the sinking fund in the cases of the tramways, electricity, gas, and water undertakings of the Corporation, with power to obtain such expert opinion and to visit such places as they deem advisable, and to report thereon to the Council as early as possible." An amendment was at once carried deleting the proposal to have an outside expert opinion. The reasons given for this do not appear in the report before us. The amended resolution to appoint a committee was only carried by twenty-seven votes to nineteen. In a matter of this kind we believe that opinions should be strongly expressed, and this was certainly done by those opposed to the inquiry. Thus a Mr. A. Willey made some condemnatory remarks as to the electricity department. He asked: "What was the object of a reserve fund? Could not they, with their statutory powers, deal with pretty nearly every item of expenditure as it arose in running their commercial undertakings? The fact was Alderman Matheson was suffering from a very sore ear in regard to the electricity department. If he had had his way, the pockets of the ratepayers would have been deeply sought into by the Electricity Committee, because this was one of the few departments which had been an unmitigated failure as a trading concern." It will be remembered that when we last touched this matter in December, the Tramway Committee, having bribed the Council with its reserve fund, was trying to oust the Electricity Committee, of which Alderman Matheson was chairman, and to merge the two departments into one. Our analyses then published will convince any unbiassed person that Mr. A. Willey's charge that the electricity department is a failure is untrue. Now that the Tramways Committee and their friends are called upon to defend a temporary reduction in rates obtained by the spoliation of the tramway reserve it is interesting to see how they do it. A committee is appointed to consider the matter, and on this, as on the Council, they have secured a majority. They refuse to have expert advice on the matter, and hence the committee sits in judgment on a theft which its own majority has sanctioned. The whole inquiry reminds one of the verse of Rudyard Kipling's which reads:

> They knew 'e stole; 'e knew they knowed;
> They didn't tell, nor make a fuss,
> But winked at 'Omer down the road
> An' 'e winked back—the same as us!

We believe that an ex-chairman of the Tramway Committee obtained for the benefit of the same a report from one of the leading tramway experts on this very question, and it is quite likely that this opinion accounts for the dislike of outside advice.

TRAMWAY RETURNS.

This week we give some extracts from the annual return of the Board of Trade for the year 1906-7 of the tramways and light railways of Great Britain, which proves to be a rich mine of useful and suggestive information. The task of having to work through fifty large pages of tabular returns is sufficiently awe-inspiring to drive away more than the most timid persons, but we think that the arrangement of the matter in this return is such as to render the information readily accessible at a minimum expenditure of trouble. The local authorities' undertakings and the companies' undertakings are grouped in separate portions, at the end of which are given totals. Thus it is possible to obtain comparative figures as to the working of both classes of undertaking, from which, we have no doubt, the conclusions drawn will vary in accordance with the attitude of the various parties towards the question of municipal and company tramway enterprise. Leaving aside for a moment questions of policy, it is evident that the extraordinary development of tramways all over the country has by no means worn itself out, though all will agree that the present and prospective expansion cannot be in the same ratio as of late—for reasons with which our readers are now familiar. The return shows that in March last there were roughly 160 more miles of tramway open than twelve months before, that the number of passengers carried in the year 1906 7 was 220 millions more than in 1905-6, and that over half a million more profit was made on the year's working. If the comparison between the results of two years and what may be called the "electric" period is striking, that between the results of the electric, steam, and horse periods is even more so. It is unnecessary to repeat here the figures which appear in another column summarising these results, but we think they bear testimony to a fact which can hardly be called in question—viz, that electricity has given an enormous impetus to tramway construction. The table shows that the percentage of gross receipts absorbed in working expenditure is much less under electric traction than under steam or horse—62·14 per cent., 76·93 per cent., and 83 81 per cent. respectively—whilst the percentage of net receipts to total capital expenditure increased from 3·97 per cent. under the horse period to 6·38 per cent. under the steam period, thence to 6.99 per cent. last year. The average receipts per passenger last year were 1·10d., against 1 23d. in 1898, which year was typical of the steam period, and 1 84d. in 1879 (the "horse" period), which, together with other statistics, show that the advent of electric traction means to the travelling public lower fares for longer distances than under any other mode of traction. It will be seen from the table which we give in another column that local authorities own 1,571 miles (149 miles of which are leased to companies) as against 823 company-worked lines The average receipts per mile of line work

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out at £5,203 for local authorities as against £4,467, but the receipts per passenger in municipal undertakings work out somewhat lower than in company undertakings. The municipalities show sound finance in making ample provision for reserve, sinking, and renewal funds. A large sum has also been paid towards relief of rates. The stability of an undertaking, however, depends on the sufficiency of the depreciation and renewals account, and it is a feature of the report that local authorities recognise this fact. The gross revenue from lines worked by companies was £3,676,843, and the net receipts £1,500,096. Of this some £865,132 was paid away in dividends and only £222,012 placed to reserve and depreciation accounts. Municipalities, on the other hand, have appropriated a much larger ratio of their net revenue to the latter accounts, and in this respect their financial policy is certainly more sound than that of the companies, while another point in their favour is the fact that they are able to make adequate provision for future renewals, and at the same time to pay a large sum in relief of rates at lower fares. It will be understood that the results of some undertakings vary considerably from the average figures given in the report—in the cases of three local authorities and four companies the returns for last year show an excess of working expenditure over gross receipts—but these need not concern us in considering the general average.

ELECTRIFICATION OF RAILWAYS.—II.*

BY DR. GISBERT KAPP.

(*Continued from page 189.*)

Fig. 41 shows a train on the Metropolitan District Railway electrified by the British Thomson-Houston Company,

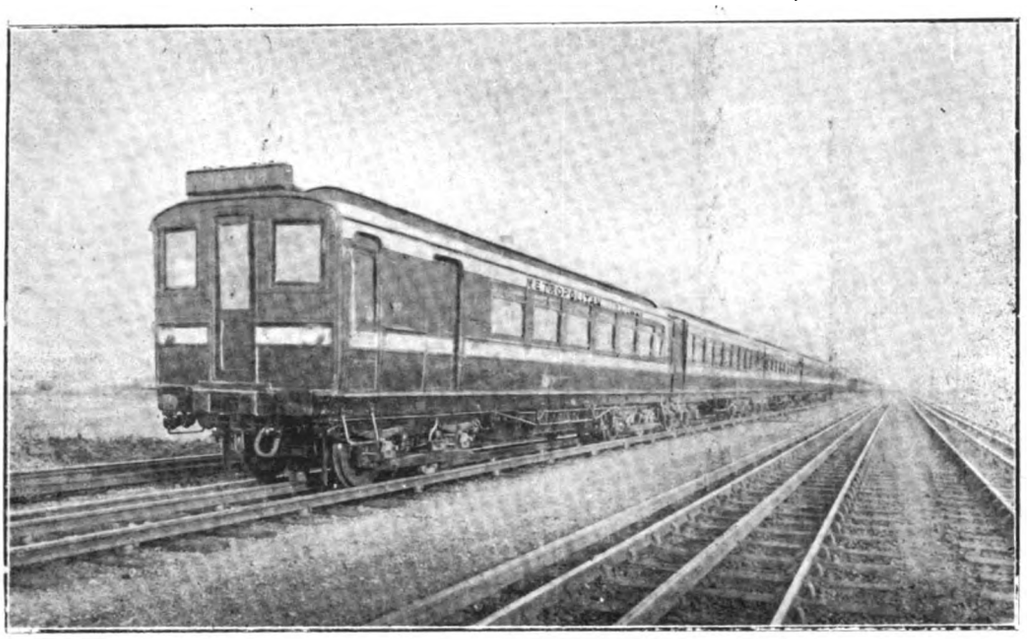

FIG. 41.—A Metropolitan Train Equipped by the British Thomson-Houston Co.

Fig. 42 one of the locomotives, and Fig. 43 the interior of the locomotive. All the rolling-stock is worked on the multiple-unit system, but whilst in the locomotive all the gear, including the contactors (shown on the left in Fig. 43), is in the interior, in the motor coaches the gear is below the floor. Fig. 44 shows the underside of a coach tilted up so as to render the contactors, air-cylinders, and other parts visible. Fig. 45 is an electric locomotive on the North Eastern Railway, a branch of which (running from Newcastle to the sea) has also been electrified by the British Thomson-Houston Company. The locomotive takes

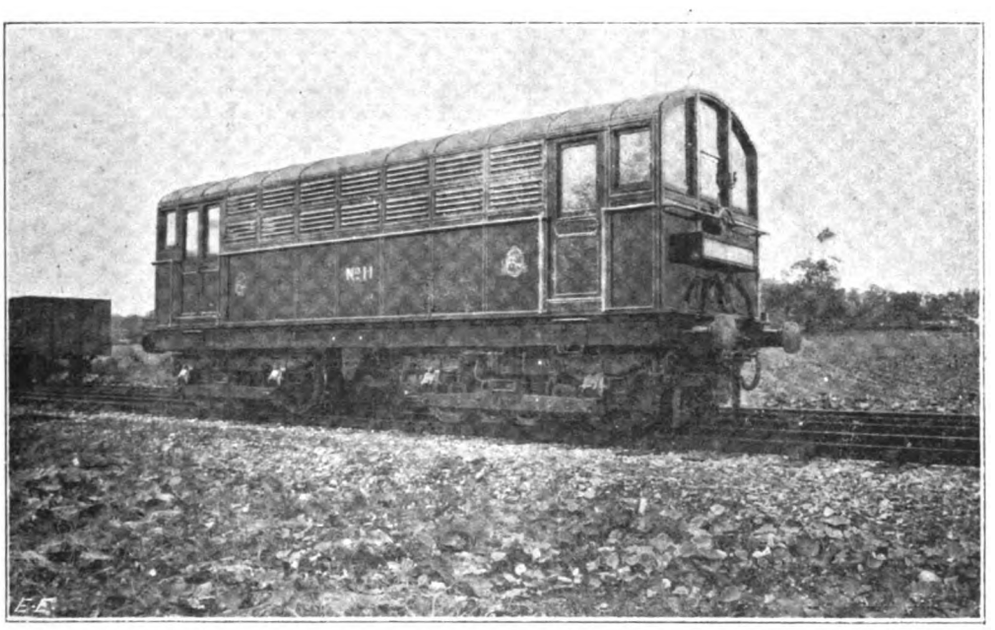

FIG. 42.—A B.T.H. Electric Locomotive used on the Metropolitan Railway.

* Lecture delivered before the Royal Institution of Great Britain, Saturday, Jan. 25,

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normally current from a third rail, but in yards, where, on account of many lines crossing, a third rail is inadmissible, it takes current from overhead wires, for which purpose it is fitted with a pantograph collector. Fig. 46 shows a

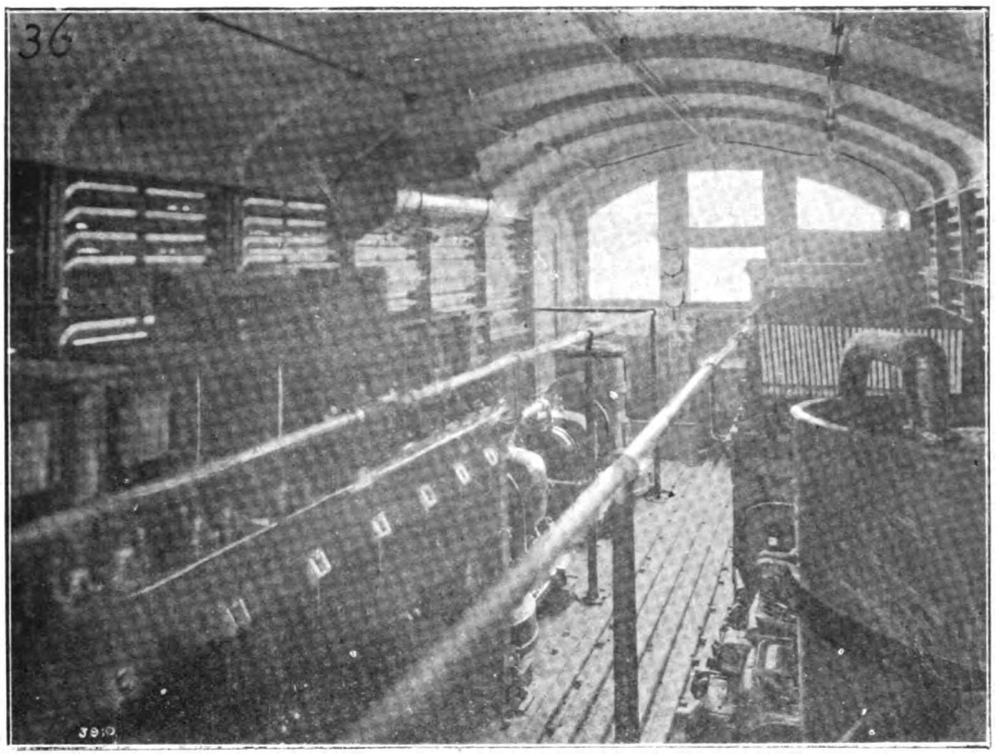

FIG. 43.—Interior of the British Thomson-Houston Locomotive, showing the Contactors.

motor-coach train on the same railway. Fig. 47 represents a train on the Liverpool Southport branch of the Lancashire and Yorkshire Railway. The electrification of this line has been carried out entirely by an English firm

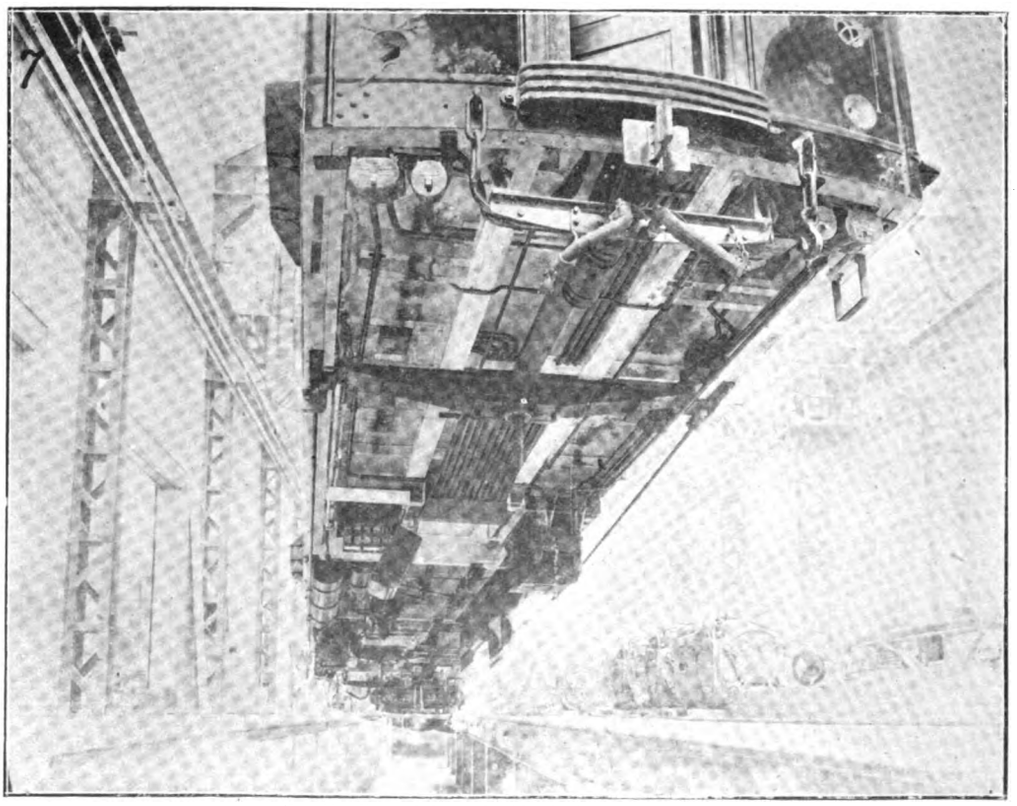

FIG. 44.—View of the Underside of a B.T.H. Motor-Coach.

(Messrs. Dick, Kerr, and Co., Limited). The work comprises 47 miles of line and about 60 miles of track. About midway between Liverpool and Southport, close to the line, is the power-house, containing four 1,500-kw. three-phase generators, which supply 7,500-volt current at 25 frequency to four sub-stations, one of which is in the power-house itself, the others being placed along the line and in close proximity to it. These sub-stations are fitted with the usual plant for transforming the high-pressure three-phase current into continuous current of 600 volts pressure, which is led into the third rail. The return current flows through the running rails. In addition to the sub-stations proper, and at intermediate points between them, there are battery stations for the purpose of equalising the load on the machinery both at the power-house and sub-stations. The batteries are combined with automatic reversible boosters, and their aggregate one-hour rate is 4,000 amperes, but for

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short periods each battery can supply about twice the normal current, so that the fluctuation of load in the power-hour is very greatly reduced and the efficiency of operation much increased. Locomotives are not used on this line, but only motor-coaches and trailers, trains being made up

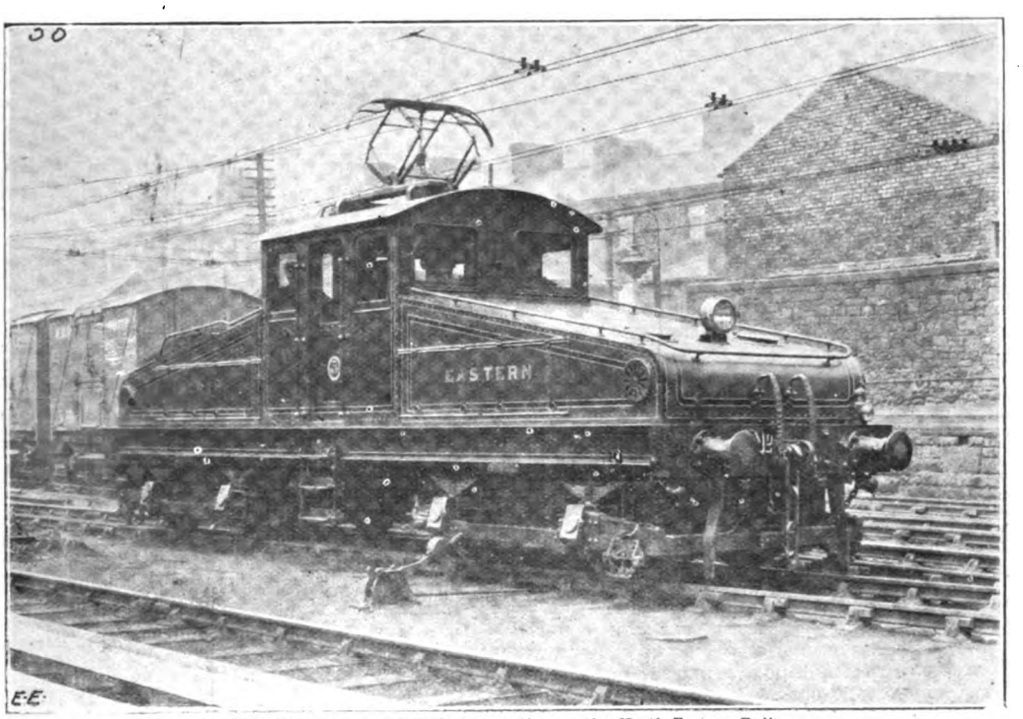

FIG 45.—View of a B.T.H. Locomotive on the North-Eastern Railway.

of two motors, and either one, two, or three trailers, according to the requirements of the traffic. The longest trains (five coaches), weighing 170 tons, are used during the so-called rush hours in the morning and afternoon. The motors are provided with two four-wheel bogies, each fitted with two motors of 150 h.p. (Fig. 48, which also shows the collecting shoes). The whole train is thus provided with eight motors having an aggregate of 1,200 h.p. The performance of one of these motors with its gear is shown in Fig. 49. Simultaneous control of the eight motors (or what I have previously called multiple-unit working) is, of course, used also here, but the special method adopted is not copied from American examples, but has been developed independently by Messrs. Dick-Kerr, and is called by them the "unit switch system." Fig. 50 represents the interior of the motorman's cab, and shows controller, vacuum brake handle, switches, and valve gear. Fig. 51 shows how the contactors and resistances are fitted to the underside of a coach. The line was first worked electrically in summer 1904, and the improvement of the service may be gauged by the facts that since its electrification the number of daily double journeys has risen from 36 to 70, and the number of daily train miles from 1,900 to 3,500.

(To be continued.)

BRICKWORK IN CENTRAL-STATION CONSTRUCTION.

The conditions attending the wear and tear of brickwork in central-station practice are, perhaps, rather more severe

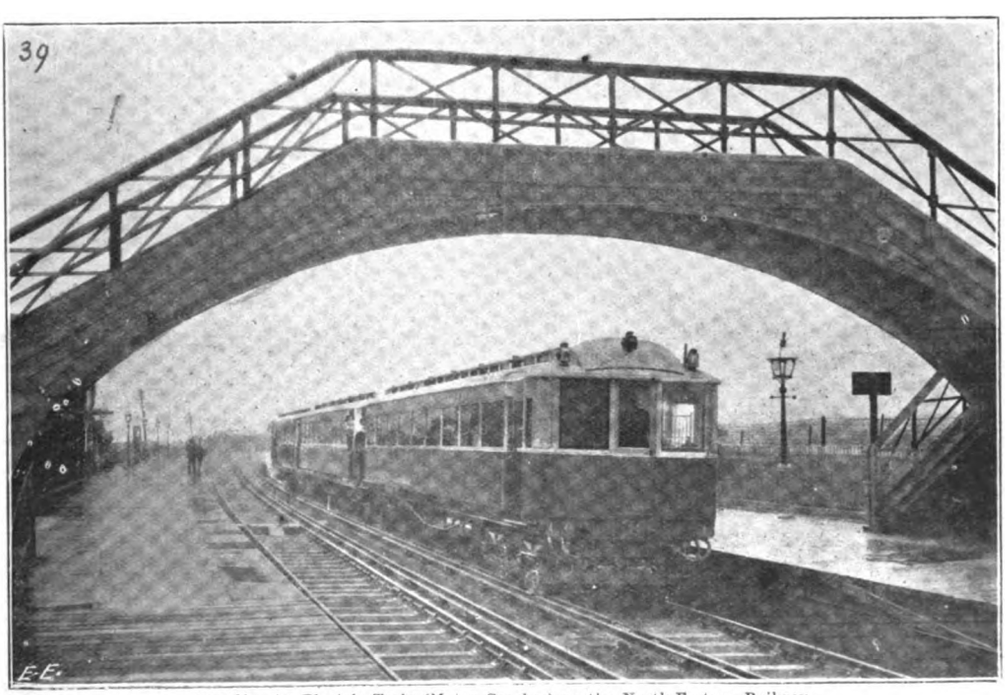

FIG. 46.—An Electric Train (Motor Coaches) on the North-Eastern Railway.

than in ordinary manufacturing buildings, inasmuch as there is not only the continuous vibration due to the pounding of heavy machinery, but certain parts of the structure are subject to intense temperature changes, rendering a very first-class construction necessary in order

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to secure long life. One or two notes concerning the construction of brickwork for central stations may not, therefore, be without interest.

The modern form of central-station buildings consists of a skeleton steel structure with wind screens of brickwork filling the spaces between girders, and there is a temptation to believe that with the absence of strain on the actual brickwork a certain amount of negligence may be allowed for the purpose of cheapening work in the actual choice and placing together of the bricks. More than once the writer has observed the very poor quality of brick being used for such structures, and is of the opinion that a few years will show that such cheapening methods are penny wise and pound foolish.

The underground work, such as pipe trenches, footings, foundations, etc., if not constructed of concrete should contain nothing but bricks of a very hard and water-resisting nature. A brick which gains a large amount of weight after having been soaked for some hours in water is of no value in this connection, as it will in course of time deteriorate, and become a source of weakness to the structure. Under-burnt bricks should be specially avoided.

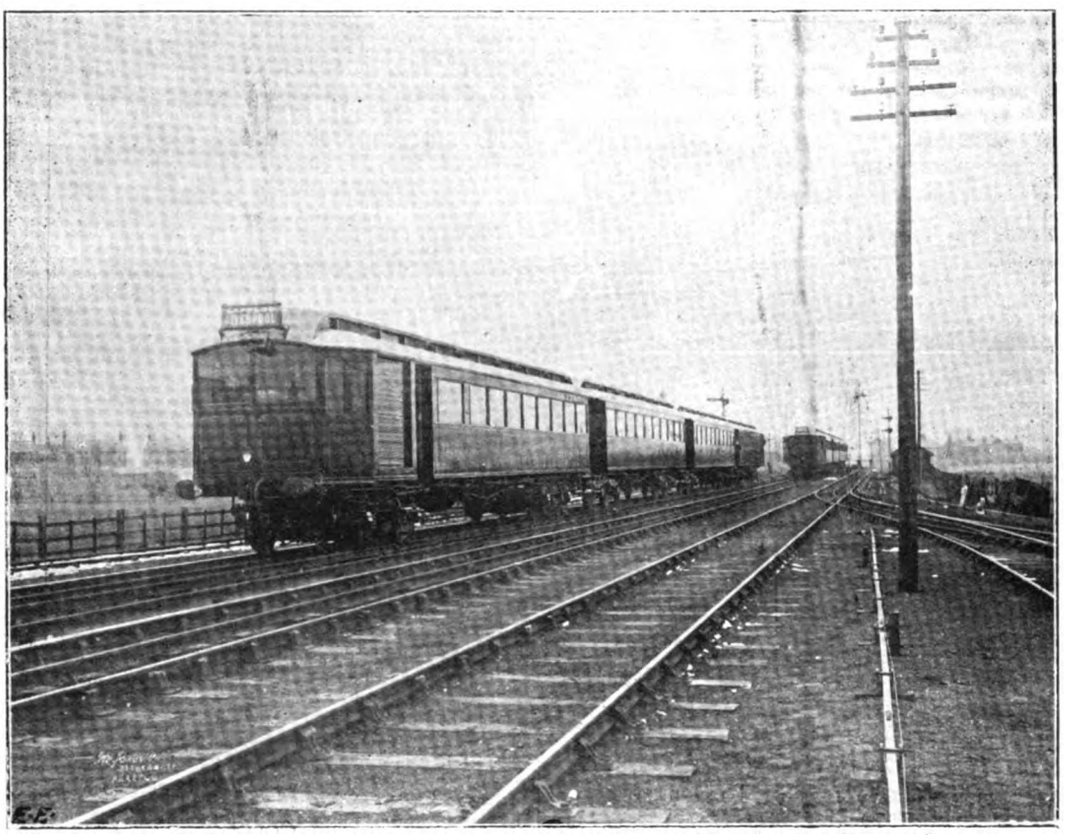

FIG. 47.—Electric Train on the Liverpool- outhport Railway, equipped by Messrs. Dick, Kerr, and Co.

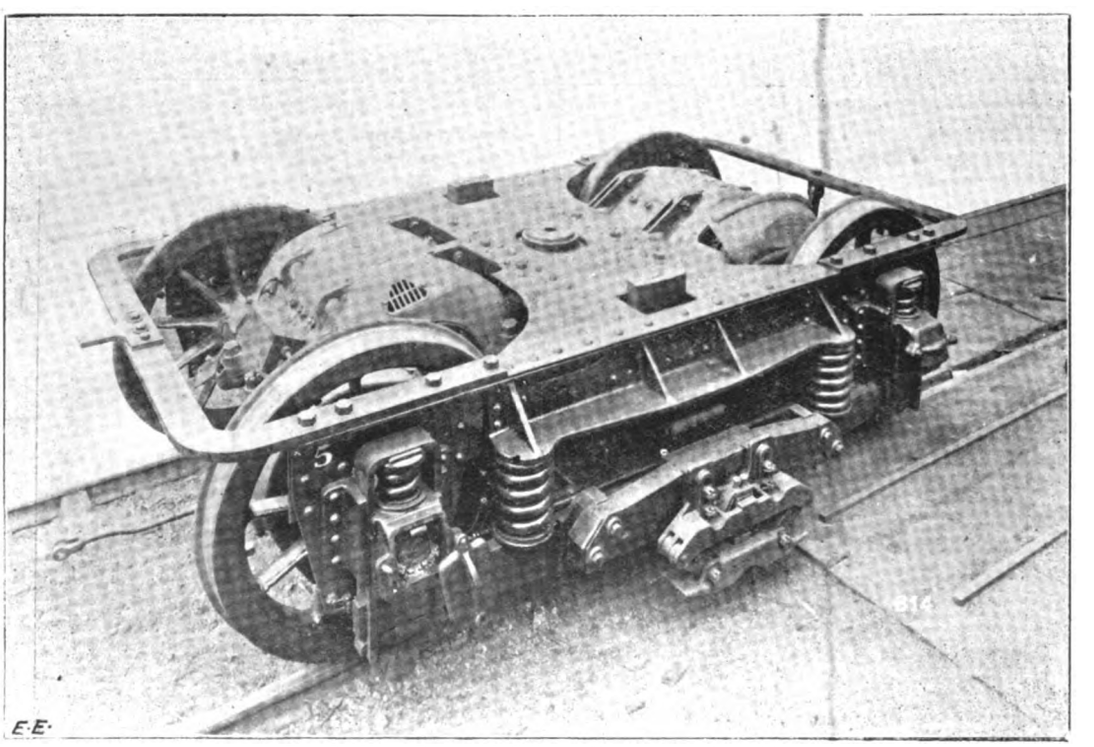

FIG. 48.—Motor Bogie with Collector Shoe mounted in position.

It is very often better to defer bricklaying until the summer months, when conditions of climate are not quite so severe, and if there is any hurry about the building there is a temptation to place the bricks quickly in position without first dipping them in water in order to clear off any dirt that may be on them, and also to keep them from

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absorbing the moisture in the mortar. Care should be taken to get the whole work up uniformly—*i.e.*, one part of the structure should not be worked on to any great extent above the level of the rest of the brickwork—and if it is impossible to get uniformity of level all round, the practice of building a straight-up section should be avoided, as weakness in a vertical direction along the joint of the older and newer material will develop if the approximate line of juncture is at all vertical. The general idea in brickwork is to make each layer of bricks round the building as far as possible an unbroken ring in order that the vertical cracks and fissures may not be developed if there is any tendency towards settlement later on in the life of the building.

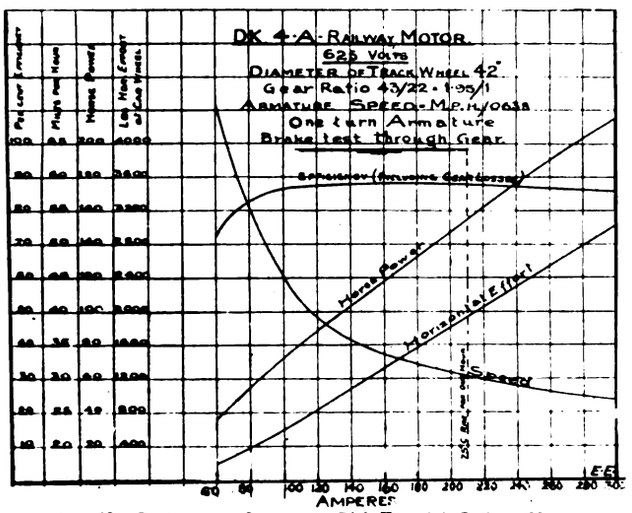

FIG. 49.—Performance Curves of a Dick-Kerr 4 A Railway Motor.

It conduces to the life of the structure if money can be spent on the provision of smooth, hard, machine-pressed bricks for the outside of all walls, as an absorbent brick gets weather worn very speedily, and diminishes the strength of the building. The bricks of the chimney stack should be specially durable in this respect, and it is advisable to make the copings, at any rate, of hard vitrified brick in order that they may throw off any settled rain-water.

The internal walls are frequently built of glazed brick on account of its fine appearance, but it should be remembered that this brick is relatively costly, and, moreover, presents a smooth cool surface for any water in the building to condense upon. This is rather important in a central station, where steam is apt to be at times rather too plentiful, and it is possible to use soft absorbent bricks for internal work in central-station practice without damage, provided that no undue weight is placed on them. Boiler settings, of course, require, at any rate on their interior, firebrick, and it should be specially borne in mind that the size of the brick adopted should be just so as to bond properly into each part of the main brickwork of the building with which it is in contact, otherwise weakness

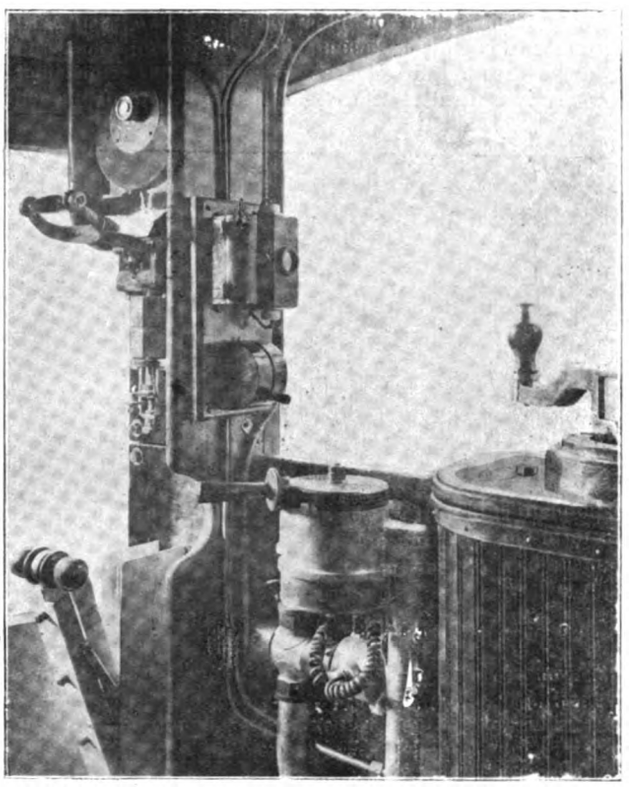

FIG. 50.—Interior of Motorman's Cab, showing Controller, Brakes Switch, and Vacuum Control and Valve Gear.

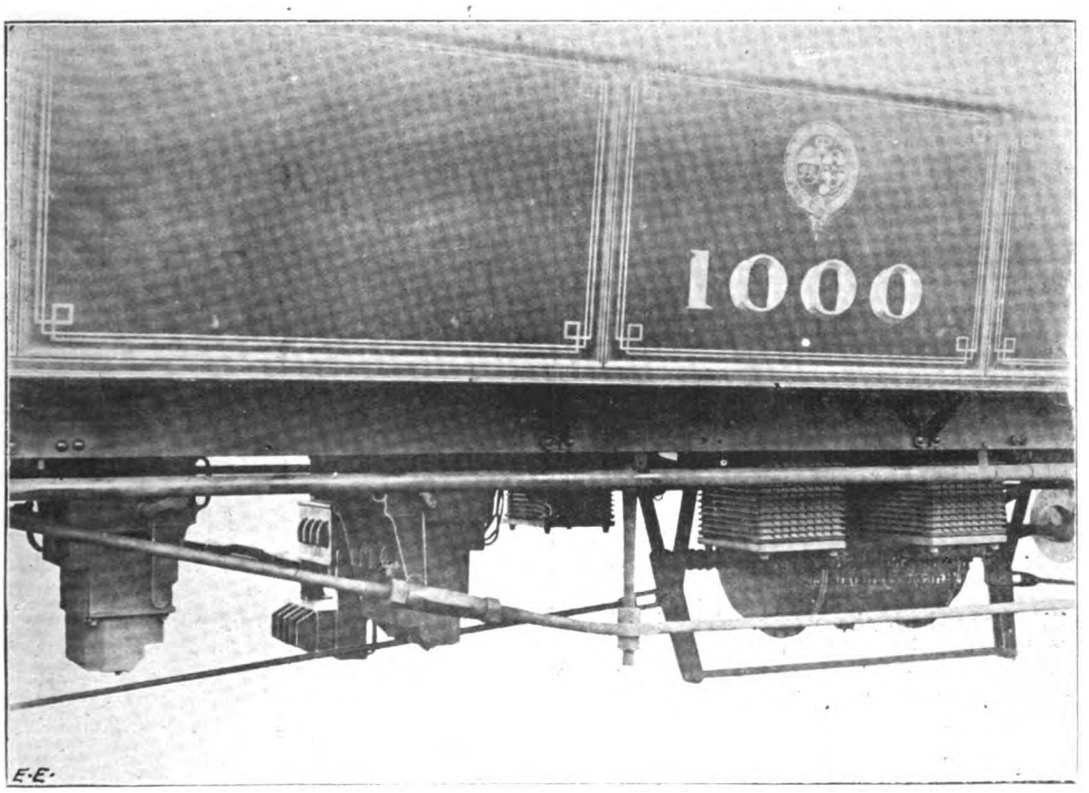

FIG 51.—Dick-Kerr Contactors and Resistances.

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might ensue, particularly under the distortion due to intense heat. All brickwork should be kept clear of contact with rivets, bolts, etc., of the boilers.

In conclusion, it is worth while emphasising the necessity for strict supervision in the erection of brickwork for central stations. The ordinary bricklayer knows how to build houses, but his conscience does not always extend to the extra care required when the special workmanship necessary in central stations is called for. A careful eye on the man who is mixing the mortar, and also the man on top of the scaffold, will well earn its reward.

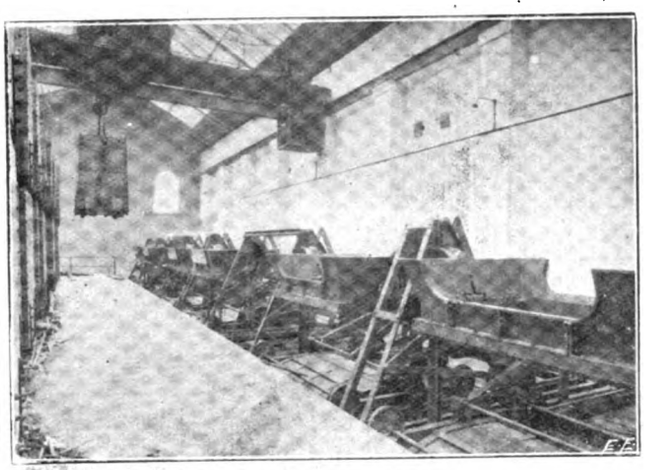

FIG. 1.—Charging Floor, showing Refuse Tubs and Water-Sealed Doors.

GREENOCK ELECTRICITY DEPARTMENT.

Opening of New Refuse Destructor Station.

On the 7th inst. Provost Denholme officially opened the new electricity supply station, in which a refuse destructor has been included. The main entrance to the works is from Dellingburn-street, where a cartage entrance and railway siding are provided. Arrangements are made at the gatehouse for weighing and recording all refuse and other material delivered to the works. The buildings are laid out in four bays, the destructor furnaces occupying the bay nearest the entrance. This bay is 110ft. long by 40ft. wide by 41ft. high. The two centre bays accommodate two sets of boilers for destructor and coal firing respectively, while the east bay (the largest of the four) is the electric power station. A pump-room, which serves both sets of boilers, adjoins the power station; and the economisers, of which there are two, are housed outside the main building. The chimney, 150ft. in height by 10ft. internal diameter is situated at the end of the boiler-house. A concrete retaining wall and water reservoir has been built at the south end of the site, and water is conveyed by an 18in. pipe from the reservoir into the power station for condensing purposes.

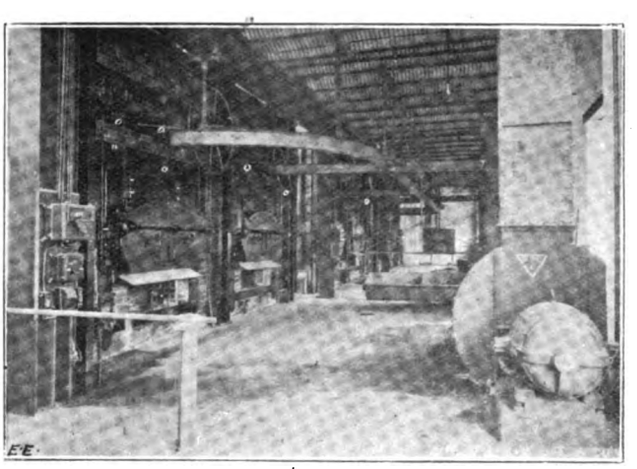

FIG. 2.—Clinkering Floor, showing High-Pressure Fans and Overhead Clinker Transporter.

The destructor consists of six large cells and combustion chambers, with three water-tube boilers, arranged so that each pair of cells with its boiler can be worked independently. By firing the two cells of each unit alternately a steady steam pressure is maintained in the boiler, while the combustion chamber is also kept at a sufficiently high temperature to thoroughly cremate the noxious gases which escape from the newly-charged refuse. The furnace grates, which slope from back to front, have each an area of 25 square feet, and are constructed to efficiently burn a full cart-load of refuse at one charge. The grate bars are perforated with a large number of small holes, and a high-pressure blast is forced through these by means of electrically-driven fans. The fans, of which there is one to each furnace, are coupled direct to "Phœnix" variable-speed motors of the totally enclosed type. The starting and regulating switches are fixed conveniently to the furnace doors, and a throw-off switch is actuated in such a way that the opening of the door automatically stops the fan. An attempt has been made to improve the unfavourable atmospheric conditions existing in most destructor installations, and ventilation is provided for by carrying the fan inlets to the under side of the storage platform and turning them inwards so that all dust and fumes emitted during the process of "clinkering" are drawn in and delivered back to the fires. Auxiliary steam-jet fittings for steam blast have also been provided, but these are only intended to be used in the event of a breakdown to the fans. The refuse is delivered from the carts to the furnaces without handling of any kind. The tipping pit is situated at the north end of the destructor house, and the refuse, which is delivered by carts, is discharged through a specially-shaped hopper into a storage tub placed ready in the pit. The pit has accommodation for four tubs, with two hoppers, the latter being arranged to move on rails

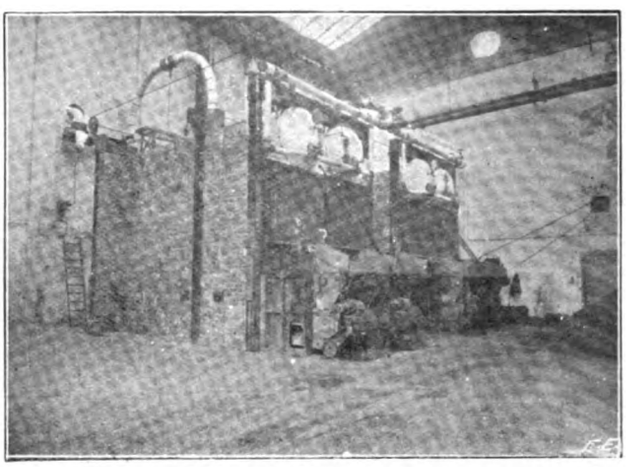

FIG. 3.—The Boiler House with Babcock and Wilcox Boilers.

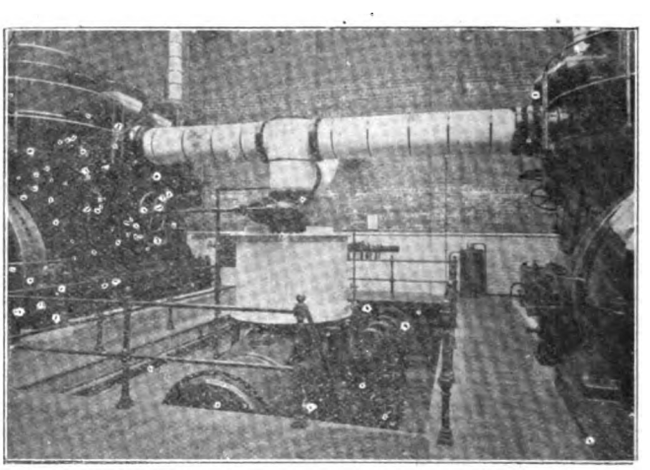

FIG. 5.—View of the Condensers.

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across the pit. When the tub has been loaded the hopper is moved clear from above it, and an electrically-operated overhead crane lifts the tub and deposits it on the storage platform. The storage platform extends the full length of the furnace blocks, and has accommodation for 80 tubs. The storage of refuse thus takes place in closed boxes, away from the heat of the destructor. When ready to charge, a tubful of refuse is lifted from the storage platform by the crane, and placed on a movable cradle on the top of a cell (Fig. 1). The weight of the tub causes the cradle to descend, and by a system of levers and balance-weights the water-sealed door is lifted from its seat and drawn on rails to one side, permitting the lower edge of the movable cradle to descend into the mouth of the charging doorway. The storage tub is provided with hinged lids at the bottom, which are held shut when the tub is suspended by the crane, but when released these lids open outwards, and the whole of the refuse thus falls directly into the furnace and spreads itself over the grate. The empty tub is then lifted by the crane, and the water-sealed door, actuated by the balance-weight, is mechanically drawn back to its seat. The whole operation of charging the cell and withdrawing the tub occupies less than a minute, and as the furnace door is open only for a few seconds, the inrush of cold air, with consequent reduction of furnace temperature, is reduced to the smallest possible amount. The crane, which has a lifting capacity of three tons at 30ft. per minute, was built by Messrs. Broadbent and Sons, Huddersfield.

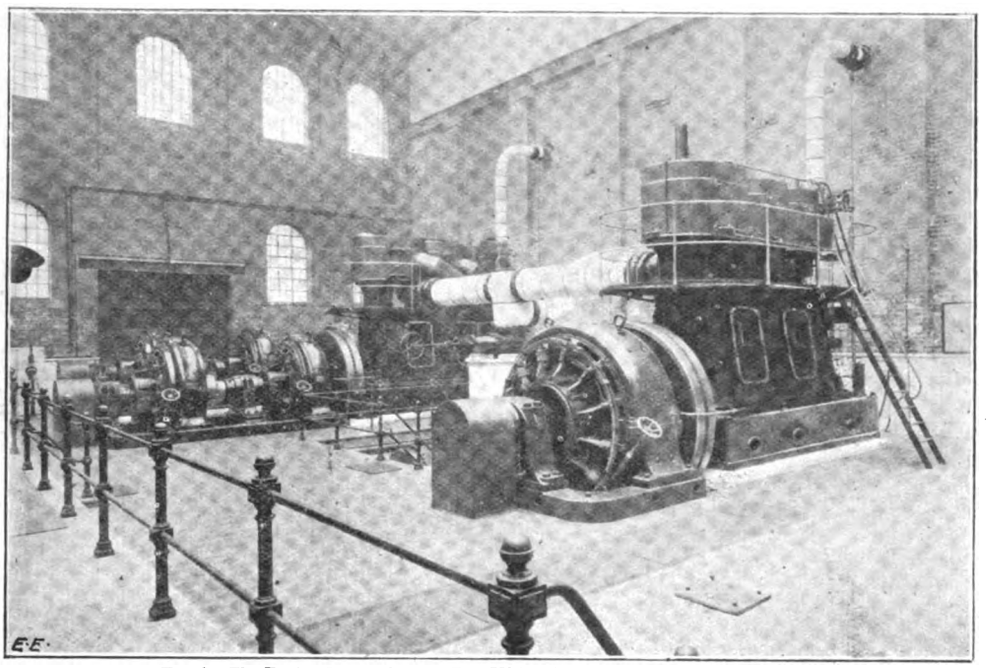

FIG 4.—The Engine Room, showing Two 750-kw. Belliss-Westinghouse Generators.

A main flue of large area is provided for each pair of cells, from which the hot gases are carried through the combustion chamber of a water-tube boiler, and a dust catcher of Messrs. Horsfall's patent type is built in between the combustion chamber and the boilers. All the flues are lined throughout with firebrick, and in the furnaces specially-made fireclay blocks set in fireclay cement have been employed. The boilers are of Messrs. Babcock and Wilcox's well-known marine water-tube type constructed for a working pressure of 200lb. per square inch, and fitted with superheaters to raise the temperature of the steam to 500deg. F. To meet any special demand for steam, auxiliary grates have been fitted for coal firing, and a by-pass is provided direct from the destructor combustion chamber to the main overhead flue, so that in the event of

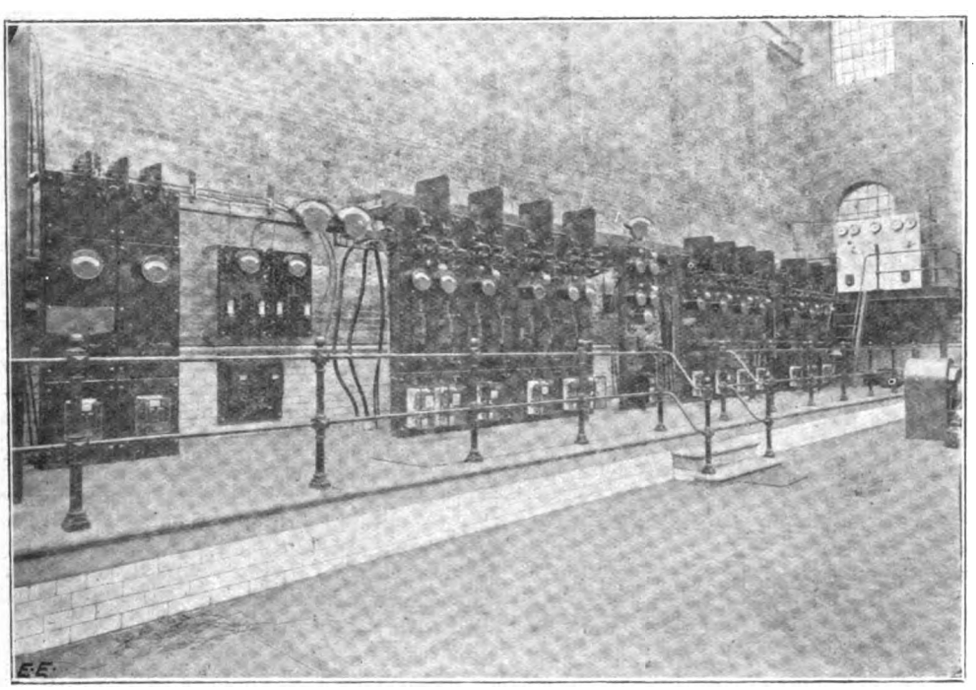

FIG 6.—View of the Switchboards.

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a breakdown to a boiler or an excess of steam being generated the whole or a portion of the hot gases may be taken by this route instead of through the boilers. After leaving the boilers the gases pass by way of the overhead main flue to an economiser, thence to the chimney. The economiser is of Messrs. Green's well-known type, built in two sections of 120 tubes each. A by-pass is also provided so that the gases may be passed direct to the chimney. The steam from each boiler is led from the superheater to a 10in. main, and carried direct to the main range which supplies the electric generators. The feed piping is connected by a branch pipe to the system supplying the coal-fired boilers, the arrangement being designed so that the destructor boilers can be fed either through their own economiser or from the hot-feed main of the coal-fired boilers. The pump-house contains two triple-throw electrically-driven Worthington pumps, and one of Messrs. Weir's double-acting steam-pumps. A storage tank of 12,000 gallons capacity is placed over the pump-room, and a combined water-softening and de-oiling plant is provided to treat the feed water. The coal-fired boilers (Fig. 3) are of Messrs. Babcock and Wilcox's double-drum type, each boiler being capable of evaporating 18,000lb. of water per hour. Superheaters are provided, and the firm's latest type of chain-grate stoker is fitted.

In the engine-room (Fig. 4) there are two Belliss-Westinghouse direct-coupled generating sets, each capable of a normal output of 750 kw. when supplied with steam at 200lb. pressure. The engines are of the triple-expansion, quick-revolution, enclosed type of 1,140 h.p. each, and are fitted with expansion valves to take overloads up to 50 per cent. The exhaust steam is taken through an oil separator into a surface condenser, which serves both sets of engines. The condenser (Fig. 5) was supplied by the Mirrlees-Watson Company, Glasgow, and is provided with Edward's air-pumps, driven by a Westinghouse motor. A special feature of the works is the use of electrically-driven auxiliaries, and, with the exception of a steam feed pump, the whole of the auxiliary plant, including pumps, stokers, and fans, is driven by electric motors. An ample supply of water for condensing purposes is available from the town's aqueducts. The electric generators are of substantial design and capable of withstanding heavy overloads without injury. No. 1 machine generates current at 500 volts, but No. 2, which comprises two machines, is arranged to deliver current at 250 volts or 500 volts as required. A motor-generator, having its parts interchangeable with the steam generators, is installed to transform current from 500 volts to 250 volts, or *vice versâ*.

The main supply from the station is for power and lighting purposes at 500 volts and 250 volts, but two rotary converters, with transformers, have also been installed to deliver alternating current at 3,300 volts to an outlying district. The main direct-current switchboard stands on a platform raised about 2ft. above the floor, and consists of 12 panels. Each panel is provided with circuit breakers, ammeter, change-over switches, and energy meter. The 'bus bars are in duplicate, and are raised on brackets above the switchboard, so that all back connections on the board are easily accessible. An electrically-operated overhead crane is provided for handling heavy parts of machinery. A cable chamber, 8ft. in height, extends the whole length of the engine-room, and accommodates the feeder and trunk cables, the latter being used to connect the station with the works at Hunter-place.

Although the equipment of the station had to be pushed forward with unusual rapidity, the plant has run since opening on Oct. 30 last without a hitch of any kind, and the results from an economical point of view are most satisfactory, the average consumption of coal during the last three months being rather under 4lb. per unit generated. The results obtained when the destructor is in operation will be awaited with the greatest interest.

The following is the list of the contractors: electric generators and switchboard, British Westinghouse Company, Manchester; engines, Belliss and Morcom, Birmingham; boilers, Babcock and Wilcox, Renfrew; refuse destructor, Horsfall Destructor Company, Leeds; condenser, Mirrlees-Watson Company, Glasgow; steam and feed piping, John Spencer and Co., Wednesbury; cast-iron piping, Caird and Co., Greenock; pumps, Worthington Pump Company, Glasgow; buildings and excavator work, R. Aitkenhead and Sons, Greenock; steelwork, John M'Ewan and Co., Greenock; carpenter, J. Miller and Co., Greenock. The whole of the work in connection with the combined scheme has been carried out to the specifications of Mr. J. A. Robertson, M.I.E.E., consulting and resident engineer to the Corporation. Mr. J. G. Hare, of the electricity department, was architect for the buildings, and Messrs. Woodrow and Thomson, Greenock, measurers and surveyors.

STANDARD PERFORMANCES OF ELECTRICAL MACHINERY.*

BY DR. RUDOLPH GOLDSCHMIDT, ASSOCIATE-MEMBER.

(Concluded from page 192.)

SINGLE PHASE COMMUTATOR MOTORS.

The real efficiency of a single-phase commutator motor is generally worse than that of a similar machine of the induction type, though the efficiency of the latter is not particularly good. The cause of this is chiefly to be attributed to the losses in the resistance connections

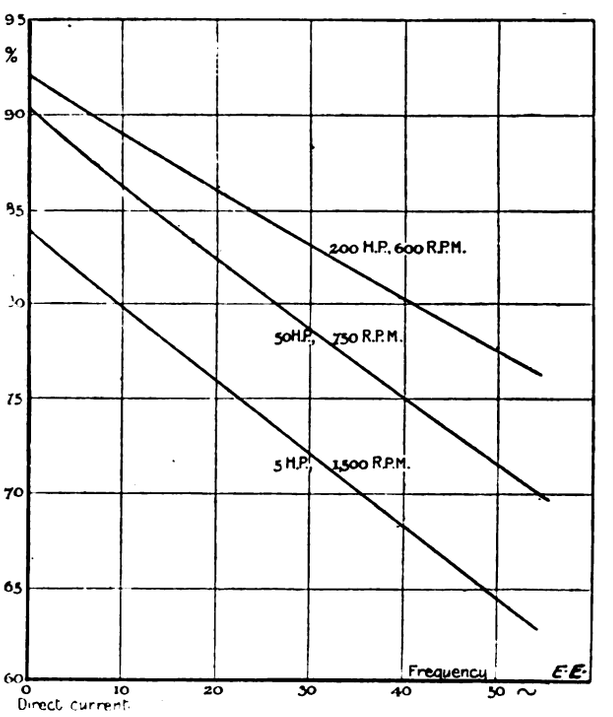

FIG. 25.—Efficiency of Alternate-current Commutator Motors.

between armature winding and commutator lugs and to the enormous core loss taking place in the whole body of the machine. These losses are particularly high with high frequencies, and this is one of the reasons why generally the frequency of single-phase motors is kept as low as possible, so that actually its performance approaches that of direct-current machines. But naturally the performance of an induction motor would also be excellent at very low frequency, though it would under no condition approach the perfect behaviour at starting of the commutator motor. As characteristic motors I have chosen a small, a medium, and a large machine—5 h.p. at 1,500 r.p.m., 50 h.p. at 750 r.p.m., 200 h.p. at 600 r.p.m.—and efficiencies and power factors have been plotted as a function of the periodicity (Figs. 25 and 26). It must be borne in mind that these curves do not represent tests on one machine—say a machine designed for 25 ~ and run at different frequencies—but the 50-~ machine is to be considered as a design entirely different from the 25-~ one, each being built so as to form the best machine for its special conditions. The power factors of Fig. 26 are those of plain single-phase commutator motors with compensating winding. They may be improved by using machines of the Latour and Winter-Eichberg type, or by applying special means of

* Paper read before the Institution of Electrical Engineers.

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other kinds to raise the power factor, generally at a sacrifice of 1 or 2 per cent. in the efficiency.

Transformers.

Transformer efficiencies at normal load only do not always serve very well as an indication of the real quality of the apparatus, less so than in the case of the average motor and dynamo. This is true, at all events, with lighting transformers. With power transformers the normal efficiency is quite a useful figure. The efficiencies plotted in Fig. 27 are not the normal but the maximum figures obtainable from a certain transformer—that is, when core

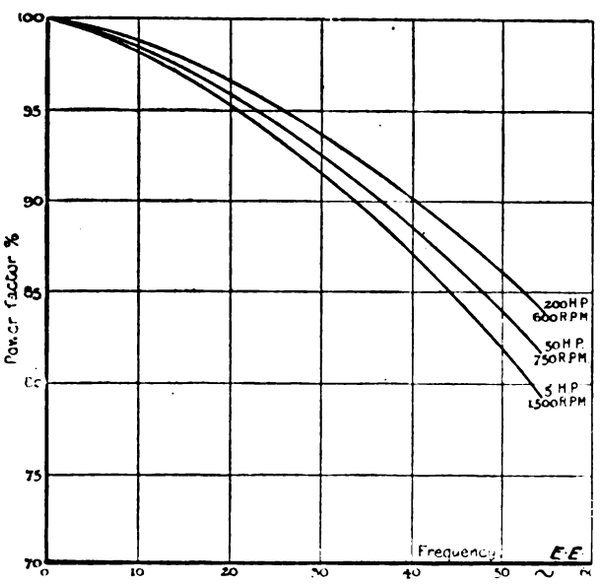

Fig. 26.—Power Factors of Alternate-current Commutator Motors.

and copper losses are equal. Usually it is possible to shift this maximum somewhat, putting it with lighting transformers near half load, with power transformers near full load. By stating the maximum efficiency only the curves in Fig. 27 will prove useful, even for finding efficiencies at very small loads, if one only takes account of the fact that one-half of the losses are core losses and the other half copper losses, which vary as the square of the output. I have not extended the scale of the K W beyond 70 kw., as such a transformer, as a rule, has as good an efficiency as a 700-kw. one. The following may be given as efficiency limits: 100-~ transformers, 98½ per cent.; 50-~ transformers, 98¼ per cent.; 25-~ transformers, 97¾-98 per cent.

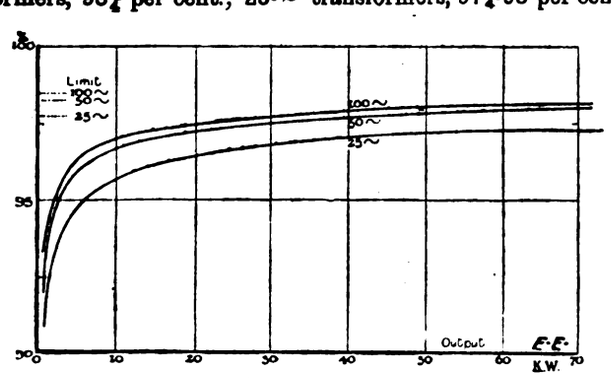

Fig. 27.—Transformer Efficiencies.

It was my intention to deal also with special machines as boosters, induction motors with pole-changing devices, motors for accelerating heavy loads, and others, but I feared that by introducing further developments and theories in this direction it would only tend to divert discussion from the main question, What is the normal performance of an ordinary machine?

Discussion.

Dr. Silvanus P. Thompson, in opening the discussion, said the paper struck him as being a very valuable communication, inasmuch as it afforded them the means at least of studying the comparative values of designs from different sources and for different classes of machinery. Many of the curves would be found particularly helpful to designers in enabling them to plot on the same framework the corresponding values of the machines with which they were acquainted. He thought that the interpretation of the paper left something to be desired, and he asked which of the curves were derived from experience and which from calculations based on first principles. The author had invited them to compare all machines on the basis of the kilowatts which the machine referred to in an early part of the paper would give out at 1,000 r.p.m. He protested against the use of the word "power" as the imaginary power which the machine would have if the revolutions were altered to 1,000 per minute, and suggested the term "powerage." In all continuous-current machines the watts per revolution were equal to the total flux from all poles multiplied by the ampere wires and by a constant. Dr. Goldschmidt had given as that constant $0{\cdot}165 \times 10^{-9}$. Dr. Thompson had found that constant to be $0{\cdot}166 \times 10^{-9}$. While they were thus practically in agreement upon this point, he maintained that the constant $0{\cdot}166 \times 10^{-9}$ was the absolute and unalterable value for continuous-current machines, but Dr. Goldschmidt had given his as the average value for continuous-current machines, polyphase alternators, and induction motors. Dr. Goldschmidt stated that for single-phase machines the constant averaged $0{\cdot}145 \times 10^{-9}$, but he (Dr. Thompson) could not understand how the value could be lower, unless it was believed that the power factor for single-phase machines was always bad. Dr. Thompson then discussed the value of the ratio between the armature load and the flux in the machines, and asked why the ratio of one to the other should be 800? The total loading of the armature must not be too great in proportion to the total flux coming in if they wanted to avoid commutation troubles, and it was apparently some such consideration which had determined a ratio of 800.

Mr. V. A. Fynn discussed the coefficient of the single-phase machine, and came to the conclusion that the figure given by the author—0·145—was too high; he made it about 0·115. This held good for induction motors, but for the conduction machines the coefficient should be practically the same as for the continuous-current or polyphase machine. In the single-phase machine there were two fluxes at right angles, but only one of these produced torque. In the two-phase machine there were also two fluxes at right angles, both of which produced torque. When the author stated that the real efficiency of a single-phase motor was generally worse than that of a similar motor of the induction type, he (the speaker) hoped that he did not mean to imply that there were no single-phase motors as good as polyphase machines.

Mr. J. C. Macfarlane drew attention to a reference by Dr. Goldschmidt to a 5-h.p. two-phase induction motor for crane work, which ran at the low speed of 500 revolutions on a 50-cycle circuit, and which also had a large overload capacity. The speaker was of opinion that the paper would be a valuable one if it prevented buyers of electrical plant from making such mistakes. The combination of low speed and high frequency in induction motors was a very common error made by buyers of such motors, and the trouble they caused to manufacturers due to this did not appear to be appreciated by them. The corresponding ordinates of the two curves in Fig. 1 bore a fixed ratio to one another, which was approximately 800—*i.e.*, for any power whatsoever the magnetic load of an armature was given by the curve as 800 times greater than the electric loading of the same armature. He could not understand why the author had selected that ratio in preference to any other ratio, nor could he see that any fixed ratio would suit the case, for he had known quite modern machines which had that ratio as great as 2,000 : 1, and he had also known machines having that ratio as small as 250 : 1—*i.e.*, the magnetic loading in the latter case was only 250 times as great as the electric loading of the armature. The figure depended to a very great extent on whether a machine had an armature core length which was abnormally great compared with its diameter, or whether it had a core length which was abnormally small compared with its diameter. The very long machines would usually have a high ratio of magnetic to electric loading, whereas in narrow machines this ratio would be usually low. The author had made two statements which he did not consider quite correct. The first was "that in most cases these fluxes are identical with the most economical flux, especially with moderate speeds"; the second was that "in commutating pole machines, the flux may be 25 per cent. or 30 per cent. less than the flux given by the curves in Fig. 1." He presumed that these were considered about the most economical fluxes for interpole machines. He did not know whether Dr. Goldschmidt referred to economy in the sense of electric and magnetic losses, or whether he referred to economy in the sense of economy in material, but in neither of these cases were his statements correct. For in the case of electric and magnetic losses it was a well-known fact that the maximum economy was to be obtained when the sum of the constant losses of a machine was equal to the sum of the variable losses of a machine. Briefly put, the electric and magnetic losses in any machine were a minimum when the total losses in the magnetic circuit were equal to the total losses in the electric circuit. Also the cost of

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material in any machine was a minimum when the cost of the material in the magnetic circuit was equal to the cost of the material in the electric circuit. Mr. Macfarlane gave some figures on two machines, one of which had the same ratio of magnetic to electric loading as given by Dr. Goldschmidt's curves in Fig. 1. The first of these machines was a non-interpole machine, and had an output of 470 kw. at 1,000 revolutions. The second machine was an interpole machine, and had an output of 475 kw. at 1,000 revolutions. The total magnetic loading of the first machine was 50,000,000 C.G.S. lines, and that of the second was 30,000,000 C.G.S. lines—*i.e.*, the magnetic loading of the non-interpole machine was 54 per cent. greater than that of the interpole machine. The electric loading of the first machine was 60,000 ampere wires, and that of the other was 100,000 ampere wires—*i.e.*, the electric loading of the interpole machine was 60 per cent. greater than that of the other. The total losses of the first machine amounted to about 14½ kw., and the total losses of the second machine amounted to about 13 kw. The loss in the electric circuit of the first machine was 3·5 kw., and the loss in the magnetic circuit was 11 kw. The loss in the electric circuit of the second machine—*i.e.*, the interpole machine—amounted to 6·2 kw., and in the magnetic circuit it amounted to 6·8 kw., making a ratio of 1·1 : 1 in favour of the magnetic circuit. With regard to costs, the total cost of the material in the non-interpole machine came out at about £154, whereas in the case of the second machine (interpole) the cost came out to be about £128—*i.e.*, therefore there was about 20 per cent. more material on the non-interpole machine than there was on the interpole machine. The material in the electric circuit of the first machine cost about £12, and the material in the magnetic circuit of this machine cost about £142, giving a ratio of about 12 : 1, whereas in the interpole machine the electric circuit material cost about £38, and the cost of the magnetic circuit material amounted to £90, making a ratio of only 2½ : 1. Although the interpole machine did not appear to be designed to give quite the most economical distribution of material, it had a considerable advantage over the non-interpole machine in this respect. It would be seen from these figures, and also for other reasons, that the fluxes given by Dr. Goldschmidt in his curves in Fig. 1 were not by any means the most economical fluxes, either from the point of view of efficiency of the economy and material. The object of the discussion was, he said, (1) to show that the selection of a fixed ratio for the magnetic to electric loading of an armature was inadmissible, for in practice this ratio varied greatly; (2) to show that the fluxes given by curve in Fig. 1 were by no means the most economical, either from the point of view of power loss or economy in material in non-interpole machines, and in interpole machine fluxes of 25 per cent., or even 35 per cent., less than those given on the curve referred to were also not even the most economical for those machines.

Mr. H. BURGE differed from the author's statement that in induction motors the percentage copper loss increased as the square root of the number of poles, and pointed out that by increasing the number of poles the speed of the output were lowered proportionally.

The PRESIDENT (Colonel R. E. B. Crompton) said they owed a great deal to Dr. Goldschmidt, who had introduced into this country many precise methods of calculating out the proportion of winding, and the proportions of flux and ampere-turns. Nevertheless, he could not understand how the standardisation aimed at by Dr. Goldschmidt could be obtained, as the proportion laid down by him would be varied a great deal if there was any change in design. As a member of the Engineering Standards Committee he raised a protest against an attempt to standardise designs or to lay down hard-and-fast rules, which were practically laid down upon existing practice, and he was inclined to think that Dr. Goldschmidt was a little premature in his attempt.

Dr. GOLDSCHMIDT, in replying to the discussion, explained that in attempting to standardise the efficiencies of power factor he was obliged to take a certain ratio of diameter to length of armature, as manufacturers had a great number of ratios which varied considerably. He thought the curves would correct themselves in use, and that those who used them would find them a trustworthy guide. They would also be helpful to the mechanical engineer. All the curves were based on first principles. He had assumed the flux curves and ampere-turn curves and then actually designed machines, and had taken machines designed by others and had then arrived at the figures which he considered as normal for the efficiency and the power factor. The curves were, therefore, developed from first principles and from actual experience. Mr. Fynn was right in pointing out that for single-phase induction motors the coefficient constant would be lower than 0·145, and he was probably right in saying that the figure would be 0·115.

Gelligaer.—Owing to the refusal of the gas company to light the village of Troedrhiwfuwch, it is stated that a syndicate is to be formed in order to establish the up-to-date light in place of gas.

SOME PROBLEMS OF ELECTRIC RAILWAY OPERATION *

BY E. V. PANNELL.

Suburban railway service is characterised by the shape of its load curve due to the rush-hour traffic. This service demands high rates of acceleration, which the steam locomotive is unable to cope with. A further advantage of electrical operation is the predetermination of train performance by graphical analysis. From the speed and tractive effort curves of the motors, speed-time and current-time curves can be plotted out for any set of conditions. A 210-ton six-car train has been assumed, equipped with eight 200-h.p. motors. The table appended gives some average weights and capacities of railway equipments.

System.	Weight of train per passenger. Tons.	Rated horse-power per passenger.
Great Northern and Piccadilly	·40	3·75
Great Western	·53	3·75
Liverpool-Southport	·32	4·4
Berlin Overhead	39	6·8
Interborough Subway	·63	4·9
Pennsylvania (Camden-Atlantic City)*	·76	6·9
Berlin-Zossen†	1·86	20
Theoretical (author)	·58	5·0

* High-speed line. † Ultra high-speed line.

For the typical 210-ton train curves have been plotted varying initial acceleration, gear ratio, schedule speed, and stops per mile. Increase of initial acceleration from ·75 to 1·5 miles per hour per second is attended with a saving of 30 per cent. energy consumption. Gear ratio should be the highest possible, provided schedule speed can be maintained. The adoption of single-phase operation is a problem which requires much consideration. The table gives comparative weights of alternating-current and direct-current train equipments.

—	Continuous-current motors and equipment. lb.	Series compensated 125 ~ motors lb.	Repulsion compensated 25 ~ motors lb.
Motors (1,600 h.p.)	48,000	83,000	75,500
Control equipment (including transformer)	16,000	37,000	22,000
Total weight of electrical equipment	64,000	120,000	97,500
Total weight of six-car train fully equipped (tons)	210	235	225

The author is of opinion that the single-phase motor is not suited to heavy and severe railway service, and that it is far behind the continuous-current motor in design. The peaked efficiency curve of the single-phase motor when running on constant voltage is a disadvantage, as it prevents economical self-regulation. It is probable that the next few years will see an appreciable increase in the average working voltage of continuous-current railway systems.

LONDON ELECTRICITY SUPPLY.

The Board of Trade has just issued a return in which some interesting figures appear concerning electricity supply in London. The return shows the number of units delivered and the average price charged by local authorities and companies in the metropolitan police district for power and heating, private lighting, and public lighting respectively during the last completed year of accounts. Taking units for all purposes, the local authorities supplied 87,795,001 units at an average price of 2·563d. per unit, while the companies delivered 125,379,278 units at an average price of 3·034d. per unit.

The following statement shows in tabular form the number of units supplied, together with the price per unit, for various purposes by local authorities and companies respectively:

	Power and heating.		Private lighting.		Public lighting.	
	Units.	d.	Units.	d.	Units.	d.
Local authorities	28,281,320	1·301	42,934,965	3·677	16,578,716	1·850
Companies	38,006,198	1·450	82,995,205	3·833	4,377,875	1·620

* Abstract of a paper read before the Northampton Institute Engineering Society on Feb. 7.

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PRIMARY TRANSFORMER STARTER FOR INDUCTION MOTORS.

If a squirrel-cage motor or a slip-ring motor with the rings short-circuited be connected direct to the supply mains, there will be a more or less heavy rush of current, depending on the resistance of the rotor windings. This is due to the fact that an induction motor at rest under the above conditions is simply a static transformer with

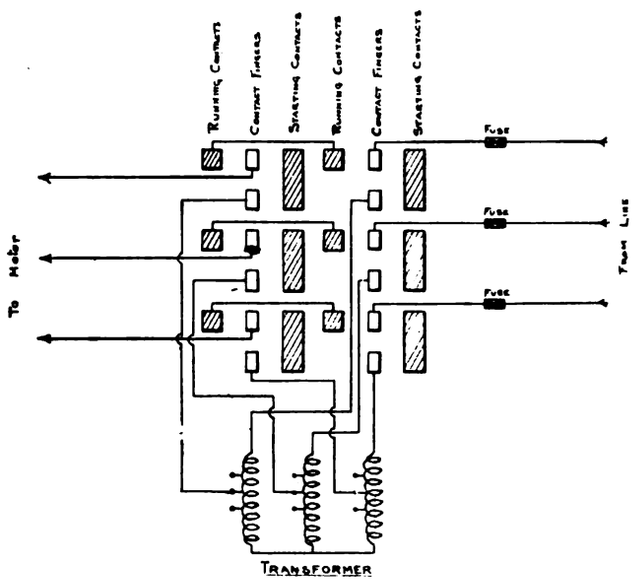
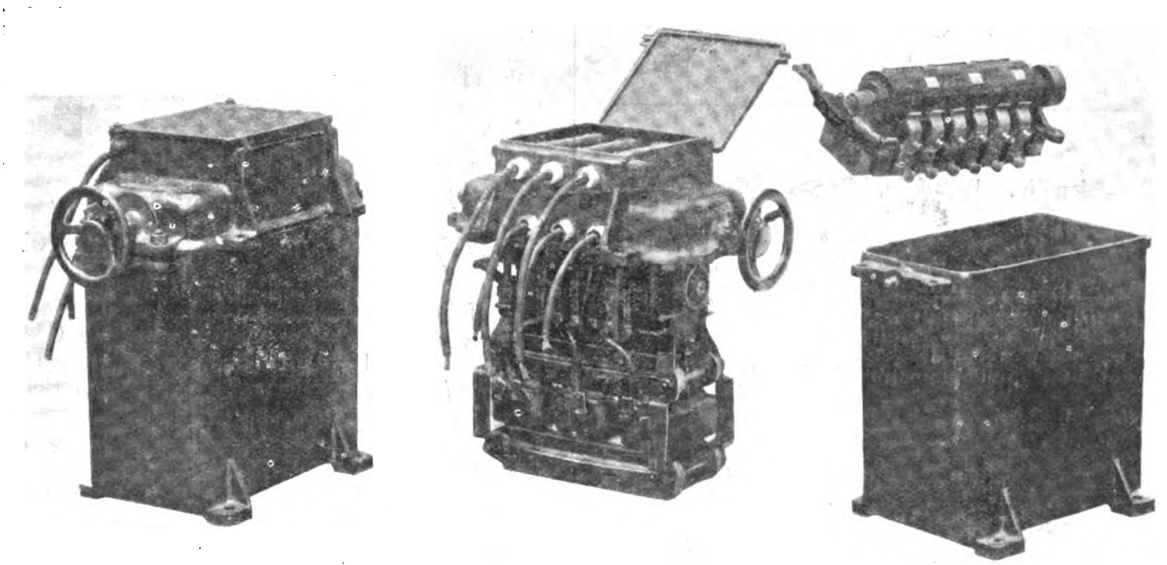


FIG. 1.—Diagram of Connections of Primary Starter for Induction Motor.

the secondary windings short-circuited. With a slip-ring motor the starting current can easily be regulated by inserting resistance in the rotor circuit, but obviously such a course of action is not possible with a squirrel-cage motor. In certain cases it is possible to make the rotor windings of a squirrel-cage motor of such high resistance that the motor can be switched straight on to the mains without the starting current being unduly heavy, but as this entails a certain loss of efficiency at normal load, due to the increased losses in the rotor, it is not always desirable to employ this form of construction. The method most commonly adopted in starting squirrel-cage motors is to reduce the voltage applied to the terminals of the primary winding, and this can be done in two ways. One method is to insert resistance in series with the stator windings, the resistance being cut out, more or less gradually, as the motor speeds up. Another way is to reduce the volts by means of a transformer in the main circuit. The latter method of operation has certain advantages over the former, and is, in most cases, recommended. Messrs. Dick, Kerr, and Co, Limited, have devised a special form of starter on this principle, which is extremely simple and strong, but at the same time combines in itself starter, main switch, and fuses, so that no further apparatus is really needed between the motor and the mains.

The transformer employed is of the "series" type—*i.e.*, there is only one coil per phase, the reduced voltage being obtained by connecting the motor leads to intermediate points on the main coil. In the firm's standard primary transformer starter three taps are provided, thus giving three different transformation ratios, any one of which can be used according to circumstances. The general form of the starter is shown in the illustrations. The three incoming leads are taken in at the top of the case, and pass through enclosed type fuses to contact fingers which press upon contacts on a controller barrel. There are twelve contact fingers in all, six on each side, the fingers on one side being diametrically opposite those on the other. The incoming leads, as stated above, are connected through fuses to three of the contact fingers on one side of the barrel, the other three fingers being connected to the end of the transformer windings. The remaining six fingers on the other side of the barrel are similarly connected—*i e.*, three of them are coupled up to the outgoing leads to the motor, and the other three to one of the sets of transformer taps. The connections are shown diagrammatically in Fig. 1, which gives a development of the controller barrel. The controller barrel is rotated by means of a hand-wheel, which is geared to it by means of a steel band. This construction enables the barrel and fingers, as well as the transformer coils, to be completely immersed in oil without necessitating the use of stuffing boxes on the hand-wheel spindle. The barrel has three positions—viz., "off," "starting," and "running." In the first position, to which the barrel is returned automatically by means of springs, if allowed to do so, the circuit is broken in two places in each phase.

To start up the motor, the hand-wheel is turned as far as it will go in the direction marked "starting," the effect of which is to connect up the motor to the line through the compensator transformer, as will be seen from the diagram of connections. The hand-wheel cannot be left in the starting position, as there is no catch to hold it, and as soon as it is released the springs referred to above return the barrel to the "off" position. As soon as the motor has run up to speed the hand-wheel is thrown right over to the "running" point, in which position the motor is connected direct to the line through the fuses, the transformer being cut out. The hand-wheel can be retained in the running position by means of a spring catch which engages in a notch when the wheel has reached its correct position. When it is desired to shut down the motor, the catch is released by pressing a button in the centre of the hand-



Primary Transformer Starter (Dick, Kerr, and Co.).

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wheel, and the springs draw the barrel into the "off" position. The fuses are located at the top of the starter, and are easily accessible by opening a cast-iron cover. The contacts are immersed in oil, which reduces any burning to a minimum, and since the hand-wheel cannot be left in the starting position, there is no risk of burning out the starter. In fact, the starter is practically both fire and fool proof.

THE TESTING OF HIGH-TENSION OVERHEAD-LINE INSULATORS.

As is pointed out by Dr. G. Benischke in a recent article in *Elektrische Kraftbetriebe und Bahnen*, no generally accepted rules exist with regard to the testing of porcelain or other high-tension insulators. The usual method is to subject the insulators to a breakdown voltage either in the dry state or under natural or artificial rain, the latter being the more practical criterion. If the insulators are tested dry by connecting a loop of wire lying in the upper groove to one pole of the high-tension supply and the iron shank to the other pole, a visible glow or brush discharge commences at a certain voltage. The discharge confines itself to the surface of the insulator, except at sharp bends and at very high voltages, when the discharge leaves the

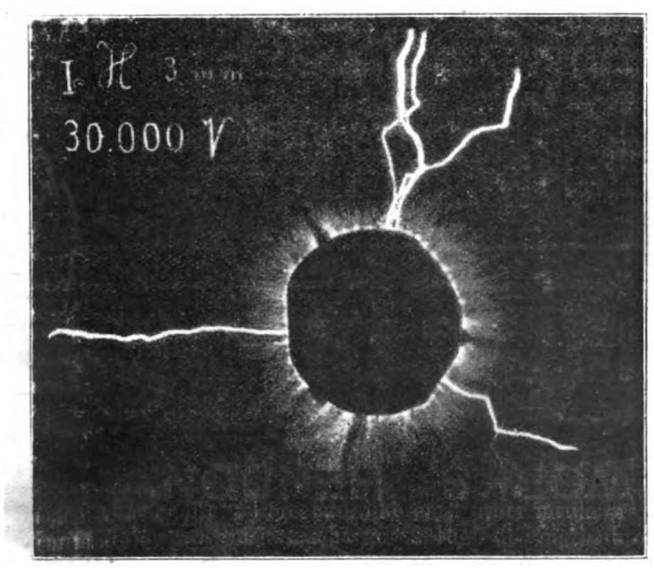

FIG. 1.

surface occasionally. Porcelain, like most other insulators, permits a glow or brush discharge through it long before an actual breakdown occurs. The action is well shown in Fig. 1, which represents the glow discharge at 30,000 volts between two metal discs separated by a 3mm. porcelain plate. The discharge at a given voltage is greater the thinner the insulation. Fig. 1 also shows the result of increasing the voltage beyond the brush discharge point. Sparks thus pass over the surface of the insulator from pole to pole. The length of these surface sparks, even with the cleanest and driest surfaces, is considerably greater than the distance which the same voltage will jump between pointed electrodes in air. Further increase in voltage causes a continuous stream of sparks or, if the supply source is sufficiently large, an arc to form.

In this connection a distinction must be made between the maximum or starting voltage and the minimum voltage or voltage necessary to maintain the arc when started. If the voltage drop of the supply circuit (transformer) is so great that the formation of the arc lowers the volts below this "minimum voltage," the arc ceases. The volts then rise again to the "maximum voltage" and another spark passes, and so on. An actual arc will only be maintained if the supply voltage remains above the "minimum voltage." Since it is difficult to take satisfactory tests in the open under natural rain, it is usual to test insulators for their behaviour in the wet state by means of artificial rain. For this purpose a shower either from a rose vertically above the insulator is arranged for or, preferably, from a rose arranged at the side and delivering a slanting stream of water under pressure, which falls parabolically on to the insulator. This latter arrangement splits the water up more nearly as in natural rain, and represents the effect of a side wind in deflecting the rain.

Under these conditions the upper surface of the insulator becomes a conductor, so that no surface glow discharge occurs, but brush discharges from the rim of the insulator follow the paths of the drops of water. Increasing the voltage leads to small preliminary sparks to the shank, and, finally, to rapidly succeeding sparks or to a continuous arc. The voltage for this becomes lower if the flow of water is so great that the drops combine into streams. This, however, does not occur with natural rain, as the maximum rainfall in Europe does not exceed about $\frac{1}{5}$in. per minute. The continuous stream is electrostatically attracted towards the shank, whilst the separate drops, owing to their weak charge, are much less attracted. They may even be repelled outwards near the rim by the action of the wet insulator rim, which practically forms part of the other pole, and is at much the same potential as the drops.

Attempts have often been made to obtain a coefficient for the purpose of comparing insulators of different makes. Thus, one suggestion is to define the quality by the amount of the product of a "rim coefficient" by a "weight coefficient," the former being the ratio of the voltage required to cause a discharge from rim to shank in the wet to that required in the dry state, whilst the latter is the ratio of the breakdown voltage in the wet state to the weight of the insulator. This method would be satisfactory if economy of production were the most important point, but in practice the heavier insulator rather than the light one of the same design would usually have the greater factor of safety. On the other hand, great thickness of porcelain is objectionable because of the difficulty of ensuring uniform drying during manufacture, and so avoiding cracks and strains. It is on this account that large insulators are often made up of separate parts cemented together.

Dr. Benischke considers that no general coefficient of quality can be set up, and that each insulator must be separately considered from the following points of view: (1) the surface breakdown voltage in the wet state—the rate of supply of water should preferably be on some uniform basis, such as $\frac{1}{5}$in. per minute; (2) the breakdown voltage through the material; (3) mechanical strength against sideway pulls; (4) mechanical strength against shocks and blows; (5) thickness of the stalk; (6) height and breadth of insulator; (7) weight compared with thickness of the stalk and height and width of insulator; (8) condition of the glazing.

A GASOLENE-ELECTRIC RAILWAY MOTORCAR.

The following particulars of an interesting gasolene-electric car made by the General Electric Company for the Delaware and Hudson Railroad are taken from the *Street Railway Journal*. The car body is of the combination type, and comprises one ordinary passenger compartment, a smoking room, baggage-room, engine-room, toilet and observation compartment. The car is single-ended, having the controlling apparatus situated in the engine-room. The principal dimensions are as follows: length over all, 50ft.; length of engine-room, 9ft. 6in.; length of baggage room, 5ft. 8in.; length of smoker, 7ft. 11in.; length of passenger compartment, 18ft. 6in.; width over all, 8ft. 8in; height over all, 12ft. 10½in.; seating capacity, 44; total weight of car and trucks fully equipped, 31 tons. This car was designed throughout with special reference to the service required, the main object in view being to secure the maximum carrying capacity with a minimum weight, and at the same time to have a car of great strength. The shape of the ends is parabolic in order to reduce the air resistance to a minimum when travelling at high speed.

The gasolene engine is direct coupled to a 90-kw., 250-volt, direct-current, eight-pole generator with commutating poles,

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which furnishes current at a variable potential by varying the exciting current. This current is fed to the motors through the medium of the control system by which the voltage of the generator may be governed according to the requirements. The excitation is obtained from a separate exciter mounted on same shaft as the main generator. The two motors are of the G.E. 72 A type, each rated at 60 h p. When running at 550 r p.m. the engine develops 100 h.p., and has a greater capacity at increased speeds. There are eight cylinders, each of which is 8in. in diameter, and has a stroke of 7in. The cylinders are placed at 90deg. to one another, or at an angle of 45deg. with the vertical. Considerable difficulty has been experienced in starting gasolene engines of this size heretofore, but in the present instance a special breech-block mechanism has been provided, which fire a charge of black powder into one of the cylinders, and this has proved a most effectual way of overcoming these difficulties.

On its trial trip the car received its passengers in the nearly completed new Union Station at Schenectady. The route selected made a circuit of about 78 miles in length, including Albany, Cohoes, and Mechanicsville. It contained its full capacity of passengers. A total of 23 stops were made, in addition to many unrecorded slow-downs due to signals and other yard restrictions, the average length of a stop being slightly less than one minute. The engine, however, ran continuously during the trip. The speed of the car varied from 23 miles per hour on a 1·3 per cent. up grade to 56 miles per hour on a ¼ per cent. down grade, except where traffic conditions and road regulations required lower speeds. Where traffic conditions permitted, a speed of 50 miles per hour was recorded on level track, and from Albany to Mechanicsville a speed of 47 miles per hour was sustained on a steadily rising grade. The eight-cylinder gas-engine developed at times 150 h.p., and the 60-h.p. motors were under such perfect control of the operator that the acceleration was noticeably smooth and free from jerks.

TRAMWAY AND LIGHT RAILWAY STATISTICS.

The Board of Trade have issued an interesting return giving exhaustive particulars respecting tramways and light railways in the United Kingdom. The statistics are brought down to Dec. 31, 1906, in respect of companies, and to March 31, 1907, in respect of local authorities. A comparative table at the beginning of the return shows that since the year 1878 the route length of line open for traffic has increased from 269 miles to 2,394 miles; the capital expenditure from £4,207,350 to £64,092,091; the number of passengers carried from 146 millions to 2,455 millions; and the net receipts from £230,956 to £4,485,413. Of the total of 1,571 miles of line owned by local authorities, 1,422 miles are worked by those authorities themselves, and the remaining 149 miles by leasing companies. Last year the route mileage open of electric line was 1,994 miles out of a total of 2,240; this year it is 2,195 miles out of 2,394. The mileage worked otherwise than by electric traction has further diminished from 246 miles to 199 miles. The net increase since last year in the number of undertakings belonging to local authorities (179 out of 318) is four, and in the number belonging to other parties (139 out of 318) is two. Local authorities who work as well as own their tramway undertakings have made a net profit of £2,985,317 on the year's traffic, out of which they have applied £963,134 towards the reduction of tramway debt and £297,456 in relief of rates, while carrying £691,644 to reserve and renewal funds.

Some of the principal figures relating to tramway working in the United Kingdom in 1906-7 are given below, a distinction being made between municipally-worked lines and those in the hands of private companies.

	Municipalities.	Companies.	Total.
Miles open	1,571	823	2.394
Gross receipts	£8.172 332	£3,676.843	£11,849,175
Expenses	£5,187.015	£2 176,747	£7.363.762
Net receipts	£2 985 317	£1,500,096	£4,485,413
Passengers carried	1,808 168,698	646,638,789	2,454 807,487
Miles run by cars	182,914,160	83,317,360	266,231,520

The following table gives a few totals for 1906-7 in comparison with a year in which the use of steam power on tramways was at its maximum and with a typical "horse" year:

—	1906-7. Electric period.	1898. Steam period.	1879. Horse period.
Length of route open (in miles)	2,394	1,064	321
Passengers carried	2,454,807,487	858,485,542	150,881,515
Capital expenditure per mile of single track open, lines, and works	£12,362	£7,770	£7.840
All items	£16,648	£10,469	£9,877
Percentage of net receipts to capital	6·99	6·38	3·97
Percentage of working expenditure to gross receipts	62·14	76·93	83·81
Passengers per mile of route	1,025,271	806,703	469,641
Passengers per car mile	9·22	9·48	7·77
Receipts per passenger	1·10d.	1·23d.	1·84d.
Paid in relief of rates	£297,456	—	—

INSTANTANEOUS WATER HEATER.

An electric water heater, in which the water itself provides the path for the current, is described in the *Electrical World*. The absence of all wire or other resistances should prove a considerable improvement on the existing types.

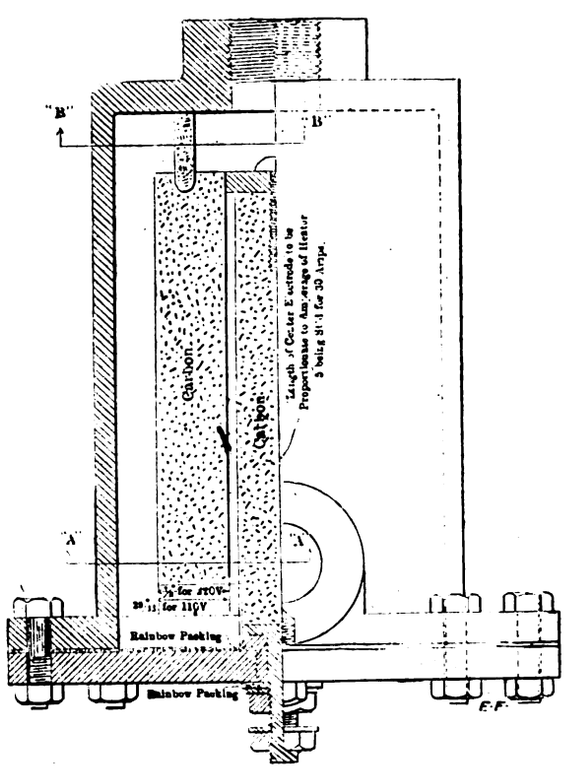

FIG. 1.

The current, taken from any ordinary 110-volt or 220-volt lighting circuit, flows through the water to be heated from one carbon electrode to another. In a cast-iron shell are placed two carbon electrodes, as shown in the sectional drawing (Fig. 1). One is a hollow cylinder and the other is a solid plug of carbon. The solid electrode is inserted into the cylinder with an intervening gap of ⅛in. to $\frac{3}{32}$in. around, and through which flows the water drawn from the mains. The water acts as a resister, and thus takes up the heat units directly. An efficiency of 99 per cent. is claimed. The wiring connections are made to terminals extending through the bottom plate of the casing or casting, both, of course, being well insulated from the case and connected to their respective carbon electrodes. The plumbing connections consist simply of the intake or supply pipe at the base of the shell. The water flows out through a connection at the top of the shell.

At St. Louis these heaters, in 440, 660, and 1,100 watt sizes, have been connected to an ordinary hot-water radiator,

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the radiator being filled with water and the energy supply obtained from the ordinary lighting circuit. The heater in this case serves as an efficient form of room-heater, the radiator, on account of its large radiating surface, giving, it is claimed, superior heating results to an electric air heater of the same wattage. In this case, the radiator is furnished with a small cup at the top to provide for the expansion of the water. It would, of course, be possible to connect a large electric heater of this kind to the hot-water heating system of a house as a substitute for the hot-water heaters requiring coal as fuel. In fact, this has been done in the case of some electric railway cars in St. Louis piped for hot-water heating. It is claimed that the water passed through this heater has all germ life within it destroyed, and hence that it acts as a purifier as well as a heater. The heater is made in various sizes from 4 amperes at 110 volts to 20 amperes at 220 volts.

HUMMING IN DYNAMOS AND MOTORS.

Of the many methods tried for eliminating the humming noise often noticed in slotted dynamos and motors, the only effective ones are (1) to keep the air-gap flux density low (under 50,000 C.G.S. lines per square inch in large machines and less in small machines) and (2) to make the effective span of the poles as far as possible from an exact multiple of the slot pitch—*i.e.*, effective polar arc ÷ slot pitch = any

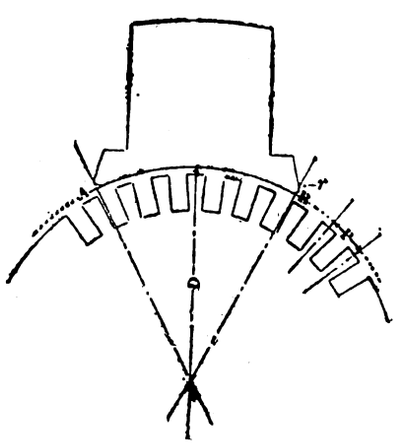

FIG. 1.

integer + ½. For this purpose the effective polar arc has been found by experiment to be given by A B − ·81 *r*, where A B is the actual pole span (Fig. 1) measured at the bore face, and *r* is the radius of the edge of the pole tip. When the ratio is an exact integer or differs from an exact integer by from ·1 to ·2, the machine is noisy, whilst if it differs by ·3 to ·6, the machine usually runs quietly.—*Electrical World* (New York).

THE TELEPHONE RATES QUESTION.

Important Deputation

In the Grand Committee Room, Westminster Hall, on Tuesday afternoon, the Postmaster-General, Mr. Sydney Buxton, received a deputation, representative of all the different commercial interests in the kingdom with reference to the telephone rates, to urge that a select committee be appointed to inquire into the system of rates and the future telephone policy.

The interview was organised by the Newcastle and Gateshead Chamber of Commerce, whose representative urged that the principle of the measured-rate system was not objected to provided reasonable charges were maintained. A continuance of the flat-rate system was advocated, and it was requested that the Postmaster-General would make a definite statement in Parliament at the earliest possible moment.

The Postmaster-General said the new measured-service rate was cheaper to the small user than the old message rate, and if they took the rates as a whole he thought they would not add to the burdens of the general community from the telephone point of view. They were not intending to interfere with those holding the flat-rate service, but there had been a good deal of exaggeration in regard to the rates. The Post Office was responsible for its own rates, and not the National Telephone Company, and these were framed at a rate which they believed was a just one as between the Post Office and the country. In regard to the measured rate, it appeared to him that most of the speakers had argued in favour of the principle of the flat-rate system. As this question had been raised, it was only fair to explain why it was that they had adopted the measured-rate in lieu of the flat-rate system. When that system was first introduced there was a good deal to be said for the flat-rate system, but it was not known how the system would work out. As time went on it became evident that the flat-rate system was not equitable as between the Post Office and its subscribers. It was also clear that the result of the flat-rate system had tended to very much diminish the development of the telephone system. The Postmaster-General gave an instance of the case of a firm who, when the flat rate began, five years ago, had 3,000 calls per year, and although this increased in the five years to 11,000, they paid no more. It was impossible, therefore, to develop the system under such circumstances. Under the flat-rate system, where a man could send any number of calls without additional payment, he might be inclined to use his line to the fullest possible extent. The result of this was that there were a very large number of unnecessary calls and a great waste of telephone material. Indeed, something like 20 per cent. of the ineffective calls, the engaged lines, were due to the overloading of the lines by those who used the flat-rate system. If the two systems were to be placed side by side, they would naturally find all the big users going on the flat rate and the small users on the measured rate, and the result would be that there would be no revenue left to the Post Office. The Post Office did not desire to fix the rate at an unduly high figure, but they ought to put the system on a business-like and paying basis. If it were possible to put the whole system on the measured service and abolish the flat-rate system, he did not hesitate to say that they could materially reduce the rate. In conclusion, Mr. Buxton said it was difficult to say what the actual rate should be without more experience. The question was a legitimate one for inquiry, but such an inquiry could only be carried out with advantage when they had a full knowledge of the question, and the present moment was premature for holding such an investigation. If a committee were appointed, there was nothing to lay before it which would enable it to arrive at an authoritative conclusion. They did not know how the new rates would work out. As to reducing the rates, they had a serious object-lesson in the case of the Telegraph Office, which was carried on at a loss.

INSTITUTION AND TECHNICAL SOCIETY NOTES.

Institution of Electrical Engineers.

At the ordinary general meeting held on the 6th inst., Colonel R. E. B. Crompton (president) in the chair, a discussion took place on Mr. J. S. Peck's paper on "Protective Devices for High-Tension Transmission Circuits." The following were elected to the Institution:

Member.—Dr. E. Rosenberg, care of British Westinghouse E. and M. Company, Limited, Trafford Park, Manchester.

Associate Members.—B. W. Bayliss, 7, North-road, Clapham Park, S.W.; H. M. Boydell, 1B, Cooper-street, Manchester; L. G. Clark, Box 83, Pilgrim's Rest, Lydenberg, Transvaal; J. E. Elliott, 14, St. Margaret's-road, Oxford; H. N. Fullarton, Thornwood, Kilmacolm, N.B.; H. M. Fulton, Munaar P.O., South India; E. W. Heather, 38, Swallowfield-road, Charlton; S. M. Hopewell, 71, Queen Victoria-street, E.C.; A. H. L. Lucas, Ordsal Electrical Works, Salford, Manchester; J. M. McGown, Electricity Works, Bo'ness, N.B.; C. R. Whipple, 9, Castle-street-arcade, Cook-street, Liverpool.

Students.—H. Autton-Carter, 28, Windermere-avenue, Kilburn, N.W.; H. A. Bailey, 34, Harriet-street, Stretford, Manchester; G. F. Barbour, 28, Richmond-crescent, Queen's Cross, Glasgow; B. G. Bellamy, 53, Barton-street, Moss Side, Manchester; D. Betts, 34, Mecklenburgh-square, W.C.; J. R. Boyer, Etton, Marcus-avenue, Bulwer-road, Durham, Natal; R. V. C. Brook, Eastgate, Greenhill-road, Moseley, Birmingham; W. Brown, 254, Nantwich-road, Crewe; J. Cunliffe, 104, St. Helens-road, Leigh, Lancs.; A. R. Dunton,

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18, Moreton-avenue, Stretford, Manchester; W. G. Edwards, 250, Nantwich-road, Crewe; A. Gardner, Thorn-hill, Burnley; S. Ghosh, Westinghouse Works, Trafford Park, Manchester; R. D. Gifford, Eaton Cottage, High-street, West Bromwich; A. Y. Jarrett, 6, Byron-road, Small Heath, Birmingham; L. M. Jockel, 51, Argyle-crescent, Joppa, Edinburgh; J. H. C. Kann, 24, Chesterford-gardens, Frognal, N.W.; V. Kilvert, Woodcourt, Brooklands, Cheshire; N. Martin, 31, Woodend-drive, Jordanhill, Glasgow; A. Mizzi, 87, Delafield-road, Old Charlton; B. F. Mulholland, Bohemia, St. Leonard's-avenue, Strafford; S. G. Nottage, 20, Lavender-gardens, Clapham Common, S.W.; H. J. K. Osborn, 249, Nantwich-road, Crewe; H. L. O. Parish, Longfleet Vicarage, Poole, Dorset; C. A. Pilson, Ashfield, Erdington, Birmingham; F. H. Pullum, 47, Queen's Head-street, Islington, N.; A. W. Puttick, 98, Parliament Hill-mansions, N.W.; J. P. Quinn, 41, Hyde-road, Edgbaston, Birmingham; N. S. Sim, Bark House, Banchory, Kincardineshire; L. Solomon, 6, Mauldeth-road West, Withington, Manchester; H. A. J. Stanton, 24, Church-street, Barrow-in-Furness; M. Swift, 61, Northumberland-road, Old Trafford, Manchester; F. E. Windross, 82, Hillaries-road, Gravelly Hill, Birmingham; M. W. Wood, Greenside House, Girtington, Bradford.

Society of Engineers.

The first ordinary meeting of the Society of Engineers for the present year was held on the 3rd inst. Mr. Maurice Wilson, the president for 1906, first occupied the chair, and presented the premiums awarded for papers read during the year—viz.: the president's gold medal to Mr. R. W. A. Brewer for his paper on "Liquid Fuels for Internal-Combustion Engines"; the Bessemer premium of books to Mr. E. J. Stead for his paper on "The Connaught Bridge, Natal"; a society's premium of books to Mr. C. A. St. George Moore for his paper on "Working Experiences with Large Gas-Engines"; and a society's premium of books to Mr. H. Blake Thomas for his paper on "Subaqueous Operations." The thanks of the society were accorded to Messrs. B. H. Thwaite and R. E. Thorpe for their paper on "The Renard and Sourcouf Road-Train System"; to Mr. E. R. Matthews for his paper on "Waterworks Construction in America"; and to Mr. H. C. Huggins for his paper on "Bridle Roads in the West Indies." The president for the present year, Mr. Joseph William Wilson, then delivered his inaugural address, which touched upon engineering progress during the period since his last presidency. He pointed out that this covered the introduction of tube railways, which had done something to relieve the traffic of London, though much more remained to be done, and he reiterated the necessity for some competent authority to direct the present unsystematic growth of our great Metropolis. After referring to the problem of the training of an engineer, he touched upon the great future in store for mechanical propulsion, for larger internal-combustion engines, and for the unlimited application of wireless telegraphy and other aspects of electricity. The address was listened to with marked attention by a large and appreciative audience, and at its close a hearty vote of thanks was accorded to the president.

Manchester Students' Section.

Instead of the usual paper and discussion, the committee of this section has arranged for the next meeting on Feb. 25 a debate on the vexed question of "Gas *versus* electricity for illuminating purposes." The council of the Manchester and District Junior Gas Association has readily accepted the challenge thrown out, and an extremely interesting debate is anticipated. A well-attended meeting is hoped for, and the Manchester Students' Section will welcome the presence of any young engineers interested in this important topic.

Manchester Geological and Mining Society.

At a meeting of the Manchester Geological and Mining Society held on Tuesday last, Mr. J. M. Johnston read a paper on "Stirling and other Water-Tube Boilers." The hon. secretary, Mr. Sydney H. Smith, announces that he will be glad to receive early notice of papers intended to be read before the society during the current session.

Physical Society.

At a meeting held on Jan. 24, a paper by Mr. Walter Rosenhain on "Observations on Recalescence Curves" was read by Dr. R. T. Glazebrook. Mr. R. S. Smith and Mr. J. G. Howarth were elected fellows of the society. Mr. W. C. Campling was elected a student member of the society.

TRADE NOTES AND NOVELTIES.

Willans "Mixed Pressure" Turbines.

By the introduction and development of their "mixed pressure" turbine, Messrs. Willans and Robinson, Limited, of Victoria Works, Rugby, have produced a machine in which the different conditions are met with in the one turbine. The exhaust steam-turbine has already proved extremely useful in cases where exhaust steam at atmospheric pressure is available, and where additional power is required without increasing to any material extent the steam supply from the boilers. In many cases, however, such a turbine could be put to greater use if a supply of high-pressure steam could be arranged to augment automatically the exhaust steam supply in the event of the latter falling short of the requirements. This is just what is possible in the case of a Willans "mixed pressure" turbine, simply by the means of arranging an ordinary Willans-Parsons high-pressure steam-turbine with special valves and governor gear to enable the high and low pressure steam to supplement one another automatically. An auxiliary runaway governor is provided which acts on either the high-pressure or low-pressure valve, or on both valves simultaneously should they be in operation. We understand that this system was first suggested to Messrs. Willans and Robinson by Messrs. Scott and Leggatt, of Cardiff, and that, acting on this suggestion, the type of turbine has been developed and forms one of the standard patterns now being manufactured at Rugby under fully protected patents.

The Development of Water Power.

The engineer is sometimes asked by manufacturers, electricians, and others whether water power is available, and, if so, how best it can be utilised. Messrs. Gilbert Gilkes and Co., Limited, of Kendal, the well-known engineers, are at hand, however, to help the perplexed engineer out of his difficulties with a class of machinery which is well designed for the purpose of utilising a supply of water power. This firm has recently issued a handsomely-got-up catalogue, which gives concise details and clear illustrations of the turbines, Pelton wheels, hydraulic machinery, and other appliances manufactured by them for the mechanical and electrical transmission of power. There are many different classes of turbines, and good results can be obtained from them. But it is the practice of Messrs. Gilbert Gilkes and Co., Limited, to design each turbine to suit, from an engineer's point of view, all the circumstances under which it has to work; at the same time, the importance of commercial considerations has not been overlooked, as the prices in the catalogue show. The efficiency of a turbine may be anything below 83 per cent., and under favourable conditions 80 per cent. may be obtained. Messrs. Gilkes have taken 75 per cent. as the basis of their calculations, thus leaving a margin of power about the guaranteed rate. In the catalogue "pressure" or "reaction" turbines are dealt with as well as "free deviation" turbines. Full particulars are given of the "Vortex," the "Kendal," the "Trent," the "Lunedale," and the "Little Giant" type, which come under the head of "pressure" turbines, and of the "Girard turbine" and the "Pelton wheel," which are known as "impulse" turbines or turbines of "free deviation." This catalogue has been prepared in a very attractive and convenient form, and will well repay perusal.

Eddy-Current Testing Brake.

We have already referred to an eddy-current brake which Messrs. Morris and Lister, of Carlton Works, Coventry, have put on the market. The 1908 pattern is now ready, and embodies some important improvements. The brake consists of two copper discs, each mounted on a cast aluminium spider. These are made fast, one at either end of a sleeve, which is keyed to the shaft of the motor under test. Riding loose on this sleeve and between the two copper discs is an aluminium casting carrying a number of electromagnets wound to have alternate polarity. These magnets consist of well-ventilated coils on circular cores fitted with pole-pieces. To the outside of each copper disc is secured a ring of wrought iron, which revolves with the copper and at the same time forms a path for the magnetic flux. These iron rings are fitted with cooling vanes, which dissipate the heat generated. When the motor is running, the magnetic flux in traversing the moving copper induces eddy currents, which absorb the energy of the motor in heating the discs. At the same time the flux tends to drag round the magnet system and levers. By suitably adjusting the exciting current the lever floats. The power is then given by:

$$\text{B.H.P.} = \frac{\text{torque in lbs.-ft.} \times \text{R.P.M.}}{5{,}250}.$$

We notice, however, that in the 1908 pattern Messrs. Morris and Lister have simplified the mechanical construction, and at the same time have been able to secure continuous rating instead of short time rating, and a reduced price per horse-power. This has been effected by doing away with the outer pole rings and substituting a disc of iron attached to each copper disc itself, on which is mounted a series of vanes which promote radiation from the heated disc and at the same time induce a current of air to circulate round the exciting coils. For high-speed work, such as is demanded by the makers of petrol motors, they claim to be able to run these brakes at speeds as great as double those listed at correspondingly greater horse-power. For such purposes the brake is frequently fitted with ball bearings, which are better suited to high-speed work.

Catalogues, Lists, etc.

From Messrs. W. T. Henley's Telegraph Works Company,

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Limited, Blomfield-street, London-wall, London, E.C., we have received a set of three-colour post-cards illustrating their patent fuse-boxes.

Messrs. Marryat and Place, 28, Hatton-garden, London, E.C., have sent us a leaflet referring to their push-button controller for flat-bed machines. This apparatus compares very favourably in every respect with the most satisfactory controllers that have yet been put upon the market. We have also received a card giving details and prices of M.P. continuous-current motors for slow speed and medium speed.

Messrs. J. H. Holmes and Co., Portland-road, Newcastle-on-Tyne, in the section of their catalogue published in January of this year give particulars of their well-known "Castle" continuous-current dynamos and motors, starting switches, etc. In the arrangement of the particulars in this catalogue special attention has been given in order that the outputs, prices, etc., may be ascertained without difficulty.

The General Electric Company, Limited, have sent us five of their latest issues, all of which have appeared within the last few days. The "Flamgold" flame arc lamp embodies novel and interesting improvements. In the pamphlet on tension limiters and lightning arresters a complete line of protective apparatus is shown and described: all the latest experience is embodied and up-to-date practice in this field represented. No. P. 1,220, small paraffin-engine dynamo sets for use with Osram lamps for private-house lighting, small hotels, warehouses, hospitals, etc., gives in concise form particulars regarding the use of Osram 25-volt lamps, whereby the initial cost of such sets is enormously reduced; prices are quoted for complete sets of 25 to 200 lamps, with or without accumulators. The next booklet, on "Easyphix" patent electric interchangeable fittings, describes how it is possible to commence business with a stock of £15 worth of fittings, and by spending only a few shillings at a time to keep it up in such a manner that a thousand different "Easyphix" pendants and electroliers can be constructed in a very short time. No. X. 1,224 contains revised prices of the well-known "Peel" switches.

RELAYS.

The question of time limit *versus* instantaneous action of circuit breakers is one to which very great attention has been given both in this country and abroad. At the present moment it may be said that the best practice calls for time-limit circuit breakers on all feeders on high-tension alternating-current systems. The installation of such circuit breakers has become

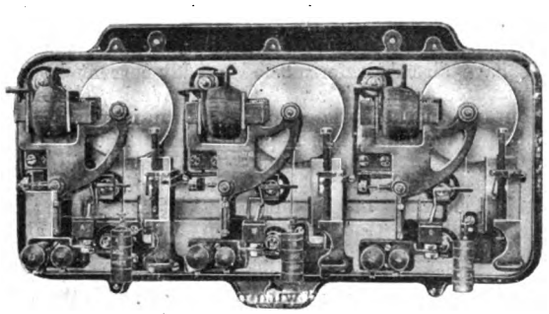

FIG. 1.—Triple-Pole Relay arranged for A.C. Tripping.

standard practice in America, and is generally adopted in this country. Generally speaking, the time-limit element is provided by means of an auxiliary relay, as it is not found possible to have an apparatus other than a relay which will allow both the time required to operate and the current at which operation takes place to be adjusted independently. The general practice

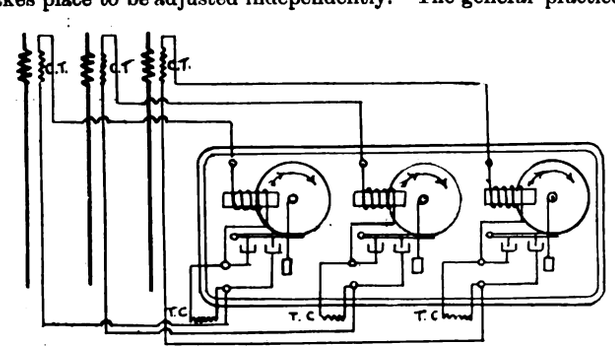

FIG. 2.—Maximum Time Limit Triple Pole Relay to Break Circuit.

is to arrange the main circuit breakers to be tripped by means of a continuous-current trip coil. In many places, however—as, for example, in sub-stations—continuous current may not be available. An installation of a special battery for working the trip coil is both expensive and complicated. Messrs. Ferranti Limited, whose alternating-current control relays are now well known in most parts of the world, have lately got out a series of alternating maximum time-limit relays, arranged so that continuous current is not necessary for operating the trip coil. We illustrate in Fig. 1 such a relay. The diagram of connections is given in Fig. 2. It will be noticed that the relay normally short-circuits the

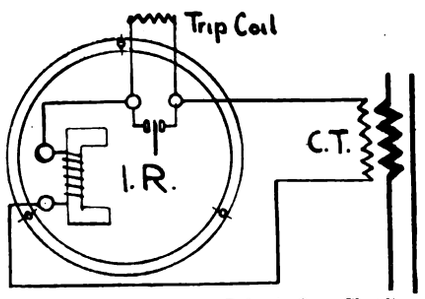

FIG. 3.—Instantaneous Relay to Open Circuit.

trip coil, which is wound for alternating current. So soon, however, as the overload is continued for the predetermined time element this short-circuit is removed, and the current from the secondary of the current transformer flows through the trip coil, operating the switch. These time-limit relays are arranged single, double, and triple pole in ordinary cases for screwing to the front of the switchboard (see Fig. 1), and also in flush-type cases. It may be mentioned that instantaneous relays can also be supplied arranged to open the trip-coil circuit instead of closing the same, so that alternating-current tripping can be arranged for in place of direct-current tripping. A diagram of such a relay is shown in Fig. 3.

FORTHCOMING EVENTS.

FRIDAY, FEB. 14.

Physical Society of London.—At 8 p.m., annual meeting in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington.

SATURDAY, FEB. 15.

Institution of Electrical Engineers (Students' Section).—At 10.30 a.m., visit to the National Physical Laboratory.

General Electric Company.—At 6.30 p.m., dinner at the Trocadero.

MONDAY, FEB. 17.

Electrical Contractors' Association.—At 6.30 p.m., annual dinner at Holborn Restaurant.

TUESDAY, FEB. 18.

Institution of Electrical Engineers (Manchester Local Section). At 7.30 p.m., "Direct-Current Turbo-Generators," by Mr. W. Hoult.

Institution of Civil Engineers.—At 8 p.m., "Shaft-Sinking at the Horden Colliery, South East Durham," by Mr. J. J. Prest; "The New York Rapid-Transit Subway," by Mr. W. B. Parsons.

WEDNESDAY, FEB. 19.

Royal Meteorological Society.—At 7.30 p.m., at the Institution of Civil Engineers, meeting.

THURSDAY, FEB. 20.

Institution of Electrical Engineers.—At 8 p.m., at the Institution of Civil Engineers, "Electrical Power in Railway Goods Warehouses," by Mr. H. Henderson; "Electric Power in Docks," by Mr C. E. Taylor.

Junior Institution of Engineers.—At 8 p.m., at the Royal United Service Institution, Whitehall, "Practical Notes on the Testing of Gas-Engines," by Mr. Gilbert Whalley.

Optical Society.—At 8 p.m., at 20, Hanover-square, W., "Resolving Power and Definition in Optical Instruments," by Dr. R. T. Glazebrook.

FRIDAY, FEB. 21.

Electro-Harmonic Society.—At 8 p.m., ladies' night at the Bechstein Hall, Wigmore-street, London, W.

Royal Institution of Great Britain.—At 8 p.m., "The Ether of Space," Sir Oliver Lodge.

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate, "Tests of a Live-Steam Feed-Water Heater," by Prof. Goodman and Mr. D. B. MacLachlan.

Luton Corporation.—Opening of new electric tramway laid by Messrs. White and Co.

SATURDAY, FEB. 22.

Institution of Electrical Engineers (Manchester Students' Section).—Visit to the works of Messrs. Ferranti Limited, Hollinwood.

Birmingham and District Electric Club.—At 7 p.m., at the Municipal Technical School, Suffolk-street, "The Electro-Deposition of Silver," by Mr. T. G. Baker.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE STAFF OF SMALL CENTRAL STATIONS.

SIR,—I notice by your correspondence columns that my article on "The Staff of Small Central Stations" has produced pyrotechnics of a considerable degree of brilliance from your reader, "Electricity Supply." If it is any comfort to him, I may state that I am now going about with a hair shirt next my skin, and have requisitioned the waste products of two boilers to supply ashes for my humble head. I also groan with regret that I am an "amateur type," a "man who would depend on my fitter rather than trust myself," and "ruination of my profession," and I may also state, with contrition, that I am not a "good, steady-going married man."

Under the circumstances I am afraid that anything I may say may be received with stern contempt by my fellow-victims to the Juggernaut of cheap electricity, and I should certainly not like to plead my cause before the young female shorthand typist clerk mentioned by "Electricity Supply," who would, I am sure, be altogether exemplary in her duties of under-secretary and storekeeper. It is my profound belief that so far from "interfering with" the young men in the engine-room, as "Electricity Supply" fears, her presence might be found high-souled and inspiring, and would reduce the percentage of inflammable language on peak load.

I feel for the lads who learn a little, ask for more money, "get," and flood the market. In order to allay my critic's fears that I have "sprung" from this class, I am obliged to confess that I do not think I have "sprung" at all, as my position and salary are still sufficiently lowly for a man who has gone through the regulation mechanical and electrical experience of the type detailed *ad nauseam* in applications for jobs that come before me. At the same time it is necessary to point out that unfeeling corporation committees invariably insist on cutting expenses down till they can't be got any lower; the lads are there—they won't keep off the doorstep, in fact—and they may as well be used. I suggest that when "Electricity Supply" forms a professional union of assistant engineers the first rule of the combination shall be that all applicants for sub assistant positions shall be shot at sight.

Apart from the personal wigging which I get, I am obliged to "Electricity Supply" for his alternative suggestions as to the way in which small stations should be staffed. I have also noted with interest the views of "One within the Five Hundred." I am disappointed, however, that more have not taken part in the discussion, as it is only by ventilation of opinions that the most satisfactory solution of a very difficult problem can be arrived at.—Yours, etc, A CENTRAL STATION MAN.

SIR,—I fully agree with the spirit of "Electricity Supply's" letter, and practically could endorse all that he lays down. The gist of the whole letter, however, lies in the statement that "it is time the assistant engineers formed a professional union." This I am convinced is the only way by which we shall ever obtain fair treatment wherever we may go. Personally I am not at all badly situated, but there are very many (far too many) who are extremely badly paid and badly treated. And it is this very large body which we must attend to first; once get the worst-paid and worst-treated section of our profession righted, then the better jobs will become better still.

It must be obvious by now to everyone that the majority of us will have to remain assistants till the end of the tale, and, surely, if the legal, medical, and scholastic professions can beneficially control their affairs by means of professional unions, it is not impossible for station engineers to do likewise. The fundamental step, however, is to obtain a ruling from the Board of Trade that all future assistants (after a given date) must have spent four years at least in a good engineering workshop, and after one or two years' station experience be compelled to pass an examination qualifying them for responsible posts. No assistant without the ensuing certificate should be permitted to hold any other than the most junior positions. Unless we obtain drastic measures such as those suggested, we shall never stop the influx of the premium pupil.—Yours, etc.,

DRASTIC.

BRITISH ASSOCIATION.

The following have been elected by the council of the British Association to be presidents of sections at the meeting of the association to be held in Dublin in September next under the general presidency of Mr. Francis Darwin, F.R.S.: Section A (Mathematical and Physical Science), Dr. W. N. Shaw, F.R.S., director of the Meterological Office; Section B (Chemistry), Prof. F. S. Kipping, F.R.S., professor of chemistry in University College, Nottingham; Section C (Geology), Prof. J. Joly, F.R.S., professor of geology and mineralogy in the University of Dublin; Section D (Zoology), Dr. S. F. Harmer, superintendent of the University Museum of Zoology, Cambridge; Section E (Geography), Major E. H Hills, C.M.G.; Section F (Economic Science and Statistics), Lord Brassey; Section G (Engineering), Mr. Dugald Clerk, M.I.C.E.; Section H (Anthropology), Prof. W. Ridgeway professor of archæology in Cambridge University; Section I (Physiology), Dr. John Scott Haldane, F.R.S., university reader in physiology at Oxford; Section K (Botany), Dr. F. F. Blackman, F.R.S., professor of botany in the University of Leeds; Section L (Educational Science), Prof. L. C. Miall, formerly professor of biology in the University of Leeds. Invitations to deliver evening discourses during the meeting of the association at Dublin have been accepted by Prof. H. H. Turner, F.R.S., Savilian professor of astronomy at Oxford, who will take as his subject "Halley's Comet"; and Prof. W. M. Davis, of Harvard University, whose lecture will be entitled "The Lessons of the Colorado Canon."

PUBLICATIONS RECEIVED.

Proceedings of the American Institute of Electrical Engineers, January, 1908, vol xxvii., No. 1.

The *Journal* of the Franklin Institute (Philadelphia), January, 1908, vol. clxv., No. 1.

Procès-Verbal of the meetings of the Société des Ingénieurs Civils de France (Paris), Jan. 10.

SOCIETE DES INGENIEURS CIVILS DE FRANCE (Paris). *Memoires et Compte Rendu des Travaux*, October and November, 1907, Nos. 10 and 11.

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LIVERPOOL ELECTRICITY SUPPLY.

The adjourned meeting of the Liverpool Council was held on Wednesday last, when the four resolutions printed in our last week's issue were brought forward. At the opening of the meeting a letter was read from the East Liverpool Ratepayers' Association supporting the demand for the proposed inquiry. Mr. W. Boote said he was a member of that association, but knew nothing of the letter in question.

Mr. GATES then moved: "That a special commission of inquiry be appointed by the Council to investigate and report on the Westinghouse turbine engines at Lister-drive, their cost and working, with authority to obtain independent expert opinion if thought necessary." Mr. Gates said he had waited three months for that opportunity, and he believed the opportunity had only been granted in deference to public opinion. During those three months every effort had been made by ridicule and the withholding of information to prevent the matter being brought to an issue. He challenged any member of the committee to stand up and say from personal knowledge that his statements were incorrect.

A large number of the committee then stood up but deferred their remarks.

Mr. GATES, proceeding, said that he had been refused the opportunity of seeing the records of the turbine, and if his information was not complete it was no this fault, but the fault of the committee. With regard to those papers which Mr. Stoddart was suspected of being concerned with, he (the speaker) affirmed that they had been spirited away in view of a possible inquiry. He did not say it as a threat, but if the Council refused an inquiry he would demand one from the Local Government Board.

Mr. W. B STODDART seconded.

Mr. J. F. LESLIE remarked that, as director of one of the largest electric supply companies, he had come into contact with questions such as the one now before the Council. His company—the South London Electric Supply Corporation—had been passing through exactly the same sort of difficulty as that encountered in Liverpool. About four years ago they ordered a generating set of a very costly character from one of the best makers in the country, and although it was delivered and put to work in 1905 they had not taken it over yet. With respect to the experience of Liverpool, he thought that, instead of making all sorts of covert allegations against the committee, they should rather sympathise with them in the troubles they had had with their contractors, and not try to cut the ground from under their feet in dealing with the contractors. He denied that a refusal on the part of the Council to sanction a public inquiry would be a confirmation of the allegations that had been made. The Council, he believed, had confidence in the Tramway Committee, and he hoped they should show that by their vote, and testify that they thought the committee were doing their best under difficult circumstances.

Mr. DART, who was chairman when the Westinghouse turbines were ordered, believed that the turbines were the best that could be got at the time. One would think from what had been said that their electrical engineer, Mr. A. B. Holmes, was inefficient and untrustworthy, but anyone who had had the pleasure of working with him knew how totally unfounded was such a charge.

Sir WM. FORWOOD took much the same view of the case as Mr. Leslie. He deplored undue influence being brought to bear on the executive of one of their generating stations, as it undermined discipline there. They ought to avoid interfering with the staffs under the various committees.

Sir WM. BOWRING supported Mr. Gates's motion, and thought that the installation might be improved under expert advice.

Sir CHARLES PETRIE (the chairman of the Electricity and Tramway Committee) remarked that Mr. Gates said he looked upon this as a political matter, and to some extent it was, as Mr. Stoddart raised the question during the municipal elections. With that he had nothing whatever to do. They would naturally expect that the gentlemen who asked for this inquiry would have put some facts and figures before the Council in order to justify such an inquiry, but to his mind they had made no case whatever. He did not care for the criticism of the committee, but he did care for the criticism of the officers, Mr. Holmes in particular, who had had charge of this matter. From its infancy the whole of the success of this gigantic undertaking depended upon Mr. Holmes, and that he had brought it to a great success he thought there could be no doubt whatever. They could produce the electrical energy as cheaply as in any other city, and the price charged to the consumer had been a moderate one. They had been enabled during many years to add large sums to the relief of the rates in the city. That showed that the undertaking had been well managed. When Mr. Gates said these machines had been a failure, he contended it was absolutely untrue. He complained of the way in which the case had been got up by asking information from members of the staff other than the chief.

After several other speeches the motion was defeated by 62 votes to 24.

The next resolution, proposed by Mr. GATES and seconded by Mr. STODDART, was that the Council sanction the printing of the shorthand notes taken at the recent Local Government Board inquiry as to the Tramway and Electric Power and Lighting Committee's application for power to borrow £200,000, and that a copy be sent to each member of the Council.

Sir CHARLES PETRIE thought the resolution was unnecessary, as the inspector had sanctioned the application.

Alderman LLOYD remarked that there was a typed transcript of the shorthand notes in the town clerk's office, to which any member of the Council had free access.

The motion was defeated by 54 votes to 15.

Mr. Stoddart's resolutions were withdrawn.

This concluded an unsavoury business, raised, as far as we can tell from the reports, largely on political grounds. The voting shows that the business men on the Liverpool Council have full confidence in their engineers, and that they consider the extravagant charges brought against the Westinghouse turbines to be absurd. We are indebted to the *Liverpool Courier* for the report of which the above is an abstract.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, Feb. 22.

MONDAY, FEB. 17.—"A" Coy.—Infantry drill, 6 p.m.
Technical drill, 7 p.m.

TUESDAY, FEB. 18.—"B" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

WEDNESDAY, FEB. 19.—"A" badge examination, 6 p.m.

THURSDAY, FEB 20.—"C" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

FRIDAY, FEB. 21.—"D" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

PERSONAL.

The Gillingham Town Council have appointed Mr. C. E. Hobson, Fulham, as canvasser to the electricity department.

Mr. E. J. Hogan has discontinued his connection with the Sunbeam Lamp Co., and has opened offices at Gloucester Mansions, Charing Cross road, W.C.

The fifth annual dinner of the drawing office of the Electrical Construction Co. was held in the Molineux Hotel on the 7th inst., and proved a very enjoyable function.

We regret to announce the death of Mr. John Lawson, who for some years held the position of resident mechanical engineer-in-charge of the Shoreditch Borough Council's Whiston-street generating station.

On the 6th inst. the Leeds Local Section of the Institution of Electrical Engineers held a smoking concert at the Hotel Metropole, a large number of members and friends being present to enjoy an excellent musical programme. The chair was taken by the chairman of the section, Mr. G. D. Aspinall Parr, and altogether a very pleasant evening was spent, and the entertainment was very much appreciated by the members.

APPOINTMENTS VACANT.

Assistant Distribution Engineer, Woolwich Borough Council. Salary £90 per annum, rising by annual increments of £10 to £140 per annum. Applications by Feb. 17. See advertisement.

Electrician for colliery lighting and power plant. Applications to Box A, care of this paper. See advertisement.

Colchester.—The Electricity Committee submitted the electrical engineer's report to the Town Council at the last meeting, and which gave the following details:

Output of electricity in units during	1907.	1906.	1905.
December (lighting)	107,014	103,364	85,105
Ditto (traction)	40,103	39,728	39,381
Used in generating station	22,368	20,519	8,621
Total	169,485	163,611	133,107

The committee also submitted a special report regarding the recent electrical exhibition. The expenditure had been £200 14s. and the receipts £171. 7s. 3d., leaving a deficit of £29. 6s. 9d. The committee had resolved to give £10 as extra duty pay to members of the electrical staff. The Chairman said his opinion, and he thought the opinion of the committee, was that the exhibition was an unqualified success.

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BUSINESS NOTES.

LIGHTING AND GENERAL.

Hackney.—The London County Council have sanctioned the borrowing of £2,450 by the Council for electric lighting purposes.

Toronto.—The Board of Control have authorised the expenditure of 2,750,000dol. either to purchase or install an electric light plant.

Oxford Electric Supply Co.—A dividend of 7 per cent. is recommended for the year 1907, including 2½ per cent. paid in September last.

Longton.—The output of electricity during January at the Corporation electricity works was 22,066 units, being an increase as compared with last year of 1,338 units.

Tunstall.—The town hall is now installed with electric light fittings throughout. The light is being supplied from the Burslem Corporation's electricity works.

Carnarvon.—The Town Council have adopted a scheme for the lighting of the Gulla Hall by electricity. The work will be carried out by the National Electric Construction Co.

London Electric Supply Corporation.—The directors have declared a dividend of 6 per cent. on the preference shares and 2½ per cent. on the ordinary shares for the year 1907.

Revelstoke (B.C.).—The Municipal Council propose to install a 400-h.p. gas-engine and a suitable gas-producer plant; also a 150-kw. dynamo. The present plant will be used for lighting only.

Faraday House Old Students' Dinner Postponed.—The above dinner, arranged for the 21st inst., has been postponed indefinitely in consequence of the death of the wife of the president-elect.

Lewes.—The Town Council have approved of an agreement with the General Post Office in reference to the installation of a telephonic system in connection with the fire brigade on a lease of 10 years.

Leipzig.—The Leipzig Council has unanimously resolved to erect municipal electric light and power works at a cost of a million pounds sterling. The works will be the largest of their kind in Germany.

Beckenham.—The Council Electricity Committee have decided to extend the cable along Clock House-road. It was stated that houses in the road which were already wired indicated a profit on the outlay.

Reading.—The report of the Reading Gas Co. for the year ended Dec. 31 states that the revenue derived from the sale of gas, etc., amounts to £73,320, compared with £74,637 for 1906—a decrease of £1,317.

Tantalum Lamps.—Messrs. Siemens Bros. Dynamo Works notify us that from the 10th inst. the 16-c.p. and standard tantalum lamps have been reduced to 2s. 6d. The Sun bulb lamps remain the same—viz., 3s. 6d.

South Shields.—It is stated that the company proposing to construct a tube under the river is making inquiries as to the price of electrical current, and there appears to be some hope now of the scheme proceeding.

Belfast.—On the evening of the 4th inst. an alarming gas explosion occurred at the shop, 121, Divis-street, with the result that extensive damage was done to the building, the lower portion of which was practically wrecked.

Minnedosa (Manitoba).—The Minnedosa Power Co. are seeking permission to dam the Little Saskatchewan River and to raise the water of Clear Lake 5ft. This company purpose supplying light and power to the Municipality.

Villa Maria (Buenos Ayres).—The concession obtained by Messrs. F. Stock and Co. for the electric lighting of Villa Maria and Villa Nueva has been passed over to a local company, which will have a capital of 200,000dol. (gold) in 1,000 shares.

Oldham.—It has been reported to the Council Electricity Committee that the number of lamps connected to date is as follows: arc, 34; incandescent, 23,799—increase during the fortnight 1 arc and 518 incandescent—total 349 arc and 24,317 incandescent.

Sunderland.—The Sunderland Corporation Electricity Committee estimates that for the half-year ending Sept. 30 the gross profits of the undertaking will be £10 315, against £8,791 last year, and the net profit to carry forward £4,077 against £2,792 last year.

Ashford (Kent).—The Chamber of Commerce have appointed a sub-committee, who are to approach the manager of the South-Eastern and Chatham Railway, in order to advocate the desirability of establishing telephonic communication with the goods station.

Malvern.—Under the auspices of the electricity department of the Urban District Council a very successful electrical exhibition has been held. The results have been excellent, new consumers having been gained, and a great deal of information given to likely customers.

Notice of Intended Dividend.—The *London Gazette* announces that the last day for receiving proofs in the estate of A. Dickinson, electrical engineer, carrying on business at 19, Upper Mill-hill, and the Electrical Works, Dixon-lane-road, Wortley, Leeds, is Feb. 28.

Montreal.—Five hundred thousand feet of gas in one of the gas-meters of the Montreal Light, Heat, and Power Co., at the works on St. Catherine-street, Hochelaga, took fire and there was a terrific explosion, which sent the flames high into the air, entailing a loss estimated at 30,000dol.

Nelson.—At a meeting of the Electricity Committee on Feb. 6 representatives of the Brierfield District Council attended and made an application for a reduction of charges for electricity supplied to their district. The committee agreed to consider the application at the end of the financial year.

Eccles.—The electrical engineer has been instructed by the Council Electricity Committee to prepare plans for the installation of one 200-kw. steam alternator and accessories, and one Lancashire boiler and superheater. It was also decided that additional office accommodation be provided at the electricity works.

Leek.—The wardens and council of All Saints' Church have decided to adopt electric light, and the fittings are to be put in with the least possible delay. The scheme has been prepared by Mr. R. M. Carr, engineer of the Leek electricity works, and the scheme will cost about £150, of which a good part is already promised.

Telegraph Construction and Maintenance Co.—The directors of the Telegraph Construction and Maintenance Co. propose, subject to audit, a dividend of 10 per cent. (£1. 4s. per share), together with a bonus of 2½ per cent. (6s. per share), in addition to the 5 per cent. already paid, making 17½ per cent. for the year 1907.

Northfleet.—At the last meeting of the District Council a plan of route cable and section poles submitted by Mr. C. F. McInnes, on behalf of the Gravesend Corporation, was approved, subject to the surveyor being satisfied with the actual position of the trench for the cable with a view to minimising as much as possible all damage to the pavement.

Royton.—A sorry tale was told at the last meeting of the District Council respecting the quality of the gas supplied to the district. Schools were almost in darkness, and services in the churches had to be abandoned owing to the wretched light. So bad did the Council consider the matter that a resolution was proposed that a claim be made for rebate from those responsible for the supply.

Durham.—The Board of Guardians have under consideration the question of electrically lighting the Durham Workhouse, and have asked the Durham Electrical Power Distribution Co. for a report upon the cost of installation and supply. This has now been received and is receiving the attention of the Finance Committee, who will report fully upon the matter at the next meeting of the Board.

Keighley.—The Town Council Electricity Committee report as follows: Units sold in December, 1907, lighting and power, 52,842; ditto, traction, 21,295—total, 74,137. Units sold in December, 1906, lighting and power, 33,671; ditto, traction, 21,103—total, 54,774; increase, 19,363. Units sold from July 1 to Dec. 31, 1907, 357,086; ditto, 1906, 263,735; increase, 354 per cent., 93,351 units.

Hammersmith.—A serious gas explosion occurred on the morning of the 5th inst. in Bridge-road, the residence of a family named Jackman. A large quantity of gas, which had accumulated from an escape, became ignited, and exploded with terrific force. The windows were blow out, the furniture shattered and strewn in every direction, and the entire lower part of the residence very seriously damaged.

Southampton.—An open verdict was returned at an inquest held on the 7th inst. on Mr. James Liston Black, managing director of the Dock Engineering Co. The deceased not having been seen for two or three days, his house was entered, and his lifeless body was found on the floor of the smoking-room covered with a blanket and a quilt, with the head resting on two pillows, in front of the gas stove. The taps of the gas-burners were turned on.

Fraserburgh.—The Town Council have appointed Mr. W. B. M'Lusky, gas engineer, of Perth, to report upon the construction and present condition of the Fraserburgh gasworks and plant, the company's position, and the probable cost of acquiring their undertaking, and Mr. Richardson, electrical engineer, of Dundee, to make an inspection and submit a report with reference to the introduction of a system of electric lighting in the burgh.

Morley.—The last report of the Corporation Electric Lighting Committee shows that the output from the electricity works for the month ending Dec. 31 was 28,285 units, against 25,080 the same period the previous year, being an increase of 3,205 units. There were sold to consumers by meter 22,932 units, against 19,561, an increase of 3,371. The total number of lamps now connected is 16,182, and there are 30 motors, with an aggregate of 101 h.p.

London's Electrical Supply Schemes.—A keen fight is anticipated during this session of Parliament over the supply of electricity to London. Private promoters have come forward with Bills, of which three are now before Parliament—viz., the London and District Electricity Supply, the London Electric Supply, and the London (Westminster and Kensington) Electricity Supply Companies. The London County Council have resolved to oppose each of the Bills.

Glasgow.—The annual dinner of the National Telephone Co.'s Glasgow staff was held on Friday evening last in Ferguson and Forrester's, Buchanan-street. Mr. D. Johnstone Smith, the company's local director, presided over a large gathering. The toast of "The Company" was given by Mr. Douglas Watson, and responded to by the chairman, who traced the progress of the business in Glasgow, giving some details of its early history. Other toasts followed.

Edinburgh.—At last meeting of the Electric Lighting Committee of the Town Council the engineer reported that the work in connection with the installation of the condensing plant at M'Donald-road power station was now almost completed, and that the whole of the street would be covered in by the end of this week, with the exception of the shaft, the causewaying over which would be finished in about 10 days. It is expected that the condensing will be commenced at the beginning of next week.

Walsall.—The Town Council are recommended by the Electricity Committee to provide a condensing plant at the electricity station, and the erection of a wooden cooler tower over half of the old gas-holder tank. The total cost will be £4,000, and it is proposed to ask the Local Government Board for a further loan of £2,600, which, together with a sum of £1,400, being the unexpended balance of a loan already sanctioned by the Board for a similar purpose, will be required to defray the cost.

St. Annes.—The following is a statement of the operations of the Council electricity department for the month ended Jan. 24: Units

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sold during December, 74,595; units sold to end of December, 556 727; total number of consumers, 633 Applications are in hand from nine consumers for the equivalent of 292 8 c p. lamps. The work of the department has been progressing satisfactorily, cables having been relaid in Beach-road, and the laying of mains in Devonshire-road has been completed.

Burnley.—On the recommendation of the Electricity Committee the Council have decided to add to the plant at the electricity works by the purchase of a 750-kw. steam generator at a cost of £6,855, and a motor-driven centrifugal pump for cooling and condensing purposes at a cost of £265. The Council have also directed the town clerk to apply to the Local Government Board for their sanction to the borrowing of the two sums of money, amounting together to £7,100, and to the repayment of the money within a period of 25 years.

Repton.—The clerk to the Rural District Council reported at the last meeting the receipt of a letter from the National Telephone Co. stating that it was their intention to erect a telephone office at Repton, and they asked the Council to allow them to erect poles on the road between Newton Solney and Repton. Answering a question put by the chairman, the Clerk said the plans submitted by the Telephone Co. were satisfactory, and the Council granted permission to erect the poles, but gave the surveyor instructions to see that they were put back as far as possible.

Scarborough Electric Supply Co.—The annual report of the Scarborough Electric Supply Co., just issued, states that though there had been an increase in the amount of energy supplied during the year, the receipts continued to be adversely affected by the depression in trade in the town, and expenses had risen owing to the higher price of coal. After placing £750 to depreciation account, a balance remains on revenue account of £4,238, from which the directors recommend the payment of a dividend at the rate of 4 per cent. per annum, leaving £248 to be carried forward.

Luton.—The electricity main in Biscot road is to be extended at a cost of £60. The electrical engineer has reported to the Council that since Dec. 23 last 134,366 units had been generated, an equivalent of 625 8-c.p lamps and three motors of 7 h.p connected, making a total of 465 consumers, with 25,566 lamps and 221 motors of 1,368 h.p. The number of units generated showed an increase of 45 per cent. over the number generated during the corresponding period of last year, and at the present time applications were in for over 1,500 additional lamps and 300 h.p. in motors.

Taunton.—At the last Council meeting the Electricity Committee reported that the Taunton Electric Traction Co. had made overtures for the removal of the agreement (which expires in August next) under which the British Electric Traction Co. guaranteed to the Corporation a minimum payment for the supply of electricity for the trams, and they had intimated that, if satisfactory terms could be arranged, the extension of the trams to Rowbarton would be at once proceeded with. The committee hoped to be able to report to the Council satisfactorily at the March meeting.

Erith.—The Council have decided to extend the distributing mains to Valley-road. Upon a statement showing capital expenditure on the electricity undertaking to Dec. 31, 1907, giving a balance in hand on capital account on that date, after payment of outstanding accounts and retention moneys of £422, which included £300 unexpended for tools, the Council have decided to make application to the Local Government Board for their sanction to the borrowing by the Council of the further sum of £5 000 for electric lighting purposes—viz., extensions of mains, transformers, motors, house services, meters, etc.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Provincial Tramways Co.'s £175,000 5 per cent. first debenture stock. The committee have also been asked to appoint a special settling day in Lanadron Rubber Estates' 70 000 shares of £1 each 5s. paid, Nos. 1 to 70 000, and Vanguard Motorbus Co.'s £199 050 6 per cent. debenture stock. The Stock Exchange Committee have appointed Feb. 19 a special settling day in Calcutta Tramways Co.'s further issue of 12,128 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 30,001 to 42,128, and ordered same to be quoted in the official list.

Bury.—The Town Council considered at the last meeting a recommendation by the Electrical Committee that application should be made to the Local Government Board for sanction to the borrowing of £72 000, the estimated cost of providing a new generating station at Chamber Hall, together with the necessary mains to the existing works. The details of the proposed expenditure are: cost of land, £2 100; buildings and siding, £17,900; plant, £35,700; connecting mains to general works in Rochdale-road, £6 300; transformers and high-tension mains for large consumers, £10,000. The committee anticipate that in the near future there will be a demand for power by manufacturers. The recommendation was agreed to.

Wolverhampton.—At a meeting of the Town Council the Electricity Committee submitted for confirmation several resolutions, the principal one relating to the mains conduits, etc, in connection with the proposed supply of electricity to the works of Thomas Parker, Limited, Wednesfield road, at an approximate cost of £2 500. The Chairman of the Electricity Committee said the whole of the £2,500 should not be really charged to Messrs. Parker, as the scheme involved the construction of three mains. Further considerations were the extensions later on to the proposed new works of Messrs. Chubb, the well known lock makers, and the prospect of connections and linking up the old structor and the Commercial-road station. The resolutions were adopted.

Llandyssul.—At the last meeting of the Rural District Council a representative of the firm of Messrs. Parkington and Co. attended and stated that it was the intention of his firm to install electric light in the town, and asked the Council's consent to run overhead wires and lay mains in places where it would be impracticable to run overhead. The clerk asked him whether in cases of accident the company would be prepared to indemnify, to which he replied that the company would be working under the Board of Trade regulations, and certainly in cases where it could be proved there had been negligence they would compensate. The risk of accidents would be very small though, as the pressure would be only 110 volts. He was asked to send in a written application, and it would be considered at the next meeting.

Newcastle-on-Tyne.—The Postmaster-General has informed the Newcastle-on-Tyne Chamber of Commerce that the underground telegraph cable from Newcastle to Durham is being proceeded with, and will be finished in four months. During the next financial year it will be extended to Leeds *via* Stockton, and as Leeds is served *via* Bradford from the London to Glasgow direct underground cable, Newcastle will then be connected underground with London. Arrangements had also been made for underground telephone routes from Newcastle to North and South Shields and Sunderland, and improved circuits are being put into operation which will improve the direct communication between Newcastle and Leeds, Hull, West Hartlepool, Edinburgh, Glasgow, Birmingham, Manchester, and London.

Dundee.—The minimum rate imposed on consumers of electric current for lighting purposes, it seems, has been a source of irritation. The fact was reported to Dundee Electricity Committee this week by Mr. Richardson, the engineer. He recommended that it should be done away with, and pointed out that the revenue received from this source amounted to about £150 per annum. The committee acquiesced, and decided to recommend accordingly. It was reported that the units generated for the nine months ending January numbered 3 948,843, as compared with 3,318,894 for the corresponding period last year. The total number of units sold was approximately 3,189 163, as against 2 692 158 last year. The coal bill was £3 969, as contrasted with £2 122 12 months ago. New consumers connected numbered 175, as against 77 for last year.

Mansfield.—A gas explosion occurred on the 7th inst. at Cromer House, Chesterfield-road, Mansfield, the residence of Dr. Martyn, and did extraordinary damage, the cost of which is estimated at about £300. The explosion occurred through a leakage in a pipe between the rafters and the roof of the breakfast-room, and this accounts for the great damage which was done to this apartment. The roof showed signs of having been considerably shaken, a large wooden beam over the window was splintered and broken, and a portion of the wall facing the yard was moved an inch or two. Inside the ceiling was in pieces, and strips of partly-burned paper were hanging down, the whole of the window was blown out, pieces of glass being all over the garden up to a distance of 20 yards, the venetian blind was completely broken and hanging out of the window, as were the heavy curtains, a portion of the latter being blown on to an apple tree several yards distant.

Crook.—The County of Durham Electric Power Supply Co. have written the Council stating that they proposed to construct overhead wires between Bankfoot Colliery and Aykleyhead sub-station, but a portion of the route was outside the area of supply covered by the company, but covered by the Cleveland and Durham County Electric Power Supply Co., which area included the urban district of Crook, consequently it was necessary that the formal consent of the Crook Council should be given to the Cleveland and Durham County Electric Power Supply Co. for the extension within the district, and which was shown on a plan which accompanied the letter. Discussion followed as to the exact spot at which the wires were needed, and the chairman stated it had already been decided not to have overhead wires in the town, but the company wanted them outside the town. Upon the latter being clearly ascertained from the plan, it was decided to grant the application made by the company.

Farnham.—The Board of Trade have postponed the revocation of the Farnham electric lighting order for three months as from Jan. 30. The Council have been approached with a view to sanctioning a supply of electricity by means of overhead wires by the Farnham Electric Light Co., but have agreed to a resolution giving instructions to the committee on the electric lighting provisional order to make a provisional report upon the following matters: as to who are the persons who are the promoters of the existing provisional order, and as to what capital has already been found and is hereafter to be provided for the establishing of electric lighting in Farnham under such order, and how and when such capital is to be raised; and as to the general nature of the scheme under which the electric lighting is to be provided, including a statement as to the site on which it is proposed to establish the electric lighting works, and as to the distribution of the electric current throughout the town by overhead wires.

Wigan.—Mr. J. Slevin, electrical engineer, reporting to the Electric Light Committee of the Corporation, says the units generated for lighting and power during December were 183,247 as against 169,333 in December, 1906. The highest daily output was 8,202, as against 8,990 units in December, 1906. The units generated for traction during the month were 128,111, as against 165,4'8 in December, 1906. The highest daily output for traction was 5 427, as against 7 574 in December, 1906. The highest load on the station during the month was 1,830 kw., as against 1 689 kw. in December, 1906; and the total units generated were 311,358 as against 331,771 in December, 1906. The maximum load on the station was 2 520 h.p.; thus the plant was loaded to within 100 h.p. of its total capacity, all the machines having to be run, leaving no spare engines in case of an abnormally heavy load or a breakdown. The engineer points out the absolute necessity of an extension to the plant before the next winter.

Bournemouth.—A letter from the secretary of the General Post Office was read at a meeting of the General Purposes Committee as to the trunk telephone service between Bournemouth and London, stating that the Postmaster-General had, as promised, caused special attention to be given to the unsatisfactory working of the circuits between the

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two places, and it had been ascertained that the difficulty was caused mainly by faults due to branches of trees having been blown down on to the lines. Special steps had been taken to clear the lines, and it was hoped that these steps would result in a much better service. It was also stated that the question of providing additional trunk circuits between London and Bournemouth was receiving attention. The cause of the disorganisation of the service just before Christmas, of which the Council had complained, was being investigated, and a further communication on the subject would be sent when the inquiries were complete. The town clerk was instructed to reply thanking the Postmaster-General for his letter, and stating that the Council will be glad to hear again in due course.

Gillingham.—At the last Council Electricity Committee meeting the engineer reported that the equivalent of 80 8-c p. lamps had been connected with the mains, and that the equivalent of 384 8-c p. lamps had been disconnected (owing to the closing of the Hippodrome) since the last meeting of the committee, making a total of 28 534 equivalent in 8-c.p. lamps with 325 consumers connected; and that applications had been received for the equivalent of 297 8-c.p. lamps. The engineer reported that he had sent an approximate estimate for the installation of electric lighting in Byron-road, Barnsole-road, and Richmond-road Schools to the Education Committee, and stating that the cost of laying public and private lighting mains up to Barnsole-road School capable of also supplying the premises *en route*, and including the replacement of three gas standards with four electric light standards, would be approximately £100; and that the cost of laying a private lighting main along Cornwall-road, capable of supplying both the schools and private houses, would be approximately £40. The committee have recommended the Council to have the necessary mains laid and the work proceeded with.

Ossett.—The Corporation have completed the transfer of their electric lighting order to the Electrical Distribution of Yorkshire, Limited, and that company is now authorised to supply electricity in the borough, so that Ossett will shortly be in the position of its larger neighbours in that the residents will have an alternative to the present gas supply. It will be remembered that Ossett Corporation obtained their powers to supply electricity in 1898, and for nearly nine years the Corporation have discussed various schemes for putting their powers into force. Many of these included the provision of a generating station. The Council decided that the disadvantages of generating electricity on a small scale existed, and the Distribution Co., who have not only powers to supply in Ossett, but Horsforth, Farsley, Calverley, Gomersal, Liversedge, and Castleford, propose to take a supply in bulk from the Yorkshire Electric Power Co. for all their undertakings, thus avoiding very large capital expenditure which would otherwise be necessary, and which would prohibit the supply being given at reasonable rates. The prices at which the company propose to supply are, we understand, as low as those charged in the larger towns, and the supply should prove a boon to the district.

Dunfermline.—On behalf of the Corporation Prof. Sir Alexander Kennedy has approached the Fife Electric Power Co. as to terms, etc., upon which the Corporation's order should be conveyed to the company. Sir Alexander has now reported that the Fife Electric Power Co. will agree to pay the Dunfermline Town Council for their electric lighting provisional order the amount of expenses incurred by them in connection with the same in so far as approved by the Board of Trade. The company will make application for a provisional order authorising the transfer of the existing provisional order to the Fife Co., the whole costs in connection with the transfer order to be borne by the Fife Co. The Fife Co. will agree to insert a maximum price of 6d. per unit in the transfer order, and agree with the Council on behalf of the Corporation on a schedule of rates to be charged consumers for lighting. Detailed terms to be adjusted between the Corporation and the Fife Co.; failing agreement, subject to the arbitration of the Board of Trade. Sir Alexander points out that as to these conditions he thinks they are reasonable. He concludes that the Council would put before the Board of Trade the whole of the expenses which they have been at in connection with the order, and ask that the Board would approve their repayment. The only thing, so far as he knows, about which there might be question, is the repayment of the Council's costs in connection with the three or four previous reports which have been prepared about the matter, but which have not been acted upon.

Abertillery.—Mr. R. H. Hooper resumed the inquiry on behalf of the Local Government Board at Llanhilleth on Thursday week into the application of the Abertillery Urban District Council for authority to borrow £10 000 for the purpose of electric lighting at Llanhilleth. Mr. A. H. Dolman, Abertillery, represented the Council, and Mr. W. J. Everett, Pontypool, opposed the application on behalf of the Abertillery Ratepayers' Association. Mr. Lloyd, of the firm of Medhurst and Lloyd, electrical engineers, London, said that the object of the scheme was primarily to supply electric light to the districts of Aberbeeg, Llanhilleth, and Crumlin. It was proposed to erect 191 lamps for street-lighting and the generating station at Llanhilleth, and overhead mains would be erected wherever practicable. The estimated cost was £10,362, and if the working was commenced in the autumn the income would balance the expenditure at the end of one full year. The sanction of the Board of Trade had been obtained, and he was satisfied that the work could be carried out for £10,300. If the demand which he anticipated arose, he thought it would be necessary to apply for power to extend the works in about 18 months. Alderman William Thomas believed that the vast majority of the people in the district were in favour of the scheme, as oil lamps were the sole means of public lighting at present. Cross-examined by Mr. Everett: He did not agreed that the expenditure of £1,750 upon the Abertillery gasworks would enable the district to be supplied with gas. That sum would only cover the cost of carrying out the improvements at the works which were now badly needed. Further evidence in support was given by Messrs. Michael Roach and A. C. Willis (miners' agents), Herbert Stone, Daniel Lloyd, and Wm. Horsefall (engineer to the Ebbw Vale Council), who spoke as to the popularity and success of a similar scheme in that district.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board.—At the last meeting of the Board a discussion took place concerning a resolution to the effect that application should be made to the Local Government Board for their sanction to the borrowing of £20,223 for additional plant at the generating station; also for sanction to the borrowing of £5 000, being the amount estimated to be required for the purchase of transformers during the next two years. Mr. Noel, in moving the two resolutions, said that when the Government inspector was over they got sanction for the purchase of transformers under a separate heading, and it was usual to receive permission in that way. Owing to the demand for power they would require the transformers within the next two years, but none of it would be spent without the matter again coming before the Board. With regard to the first application, they were looking ahead, and they were bound to prepare themselves. At the present time they had applications for 2,500 h.p., and they were being continually approached. At the moment they were not proposing to spend a single penny, but they desired to be in a position to cope with the future demands. The Chairman said the Ray Mills (Stalybridge) were expected to be ready within the next six months, and that meant a supply from the generating station of 1 500 h.p., whilst there was still 1 300 h.p. to go to the Premier. From his own personal knowledge, and from the concerns with which he was connected, considerable application for power was still to be made. Mr. Jas. Bottomley said there was another concern near the generating station which was intending to be supplied. The Chairman agreed, and added that there would be nine places at least within a quarter of a mile of the generating station which would be supplied with considerable power, and, as far as he could judge, the electrical power had been a blessing to the employers in Tame Valley. Mr. A. Simpson observed that as chairman of the Sanitary Committee he knew that one great feature of electrical power was the ability to work without smoke. The resolutions were unanimously agreed to.

Worcester.—Mr. H. R. Hooper held an inquiry on behalf of the Local Government Board at the Guildhall on Tuesday last with respect to an application of the City Council to borrow £10,000 for the purposes of the electricity undertaking. There were present the Town Clerk, Mr. A. H. Parker (chairman of the Electricity Committee), and Mr. C. M. Shaw (electrical engineer). Messrs. W. Moore and J. H. Bowen (representing the City Ratepayers' Association) opposed the application. Mr. Parker, referring to a sum of £1,050 of the total sum, said it was required for the extension of the boiler-house and coal-house, and the distributing station at the Cross. It was not proposed to carry out the extension of the boiler-house this year, but future demands would make such an extension necessary. The Corporation were applying for the loan of that sum because the work was part of the scheme. The only immediate extension was a small extension of the pump-house. Mr. Shaw pointed out that, although they had had to pay more than 31 per cent. for coal, the bill was £285 less than last year, with an increased output of 14 5 per cent. In 1904 there was a deficit of £1 351; in 1905, £298; in 1906, £183; and in 1907 a loss of £198. Mr. Shaw said that the consumers in 1906 numbered 730, and in 1907, 793; the maximum demand was 798 kw. in 1906 and 899 kw. in 1907. He said unless they obtained sanction for the loan soon he could not take on any more consumers. Mr. Bowen said the ratepayers' association protested in June against the proposal to borrow £10,000, and he repeated that protest now. He had been told that the loss was about £40,000. The association objected strongly to the Corporation borrowing money before they needed it. It was admitted that part of this loan was not required immediately. He understood that some of the ratepayers found the light expensive, and were going to give it up. The Inspector remarked that people changed their minds on all matters. The Town Clerk asked Mr. Bowen whether he knew that there had been a loss of £40,000. Mr. Bowen: I have been told so by members of the Council. The Town Clerk: And do you think it right to come here and say there has been that loss? The Inspector: I think it is put forward as an entirely unsupported statement, and we can accept it as such. Mr. Bowen: Do I understand there was not a loss of £40 000? Mr. Hogben: No; about £3 000 or £4 000. Mr. Bowen: I was wrongly informed. The inquiry then closed.

TRACTION.

Buenos Ayres Grand National Tramways Co.—The directors announce an interim dividend of 2s. 6d. per share, less income tax, on the 5 per cent. cumulative preference shares of £5 each

Victoria (B C.).—Many portions of the Canadian Pacific Railway are to be electrified. It is intended to proceed immediately with the electrification of the boundary section of the Crow's Nest Pass division.

La Plata.—The Bill granting a concession to Messrs. Otto Franke and Co. for a high-speed electric railway between La Plata and Buenos Ayres has been definitely approved by the Legislature of the province of Buenos Ayres.

St. Helens.—An electric tramcar belonging to the St. Helens Tramways Co. left the rails near Rainhill Station on Monday and crashed into a confectioner's shop, wrecking the front of the shop. No one was injured.

York.—The Light Railway Commissioners (the Hon. G. Gathorne Hardy, chairman) will hold an inquiry into the application of the York Corporation for a light railway (tramways) order for the city of York on Tuesday, the 25th inst.

Sunderland.—The Corporation tramways are feeling the effect of the depression in the town, and the analysis of traffic shows that

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during the month of January 115,256 less passengers used the trams, and the takings fell from £5,444 to £4,963—a decrease of £481.

Brierley Hill.—At the meeting of the Council the Tramways Committee recommended that the Council support the action of the Dudley Corporation in requesting the tramway company to provide better waiting-room accommodation than an old tramcar at Scott's Green, Dudley.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Feb. 4, 1908, converted to gold were £3,562; corresponding period 1907, £3,776 — decrease, £214. Aggregates from Jan. 1, 1908, £18,220; aggregates from Jan. 1, 1907, £18 489—decrease, £269.

Darlaston.—The question of the increased fare charged to children by the Birmingham and Midland Tramways Co. has been brought before the General Purposes Committee, and they have referred the same to the Association of Midland Local Authorities to see what united steps can be taken to get the fares reduced.

Halifax.—At the request of the Corporation Tramways Committee, Major P. Cardew and Mr. H. Graham Harris have inquired into the structural form of the cars and the types of brakes in use on the Halifax tramways. Besides taking evidence, they visited the tram depôt, and made a tour of the routes. Their report will be presented in due course.

Matlock.—A report from the cable tramway manager to the Urban District Council showed an income of £56. 19s. 2d. during the past month, and the expenses were £84, leaving a deficit of £27. The cable continued about the same as a month ago. He had seen several broken wires in splice, and he recommended the putting in of the new cable for Easter. The present cable had run the year and 10 months.

Stoke Newington.—Some excitement was caused on the morning of the 6th inst. in the High-street by one of the London County Council electric cars, City-bound, bursting into flames. The car was crowded to its utmost, and all had an exciting time in alighting. The outbreak was caused through the plough underneath fusing. After a time the fire was got under, when it was found that the road was on fire. This was soon extinguished.

Notts and Derbyshire Tramways Bill.—The Nottinghamshire and Derbyshire Tramways Bill, which is promoted to extend the time limit for the purchase of land and the completion of works authorised in 1903 and for other purposes, came before Mr. Registrar Campion, examiner of private Bills, on the 10th inst. After proof had been given of compliance with the Standing Orders, it was ordered to be reported to the House of Commons for second reading.

Underground Electric Railways Co.—An advisory committee, consisting of Mr. Edwin Waterhouse (chairman), Mr. Spencer Phillips, Mr. Marlborough Pryor, Mr. Thomas Skinner, and Mr. John Akroyd, with Mr. Lynden Macassey as secretary, has been formed for the purpose of considering, in conjunction with the Board and Messrs. Speyer, a scheme dealing with the profit-sharing secured notes and the financial requirements of the Underground Electric Railways Co. of London.

Longton.—Attention was called at the last meeting of the Town Council to the proposed alterations in the fares and conditions of the Potteries Electric Traction Co., more particularly with reference to workmen's tickets, and it was recommended that a strong protest should be made against the proposed alterations in the fares and conditions, particularly those affecting workmen's tickets, and authorise the town clerk to bring the matter before the Board of Trade if necessary.

Bradford.—The Corporation have confirmed the minutes of the Tramways Committee, which contained resolutions instructing the manager to apply to the Parks Committee for a site on the Wyke recreation ground for a waiting-room at the Wyke tramway terminus, and accepting the offer of Mr. J. Rennie Wilkinson to let to the Corporation on a 14 years' lease from April 1 next, with the option of purchase, the premises 5 and 7, Hall Ings, for use as central tramway offices at a rent of £460 per annum.

Keighley.—The Tramways Committee have reported to the Town Council that it is not anticipated that there will be any need for assistance from the rates for the year ending March 31, 1909. The Chairman of the committee said that this was the first time it had not been necessary to apply for assistance from the rates. For the present financial year they had already received £280 more since July than in the corresponding period of the previous year, and it was likely that for the full year there would be a net surplus of £500 to £600. In addition they would have £400 which was received from the rates last year, making altogether, they anticipated, about £1,000 to carry forward to a renewals fund.

Coatbridge.—The Glasgow Corporation Tramways Committee at their last meeting received a deputation from Coatbridge Town Council, who asked them to extend their lines from Baillieston to the centre of that town, a distance of three miles. The deputation stated that from a correspondence which they had had with the Lanark County Council they inferred that that body were in favour of the extension, but for some time the policy of the Corporation has been not to proceed with any tramway scheme outside the city until they are asked to do so by the local authority of the district, which in this instance is the County Council. In any case parliamentary powers would be required for the making of the extension.

Edinburgh.—The Dean of Faculty (Mr. Campbell, K.C.), the arbiter under the lease between the Corporation of Edinburgh and the Edinburgh and District Tramway Co., has issued his finding in connection with the dispute between the Corporation and the tramway company as to the running of cars on the circular route by Marchmont-road and Grange-road. Counsel was recently heard by the Dean of Faculty—Mr. Cooper, K.C., representing the Corporation, and Mr. Clyde, K.C., appearing for the tramway company. The Dean of Faculty has now decided that the tramway company are bound, when called upon by the Corporation, to restore the circular route, known as the Marchmont-road circular route.

Reading.—At a meeting of the Town Council the town clerk submitted to the Tramways Committee a letter from Messrs. Haslam and Son, of Reading, estate agents, stating that they had received an offer of £1,400 for the purchase of the site of the former tramways depôt and stables in Oxford-road, and requesting to be informed whether the Corporation would accept it. The committee recommended that the offer be not accepted, but that the chairman of the committee be empowered to accept an offer of £1,500 for the site, upon condition that any houses or shops erected upon it shall have a frontage of not less than 15ft., and be of a value not less than the value of the houses now erected and fronting upon Ormsby-street. This report was approved.

Glasgow.—Owing to the failure of the brakes of a tramcar, an accident occurred in Glasgow on the 11th inst. in the neighbourhood, and practically at the same hour, as the recent disaster which resulted in the death of two people and the injury of a number of others. A horse and lorry, the property of the East Coast Railway Co., were being driven across Castle-street and Cathedral-square, when the lorry was struck and damaged by the tramcar. The force of the collision knocked the lorry against the front part of another lorry, the horse yoked to which was thrown down on the pavement. Patrick M'Laughlin, who was sitting on the first-mentioned lorry, was thrown to the ground and injured. He was removed to the Royal Infirmary, where it was found that he was suffering from internal injuries and shock. The driver of the car stated that the brakes of his vehicle failed to act. The car was damaged.

Leeds.—On the 10th inst. a conference took place at the Leeds Town Hall between sub-committees of the Leeds and Bradford Corporation Tramways Committees in reference to the proposed service of through cars between Leeds and Bradford. The ingenious mechanism invented by Mr. C. J. Spencer, the Bradford city tramways manager, and Mr. W. H. Dawson, the deputy city surveyor for Bradford, by means of which the wheels on the cars are altered to fit the different gauges of the rails on the two systems, was some time ago given a thorough test, extending over five weeks, and gave much satisfaction in both cities. The conference was held for the purpose of arranging between the two committees terms upon which a through service should be permanently maintained. The matter was discussed at considerable length, and certain proposals were made which will be brought before a meeting of the Bradford committee.

Hastings.—The Railways and Tramways Committee reported to the Town Council at the last meeting that they had considered the question of the existing inequalities in the tramway fares. They referred the matter to a sub-committee, who communicated with the engineer and general manager of the Hastings Tramways Co. on the matter, especially pointing out that the fare from Hollington to the Albert Memorial was 1d. whilst that from Hollington to the south end of London-road was 2d., and that other inequalities were manifest. The general manager to the company has acknowledged receipt of the letter, stating that the matter had received the consideration of the directors at their last meeting, and that the fares fixed were manifestly too low, and, as a matter of fact, the fares had been found to be totally inadequate, and resulted in a loss on every passenger carried, and it was only by the application of a more adequate scale of fares on other parts of the system that the service of tramways could be maintained.

Stoke-on-Trent.—At a special meeting of the Highways Committee of the Council the town clerk submitted draft of a provisional order proposed to be applied for by the Potteries Electric Traction Co. and the North Staffordshire Tramways Co., under the Tramways Act, with respect to the alteration of tramways, confirmation of orders carried out, etc., and it was recommended that the town clerk be instructed to lodge objections to such draft order on the lines suggested by the borough surveyor. At an ordinary meeting of the committee the borough surveyor submitted a request from the Potteries Electric Traction Co. in connection with the proposed relaying of the tramway track from Campbell-place to the borough boundary at Fenton, that they might be allowed to construct a temporary track along the side of the road to enable the work to be more efficiently carried out. The committee recommended that the request be acceded to, provided the company undertake to carry out and complete the relaying from Campbell-place to Glebe-street within one week from the time the new metals are laid.

Kirkcaldy.—The fifth annual social under the auspices of Kirkcaldy burgh tramway and electric lighting employés was held in the Adam Smith Hall on the 5th inst. Councillor Fergusson, convener of the Tramway Committee, presided, and there was a crowded attendance. The Chairman stated that from May 15 to Dec. 31 they had sold 23,000 more units at the generating station for lighting than during the corresponding period last year, an increase of 27 per cent., and for motive power 86,000 extra units, equal to an increase of 66 per cent. on last year's figures. They had added 72 customers during the year, making a total of 400. Since the adoption of the mutual running of the tramways on Nov. 14 till Jan. 22 they had carried 30,000 more passengers than for the corresponding weeks of last year and taken £145 more money, while they had a saving of 180 in car miles run, or a net gain of £325. He had stated that the new system would mean a saving of about £1,000 a year, and on the same lines as at present they might look for a saving of £1,200. Last year they carried 4,640,000 passengers, and at the close of this year he believed they would have carried 5,000,000 passengers during the year, which would mean that they had carried the whole population of Kirkcaldy 120 times during the 52 weeks. During the evening an excellent programme of music was submitted, after which dancing was engaged in.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Paris.—Tenders are invited for the erection of a wireless telegraphy station at Cherbourg. Tenders by Feb. 19.

Manchester.—Tenders are invited for the supply of four water-tube boilers and accessories. Tenders by Feb. 25.

Marylebone.—Tenders are invited for the supply of coal to the electricity generating station. Tenders by Feb. 19.

Salford.—The Corporation invite tenders for the installation of electric light at the car depôt. Tenders by Feb. 17.

Salford.—The Tramways Department invite tenders for electrical and mechanical car accessories. Tenders by Feb. 17.

Islington.—The Borough Council invite tenders for the supply of electrical and engineers' stores. Tenders by Feb. 18.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Berlin.—Tenders are invited by the Prussian Government Railways for telegraph construction material. Tenders by Feb. 21.

Bukharest.—The Municipality of Craiova invite tenders for the construction of tramways. Deposit, £200. Tenders by March 13.

Remscheid.—The Municipality invite tenders for high-pressure turbines and turbo-pumps for the waterworks. Tenders by Feb. 15.

Wimbledon.—Tenders are invited for the annual supply of cables and conduits for the Electricity Department. Tenders by Feb. 18.

Wimbledon.—Tenders are invited for the annual supply of flame arc lamp carbons to the Electricity Department. Tenders by Feb. 18.

Manchester.—The Tramways Committee invite tenders for the supply of stores and materials. Tenders by Feb. 24. See advertisement.

Blackburn.—The Corporation invite tenders for the annual supply of stores to the electricity and tramways departments. Tenders by Feb. 15.

Reme.—The Post and Telegraph Department invite tenders for renewal of zincs for 110,000 batteries. Estimate, £2,860. Tenders by Feb. 20.

Paris.—The Post and Telegraph Department invite tenders for the supply of various materials for a period of three years. Tenders by Feb. 28.

Swansea.—The Corporation invite tenders for the supply of motors and starting switches during 12 months. Tenders to the Town Clerk by Feb. 21.

Hornsey.—The Borough Council invite tenders for the installation of electric light wiring and fittings in various public buildings. Tenders by Feb. 17.

Dover.—Tenders are invited for the supply of clothing and caps for the tramway inspectors, drivers, and conductors, for the Town Council. Tenders by Feb. 17.

Dusseldorf.—The Municipality invite tenders for the annual supply of materials and appliances to the Electric Supply Department. Tenders by Feb. 20.

Madrid.—The Public Works Department invite tenders for the construction and working of electric tramways in Barcelona and Seville. Tenders by Feb. 29.

Battersea.—The Borough Council invite tenders for the annual supply of various materials for the electricity department. Tenders to the Town Clerk by Feb. 18.

Sydney (N.S.W.).—The Postmaster-General invites tenders for 33 switchboards for private branch exchanges for common-battery working. Tenders by March 4.

Hammersmith.—The Borough Council invite tenders for the annual supply of stores for the electricity department. Tenders to Mr. H. Thompson, town clerk, by Feb. 19.

Salford.—The Tramways Committee invite tenders for the annual supply of stores, including electrical car accessories. Particulars from the General Manager. Tenders by Feb. 17.

Reading.—The Corporation invite tenders for the supply of about 3,000 tons of steam coal for the tramways fire station during year ending March 31, 1909. Tenders by Feb. 17.

Nelson.—Tenders are invited for the supply of clothing, for the Light Railways Committee. Samples may be seen at the Manager's Office, Electricity Works. Tenders by Feb. 20.

Handsworth.—The Urban District Council invite tenders for 315-kw. engine and dynamo and switchgear, and feed pump, economiser, and pipework. Tenders by March 4.

Gravesend.—The Electricity Committee invite tenders for the supply of 3,500 tons of rough small coal for the electricity works. Tenders to Mr. H. H. Brown, town clerk, by Feb 17.

Ilford.—The Urban District Council invite tenders for one 1,000-kw. steam dynamo and one water-tube boiler and accessories. Tenders by Feb. 25. See advertisement in last issue.

Hull.—Tenders are invited for the supply and erection of three 500-kw. 2,250-volt continuous-current dynamos. Tenders to the Chairman of the Electric Lighting Committee by Feb. 27.

Stockton-on-Tees.—The District Fund, Gas, and Electricity Committees invite tenders for the annual supply of stores. Tenders to the Town Clerk by Feb. 17. See advertisement in last issue.

Kilkenny.—Tenders are invited for the erection of an electric power-house at the asylum, for the Committee of the Kilkenny District Asylum. Tenders to Mr. M. J. Hogan, clerk, by Feb. 17.

Brussels.—Tenders are invited for the construction of an electric railway at Namur. Tenders to the Société Nationale des Chemins de Fer Vicinaux, rue de la Science 14, Brussels, by Feb. 25.

Salford.—The Tramways Committee invite tenders for the supply of uniform clothing for the tramway employés for the year ending March 31, 1909. Tenders to Mr. L. C. Evans, town clerk, by Feb. 17.

Portsmouth.—The Tramways Committee invite tenders for the supply of uniforms for inspectors, timekeepers, motormen, and conductors, etc. Particulars from the General Manager. Tenders by Feb. 17.

India Office, S.W.—The Secretary of State for India in Council invites tenders for the supply of rails and fastenings. Particulars from the Director-General of Stores, India Office, Whitehall, S.W. Tenders by Feb. 18.

Stockport.—The Electricity Committee invite tenders for the labour and materials required in erection and completion of stores, offices, etc., in Millgate, adjoining the electricity generating station. Tenders by Feb. 27.

Barking.—The Urban District Council invite tenders for the annual supply of stores for the electricity and tramways departments. Particulars from the Engineer at the electricity works. Tenders to the Clerk by Feb. 25.

East Ham.—The Corporation invite tenders for the installation of an approved generating plant with distributing pipes and radiators, and all other requisites, at the isolation hospital extensions. Tenders to the Town Clerk by Feb. 24.

London, N.E.—The London County Council invite tenders for the installation of electric lighting and fans at the Hackney Downs secondary school extension, Downs Park-road, N.E. Tenders by Feb. 26. See advertisement.

Leeds.—Tenders are invited by the Tramways Committee for the annual supply of stores, including electrical sundries. Particulars from Mr. J. B. Hamilton, general manager, Tramways Office, City-square, Leeds. Tenders by Feb. 21.

Aston Manor.—The Corporation invite tenders for one 2,000-kw. turbo-alternator, complete with condenser, air, and circulating pumps, etc. Tenders to the Chairman of the Electricity Committee by Feb. 17. See advertisement in last issue.

Rawtenstall.—The Corporation invite tenders for the supply and erection of one overhead travelling crane, and of a battery of accumulators, automatic reversible booster, etc. Tenders to the Town Clerk by Feb. 21. See advertisement in last issue.

Islington.—The Lighting Committee invite tenders for the supply of one 1,500-kw. steam turbine, condensing plant, switchgear, alternator, exciter, etc., and also for water-tube boilers and coal-conveying plant for the electricity works. Tenders by Feb. 25.

Bristol.—Tenders are invited for the supply of cables and appliances for conveying electrical energy to the Avonmouth Docks, and for construction and maintenance for 12 months. Tenders to the Secretary of the Docks Committee, 19, Queen-square, Bristol, by Feb. 17.

Belfast.—The Tramways and Electricity Committee invite tenders for the supply of low-tension insulated vulcanised bitumen cables during 12 months ending March 31, 1909. Tenders to Mr. T. W. Bloxam, city electrical engineer, by Feb. 25.

Manchester.—The Tramways Committee invite tenders for the supply of (*a*) steel girder tramway rails, (*b*) tiebars, (*c*) span wire brackets. Particulars from the General Manager. Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by Feb. 18.

Wimbledon.—The Corporation invite tenders for one 1,000-kw. steam-driven turbo-alternator, with condensing plant, two water-tube boilers, economisers, pipe work and feed pump, high-tension main switchboard, and switchboard gallery. Particulars from the Borough Electrical Engineer. Tenders by Feb. 18.

Castlerea.—The Rural District Council invite tenders for suction gas plants, gas-engines, dynamos, battery, switchgear, overhead distribution lines, arc lamps, and service connections, in connection with the electric lighting scheme for the town of Ballaghaderreen. Tenders to Mr. P. A. Flanagan, clerk of the Council, by Feb. 22.

Bermondsey.—The Borough Council invite tenders for the annual supply of stores to the electricity and destructor works, including arc lamp carbons and brushes, cable and jointing materials, conduits, electricity meters, demand indicators and main fuses, engine oils, meter boards, street frames and covers, and joint-boxes. Tenders to the Town Clerk by Feb. 17.

Wimbledon.—Tenders are invited for the annual supply of stores for the electricity department, including (1) engine room stores; (2) joint boxes and jointing material; (3) transformers; (4) meters; (5) oils; (6) incandescent electric lamps, carbons, and accessories; (7) castings; (8) firebricks and fireclay. Particulars from the Chief Electrical Engineer. Tenders to the Town Clerk by Feb. 29.

RESULTS OF TENDERS.

Bury.—The Corporation have accepted the tender of C. Dennis, Manchester-road, for the erection of a chimney shaft at the intended electricity station, Chamber Hall, Bury.

Hackney.—The Libraries Committee recommend the acceptance of the tender of Messrs. Smith and Co., of 25, Lower Clapton-road, for the supply and fixing of intercommunication telephones.

Stepney.—The Electricity Supply Committee recommend the acceptance of the tender of W. T. Henley's Telegraph Works Co. for the supply of 7/18 concentric paper-insulated lead-covered cable, at £98 per mile, during the period ending Dec. 31, 1909.

Colchester.—The tender of Stanford and Co. has been accepted for the supply of a 24in. square steel pipe for connecting up the two sides of the boiler-house with the forced air draught and the overhead driving gear for the mechanical stokers, together with two isolating dampers.

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Worcester.—The Council have accepted the following tenders for machinery to be installed at the Hylton-road station: Phœnix Dynamo Manufacturing Co., Bradford, balancer dynamo, £123; Electric Construction Co., Wolverhampton, 400 kw. generator, with Belliss and Morcom engine, £2,262; W. H. Allen, Son, and Co. Queen's Engineering Works, Bedford, condenser, air pump, and circulating engine, £925.

Salford.—The Town Council have accepted the following tenders: United Electric Car Co., Preston, 20 car bodies, £4 8s. 12s. 6d each; Hurst, Nelson, and Co., Motherwell, four car bodies, £458. 17s. 6d. each; Mountain and Gibson, Bury. 23 trucks. £64. 10s each, and one truck at £110; British Westinghouse Co., Trafford Park, Manchester, 24 electrical equipments, including trolley base £279 each; S. Rawlinson and Sons, Blackburn, four salt wagons, £125 each.

Stepney.—The Electricity Supply Committee have received the following quotations for the provision of a power-driven lathe:

W. H. Willcox and Co.	£79	0	0
Ditto	66	19	0
G. Hatch, Limited	69	10	0
Buck and Hickman	84	10	6
Pfeil and Co.	87	13	0
Ditto *	94	10	0
Burton, Griffiths, and Co.	113	5	0
Ditto	116	7	6
Smith and Coventry	127	0	0
Hetherington and Sons	185	0	0

* Recommended for acceptance.

London.—The London County Council have received the following tenders for the manufacture, delivery and laying of low-tension electric cables, telephone cables, etc., required for the electrification of the Caledonian-road and Seven Sisters-road tramways:

Johnson and Phillips, Charlton*	£4,020	18	4
British Insulated and Helsby Cables, Prescot	4,056	18	3
Western Electric Co., North Woolwich	4,070	2	2
Siemens Bros. and Co., Westminster	4,093	17	9
W. T. Henley's Telegraph Works Co., London-wall, E.C.	4,118	16	10
Callender's Cable and Construction Co., Victoria-embankment, E.C.	4,148	16	3
W. T. Glover and Co., Manchester	4,401	16	11
Union Cable Co., Eagle Wharf-road, N.	4,768	18	10

* Recommended for acceptance.

London.—The London County Council have received the following tenders for the laying of cable ducts, etc., for the electrification of the Caledonian-road and Seven Sisters-road tramways:

Dick, Kerr, and Co., Cannon-street, E.C.*	£3,375	17	8
C. Ford, Willesden Junction, N.W.	3,734	14	10
W. Muirhead and Co., Queen Victoria street, E.C.	3,748	4	1
D. R. Paterson, Limited, Camden Town, N.W.	3,804	8	11
Westminster Construction Co., Westminster, S.W.	3,881	10	0
J. Mowlem and Co., Westminster, S.W.	4,069	4	5
Greig and Matthews, Queen Victoria street, E.C.	4,196	19	5
Callender's Cable and Construction Co., Victoria-embankment, E.C.	4,200	11	3
Reid Bros., Wharf-road, N.	4,359	7	0
Fry Bros., Greenwich	4,741	15	3
J. A. Ewart, Westminster, S.W.	4,811	3	10

* Recommended for acceptance.

OPENINGS FOR CONTRACTORS.

ABBASSIA (EGYPT)—Lunatic asylum, Public Health Department.

ABERDARE—Workmen's dwellings (£10,000), Urban District Council.

ABERDEEN—Three houses, Clifton-road, Mr. W. Ferrans; additions to granite works, King-street, Hill-o'-Fare Granite Quarrying Co.; additions, 2, Bon Accord-square, Mr. W. E. Gauld, architect; dwelling-house, View-terrace, Messrs. Brown and Watt, architects; alterations and additions, 17-19, Bon Accord-street, Messrs. Campbells, Limited; additions, fish-curing premises, Ocean-row, Mr. R. Melville.

ABERLOUR—Additions to orphanage, Inverness Trustees.

ACCRINGTON—Twenty-four houses, Stevenson-street, Messrs. Howard and Bullough.

AGHALEE—Labourers' dwellings (£10,250), Rural District Council.

ALDERSHOT—Two houses, Coleman-road, Mr. J. Sumpster; coach-house, etc., Perowne-street, Mr. W. B. Fawn; extension of mission church, Queen's road, Rev. J. Le Verd Leigh; house, St. Michael's-road, Mrs. H. Fowler.

ALDERSHOT—New hippodrome, Mr. C. Soames.

ALNWICK—Villa, Alnmouth road. Mr. W. Hindmarsh; alteration of premises, North-Eastern Bank.

ALSAGER—Additions to Congregational Sunday school. Mr. W. Campbell, architect, Hanley.

ANDOVER—Two houses, Charlton-road; drill hall, East-street, Messrs. Beale and Sons; bungalow, Andover Down, Mr Howe; two houses, Weyhill-road, Mr. A. Sainsbury; two houses, Love-lane, Mr. Newton.

APPLEBY—Elementary school, Westmorland Education Committee.

ASTON—Extensions to electricity undertaking (£33,000), Town Council.

ARMITAGE BRIDGE—Houses, New-road, Mr. M. Cartwright.

ASPULL—Three houses, Wigan-road, Mr. M. Armstrong; two houses, Bolton-road, Mr. T. Mercer.

AVIEMORE—Motor garage, Station Hotel, Messrs. Ballie and Gifford, Edinburgh.

AUCKLAND—Alterations, Co-operative stores, Coundon; alterations, working men's club, Newfield.

AUDENSHAW—Offices, house, etc., Hanover-street, Mr. A. Hopkinson.

AXBRIDGE—Stabling, etc. (£300), Town Council.

AYLESBURY—Additions to Royal Buckinghamshire Hospital (£10,000), Hospital Committee.

BACUP—Rebuilding Traveller's Rest public-house, alterations Farholme Tavern, alterations Hare and Hounds Inn, Messrs. J. Baxter.

BALDOCK—Convent. Messrs. Underwood and Kent, architects, Letchworth.

BALLAGHADEREEN—Electric lighting for the town, Castlerea Rural District Council.

BALLYMENA—Labourers' dwellings (£18,860), Rural District Council.

BALLYWATER—Additions, First Presbyterian Church, Trustees.

BANBURY—Additions to house, Wykham Park, Mr. R. W. Perks, M.P.; showroom, Horse-fair, Banbury Motor Co.

BANHAM—Alterations and additions to elementary school, Norfolk Education Committee.

BARNBY MOOR.—Foxhound kennels, boiling-house, meal stores cottages, etc. Mr. G. A. Wilson, Sheffield, architect.

BARTON—Hotel, Trafford-road, Mr. E. Holt.

BATH—Rebuilding business premises, Northumberland-place. M C. B. Oliver, architect.

BATLEY—Completing town hall (£3,653); improvements to market (£9,746), Town Council.

BATLEY—Twenty houses, Pearl-street and Ambler-street, Mr. G. Mortimer.

BAWNBOY—Labourers' dwellings (£9,677), Rural District Council.

BELPER—Post office, Town Council.

BEN RHYDDING—Elementary school, North Riding County Council.

BEN RHYDDING—Private residence. Mr. W. H. Marten, architect.

BERKSHIRE—Extensions to asylum (£5,192), Berkshire County Council.

BERMONDSEY, S.E.—Flats, Willow-street, Mr. J. Harman; extensions to bakery, Messrs. Spillers and Banks; shop, Lynton-road, Mr. T. Sloman.

BERWICK—Disinfector house, workhouse, Board of Guardians.

BIRKENHEAD—Post office, Argyle-street (£12,000), Mr. J. Gabbuti.

BIRMINGHAM—Fire station, City Council.

BLACKBURN—Alterations and additions to Mayson-street Council Schools, Town Council.

BLACKBURN—Wesleyan church, Montague-street. Mr. F. G. Parkinson, architect.

BOLTON—Extensions to cotton mills, Messrs. Young, Limited; mill extensions, Messrs. Taylor and Co.

BOSTON SPA—Detached house. Mr. F. Mitchell, architect.

BRADFORD—Warehouse and boiler-house, Leeds-road, Messrs. S Robinson and Sons.

BRAMALL—Business premises, Moor-lane, Messrs. Birkerton and Day.

BRIDLINGTON—Schools (£12,000), Town Council.

BRISTOL—Alterations to Old Dutch House, Wine-street, Mr. W. S. Skinner.

BRISTOL—Banking premises, St. Stephen's-avenue. Mr. W. H. Watkins, architect.

BROADSTAIRS—Pumping station, Rumfields, Urban District Council.

BROMLEY—Secondary school (£3,708), Town Council.

BROMLEY—Two houses, Bromley-crescent, Messrs. A. P. Poingdestre and Son; 21 houses, Bickley-crescent, Mr. E. R. Ellis.

BRYMBO—Elementary school, Denbighshire Education Committee.

BUDE—Elementary school, Cornwall Education Committee.

BURNHAM—Additions, technical institute, Somerset County Authority.

BURNLEY—Steam generator (£6,835), Town Council.

BURTON—School premises, managers St. Modwen's School.

BURY—Secondary school, Wellington-road (£12,500), Education Committee.

BYFLEET—Parish church (£3,000), Ecclesiastical Commissioners.

CAISTOR—Pumping station. Mr. E. J. Silcock, engineer.

CALLAN—Labourers' dwellings (£24,913), Rural District Council.

CAMBERWELL S.E.—Extensions to King's College Hospital, Denmark-hill, Hospital Committee.

CAMBRIDGE—Elementary school and school of arts and crafts (£11,500), Education Committee.

CARNARVON—Public slaughter-house (£450), Town Council.

CARLISLE—Chapel in Lowther-street, Wesleyan Trustees.

CAVAN—Housing scheme (£68,384), Rural District Council.

CHARLTON—Church, Messrs. Beale and Sons, Andover.

CHATTERIS—house, South Park-street, Mr. J. S. Nix.

CHELMSFORD—Alterations to schools in The Friars; schools to accommodate 600 scholars in the Springfield Ward.

CHELTENHAM—Alterations, Red Lion public-house, Mr. Higgins.

CHELTENHAM—Sanatorium for consumptives, Birmingham Health Committee.

CHRISTCHURCH (BOURNEMOUTH)—Infirmary, Board of Guardians.

COLCHESTER—Four houses, Greenstead-road, Mr. J. Smith; two houses, Honeywood road, Mr. W. Stone; factory, Hawkins-road, Messrs. Spottiswoode and Co.

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COLCHESTER—Secretarial offices, etc., Essex Agricultural Society.
CLACTON—Electric generating plant, etc. (£4,000), Urban District Council.
COLNE—Installation of high-tension cable (£1,670) and extension of mains (£1 000), Town Council.
COLSTON—Elementary school (£10,00), Maryhill School Board.
COOKHAM—Elementary school (£600), Berkshire County Council.
COOKSTOWN—Housing scheme (£16 7s9), Rural District Council.
CORK—Additions, Lee road, City Engineer.
CRAMLINGTON—Mortuary chapel to accommodate 120 persons, Urban District Council.
CRAVEN—Additions to high school, Education Committee.
CREWE—Training college (£28,914), Cheshire Education Committee.
CROWBOROUGH—Enlargement of schools, East Sussex Education Committee.
CRYNANT—Villas. Mr. J. C. Rees, architect, Neath.
DARLINGTON—Shelter, etc., Bank Top Park, Corporation.
DARLINGTON—Refreshment rooms (£300), Town Council; new mortuary, Town Council.
DARLINGTON—Two houses, Cobden street, Messrs. Kitching and Lee; houses, Staindrop, Woodlands, and Leafield roads, Messrs. Richardson and Co.; six houses, Lewes-road Mr. J. E Chilton; six houses, Crosby-street, Mr. F. Martin; 12 houses, Oak Dene-avenue, Mr. E. Berry; alterations to London Tavern, Priestgate, Mr. G. W. Davis.
DARTMOUTH—Houses, Mayor's-avenue. Mr. E H Beck, architect.
DONCASTER—Hotel, High-street, Corporation Sanitary Committee.
DORCHESTER—Alterations to Council school, Colliton-street, Education Committee.
DUMBARTON—Repairs to parish church (£1,500), Ecclesiastical Commissioners.
DUNDEE—Workshop, Broughty Ferry-road, Messrs. Imrie and Summers; school, Lawside-road, Sisters of Mercy; houses, Strathmartine-road, Messrs. J. Maclaren and Sons; shop, Lochee-road, Mr. A. Johnstone.
DUNDEE—Extensions to post office, Commissioners of Public Works.
EALING—Elementary school, Mattock-lane, Education Committee.
EASINGWOLD—Salvation Army hall.
EASTBOURNE—Additions, Holy Trinity Church, Church Council.
ELLAND—Villa, Victoria-road, Mr. B. Sutcliffe.
ELLESMERE PORT—Public library, Town Council.
ERDINGTON—Technical school, Birmingham Education Committee.
EAST GRINSTEAD—Board-room, lavatories, etc., Board of Guardians.
EAST HAM—Generating plant, Town Council.
EASTHAMPSTEAD—Elementary school (£1,580), Berkshire County Council.
EAST ILSLEY—Elementary school (£2,548), Berkshire County Council.
ECCLES—Elementary school, Clarendon-road. Mr. H. Lord, architect, Manchester.
ECCLES—Alterations and extensions, Hare and Hounds Hotel, Church-street.
ECCLES—Shop, Willington-road, Mr. W. Gatward.
EDGWARE—Chapel. Mr. W. Parmenter, Braintree, architect.
EDINBURGH—Electricity supply, burgh assessor's office, Mr. F. A. Newington.
EDINBURGH—Extensions to law courts, Commissioners of Public Works.
EDINBURGH—Three houses, Canongate, Mr. J. B Smith; construction of platforms, Balgreen-road, N.B.R. Co.
EDWINSTOWE—Alterations and additions to Wesleyan chapel, Trustees.
EVESHAM—Alterations and additions to institute buildings, Market-place, Mr. G. Hunt.
EXMOUTH—Public conveniences, Urban District Council.
FAIRFIELD—Additions to school (£150), Fairfield Endowed School Trustees.
FARNHAM—House, Great Austen Estate, Mr. J Price; house, Hyde Park-road, Mr. J. H. Hale; house, Searle-road, Mr. F. Robins; additions to St. Polycarp's Roman Catholic School.
FARNWORTH—Additions, electricity works, District Council.
FECAMP (FRANCE)—Bath and wash-houses (500,000fr.), Municipal Council.
FELIXSTOWE—Extensions to electricity plant (£1,559), Urban District Council.
FINCHLEY—Extension of electric lighting undertaking (£22,000), District Council.
FINSBURY, E.C.—Three warehouses, Chiswell-street, Mr. C. E. Jackson.
FRASERBURGH—Three schools (£12,000), School Board.
GAINSBOROUGH—Hospital, Hospital Committee.
GAINSBOROUGH—Refuse destructor (£7,000), Town Council.
GOLCAR—Villa residence, Station-road. Mr. J. Berry, architect.
GORSEINON—Chapel (£2,000), Trustees of the Welsh Church.
GRANARD—Housing scheme (£27,024), Rural District Council.
GREAT CORNARD—Elementary school, Bury St. Edmunds Education Committee.
GREENWICH, S E.—Baths, Borough Council.
GRIMSBY—Model lodging-house and shop, King Edward-street. Mr. J. J. Creswell, architect.
GWERSYLLT—Elementary schools, Rhosrobin-road, Education Committee.
GREYSTONES—Installation electric light (£3,000), Town Council.
HACKNEY, N.E.—Thirty-six houses, Egerton-road, Mr. P. Roche.
HALIFAX—Café, Commercial-street. Mr. W. Clement Williams, architect.
HAMMERSMITH, W.—Extensions to electricity undertaking (£12,190), Borough Council.
HAMMERSMITH, W.—Factory, Brook Green, General Electric Co.
HAMPTON—Enlargement of grammar school, Urban District Council.
HANDSWORTH—Extensions to electricity plant, Town Council.
HANLEY—Electric lighting (£18,000), Town Council.
HAREHOLME—Generating station, Town Council.
HARPURPHEY—Baths and wash-houses (£38,500, Manchester Corporation.
HARROGATE—Fitting kursaal (£3,965), Town Council.
HARROGATE HILL—Elementary school, Education Committee.
HARTLEPOOL—Primitive Methodist church (£3,000), Central Estate District.
HASTINGS—Additions to infirmary, Frederick-road, Guardians.
HASTINGS—Alterations, Hare and Hounds public-house; alterations, Angel public-house, Southdown and East Grinstead Breweries; bakery, Shepherd-street, Mr. W. H. King.
HENDON—Fifty houses, Child's Hill, Urban District Council.
HENGOED—Alterations and additions at the Council schools, Glamorgan County Council.
HEOLYCUE—Elementary school, Education Committee.
HERNE HILL, S.E.—Buildings, Norwood-road, Messrs. May and Perrin.
HEYSHAM—Improvement of town hall (£1,400), Town Council.
HEYWOOD—Additional extensions to electricity works (£3,000), Town Council.
HODDESDON—Two houses, Walton-road, Mr. Byatt.
HOPETOWN—Elementary school, Education Committee.
HOUGHTON—Sub-station at Philadelphia, Rural District Council.
HULL—Alterations to Locomotive Hotel, Hessle-road, Messrs. Habron and Robson.
HULL—Electric lighting, Selby-street West School. Mr. J. H. Hurst, architect.
HULL—Shop, Plane-street, Mr. E. Whitlock; alterations at Crowle-street, Gordon-street, Norfolk-street, and Church-street police stations, Town Council.
HUTTON-LE-HOLE—House. Messrs. Ridgway and De Bock Porter, architects.
HYTHE—Houses, Earlsfield-road, Mr. R. Reynolds; business premises, High-street, Mr. F. Austin.
ILFORD—Extensions to electricity plant, Urban District Council.
ILFORD—Additions to St. Mary's Church, Ecclesiastical Commissioners.
ISLINGTON, N.—Electric lighting plant, Borough Council; additions 95, Hornsey-road, Messrs. Thorpe and Furniss.
JAMESTOWN—Additions, parish church, Churchwardens.
JERSEY—Post office, Commissioners of Public Works.
KEIGHLEY—Office, etc., Parson-street depôt, Town Council.
KESWICK—Six houses, Blencathra-street, Mr. Ralph; alterations, Queen of the Lake's Pavilion and Royal Oak Hotel, Mr. T. Hodgson.
KILKENNY—Electric power-house at the asylum, Lunacy Commissioners.
KILMARNOCK—Infectious diseases hospital at Kirklandside (£10,877), Town Council.
KING'S NORTON—Public baths at Stirchley (£10,000), District Council
KING'S LYNN—Motor garage, Globe Hotel. Mr. L. F. Eagleton, architect.
KINGSWOOD—Thirteen dwelling-houses. Mr. A. R. Trew, architect, Bristol.
LANARK—Laundry, Cambuslang-road, Richmond Park Laundry Co.; two villas, Sandyhills, Messrs. Wards and Wallace; three houses, Brownlie-gardens, Messrs. R. Buchan and Co.; three houses, Balmore-road, Mr. D. McBeth; three houses, Calton-street, Mr. A. Simpson; warehouse and buildings, Shieldhall, Scottish Co-operative Wholesale Society.
LANCASTER—Children's homes, Board of Guardians.
LEDBURY—House, New-street, Mr. C. Davies.
LEEDS—Congregational church, Hunslet-road, Local Committee.
LEOMINSTER—Elementary school, South-street, Hereford County Education Committee.
LEOMINSTER—Alterations to premises, Corn-street, Mr. Smith.
LERWICK—Ice factory, Town Council.
LEVENSHULME—Extensions to premises, Manchester and Salford Co-operative Society.
LEWES—New wards, isolation hospital, Town Council.
LIMERICK—Housing scheme (£17,734), Rural District Council.
LINGDALE—Workmen's institute (£1,500), Trustees.
LINTHWAITE—Two houses, Warneford-road, Mr. J. Crowther; house, Cowersley-road, Mr. C. Livesey.
LITTLEHAMPTON—Shelter on green (£1,500), Urban Council.
LLANDRINDOD WELLS—Additions to Holy Trinity Church (£9,000), Churchwardens.
LLAWR-Y-BETTWS—Elementary school, Welsh Campaign Committee.

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LONDON, N.—Fire station, Caledonian-road, London County Council.
LONG EATON—Lace factory, Oxford-street. Mr. J. Shelton, architect.
LONG EATON—Electricity works (£10,000), Urban District Council.
LONGTON—Additions to Globe Inn, Heathcote-road, Messrs. J. Joule and Sons; additions to Phœnix Laundry, Stone road, Phœnix Laundry Co.; workshops and storerooms, Longton Hall, Messrs. Ferneyhall and Son.
LUTON — School-chapels in Dallow and Dunstable roads, Local Wesleyans.
LUTON—Eight houses, Reginald-street, Mr. W. Baxter; two houses, West Hill-road, Mr. T. Allen; six houses, Naseby-road, Mr. T. Ashton; two houses, Reginald-street, Mr. T. Chandler; eight houses, Naseby-road, Mr. S. W. Johnson; 16 houses, Selbourne-road, Mr. H. H. White; six houses, Clipston-road, Mr J. Frost; six houses and shop, Dallow-road, Mr. W. Frost; two houses, Chatsworth-road, Mr. A. Brown; 14 houses, Newcombe-road, Messrs. Hill Bros.; elementary schools, Wellington-street and Adelaide-street, Trustees of Baptist Church; mission-room, Dumfries-street, Trustees.
LYTHAM—Vestry, St. Cuthbert's Church (£430), Churchwardens.
MAGOR—Elementary school, Monmouthshire Education Authority.
MAIDSTONE—Brewery, Messrs. Style and Winch, Limited.
MANCHESTER—Public conveniences, Delamere-street, Corporation.
MANCHESTER—Elementary school, York-street, Education Committee; packing warehouse, Princes-street, Messrs. James, Limited; packing premises, Princes-street, Messrs. Vickers; business premises, Piccadilly, Messrs. Pugh, Davis, and Co.
MANSFIELD—Additions to Broomhill School, Education Committee.
MANSFIELD WOODHOUSE—Congregational hall, Priory-road, Trustees.
MARSDEN—Elementary school (£4,320), Colne Valley District Education Sub-Committee.
MARSDEN—Engine-shed, New Inn, Mr. J. Brook; houses, High Level, Mr. Hanson; weaving shed, Messrs. Robinson Bros.
MERTHYR—Pavilion at Mardy Hospital, Health Committee.
MEXBOROUGH—Fire station (£450), market (£1,120), Town Council.
MIDDLETON—Enlargement to Council schools, East Suffolk Education Committee.
MILFORD—Chapels, etc., cemetery, Parish Council.
MONAGHAN—Additions to workhouse, Board of Guardians.
MONTEVIDEO—Central station and offices (25,000dol.), Montevideo Telephone Co.
MORLEY—Alterations to Grove Mills. Mr. T. A. Buttery, architect.
MORPETH—Elementary school (£1,500), Northumberland Education Committee.
MURDIESTON—Church, Members of the existing Mount-pleasant U.F. Congregation.
NELSON—Housing scheme (£14,000), Town Council.
NEWBURY—Reconstruction, railway station, Great Western Railway Co.
NEWCASTLE — Municipal dwellings, Walker-road, (£8,748), Town Council.
NEWHEY—Extensions to Coral Spinning Mill. Messrs. Smethurst, architects.
NEWPORT—Elementary school, Stow-hill, (£26,000): technical institute, Clarence-place, (£20,000).
NEW ROMNEY—Lifeboat house, Town Council.
NEWTOWNGORE — Dispensary and dispensary residence, Bawnboy Board of Guardians.
NORTH BERWICK—Public-house. Mr. Ness, architect.
NORTH BROOMHILL—School-chapel, Primitive Methodist Trustees.
NORWICH—Mission hall, St. Martin's, Churchwardens.
NORWOOD—Six houses, Canterbury-grove. Mr. J. Wilson.
OBAN—Additions to the Argyllshire Gathering Hall. Mr. C. Macintyre, architect.
OGMORE VALE—Chapel. Mr. J. Hurley, architect, Glamorgan.
OLDHAM—Palace Hippodrome, Union-street, Variety Enterprises, Limited.
OLDHAM—Spinning mill (£80,000), Devon Cotton Spinning Co.
OXFORD—Police offices, City Council.
PAIGNTON—Science and art school, Bishop's-place, Urban District Council.
PADDINGTON, W.—Stores and stabling, Paddington-green, Messrs. W. F. Meakin and Sons; House, Blomfield-road, Mr. G. Remington.
PENDLETON—Additional electric light installation, central car depôt, Salford Tramways Committee.
PENTRE—Alteration to business premises, Ystrad-road, Mr. T. E. Richards.
PENTYRCH—Residence, Mr. F. C. Stibbs, Cardiff.
PONTYCYMMER — Higher elementary school, Glamorgan County Council.
PONTYPRIDD—Additions at Llwynpia Workhouse, Board of Guardians.
PORTSMOUTH—Service home for soldiers and sailors, Wesleyans.
PRESTON—Six houses, Guardians.
PRESTON—Public baths (£16,000), Town Council.
PRESTONPANS — Public-house, Redburn, Messrs. Bruce and Sons, Edinburgh.
PRUDHOE—Two shops and houses, Front-street, Mr. J. Harkness.
PYNTYLA—Villa residences, Messrs. Evans and Williams, Pontypridd.
RAGLAN—Elementary school, Education Authority.
RAMSGATE—Elementary school, Town Council.
RAWTENSTALL—Extensions to electricity plant, Town Council.
READING—Public conveniences, Southampton-street (£550).
REDDISH—Rebuilding Grey Horse Inn, Broadstone-road, Mr. A. Lees.
REDDITCH—Electricity works (£1,500), Urban District Council.
RHYL—Assembly-rooms (£8,087), Town Council.
ROSSENDALE—Vicarage (£1,400), Parishioners of St. Anne's.
ROTHERHAM—Business premises, Masborough Equitable Pioneers' Society.
ROYTON—Church, parish of St. Annes; additions to Monarch Mill, Monarch Mill Co.
RUGBY—Alterations at the slaughter-houses, Bath-street, Urban District Council.
ST. ANNES ON-SEA—House. Mr. Herbert Wade, architect.
ST. DOGMAELS—Factory. Mr. L. Lewis, architect, Cardigan.
SANDWICH—Two houses, First-lane, Mr. Frost; alterations to house, Sandown-road, Mr. S. Shultz.
SHEFFIELD—Dwellings (£10,309), City Council.
SHEFFIELD — Extensions at the engineering shop, Abney-street, University.
SHOEBURYNESS—Four houses, Richmond-avenue, Mr. A. J. Harris.
SKEGNESS—Hydropathic establishment. Mr. R. C. Sutton, Notts, architect.
SOUTHALL—Additions to sanatorium, Urban District Council.
SOUTHAMPTON — Additions to grammar school, West Marlands (£2,902). Mr. A. F. Gutteridge, 9, Portland-street, architect.
SOUTH CROSSLAND—Four houses, Summer-street, Mr. M. Pearson; business premises, Co-operative Society.
STAFFORD — Houses, Cambridge-street, Messrs. Silvester, Parker, Norris, and Hanson; house, Edge-street, Mr. E. S. Bream; three houses, Marsh-street, Mr. J. Taylor; motor garage, Alexandra Hotel, Tipping-street, Messrs. Eley's Stafford Brewery.
STANTON HILL—Primitive Methodist Sunday school, Circuit Steward.
STEETON—Seven houses, Mr. W. Bailey, Bradford.
STEETON Seven houses, East-parade, Messrs. J. Dixon and Sons.
STOCKPORT — Stores, offices, etc., Millgate, adjoining electricity generating station, Electricity Committee.
STOKE-ON-TRENT—Extension of the generating plant (£5,965), Town Council.
STRABANE—Workmen's dwellings, Rural District Council.
STRATTON—Additions, Council schools, Wilts Education Committee.
SUNDERLAND—Catholic school, Spring Garden-lane; mission church in Rutland-street, Trustees
SUNDERLAND—Two houses and shops, Windsor-terrace, Mr. H. T. D. Hedley; house, West Moor-road and Exeter-street, Mr. Joseph Spain; two houses, Canon Cochin-street, Mr. H. E. Robinson; house, Tunstall-road, Mr. John Eltringham; two houses, Hastings-street, Mr. H. E. Robinson; two houses, Exeter-street and Oxford-street, Mr. Joseph Spain.
SWAFFHAM—Alterations and additions at workhouse, Board of Guardians.
SWAFFHAM—Business premises, Station-street, Messrs. Kenny and Co.
SWINDON—Eighteen houses, Elmina-road, Mr. A. Colborne; 26 houses, Harcourt-road, Mr. H. Cook.
TAMWORTH—Extension to cemetery (£1,600), Town Council.
TEDDINGTON—Housing scheme, Urban District Council.
TERRINGTON—Two houses. Messrs. Walker and Walker, architects, Wisbech.
TINGLEY—Wesleyan Sunday schools. Messrs. Garside and Pennington, architects.
TONBRIDGE—Additions, Sussex-road Council School, Kent Education Committee; additions, Walmer House, Bordyke, Mr. A. T. Beeching; house, Yardley Park-road, Messrs. Martin and Co.
TORQUAY—Pavilion, Town Council.
TORQUAY—Electricity station at Upton (£20,000), Town Council.
TRURO—Additions to cathedral (£15,369), Ecclesiastical Commissioners.
TUNSTALL—Manufactory, Scotia-road, Grindley Hotel Ware Co.
UCKFIELD—Single-cylinder steam road-roller (£380), Rural District Council.
VELINDRE—Public hall, Parish Council.
VLADIVOSTOK—Electric tramways (£158,000).
WALLASEY—Grammar school, Cheshire Education Committee.
WALLSEND—Buildings, Thermal Syndicate Co-operative Society.
WANDSWORTH, S.W.—Motor garage, Streatham-hill, Messrs. Treacher and Son.
WARRINGTON—Branch shops, Co-operative Society.
WELLINGBOROUGH—Two houses, Gisbourne-road, Mr. W. Stevens; eight houses, Albert-road, Mr. A. W. Curtis.
WESTON-SUPER-MARE—Alterations, Council school, Somerset County Education Committee.
WESTMINSTER, S.W.—Block of office buildings, Tothill-street, Mr. J. S. Gibson.
WESTMINSTER, S.W.—Buildings, Palmer-street. Messrs. Barlow and Roberts.
WHITEBROOK — Elementary school, Monmouthshire Education Authority.
WHITLEY BAY—Goods station, N.E.R. Co.
WEYBRIDGE—Public offices, Urban District Council.

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WILMCOTE—Four villa residences near Stratford-on-Avon. Messrs. Knight and Hebery, architects.

WILLIAN—Houses, Messrs. Underwood and Kent, Letchworth.

WINCHESTER—Public convenience, City Council.

WINDSOR—Secondary school, Berkshire County Council.

WINTON—Houses, New-lane, Mr. W. Gatrix; additions to school, Worsley-road, trustees U.M.F. Church; houses, Worsley-road, Mr. E. Kearsley.

WISSAGE—Children's home. Mr. R. J. Barnes, architect, Litchfield.

WOODLEY—Alterations and additions at Council school, Stockport Education Committee.

WORCESTER—Plant, Hylton-road station (£3,310), Corporation.

WORTHING—Free library and museum, Chapel-road, Mr. H. A. Crouch.

WORLE—Elementary school, Somerset Education Committee.

WREXHAM—Six houses, Baron's-road, Mr. E. Hughes.

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

The half-yearly meeting of the City and South London Railway Co. was held on Tuesday at 71, Finsbury-pavement, E C.

The Right Hon. C. B. STUART-WORTLEY, M.P., presided, and in moving the adoption of the report stated that the extension of the line to Euston was now open for traffic, and had brought them the substantial increase of £6,376 to their net revenue. This was not so great an increase as they were led to hope. Had the increased traffic gone on at the average rate of £645 per week, which was shown for the first fifteen weeks, they would have had an increased gross revenue for the half-year ending December, 1907, of £16,700 instead of £12,027. The cause for this increase was to be found in the fact that their customers had open to them for fresh-air purposes three beautiful new districts which they had not in 1906, which districts were served by the London and North-Western, Midland, and Great Northern Railways, and he hoped that if 1908 had a fine summer they would gain from the increased temptations offered to visit these districts something of that which a fine summer caused them to lose on their purely urban traffic. This consideration also applied to the Charing Cross and Hampstead Tube, which was opened in June last, and from which they hoped to get a great advantage. They had suffered from increased tramway competition in the North of London, which had been brought about by the opening of the London County Council tramways running from the northern end of Finsbury-pavement to Islington and King's Cross. This might account for the sum of nearly £1,000 decrease shown in the bookings to and from the Angel for the half-year. His attention had been drawn to the extent to which railway construction and extension had been checked by the high rates at which railways now had to raise money. They had done their share in finding employment for British labour during the last five years, and the question had ceased to have for them any direct interest, except in so far as the general reluctance to incur capital expenditure, and political and other campaigns might be the means of deterring the London and North-Western Railway from beginning their deep-level line leading from Watford into the joint subway at Euston, which connected with their own station there. He had referred on several occasions to the internecine competition between urban transit industries in general, and in particular upon municipal competition. He could only hope that the kind of municipal policy which lowered a tramway fare from 1d. to ½d. on the eve of an election would be reconsidered, if not entirely reversed. They all knew the difficulty that there was in the way of raising fares when once lowered, but it would be well to recall the fact that this particular piece of municipal policy was followed by one of the biggest votes of censure that was ever passed by an electorate upon its representatives. The increase in the number of passengers carried was 1,627,852, or nearly 18 per cent., while they had run 93,055 trains, as against 90,130 in the corresponding period of last year. The rate of working expenses had been enhanced by the increased price of coal and stores. They had arranged through bookings with the suburban stations on the Great Northern and Midland Railways, and also with the Metropolitan Railway, and the Central London, Hampstead and Highgate, and Piccadilly Tubes.

Mr. CHARLES SEYMOUR GRENFELL seconded the motion, which was carried unanimously.

DUBLIN UNITED TRAMWAYS.

The half-yearly meeting of the Dublin United Tramways Co. was held on the 4th inst., Mr. Wm. M. Murphy, J.P. presiding.

The report stated that the amount available for division is £64,840. 11s. 6d., out of which it is recommended that dividends be paid for the half-year at the rate of 6 per cent. per annum on the preference shares. and at the rate of 6 per cent. per annum, free of income tax, on the ordinary shares, together with a bonus of 1s. per share, also free o fincome tax, on the ordinary shares. The dividends recommended and the sums added to reserve will absorb £56,100, leaving £8,740. 11s. 6d. to be carried to next account.

The CHAIRMAN, in moving the adoption of the report and statement of accounts, said the gross receipts from passenger traffic for the last half-year were £170,851, against £138,818 for the corresponding half-year of 1906, being an increase of £32,033, or more than 23 per cent., and amongst the other receipts there was an increase of £43 in rents, £224 in parcels, and £52 in advertisements, the total receipts from all sources being £177,502, against £145,146 in 1906. They had a substantial share of their gross receipts, £10,750, to the good after charging the additional cost of working, which amounted to £12,600, being an increase of only 16 per cent. in the working expenses, against 23 per cent. increase in receipts. They had now nearly got to the end of their cheap coal contract which they made more than two years ago, and would have to pay an advance of some 3s. per ton in the immediate future. The balance of revenue over working expenses was £86,348, being not far short of £20,000 more than in 1906, and as they brought forward some £1,200 more from last half-year than from the corresponding half-year, they had a total net revenue of £21,200 in excess of the second half-year of 1906. The balance available for division after all charges were made amounted to £64,840, against £51,764, a net increase of £13,000. Before long they would have to reconstruct another portion of the line to Blackrock, and it was proposed to appropriate £10,000 accordingly. They proposed to add £1,000 this year to accident insurance reserve fund, which would bring it up to £5,000, and he did not think this fund need be further added to. They proposed to add £5,000 to reserve, bringing the fund now up to £36,000. Finally, in addition to the usual dividend of 6 per cent. to the ordinary shareholder, they proposed to add a bonus of 1s. per share, making the dividend for the half-year at the rate of 7s. per share, or 7 per cent. per annum, free of income tax.

Alderman COTTON seconded the adoption of the report, which was unanimously adopted.

GREAT NORTHERN AND CITY RAILWAY.

The nineteenth half-yearly ordinary general meeting of the Great Northern and City Railway Co. was held on the 6th inst. The Earl of Lauderdale (chairman of the Company) presided.

The CHAIRMAN, in moving the adoption of the report, stated that the Company had had the adverse element of the high price of coal to contend with. This and the fact that their traffic receipts were less than those for the immediately preceding half-year accounted for the difference in percentage of working expenses. This percentage was 52·07, as compared with 49·39 for the preceding half-year. Taking the figures for cost of coal and deficiency in traffic revenue into account, and the percentage they produced, the Company's working expenses had increased by 2·68 per cent. There was a falling off of 358,749 passengers as compared with the number in the corresponding half-year, and the gross receipts themselves showed a decrease of £785. The directors did not attempt to disguise that they were disappointed at this temporary set-back in the Company's progress. They wished to state clearly that nothing had occurred in the system or in its working to account in any way for the falling off. The diminution of passengers was due almost solely to the opening up of alternative routes. The Brompton and Piccadilly line and the City and South London Railway extension to King's Cross were in a measure responsible, but the most important factor in the decline of the traffic had been the competition of the London County Council electric trams. On July 29 the electric tram service was inaugurated from Highbury, and from that day onwards a steady and increasing drop in the number of passengers carried as compared with the figures of the previous half-year had occurred. As a result of negotiation with the Great Northern Railway Co. a revised list of fares was adopted, and it resulted in checking the augmenting decrease in the revenue. The Company lost 5½ per cent. in revenue, against a loss of 4¾ per cent. in passengers during September and October, while in November and December (the first three months in which the revised list was in operation), although they lost 11½ per cent. in passengers, they only lost 1½ per cent. in revenue. This finally resulted in a decrease during the half-year of £785, instead of £2,000 or more, which it would certainly have been had a revision of fares not taken place. The Company had to compete with London County Council tramways, which had the advantage of being a surface system cheaply conducted at the municipal cost, carried on at municipal risk, and undercutting their fares in a most disastrous manner. Even with these advantages he was not aware that the undertaking of the Council was being conducted on a commercial basis, considering the very low fares at which passengers were carried. The mild weather at the end of 1907 deprived the Company of a portion of their winter traffic. Their fares were still very low, but could not be increased in face of the competition. The Board looked forward to a steady growth at these fares, which were remunerative to the Company and fair to the passengers. The consoling fact remained that the Company's line was still the shortest and quickest route to the City, and he trusted they had seen the lowest point of their passenger traffic. The result of the revision of fares had been to stop the greater part of the very serious diminution in actual traffic receipts, to largely add to the number of season-ticket holders, and to effect savings in car miles. The Company's time for the extension of their undertaking to the Bank was extended in 1907, and they had plenty of opportunity before them if only the increase in their traffics would justify the provision of the further money required.

Mr. CHARLES STEEL seconded the motion, which was carried unanimously.

GIANT'S CAUSEWAY ELECTRIC TRAMWAY.

The ordinary general meeting of shareholders of the Giant's Causeway, Bushmills, and Portrush Electric Tramway was held last week, the chairman, Dr. Anthony Traill J.P., provost of Trinity College, presiding.

The directors' report stated that there was a falling-off in the receipts of the last year to the amount of £385 compared with that of 1906. They, however, still exceeded those of the year 1904 and of all preceding years. The fall was accounted for by the abnormally wet season, the International Exhibition in Dublin, and the prolonged

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strike at Belfast. There had been a rise in five out of the six items, causing a total outlay of £3.006, exceeding that of the previous year by £564. This excess, added to the fall of £385 in the receipts, had reduced the net profits to £788, a reduction of £949 from the corresponding figure for the year 1906. The increase in expenditure would, however, prove reproductive. Besides the increase in expenditure on the revenue account an item of £363. 15s. 5d. had been added to the expenditure on capital account for the machinery and woodwork of the new electric car. This had increased the capital balance against the Company on the general balance sheet from £2,725. 4s. 4d. to £3.083 19s 9d. While there had been a temporary set-back in the steady increase of prosperity which was the good fortune of the Company for the last nine years, it must be taken as an accidental occurrence.

The report was adopted.

The chairman and Mr. J. Stewart-Moore, D.L., retiring directors, were re-elected.

BRUSH ELECTRICAL ENGINEERING.

A general meeting of the holders of the £125 000 4½ per cent. perpetual debenture stock of the Brush Electrical Engineering Co. was held on the 6th inst. at Salisbury House, London-wall, to consider a resolution approving the scheme for consolidating the Company's debenture stock, at present consisting of £125,000 of first and second debenture stock, into £237,000 of new 4½ consolidated stock, and the issue by public subscription of a further £112,500 of that stock as the directors may deem advisable. Mr. J. B. Braithwaite, representing the trustees, presided.

The CHAIRMAN said that they required the holders of £25,000 of stock to be represented in person or by proxy in order to form a quorum, and only £21,400 was represented at the meeting.

After some further informal discussion, the meeting stood adjourned for a week in the absence of a quorum.

A meeting of holders of the 4½ per cent. perpetual second debenture stock was held afterwards, when Lord VAUX (the chairman of the Company) stated that their concern was one of the oldest engaged in the electrical industry. Its first operations were confined to the manufacture and instalment of electrical machinery for lighting and power purposes. Subsequently, however, upon the advent of electric traction and the construction of railroads for electrical tramway undertakings, that branch of manufacture was constituted its principal department, and it had enabled them to turn over their money fairly quickly. Latterly, owing to the fact that most of the important cities and towns in the United Kingdom had completed their electrical systems, the demand for tramways had fallen off, and they had been compelled to pay more and more attention to the work of providing rolling-stock for the main-line railways. These contracts ran into very large figures, and involved a considerable lock-up of money. The amount of working capital at their disposal had not been sufficient to enable them to keep pace with the volume of work in connection with this business, and they had been obliged to meet the situation by means of temporary loans from their bankers. At the present time they had two separate issues of debenture stock, and it was a difficult matter to find a satisfactory market for them; but by consolidating the stock and enlarging the issue to £350 000 a better and more sensitive market would be created, and this would be to the advantage of investors who at any time might desire to realise their holdings. Their scheme provided for a sinking fund which would be used for the purchase of the stock in the open market, and these periodical purchases would have the effect of maintaining prices, while the Board would have the power to redeem this stock in 20 years' time at the price of £110. Another point arising under this scheme was that the security of the debenture holders would be very materially strengthened by the fact that it had a specific charge attached. The Board had given the matter their serious consideration, and had come to the conclusion that it was the best scheme to place before the shareholders, and he in every way recommended it to the proprietors.

After a short discussion, it was decided to adjourn the meeting for a week.

TYNESIDE TRAMWAYS.

The half-yearly meeting of the Tyneside Tramways and Tramroads Co. was held in Newcastle on Monday, the chairman, Dr. J. T. Merz, president. The available balance, according to the directors' report was £2,968, out of which they recommended a dividend on the preference shares at the rate of 5 per cent. per annum, absorbing £271; on the ordinary shares of 2½ per cent. (compared with 2 per cent. for the corresponding half-year of 1906), absorbing £1,673. and carrying forward £600 to the reserve, which now amounts to £4 600.

In moving the adoption of this report Dr. MERZ said the traffic receipts amounted to £24,068, against £22,996 in the previous year, an increase of £1 072 or 4 per cent., and the car miles run were 679 692, against 674,694, being an increase of 4,998, or ¾ per cent. The significant fact was that the passengers carried numbered 4.703 459. against 4,247 955, or 455,504 more—nearly half a million increase, and only owning a trifling more miles. That was, of course, more profitable, the receipts per car mile having increased from 8·18d. to 8·49d. Working expenses had also increased by £614, of which £425 was for upkeep of the permanent way, and £330 more had been paid for electrical current. The expenses had risen from 5·64d. per car mile to 5 82d., or ·18d. increase. On the Newcastle Corporation line the expenses were 6 04d., but the receipts were 11·56d. against 8 49 on the Tyneside system. Their profits had risen from £3.104 gross in 1903 to £8,261 in 1907. The item £425 included charges written off and items paid for out of revenue instead of capital, and, as they would see, the directors had added liberally to the reserve fund. They had really charged revenue with £1,830 besides the increase on the upkeep and writing off petty expenses, and the reserve now amounted to £4,600. Of the 3,000 preference shares, 2,833 had been placed and debt extinguished to that amount, and would be further extinguished by further issues or out of reserves. In regard to the prospects, the traffic remained about the same. The reduction of £52 in the published figures was due to one day less being taken in.

The report was adopted, and the dividends were agreed to. Mr. J. H. B. Noble having retired from the Board owing to his other numerous business engagements, it was agreed not to fill his place, but to reduce the number of directors to five. Mr. Summers Hunter was re-elected a director, and Mr. Thos. Harrison was re-elected an auditor.

IMPERIAL TRAMWAYS.

The report of the Imperial Tramways Co. for the year ended Dec. 31 last, to be presented at the meeting at Bristol on the 17th inst., states that the gross receipts from the Middlesbrough, Stockton, and Thornaby Electric Tramways amounted to £54,747, showing a decrease of £387 on the receipts for the previous year. The number of passengers carried was 10,700,643, as compared with 10,673,758 last year, an increase of 26,885. After placing £2,500 to the reserve fund for renewals (bringing the total of that fund up to £15,900), the net profit for the year is £16,884. The directors have to report that the trade of the district served by the Corris Railway has not improved during the past year. Compared with the corresponding period, the working expenses have been reduced by £303, but after payment of the debenture interest, the revenue account shows an adverse balance amounting to £63, which is carried forward. The revenue derived during the year from the London United Tramways is £21,111, being the same amount as for the corresponding period. The Company's holding of shares in this important undertaking remains the same—namely, 44,446 5 per cent. cumulative preference shares of £10 each, fully paid up. The Company's net revenue account for the year shows an available balance of £41,573, and after payment of interest on the debenture stock for the whole year and interim dividends on the preference and ordinary shares in respect of the half-year to June 30 last, amounting together to £26,125 it is proposed to appropriate the balance as follows: dividend at 6 per cent. per annum on the preference capital, paid on Jan. 1 last, £5 700; final dividend at 10 per cent. per annum, making 9 per cent. for the year, on the ordinary capital, less income tax, £9,500; and to carry forward £243. The reserve funds now amount to £128,771.

LANARKSHIRE TRAMWAYS.

The report of the Lanarkshire Tramways Co. for the half-year ended Dec. 31 last, to be presented at the meeting on the 20th inst., states that the result of the half-year's working is as follows: Revenue, £34,926; expenses, £20.732, leaving £14,194, less interest on debenture, £608; interest on loans, £306; contributions payable to local authorities, £620; amounts written off, as per revenue account, £2,589; add balance brought forward from June 30, 1907, £5,182, leaving £15,252. Of this amount, £5,500 has been placed to reserve for depreciation, and the directors recommend that the balance be disposed of as follows: £8,616 to dividend at the rate of 6 per cent. per annum on the issued share capital for the half-year; £240 to directors, being 10 per cent. of net profits after payment of 5 per cent. dividend for the year; £894 to revenue new account. During the half-year £5,000 has been paid off the loan from the Company's bankers. The time allowed for the construction of the extensions authorised by the Company's order of 1903 expires next August, and application is now being made to Parliament to extend the time for a further period. The directors, however propose to proceed at once with the construction of two short extensions, one to the Hamilton burgh boundary in the Bothwell-road, and the other from Motherwell Cross to the Motherwell burgh boundary beyond Coursington Bridge. To meet the immediate requirements for capital expenditure for these extensions and seven additional cars, the shareholders are now invited to subscribe for £20,770 additional share capital at par, which is the balance the Company is now authorised to issue without further sanction from the shareholders. The shareholders will be asked at an extraordinary general meeting to be held immediately before the general meeting to grant authority to issue the remaining share capital authorised by the Company's order of 1903 as and when required.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT.

The report of the St. James's and Pall Mall Electric Light Co. for the year ended Dec. 31, 1907, to be submitted at the meeting on the 18th inst, states that the supply has been distributed from the Carnaby-street and Mason's-yard works of this Company to the equivalent of 341,428 lamps (10,926 kw.), being an increase of 32 444 lamps (1,038 kw.). For this purpose 5,429,190 units were generated at these works and 5 286,440 units were purchased from the Central Electric Supply Co. A dividend of 5 per cent. on the ordinary shares has been declared by the Central Electric Supply Co., in respect of which a sum of £2 500 will in due course be payable to this Company. This Company, in conjunction with the Westminster Electric Supply Corporation, the Central Electric Supply Co., the Kensington and Knightsbridge Electric Lighting Co., and the Notting Hill Electric Lighting Co, is promoting in the present session of Parliament a Bill under the short title of "The London (Westminster and Kensington) Electric Supply Companies' Bill, 1908," with the principal objects of securing additional economy of production and regularity of service by linking up their several sources of supply in the West-end of London. The net profits for the year

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1907, applicable to dividends on shares, amount to £27,899, add balance brought forward from 1906 £486, together £28,375, less interim dividend paid in August last for half year ended June 30 at the rate of 7 per cent. on preference shares and 10 per cent. on ordinary shares, leaving an amount now to be dealt with of £14,875. The directors propose a dividend on the ordinary shares for the second half year of 5s per share, making a total distribution of 10 per cent. for the year, leaving £1,375 to be carried forward.

BRISTOL TRAMWAYS AND CARRIAGE.

The report of the Bristol Tramways and Carriage Co. for the year ended Dec. 31, 1907, states that the gross receipts for the year amount to £263 689 16s 5d, and the working and general expenses to £178,342 6s 6d., leaving a net revenue of £85 347. 9s 11d The following amounts have already been distributed—viz.: interest on 4 per cent. mortgage debenture stock, on deposits and bankers' interest, £14,889. 7s 6d.; dividend on 4 per cent. preference shares, £19,000; interim dividend at the rate of 8½ per cent. per annum (subject to income tax), for the half-year ending June 30, £20.187. 10s.; and it is proposed to appropriate the balance as follows: final dividend for half-year at the rate of 9½ per cent. per annum (subject to income tax), £22 562. 10s; addition to reserve fund for contingencies and renewals, £8.708. 2s. 5d. The Company's investments at Dec. 31 last, taken at market value, amounted to £166,536. 19s. 4d., and since the close of the year additional investments have been made, bringing the total up to £179.826. 3s. 5d., the amount of the reserve fund appearing in the balance-sheet. With the addition now proposed of £8 708. 2s. 5d the reserve fund will be £188,534. 5s. 10s. The total number of passengers carried during the year on the cars and omnibuses was 46 585,050, as compared with 46 902 257 the previous year. Amongst improvements effected in the undertaking last year may be enumerated the building of a commodious electric car depôt at Eastville, a new motor-omnibus depôt (also available for electric cars if required) at Filton, and the conversion of the Colston-street depôt so as to concentrate there the whole work of the outdoor electrical department dealing with the cables and overhead line. Similarly the engineering and permanent-way departments have been brought together by the provision of comprehensive offices, stores, and workshops on the site formerly occupied by the Whitson-street depôt and adjacent properties acquired for the purpose. Additional cables extending to nearly four miles have been laid to Kingswood and Staple Hill, to assist the accelerated services on those routes, and supply current for the authorised extensions branching out of them. Substantial progress has been made with the additions and alterations to the Company's central power station at Counterslip, and when completed, within the next three months, the capacity of the station will be increased by 50 per cent. and be more than sufficient for the working of the whole of the authorised extensions. The directors are now able to proceed with the construction of the other extensions authorised at the same time as the Filton line already opened. The next section to be taken in hand will be that to Westbury-on-Trym, which will be constructed during the ensuing summer. A Bill has been deposited in Parliament to extend the time limited for the construction of the new lines, and will be submitted for the approval of the shareholders at the coming meeting. Since the close of the year the necessary capital has been raised by the issue of £250.000 4½ per cent. mortgage debenture stock, which was over-subscribed by the stock and share holders and the general public.

NATIONAL TELEPHONE.

The report of the National Telephone Co. for the half-year ended Dec. 31 last, to be presented at the meeting on the 20th inst., states that the income accrued in respect of the business of the half-year amounts to £1.387,189, as compared with £1.241 843 for the corresponding period of 1906, being an increase of £145.346. The working expenses for the half-year amount to £780,332, as compared with £710,492 for the corresponding period of 1906, being an increase of £69.840. The net result for the half-year, after deducting the Post Office royalties amounting to £132.621, is a profit balance of £474,235, as compared with £412 850 for the corresponding period of 1906, being an increase of £61,385. The rentals carried forward for unexpired terms of running contracts amount to £1,168,389, as compared with £1,057.806 at the corresponding period of 1906, being an increase of £110,583 Out of the available balance of £369,887 the Board will recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 6 per cent per annum on the deferred stock and new shares, less income tax in all cases. The Board also proposes to transfer £145,000 to the reserve fund account and to carry forward £10,438. The sum of £545 752 has been expended on capital account during the half-year in the erection of 18,405 additional exchange and private stations, and in the construction of underground works.

GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The report of the Great Northern, Piccadilly, and Brompton Railway Co. for the half-year ended Dec. 31 last, to be presented at the meeting on the 18th inst., states that the capital expenditure during the half-year amounted to £20,727. The gross receipts on revenue account amounted to £119.271, and the working expenditure (including rates and taxes) has been £70,752. After providing for interest and rents there remains a balance of £7,114 available for dividend, and the directors recommend a dividend at the rate of 4 per cent. per annum on the ordinary shares other than those held by the Underground Co. or their nominees, who have consented thereto. The number of passengers carried including estimated journeys by season-ticket holders, was 13 914,779. The Company's traffic is increasing most satisfactorily. The receipts during the four weeks of January in this year show an increase of 55½ per cent. on the receipts for the corresponding weeks in 1907. The construction of the railway having now been completed to the entire satisfaction of this Company, the directors have been engaged in settling up with the Underground Electric Railways Co. of London questions of account relating to the construction contracts. The mutual claims arising out of these questions approximately balance each other, and the directors have come to the conclusion that the best way of dealing with them is to make a general compromise and settlement involving no payment on either side except a payment of £10 000, which, although not provided for in the construction contracts, the Underground Co. have agreed to make in order to supply the Company with working capital on the cancelment of the existing agreement for leasing the undertaking to the Underground Co. An agreement to this effect will be submitted to the shareholders for their approval at the general meeting. The directors have been in communication with the directors of the Underground Co. in regard to the agreement between the two companies, dated Jan. 13, 1903, under which this Company agreed to grant, and the Underground Co. agreed to take, a lease of the undertaking in perpetuity at a rent equal to 4 per cent. per annum on the debenture and share capital of the undertaking. The Underground Co. desire that the above-mentioned agreement should be cancelled. Inasmuch as the Underground Co. or their nominees are entitled to the whole of the share capital of the Company except 35 704 shares of £10 each, the directors see no objection to the cancelment of the agreement of Jan. 13, 1903, on condition that 33.540 of such shares, which are held by shareholders unconnected with the Underground Co., are converted into preference shares bearing a fixed preferential dividend at the rate of 4 per cent. per annum, payable out of the profits of the Company in each half-year, and that the Underground Co. guarantee such dividend in perpetuity and also guarantee payment of the interest on the debenture stock of the Company. A Bill has accordingly been deposited in Parliament, and will be submitted to the proprietors for approval at the special meeting to be held after the general meeting, by which power is sought to cancel the agreement of Jan. 13, 1903, and to convert into preference shares on the above terms the 33,540 shares of which the denoting numbers are scheduled in the Bill, and which are held by shareholders other than the Underground Co. or their nominees. The Bill also seeks to enable the Company, with the previous consent of the Underground Co., by resolution from time to time, to convert not exceeding 86.460 further shares into preference shares, ranking *pari passu* with the above-mentioned 33.540 shares, but (unless the Underground Co. otherwise expressly declare) without the benefit of the guarantee of the Underground Co. to which such 33 540 shares will be entitled. The arrangements with the Metropolitan District Railway Co. for the use of that company's widened line between West Kensington and Hammersmith, and for the grant by the District Co. of rights of user of their South Kensington, Gloucester-road, and Earl's Court stations have now been finally adjusted and embodied in formal agreements. These agreements comprise the sale by the District Co. to this Company of lands for the car-sheds at Lillie Bridge and for stations and sidings. The compensation payable to the District Co. (except for the running powers to Hammersmith and other matters connected therewith which are outside the contruction contracts) has been paid by the Underground Co. The agreement granting the running powers over the District Railway to Hammersmith in consideration of £12 000 per annum subject to revision by arbitration at the request of either company on or after Jan. 1, 1910, is scheduled to and is to be confirmed by the Bill referred to above. The directors propose that the Right Hon. Sir Algernon West, K.C.B., be added to the Board.

BAKER STREET AND WATERLOO RAILWAY.

The report of the Baker-street and Waterloo Railway Co. for the half year ended Dec. 31 last, to be presented at the meeting on the 17th inst., states that the capital expenditure during the half-year amounted to £161,044. The gross receipts on revenue account amounted to £69,249, which shows an increase of £24 669, or 55·3 per cent. on the gross receipts in the corresponding half of 1906. The working expenditure, including rates and taxes, has been £43 925. No detailed comparison with the expenses in 1906 is given in the accounts, as in 1906 this Company was not bearing, as it does now, the whole of the revenue expenditure. After providing for interest and rents and crediting to net revenue account the sum of £2 440 receivable from the Underground Electric Railways Co. of London, under their guarantee agreement, there remains a balance of £17,670 available for dividends, and the directors recommend that a dividend at the rate of 4 per cent. per annum be declared on the preference shares, and that a dividend at the rate of 3 per cent. per annum be declared on the ordinary shares other than those held by the Underground Co. or their nominees, who have consented thereto. The number of passengers carried in the half-year, including estimated journeys by season-ticket holders, was 10,662,876, an increase of 3.862,981 compared with the corresponding period of 1906 A conference has been formed under the title of the London Passenger Traffic Conference, composed of certain London railway companies, tramway companies, and the London Omnibus Owners' Conference, for the purpose of conferring in regard to fares, routes, and other matters of common interest. The conference has held several meetings, and already a large number of fares have been mutually agreed. Further progress has been made with the extension of thorough booking facilities. Negotiations are also in progress with other railway companies who

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are parties to the London Passenger Traffic Conference for a joint scheme of advertising, so as to encourage and develop the use of all the urban railways as one comprehensive system.

HASTINGS ELECTRIC TRAMWAYS.

The report of the Hastings and District Electric Tramways Co. for the year ended Dec. 31 last, to be presented at the meeting on the 17th inst., states that the revenue account of the Hastings Tramways Co. shows a credit balance of £24,072, which has been handed over by way of dividend on its shares, which are all owned by this Company. The revenue account of this Company, therefore, shows receipts aggregating £24,099, or, after deducting its administration expenses, £22,206; adding to this the sum of £300 for interest earned on moneys in hand, and £733 brought forward, and deducting £9,472 debenture stock interest paid, there remains a balance of £13,767. From this has been paid during the year by way of interim dividend on the preference shares the sum of £4,000, being at the rate of 4 per cent. per annum, and the directors now propose to pay a further sum of £8,000, being at the rate of 8 per cent. per annum, making the full 6 per cent. for the year 1907, and to carry forward £1,767.

SMITHFIELD MARKETS ELECTRIC SUPPLY.

The report of the Smithfield Markets Electric Supply Co. for the year 1907, to be submitted at the meeting on 21st inst., states that the gross profit amounts to £5,194, compared with £5,135 last year, and the net profit to £3 337, compared with £3,172, an increase of £165. This balance it is proposed to carry to the general reserve fund. The directors regret that they are still unable to recommend the payment of a dividend for the reasons already given at the last meeting of the shareholders. The output of the station shows an increase over the previous 12 months, but the high price of coal during the latter half of the year has had a material effect on the profits. The directors have been successful in obtaining a reduction of £700 in the rating of the Company's generating station, the full benefit of which will accrue during the current year.

CENTRAL ELECTRIC SUPPLY.

The report of the Central Electric Supply Co. for the year ended Dec. 31, 1907, states that energy has been supplied to the St. James's and Pall Mall Electric Light Co. and the Westminster Electric Supply Corporation throughout the year to an amount of 17,431,370 units. After making a full allowance for sinking fund and depreciation, the net balance for the year 1907 is £5,036, add balance brought forward £6, leaving an amount now to be dealt with of £5,042. The directors propose a dividend at the rate of 5 per cent. on the ordinary shares for the year, leaving £42 to be carried forward.

DUBLIN AND LUCAN ELECTRIC RAILWAY.

The report of the Dublin and Lucan Electric Railway Co. for the half-year ended Dec. 31 last, presented at the meeting at Dublin on the 13th inst., states that the gross receipts for the half-year are £3,576, being £256 in excess of those of the corresponding period of last year. After providing for debenture interest there is an available balance of £987, out of which the directors recommend the payment of the usual half-yearly dividend on the 5 per cent. preference shares, and that the balance of £512 be carried forward to next half-year, as against £644 carried forward from the corresponding period of the previous year.

CHARING CROSS, EUSTON, AND HAMPSTEAD RAILWAY.

The report of the Charing Cross, Euston, and Hampstead Railway Co. for the half-year ended Dec. 31 last to be presented at the meeting on the 18th inst., states that the capital expenditure during the half-year amounted to £82,731. The gross receipts on revenue account for the half-year amounted to £74,328, and the working expenditure, including rates and taxes, has been £61,353. The number of passengers carried during the half-year, including estimated journeys by season-ticket holders, has been 9,881,357.

NEW COMPANIES REGISTERED.

Peebles and Co., Limited.—Registered Jan. 27 in Edinburgh. Capital, £15,000 in £1 shares. Objects: to purchase and carry on the business of gas-meter, gas-governor, and gas-apparatus manufacturers carried on by Bruce Peebles and Co at Tay Works, Bonnington, Edinburgh. Power is also taken to carry on the business of engineers, electricians, brass and iron founders, tube makers, metal workers, wire drawers, etc. Registered office: Tay Works, Bonnington, Edinburgh.

Arbroath Electric Light and Power Co., Limited.—Registered in Edinburgh Jan. 30. Capital, £30,000 in £1 shares. Objects: to carry on the business of an electric light, heat, and power supply company, to undertake the lighting by electricity, gas, or other illuminant of towns, buildings, and other public or private places, particularly in Arbroath, to construct and maintain and work by electricity or other power tramways or other undertakings, etc. Registered office: Brothock Bank House, Arbroath.

West Carbery Copper Estates, Limited.—Registered Jan. 28 by Budd, Johnson and Jecks, 24, Austin-friars, E.C. Capital, £52,000 in 50,000 "A" shares of £1 each and 40,000 "B" shares of 1s. each. Objects: to acquire the right to prospect for and work minerals in or under the townlands of Ballycummisk, Foilnamuck, Rossbrin, Cappaghnacallee, and Cappaghlass, in the barony of West Carbery, co. Cork, or some of them, or any other lands in Ireland, to adopt an agreement with Sir Thomas Tancred and to carry on the business of miners, etc. No initial public issue.

Liens Registered.

Chenderiang Rubber, Limited, London, W.C.—Mortgage Jan. 29, £1,000 (10s. per share now uncalled on 8,990 shares).

Armorduct Manufacturing Co., Limited, London, E.C.—Lien Jan. 27, £1,000 6 per cent. debenture, part of £5,000 now issued. No trustees (general assets).

New Motor and General Rubber Co., Limited, London, W.C.—Lien registered Jan. 29, £1,500 5 per cent. debentures, part of £10,000. Amount previously issued, £8,050. Trustees: A. C. Baber and T. Warwick (undertaking, goodwill, and business).

Dublin United Tramways Co. (1896), Limited, Dublin.—Lien registered Jan. 29 for £30,900 debenture bonds. Amount previously owing by company, £600,000 (undertaking and all the property, including certain premises in the county of the city of Dublin).

Lanchester Motor Co., Limited, Birmingham.—A memorandum of satisfaction to the further extent of £4,453. 10s. 8d. of second mortgage debentures, dated Jan. 12 and Nov. 2, 1905, securing in all £17,814. 2s. 9d., has been filed. Previous partial satisfactions registered, £8,907. 1s. 4d.

Provincial Tramways Co., Limited, London, E.C.—Trust deed Jan. 29 for securing an issue of £175,000 5 per cent. first mortgage debenture stock. Trustees: Western Trust, Limited. Specific charge on certain shares held in various subsidiary companies, together with a floating charge on the whole of the other assets and undertaking.

West, Limited (Motor Manufacturers, London).—Particulars of £8,000 debentures, created by resolution of Nov. 13, 1907, have been filed pursuant to Section 14 (4) of the Companies' Act, 1900, a debenture of recent date being produced to the registrar. Property charged: the company's undertaking and property, present and future, including uncalled capital. Subject to prior mortgage for £1,550. No trustees.

Lancashire Dynamo and Motor Co., Limited.—Issue on Jan. 8 of £1,600 5 per cent. first mortgage debentures, part of series created by resolutions of March 4 and June 24, 1907, to secure £75,000. Charged on certain land in Trafford Park, Stretford, Lancs., with works and buildings thereon and plant and machinery therein, and the company's undertaking and other assets, present and future, except uncalled capital. Trustees. Total amount previously issued of same series, £65,000.

British Westinghouse Electric and Manufacturing Co., Limited.—A security, dated Jan. 7, 1908, to cover £56,000 (interest at 1 per cent. in excess of bank rate, with a minimum of 4 per cent.), has been registered. Property charged: £250,000 6 per cent. prior lien debentures, part of a series, limited to £300,000, to be issued and to be secured in priority to existing debenture stock by a trust deed in favour of the Merchants' Trust (as trustees), by a first specific mortgage on land, works, and plant at Trafford Park and by a floating charge on the company's general assets and uncalled capital, but without power for the company to charge in priority to or *pari passu* with the prior lien debentures any of its materials, supplies, apparatus in process of manufacture or on consignment, finished products, loose machinery, plant, tools, dies, equipment, patents, or goodwill. Holders: Glyn, Mills, Currie, and Co., 67, Lombard-street, E.C.

LEGAL INTELLIGENCE.

BOURNE AND HOLLINGSWORTH v. ST. MARYLEBONE BOROUGH COUNCIL.

On Tuesday in the King's Bench Division of the High Court, Mr. Justice Ridley delivered judgment on a legal point as to the defendants' liability in the case of Bourne and another *v.* the St. Marylebone Borough Council, in which the plaintiffs, who are drapers, of Oxford-street, London, claimed damages against the defendants for alleged breach of contract for supply of electricity to plaintiffs' premises. By a contract between the parties, it was agreed that the defendants should supply electric light to plaintiffs' new premises in Berners-street by the first week of September, 1905, the supply to be at 240 volts. Plaintiffs, however, alleged that the defendants did not commence giving the supply until Oct. 9 following. In the meantime a temporary supply at 200 volts was agreed upon, but with the new contract there was a delay on the part of the plaintiffs. Defendants said that no authority was given their representatives to enter into either of the contracts, and the seal of the Corporation was placed upon neither. At the hearing of the case a verdict was returned in favour of the plaintiffs.

Mr. Justice Ridley now delivered his reserved judgment, and in doing so said that in this case it seemed to him that it was not for a breach of the statutory obligation that the action was brought, but for breach of alleged contract. The action was brought for not performing a contract for which due consideration was given—namely, to supply current at a voltage of 240 volts by Sept. 1, 1905, and for not performing another contract to provide current at a voltage of 300 volts. He thought the plaintiff was entitled to judgment for the agreed sum of £500 and costs. His Lordship, therefore, gave judgment for this amount, and granted a stay of execution with a view to appeal on the point of law, the costs to be taxed on the usual terms.

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UNITED MOTOR INDUSTRIES v. C. A. VANDERVILL AND CO.

In the Court of Appeal on Tuesday, before Lord Justice Vaughan Williams, Lord Justice Farwell, and Lord Justice Kennedy, the case of the United Motor Industries *v.* C. A. Vandervill and Co. came before their lordships on an appeal from the judgment of Mr. Justice Walton in the King's Bench Division, after a trial before his lordship and a special jury.

The action was brought against the defendants for breach of an expressive and implied agreement, and for an injunction restraining the defendants from further violating the agreement. Defendants, whilst admitting the act which was involved in the alleged breach of agreement, repudiated agreement by implication, and denied liability. In 1901 plaintiffs had been selling dry batteries which they had been getting from Paris. About that time they were informed that the defendants were making a useful ignition battery. The dry batteries had been used up to that time, and as plaintiffs desired to build up a business in ignition accumulators they approached the defendants, with whom, plaintiffs said, they negotiated to make the accumulators and sell them exclusively to them, plaintiffs, on their part, to build up a large business by extensive advertising. The accumulators were to be known as "The Castle." A written agreement was made on Oct. 12, 1902, by which plaintiffs agreed during 1903 to take not less than 1,000 accumulators from the defendants, who had to make them a special form with a specially-designed plate. On the other hand, defendants were not to supply the accumulators to any other firm of accumulators of a similar capacity or persons at a price less than they sold to the plaintiffs. Plaintiffs, on their part, undertook to sell no "Castle" accumulators except those manufactured by the defendants so long as the quality was sustained, and the defendants undertook that they would not divulge that the "Castle" accumulators were made by them. Defendants made and sold another accumulator, known as the "C.A X." Plaintiffs were supplied by the defendants with the accumulators during 1903, but their case was that the obligation upon them not to divulge that they were the manufacturers continued for one year only and that afterwards they were at liberty to do what they pleased. In April, 1907, defendants advertised that that they were the manufacturers of the "Castle" accumulator as sold by the plaintiffs, and they were no longer supplying that firm, and that the same accumulator would be sold by them as the "C.A.X." accumulator. In these circumstances the plaintiffs brought their action. At the trial the jury found that there was such an implied agreement, and assessed the damages at one farthing. In a reserved judgment his Lordship said he thought the fair meaning of the verdict was that an action for damages ought not to have been brought, but he could not regard the action for injunction as frivolous. He thought the plaintiffs were entitled to an injunction and judgment for one farthing damages, and that justice would be done if plaintiff had judgment with costs, except as to two-thirds of the cost of the trial.

After hearing counsel's arguments, Lord Justice VAUGHAN WILLIAMS, in giving judgment, said all the authorities showed that mere smallness of damages was not a good cause for depriving a successful litigant of the costs of the issues on which he had succeeded. It was quite true that the damages awarded in this case were only one farthing, but that smallness of damage did not in his opinion go to show that it was unjust that the general rule laid down should be applied. It was said it was unjust that the rule should be applied because the claim for damages had occupied a very unnecessary time, and had thereby increased costs. In his opinion it was not the case that time had been unnecessarily wasted by that claim. For those reasons he held that the appeal must be allowed.

Lord Justice FARWELL agreed.

Lord Justice KENNEDY dissented. He said that in dealing with questions which arose as to good cause the Court of Appeal neither in principle nor in practice could be asked to entertain an appeal from the exercise of an erroneous discretion on particular facts. In his judgment, the Court of Appeal had no right to say they would have come to a different conclusion on the material which was before the judge. So far as affecting the order as to costs, it seemed to him Mr. Justice Walton's judgment was plain as to the grounds upon which he acted.

The appeal was, therefore, allowed, with costs, by a majority of the Court.

PROVISIONAL PATENTS, 1908.

JAN. 31.

2175. Improvements in or relating to electric switches. John Alexander Kennedy McGregor and Harry Herbert Mountford, 5, Corporation-street, Birmingham.

2195. Improvements in and relating to dynamos. Georges Derain, 6, Great Winchester-street, London. (Date applied for under Section 91 of the Act, Feb. 6, 1907, being date of application in France.) (Complete specification.)

2203. Improvements in and relating to magnetic separating machines. The Rapid Magnetting Machine Company, Limited, Herbert Huband Thompson, and Alfred Evan Davies, 77, Colmore-row, Birmingham.

2206. Improvements relating to radio-telegraphy. The Amalgamated Radio-Telegraph Company, Limited, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Jan. 31, 1907, being date of application in Germany.) (Complete specification.)

2214. Improvements in and connected with trolley heads. John Juille, 154, St. Vincent-street, Glasgow.

2222. Electrical motor. Louis Philippe Jean André Hector Messier, 116, High Holborn, London. (Complete specification.)

2244. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

FEB. 1.

2254. Supports for incandescent electric lamp filaments. Alfred Harry Stanley Colebrooke, Stanley-road, Huyton, near Liverpool.

2261. Improvements in arc lamps. Arthur Holman, 44, West George-street, Glasgow.

2281. Improved method of operating electric switches. Bernard Mervyn Drake, Albert Barnes, and Drake and Gorham, Limited, 66, Victoria-street, Westminster, London.

2292. Improvements in or relating to magneto-ignition for internal-combustion engines. John Dalrymple Bell, 18, Hertford-street, Coventry.

2294. Improvements relating to electric accumulators. Edward Alfred Tunbridge, 321, High Holborn, London.

2303. Improvements in single-phase commutator motors. Siemens Bros. Dynamo Works, Limited, and Francis Lydall, Queen Anne's-chambers, Westminster, London. (Complete specification.)

2308. Improvements in electrically selecting one of several receivers connected with a common conductor. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Feb. 11, 1907, being date of application in Germany.) (Complete specification.)

FEB. 3.

2375. Improvements in alternating-current relays. Lemuel Frederic Howard, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Section 91 of the Act, Feb. 2, 1907, being date of application in United States.) (Complete specification.)

2404. Improvements in magneto generators. Leon Le Pontois, 55, Chancery-lane, London. (Complete specification.)

2411. Improvements in or relating to electric current generators. William Joseph Still, 46, Lincoln's-inn-fields, London.

FEB. 4.

2452. New improved electric light or power switch. Arthur Ford Lloyd and Charles Stirling, 12, Vernon-square, King's Cross, London.

2480. Improvements in electrically-driven elevating gear for ordnance. Fried. Krupp Aktien-Gesellschaft, 33, Chancery-lane, London. (Date applied for under Section 91 of the Act, May 16, 1907, being date of application in Germany.) (Complete specification.)

2481. Improvements in or relating to holders for electric incandescent lamps. Siemens Bros. Dynamo Works, Limited, and Herbert Christopher Wheat, 139, Queen Victoria-street, London. (Complete specification.)

2488. Improvements in insulated joints for railway rails. Benjamin Wolhaupter, Palace-chambers, Westminster, London. (Complete specification.)

2492. Improvements in or relating to means for turning on and off gas or electric lamps from a distance. Johan Victor Wengelin, 111, Hatton-garden, London. (Complete specification.)

2495. Improvements in electrically-propelled motor road vehicles. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

2498. Improvements in magnetic separators. Lawrence Stevens Burt, 1, Queen Victoria-street, London. (Complete specification.)

FEB. 5.

2547. New or improved arrangement of connecting terminals or couplings to electric cables. Henry Gardiner Atkinson and Walter White, Prudential-buildings, Corporation-street, Birmingham.

2569. Means for adjustably supporting electric incandescent lamps and shades or reflectors therefor. John Joseph Rawlings and Robert Tweedy Smith, 34, High Holborn, London. (Application for patent of addition to No. 8,151, 1907.) (Complete specification.)

2581. Improvements relating to relay devices for electric circuits. Gilbert North and John Liddon Orchard, Westinghouse Building, Norfolk-street, Strand, London.

2610. Improvements in electric switches and the like. Charles John Baker, 88, Chancery-lane, London.

FEB. 6.

2621. Improvements in and relating to induction coils for igniting miners' safety lamps and like purposes. Henry Davies, 42, Fountain-street, Ferndale, Glamorgan.

2673. Improvements in safety devices for use with electrical apparatus. Charles John Baker, 88, Chancery-lane, London.

2707. Improvements in and relating to incandescent electric lamps. John Howard, 70, Chancery-lane, London.

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2676. Improvements in or relating to holders for electric incandescent lamps. Alfred Loebl. and British Ever Ready Electrical Company, Limited, 111, Hatton-garden, London. (Complete specification.)

2685. Improvements in receivers for wireless telegraphy. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Feb. 8, 1907, being date of application in United States.) (Complete specification.)

2699. Improvements in and relating to valves for controlling the supply of motive fluid to prime movers. The British Thomson Houston Company, Limited, and Frederick Samuelson, 83, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Feb. 20.)

1906.

24132. Manufacture of incandescing bodies for electric lamps. British Thomson-Houston Company. (Allgemeine Elektricitats-Ges.)

24233. Electric incandescent lamps having incandescing bodies of refractory metal. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

1907.

1947. Electrically-operated installation for forwarding postal letters and the like through a tube. Hansel.

1963. Electrical switches. Loebl, and British Ever Ready Electrical Company.

2132. Means for controlling motors and other apparatus from a distance. Fiottner, and Felten und Guilleaume-Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Jan. 27, 1906.)

2283. Coherers for wireless telegraphy. Muirhead.

2413. Electrical block signalling system for railways. Brown.

2416. Alternating-current instruments and appliances employed therewith. Sumpner.

2417. Electrical switches for use with internal-combustion engines. Chambers and Bennett.

3116. Electric heaters for bedding, clothing, and the like. Cunnington.

3739. Method of and means for automatically equalising the power supplied to electric motors subjected to an intermittent load with the object of equalising the demand on the generating plant. Lancashire Dynamo and Motor Company, Warburton, and Kelsall.

4129. Apparatus for suspending lamps, electroliers, and the like. Brockie.

4364. Incandescing bodies for electric lamps. British Thomson-Houston Company. (General Electric Company.)

4706. Single-phase alternating-current motors. Howorth. (Akt.-Ges. Brown, Boveri, et Cie.)

4742. Alternating electric current motors. British Thomson-Houston Company. (General Electric Company.)

5037. Methods of and means for regulating electric lighting systems. British Thomson-Houston Company. (General Electric Company.)

7883. Electrically-controlled elevators or lifts. Naujoks, Naujoks, and Goeppert.

8138. Protected fusible cut-outs. Berry, Skinner, and Markham.

8874. Alternating-current vapour apparatus. Hahn.

9363. Electrically-operated signals for railways and the like. British Thomson-Houston Company. (General Electric Company.)

14725. Electrical potential regulators or speed-controlling devices. Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.)

15099. Alternating-current electromagnets. Felten und Guilleaume Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, April 2, 1907.)

15442. Voltage regulation of dynamo-electric generators. Conrad. (Date applied for under International Convention, July 9, 1906.)

16745. Electric junction boxes or like cabinets for electrical apparatus. Le Manquais.

16854. Telephonic apparatus. Tardieu. (Date applied for under International Convention, Jan. 12, 1907.)

17455. Electric signalling apparatus. Deutsche Telephonwerke Ges. (Date applied for under International Convention, Aug. 24, 1906.)

17617. Coin-controlled pay station for telephones. Carter.

18152. Apparatus for determining the direction of space telegraph signals. Stone. (Date applied for under International Convention, Aug. 17, 1906.)

18868. Electromagnetic make-and-break ignition devices for explosion engines. Kwapil and Bihn.

19865. Device for transferring drawings, manuscripts, and the like to a distance by electricity. Wackermann.

21966. Adjustable holder for telephones. Chiswell.

27541. Electric incandescent filament lamps. Pauli.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price.
	£	£
Alliance Electrical Co., 5 per cent Cum. Pref., Nos. 1-70 000	1 ..	½ ⅝
—— Ord., 1,125 000	1 ..	½-¾
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125 000	1 ..	11/16-13/16
—— Ordinary, Nos. 1 125,000	1 ..	5/ 6 5/16
British Aluminium Co., Ordinary, 2 001 40 000	5 ..	3¾ 4¼
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4¾ 5¼
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	4¾-5⅛
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	97 100 xd
British Insulated and Helsby Cables Ord., 1-100 000	5 ..	6-7⅛
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5¼-6
—— 4½ per cent. Mortgage Debentures	100 ..	102-103
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock Red.	100 ..	85-89
British Westinghouse Elec and Manuf. 6 per cent Pref., 275 001-375 000	3 ..	⅝-1
—— 4 per cent. Mortgage Debenture Stock	100 ..	40-45
Brush Electrical Engineering, Ordinary, Nos. 1 105 731	2 ..	0-¼
—— Non Cum., 6 per cent., Pref.	2 ..	5/16-9/16
—— 4½ per cent 1st Debenture Stock	100 ..	79 82
—— 4½ per cent. 2nd Debenture Stock	100 ..	63-66
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10¼-1 ¼
—— 5 per cent. Pref.	5 ..	5¼ 5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-7/16
Crompton and Co.	3 ..	1⅞ 2
—— 5 per cent Debentures	100 ..	92-95
Dick Kerr and Co., Ordinary, 1 250 000	1 ..	1-1¼
—— 6 per cent. Cum. Pref., 1 305 000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock Red.	100 ..	99-102
Edison and Swan United, "A" Shares, 1- 9 261	5 ..	¾-1
—— "A" Shares 01-017 139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112 100	2 ..	5/16-7/16
—— 7 per cent. Cumulative Pref.	2 ..	⅜-1½
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	65-69
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent 1st Mort Deb. Stock Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7¾-8¼
—— 4 per cent. 1st Mort. Deb Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	11½-12½
—— 4½ per cent. Preference	5 ..	5-¼
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	14¾-15⅜
—— 4 per cent. Debentures	100 ..	98-100
National Electric Construction Co., 1-170,000	1 ..	¼-⅜
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	31-33
—— 4 per cent Bonds	100 ..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9

Electric Lighting and Supply.—

Name.	Amount paid.	Last price.
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10.000	5 ..	4⅝-5¼
Bournemouth and Poole, Ordinary	10 ..	1⅛ 1¼
—— 4½ per cent. Cum Pref., 7 501-15 000	10 ..	10- 1
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	10¼-11
—— 4½ per cent. Debenture Stock, Red.	100 ..	100- 03
Bromley (Kent) Electric Light and Power Co	5 ..	4⅜-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	96-98
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60.000	5 ..	7-7½
—— Nos. 80,000-100 000	5 ..	5½-6⅝ xd
Cambridge Electric Supply Company £10 Ord.	8 ..	12½-13¼
Canadian General Electric Co., Common Shares	$100 ..	9-10⅜
Central Electric Supply, 4 per cent. Guar Deb. Stock	100 ..	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80.000	5 ..	4⅜ 4⅝
—— 4½ per cent. Cum Pref., 1-80 000	5 ..	4⅜ 5
—— 4 per cent. Debenture Stock, Red.	100 ..	97 100
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	4¼-4⅜
—— ditto (905) 40,001-80 000	5 ..	4⅜-4⅞
Chelsea Electricity Supply	5 ..	3⅝-4¼
—— 4½ per cent Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	10-11
—— 6 per cent. Cumulative Pref	10 ..	11¼-11⅝
—— 5 per cent. Debenture Stock	100 ..	120-123
—— 4½ per cent 2nd Deb. Stk. Prov. Certs (all pd)	100 ..	98-101
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50 ..	50-53
Cordoba Light and Power Co., 1st Mt. stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50.000	5 ..	3¼-4¼
—— 5 per cent. Preference, 1-50,000	5 ..	4⅜-4¾
County of London Elec. Supply, Ordinary	10 ..	7¼-8
—— 6 per cent. Cum Pref.	10 ..	11¼-11⅝
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100 ..	105-108
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50 000	5 ..	⅜-½
—— 6 per cent. Cum Pref.	5 ..	⅜-½
—— 4½ per cent. First Mort. Deb	100 ..	75-80
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	— ..	75-78 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-2⅜
—— 5 per cent Debenture Stock, Red	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	92-95
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4⅜-5¼
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	5-5¼
—— 4½ per cent. First Deb Stock Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13 000	5 ..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	98-101
Isle of Wight Elec. Lt. and P'r., 4½ p.c. Db. Stk., Red	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150,000	1 ..	9/16-11/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5 ..	1½-1⅝
—— 6 per cent Pref.	5 ..	4⅝-5⅛
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	91-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.) all paid	100 ..	92-95
Metropolitan Ordinary, 00 001-00,000	5 ..	6-6½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	102 106
—— 4½ per cent. Cum. Pref.	5 ..	4⅞-5⅛
—— ½ per cent. Mortgage Debentures, Red	100 ..	85 90
Mexican Electric Light Co., 7 per cent. 1st Mort. Gold Bds 1933, C 1 1 000 ($10), D 1-5,000 ($500), M 1 4,400 ($1 000	— ..	77-79 p.c.
Mexican Light and Power Co Capital Stock	$100 ..	55-57
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001 14 000 ($1 000)	— ..	79-80 p.c.
Midland Electric Power Co., 4½ p.c. 1st Mort. Deb	— ..	98 101
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57 009	5 ..	6½-6⅝
—— do., 57 010-75 000	5 ..	6½-6⅝
—— do., 75,001-87 500 (issued at £2 prem., 16s. paid)	5 ..	6½-6⅝
—— 5 per cent. Pref., 1-57,009	5 ..	5-5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5 ..	5-5⅛
Notting Hill Electric Lighting	10 ..	11½ 12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5 ..	5⅜ 6⅛
—— 4 per cent. Debenture Stock	100 ..	95-00
River Plate Electricity Co., Ord., 1 119 687 & 120 501-120 507	1 ..	27/32 31 32
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	29/32-1 1/32
—— 5 per cent. Debenture Stock Red.	100 ..	96 98
Rosario Electric Co 6 per cent Cum 2nd Pref., 1-20 000	5 ..	4⅜ 5⅛
—— 6 per cent Cum 2nd Pref., 1-15 000	5 ..	4⅞ 5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cum 1st Mt. Rds.	— ..	101-103 p.c.
Smithfield Markets Electric Supply, Ord., 1-12 000	5 ..	1 1⅛
—— 4 per cent. Debenture Stock	100 ..	70-74 xd
South London Ordinary	5 ..	2⅛-3
South Metropolitan Electric Light and Power, Ord	1 ..	⅝-¾
—— 7 per cent Cum Pref.	1 ..	1⅛ 1⅜
—— 4½ per cent 1st Mort Deb.	100 ..	101 104
St. James's and Pall Mall, Ordinary, 101-20 000	5 ..	7⅜ 8¼
—— 7 per cent. Pref.	5 ..	6⅞-7
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 1-30 007	5 ..	1½ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	2-2½
Westminster, Ordinary	5 ..	8-9
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	5-5½

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260 007	5 ..	6-7⅛
—— 10 per cent. Non-Cum 2nd Pref., 260,008-280,007	5 ..	8 1/16-8 5/16
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	129 132
Auckland Elec Trams., 5 p.c. 1st Mor. Deb Stk., Red.	100 ..	103-106
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref Shares, 1 10 000	10 ..	—
—— 5 per cent Deb., Red., 1 600	100 ..	—
—— 4½ per cent. Red. Deb Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord Shares 75,001 1 0,606	1 ..	⅛-¼
—— 5 per cent. Cum Pref. Shares, 1-75 000	1 ..	13/16 15/16
Birmingham and Midland Trams., 4½ p.c 1st Deb. Stk., Red	100 ..	9[illegible]6
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 1⅝
Bombay Elec Supply and Trams Co., 6 per cent Cum. Pref	10 ..	9⅛ 9¼ xd
—— 4½ per cent. Deb Stock, Red.	100 ..	95-97
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	7⅜-⅝
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅝ 4⅞
—— 4½ per cent Deb. Stk., Red., Prov Certs. all pd	100 ..	97 101
British Columbia Electric Railway Co., Ord Def.	100 ..	127-130
—— Ord Pref.	100 ..	106 110
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	104 107
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	100-103
—— 4½ per cent Vancouver Power Deb.	100 ..	9 102
British Electric Traction, Ord. 1-300 000 & 60 001-90,000	10 ..	1⅜-½
—— 6 per cent. Cm Pf., 3 9001-60 000	10 ..	4⅞ 5⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	86-100
—— 4½ per cent 2nd Deb. Stock	100 ..	72-76
Buenos Ayres and Belgrano Trams	5 ..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-4 000	5 ..	4- 5⅛
—— "B" 6 per cent Cm. Pf., 1 27 500	5 ..	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110 116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c Deb Stk., Red.	100 ..	95-99
Buenos Ayres Gd. Nor. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red 1-2,275	100 ..	100-104
Buenos Ayres Lacroze Trams. Co., Stg 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90 93
Calcutta Tramways, Ord., Nos 1-137 610	5 ..	5 5⅛
—— 5 per cent. cum. Pref., Nos. 1 70 000	5 ..	4⅞ 5⅛
—— 4½ per cent. 1st Deb. Stock Red	100 ..	101 105
Cape Electric Tramways, Nos. 1-480,000	1 ..	3 15-7/16
City of Birmingham Tramways, 5 per cent. cum Pref.	5 ..	4¼-4⅜
—— 4 per cent 1 t Mortgage Deb., 1-3 000 (1917)	100 ..	98-101
City of Buenos Ayres Trams. Co (1 04), 1-213 000	5 ..	5⅛-⅜
—— 4 per cent Deb. Stock, Red 1 85	100 ..	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red	100 ..	91-95
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	1⅛-1⅜
—— 6 per cent. Cum Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10 ..	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12⅜-1 ⅜
—— ½ per cent. Mort Debs., 1-3 000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk. Red.	100 ..	97-100
Havana Electric Railway Consolidated Mort 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1 000 ..	80-85
Imperial Tramways Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref	all ..	13-13½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 40 001-60 000	5 ..	⅞-1⅛
—— 4 per cent 1st. Mt. Deb Stock Red	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250 000	1 ..	1/ 6-¼
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10- 0½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	91-94
—— £296 500 2nd Mort. Deb. Stock	— ..	—
—— £283, 30 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594, 88	1 ..	⅞-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425 553	1 ..	⅞-1⅛
—— 5 per cent. Mort Deb., 1-5,000 Red	100 ..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7⅛-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	81-85

Name.	Amount paid.	Last price.
	£	£
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-98
Manila Elec R.R. and Lighty. Corp., 5 p.c 1st Lien and Coll Tr Stkg Fund Gold Bonds of 1953 Red. 1-[illegible],635	$1 000 ..	88-92
Manx Electric Railway Co., 5½ p.c Cum Pref., 301-[illegible]6 35 and 23,436 25 000	5 ..	4¼-5
—— 4½ per cent 1st Mort Deb Stock Red	100 ..	95-98
Metropolitan Elec Trams., Defd 1 000 001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref. 500 001 1,000 000	1 ..	13/ 6- 5/16
—— 4½ per cent Deb Stock Red.	100 ..	97-100
Mexico Trams. Co., Gen. Cons 1st Mort 50-year 5 per cent. Gold Bonds	— ..	85-87 p.c.
Milwaukee Electric Rail and Light 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7 001-8 000	$1 000 ..	103-105
Montreal Street Rail, 4½ per cent. Sterling Deb. 001-2 000 1922	100 ..	100-102 xd
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5 ..	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W A) 5 per cent. 1 Mrt. Deb. Stk.	100 ..	99-103
Potteries Electric Traction Ordinary 1-945 000	1 ..	⅛-¼
—— 5 per cent Cum Pref. 300 001-545 000	1 ..	⅛-¼
—— 4½ per cent Debenture Stock	100 ..	9[illegible]-96
Provincial Tramways Co., Ordinary 1-24 912	10 ..	4½-5
—— 6 per cent. Cum. Pref., 1-10 000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co. 6 p.c. Cum Pref., 1-30 000	5 ..	5 5⅛
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	96½-97⅛
San Paulo Tramway, Light, and Power Co	$100 ..	120-124
—— 5 per cent. 1st Mort Deb., Red. 1929 1-11,000	$500 ..	96-97 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum Pref., 19,571-169 570, Prov Certs.	1 ..	⅞ 1⅛ xd
—— 4 per cent. Deb Stock Red. 1 40	100 ..	78 82
Southend and District Electric Tramways 5 p.c 1st Mort. Debs., Red. 1 1 600	100 ..	60-70
Yorkshire (West Riding) Elec Tram Co., Ord., 70 001-110,000	5 ..	1-1⅛
—— 6 per cent Cum Pref., 1-46,261	5 ..	3¼ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	67-68
—— 4 per cent. Pref.	100 ..	84-86
—— " " deferred	100 ..	4 -46
—— 4 p.c Deb. Stock (Prov Certs., fully paid)	100 ..	101-103
City and South London, Consolidated Ordinary	100 ..	40-44
—— 4 per cent Debenture Stock	100 ..	101-104
—— 5 per cent. Pref. Stock '91	100 ..	116-119
—— " " " '96	100 ..	114-117
—— " " " '01	100 ..	113 116
—— " " " '05	100 ..	110-113
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10½
—— Ordinary, 1-50 000	10 ..	3⅜-3⅝
—— 4 per cent. Mortgage Debentures, Red., 1-1 700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	— ..	36-40

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs. Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Coll. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000 ..	86-88
Anglo-American Telegraph Co., Ordinary	100 ..	57-60
—— 6 per cent. Preferred Ordinary	100 ..	101½-103½
—— Deferred Ordinary	100 ..	1⅛-1⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red	100 ..	99-102
Chili Telephone Co., 1-44 000	5 ..	6⅜ 7⅛
Commercial Cable Co., Nos. 1 500-year 4 p.c. Deb. Stk., Red.	100 ..	8 -90
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10 ..	6⅜ 7⅛
—— 10 per cent Preference, 1-6 000	10 ..	15⅜ 16⅜
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼ ⅜
—— 10 per cent Cum. Preference	5 ..	8¼ 9⅛
—— 4½ per cent Debs., 1 000	50 ..	98½ 102½
Direct United States Cable Co.	20 ..	13⅝-14
Direct West India Cable Co., 4½ per cent. Debs., reg within 1-1,200 Red.	100 ..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3 000, 1909	100 ..	98-101 xd
—— 4 per cent. Red. Mort. Debs. (Mauritius Subsidy), 1-8 000 1913	25 ..	99-101
Eastern Extension Australasia and China, 1 300 000	10 ..	12½ 13
—— 4 per cent. Mort. Deb Stock Perp	100 ..	99-102 xd
Eastern Telegraph Co., Ordinary Stock	100 ..	130-135
—— 3½ per cent. Pref Preference Stock	100 ..	86-87
—— 4 per cent. Mortgage Debenture Stock	100 ..	10 -103
Great Northern Telegraph Co. (of Copenhagen)	10 ..	32-34
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort Debs., within 1-1 200, Red	100 ..	99-101
Indo-European Telegraph Co.	25 ..	5-5⅛7
Marconi's Wireless Telegraph Co., Nos 25 128- 84,190	1 ..	⅜-⅝
Monte Video Telephone Co., Ordinary 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	⅞-1
National Telephone, Preferred	100 ..	110½-112½
—— Deferred Stock	100 ..	111-113
—— 6 per cent Cum. First Pref.	10 ..	11-13
—— 6 per cent Cum. Second Pref.	10 ..	10½-12½
—— 5 per cent Non Cum. Third Pref.	5 ..	5⅜-5⅝
—— 5½ per cent Deb. Stock, Red.	100 ..	97- 9
—— 4 per cent Deb. Stock, Red.	100 ..	100-102
Oriental Telephone and Electric Company	1 ..	1 3 32 1 7/32
—— 6 per cent. Cum Pref	1 ..	1 1-16-1 3/16
Pacific and European Tel., 4 p.c. Guar. Deb. Red., 1 1 000	100 ..	98 101
United River Plate Tele. Co., Ordinary 1-100 000	5 ..	6½-7
—— 5 per cent Cum. Pref., 1-40,000	5 ..	4⅜-5⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	99- 2
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10½
West Coast of America, 1-50 000 and 53 001-53,008	2½ ..	1⅜ 2
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	98 101
West India and Panama Telegraph Co., Ordinary	10 ..	⅛ ⅝
—— 6 per cent. Cum. 1st Preference	10 ..	7⅜ 8¼
—— 6 per cent. Cum 2nd Preference	10 ..	7⅜-8¼
—— 5 per cent. Debs., Red., 1-800	100 ..	100 103
Western Telegraph Co., 1-207,930	10 ..	13-13⅝
—— 4 per cent, Debenture Stock, Red.	100 ..	98½-101⅛

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Feb. 5	1,149	1,149	—	- 1,310*h*	27½	27½	May 31	72,605	17,676 000	1,529 682	0 98	11·39	4,987	6·34
Ayr Corporation	,, 8	175	157	+ 18	—	8	8	,, 15	15,283	3,603,784	378,894	·97	9·28	1,917	5 35
Baker Street and Waterloo Ry.	,, 8	3 035	2,445	+ 590	+ 4,613	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 9	1,0 4	903	+ 51	+ 188	23 53	25·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 1	6 295	5,0 5	+1,290	—	56½	5 ½	,, 3	18 557	5,752,098	215 345	87	16·2	9.228	—
Blackburn Corporation	,, 5	940	897	+ 43	+ 3,363	23·80	23·80	,, 25	54,951	10,094,028	1,002 372	1 25	12 64	2,309	8·02
Blackpool Corporation	,, 6	353	305	+ 48	- 1,211	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	6½	Dec. 31	34,819	2,707,918	625,110	3·09	12 803	—	7·795
Bolton Corporation	Feb. 9	2,115	1,912	+ 203	- 101 776	42	42	March 31	11 294	25,410,690	2,411,969	1·14	11·03	2 649	6·12
Bournemouth Corporation	,, 5	1,253	1,131	+ 122	+ 1 9 3	23¼	24¾	,, 31	85,665	13,503,610	1,765,098	1·48	11 37	2 860	7·28
Bradford Corporation	,, 1	4 038	3 890	+ 208	+ 4,738	8	95	,, 31	232 427	46 728,977	5,167,26	1 19	10 79	2.421	—
Brighton Corporation	,, 9	6 5	627	+ 28	- 3,142	17·191	17·191	,, 31	50,652	10 759,310	1,798,105	1·09	10·49	2 844	7·4
Bristol Tramway Company	,, 7	4 502	4,342	+ 160	—	53½	51½	,, 31	265,769	6 902,257	6 178,886	—	—	—	—
Burnley Corporation	,, 8	1,166	1,070	+ 96	—	19⅔	19⅔	,, 31	62 699	11,967,4 8	1,205,830	1 31	12 48	5,825	8·21
Burton Corporation	,, 9	2:0	211	- 1	- 618	9⅞	8¼	,, 31	15 576	3,783,827	421 317	07	8 87	1,7 8	6·14
Cardiff Corporation	Jan. 11	1,894	1,9 8	- 24	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624.504	1·04	9·74	3,266	6
Carlisle Tramways Company	Feb. 8	140	1 6	+ 14	+ 48	8·5	8·5	Dec. 31	10 254	2 790 699	350,417	—	—	—	7·96
Central London Railway	,, 8	6 101	6,426	- 325	- 1,267	6	6	,, 31	349 298	43,057,997	1,279 698*a*	1·85	62 29*a*	55,357	35 22*a*
Charing X, Euston, & Hamp. Ry	,, 8	3,145	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 9	3,331	3 150	+ 181	+ 2,088	9	6¼	*h* June 30	82,456	10 048 780	—	—	—	—	—
Colchester Corporation	Jan. 29	146	138	+ 8	—	8	8	*March 3	10,588	2 457,553	320,788	·97	7·47	1,401	6·12
Cork E. P. and L. Company	Feb. 6	403	397	+ 6	- 176	15½	15½	Dec 31	25,03-	5 966 364	891 9 8	—	6 74	—	4 78
Croydon Corporation	,, 7	1,192	—	—	—	12 *c*	12 *c*	March 3	64,065	13,51 .9 8	1,102 408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 7	229	224	+ 5	- 43	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1,124	4¾	4¾	,, 31	12,468	3 178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Feb. 7	94	81	+ 13	— *h*	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 7	4 727	4,514	+ 213	+ 358	54½	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 5	1,090	995	+ 105	+ 1,893	22	22	May 15	57 672	15 554 905	1,162 792	·878	1·9	4,352	7 3
East Ham Corporation	,, 8	792	732	+ 60	+ 547	14	14	March 31	47,140	15,049,240	1,062 151	·74	0 49	3 636	7 14
Glasgow Corporation	,, 8	16,717	15,937	+ 780	+17 884*h*	177½	169	May 31	387 381	121,063,068	20,350 367	·95	0·47	5,035	5 21
Gloucester Corporation	,, 5	203	209	—	—	15	15	March 31	15,033	3 182,111	579,996	1·06	6 94	1,002	5·1
G.N., Piccadilly and Brompton	,, 8	5 390	3, 80	+ 1,610	+ 10 986	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·57	37	,, 31	77 996	18,293,242	1,624 275	—	1·52	—	8·65
Huddersfield Corporation	,, 8	1,437	1,356	+ 81	+ 3 285	35½	35	,, 31	87,196	15 252,150	1 804 745	1 82	0 79	2 770	5·92
Hull Corporation	,, 8	2 440	2,28	+ 151	+ 6,359	26	26	,, 31	121,186	29,151,543	2,956,406	1	·84	—	—
Ilford Corporation	,, 1	391	380	+ 11	—	10½	10½	,, 31	26,499	6,586,754	615,117	8·	9 58	2,225	6 5
Ilkeston Corporation	,, 5	125	111	+ 14	+ 405	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 5	224	219	+ 5	—	7½	7½	May 15	13,702	4,640,618	466,919	6 2	7 55	1 773	4 95
Lancashire United Tramways	,, 5	1,129	1 016	+ 113	+ 40)	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 1	5,977	5 606	+ 372	+12,1 2	96½	96½	March 3	327,794	73,024,853	7,358,185	1 06	0 69	3,352	5 58
Leicester Corporation	,, 8	1,978	1 951	+ 27	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 1	10,193	9,995	+ 198	+ 1,557	104	104	Dec. 31	565 793	122 094 528	12 115 934	1·108	1 17	5,421	7·75
Liverpool Overhead Railway	,, 9	1,405	1,332	+ 73	- 3*h*	4 25	6 65	June 30	77 568	10.957.148	1.102 809	—	—	—	—
London County Council	Jan. 25	28 211	24,057	+4,154	+2 7,879	98	98	March 31	1 78,611	314 227 030	30,170 997	1·05	10 98	—	8·56
Lowestoft Corporation	,, 11	144	15)	- 6	+ 10	3½	—	Sept. 30	11 039	2,6 2 922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	Feb. 3	144	69	+ 75	—	3½	2	March 31	5,917	1 185 5 6	157,050	1·14	8 6	2 956	6·2
Manchester Corporation	,, 8	13,828	12 9 9	+ 869	+ 43 661	172	161	,, 31	719,673	143.264.501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 8	9,013	7 958	+ 1,0 5	+ 5 716	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 9	14,751	14 633	+ 118	+ 319	25½	23½	June 30	637,794	97.639,334	—	1·39	—	—	—
Nelson Corporation	,, 8	130	121	+ 9	- 22	2⅔	2⅔	March 31	7,109	2 035,300	203,203	86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 8	3,825	3,843	- 17	+ 1,312	59⅛	57¼	,, 31	210 491	45,5 6 468	4,263,174	1 11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 8	546	529	+ 17	+ 2,033	14½	14½	,, 31	32,421	7 760 403	772 753	1 03	10 01	1 525	6 87
Oldham Corporation	Dec. 8	1 805	1,744	+ 61	+ 4,350	35⅔	35⅔	,, 25	4 948	18,647,751	1,818,444	1 19	12·53	2 603	7 2·9
Portsmouth Corporation	Jan 18	1,470	1 4 6	+ 54	—	28½	28½	,, 31	98.911	20 668 825	2.199.823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,651	8,120 179	918 825	9	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749.202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,745,298	618,211	1 12	10 45	2,691	7·38
Salford Corporation	Feb. 3	4,225	3,971	+ 254	+ 6 215	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 *c*	4·78 *c*	Dec. 31	7,779	1.537 845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 9	5,370	5,105	+ 265	+11 678	65¼	65⅔	March 25	276.907	73 966,299	6,804,456	898	9 767	4,174	5 94
Southampton Corporation	,, 5	888	770	+ 128	+ 2,815	18	18	,, 31	49,185	9 437,396	1,143.085	1 25	10 71	—	7 7
Southend-on-Sea Corporation	Jan. 29	233	201	+ 32	+ 106	9	9	,, 31	20,07-	4,431,728	390,578	1 07	12 33	3,155	6 75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8.617,127	1,248 656	—	9 464	—	4 849
Sunderland Corporation	Feb. 9	1,137	1,252	- 115	- 1 818	20	20	,, 31	72,396	17 483 132	1.575 425	1·006	11·261	3,687	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	Feb. 6	1 8	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 8	725	683	+ 42	+ 687	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19 204	4,965 296	429 785	—	·0 724	1 989	6·95
West Ham Corporation	,, 6	2,056	1,974	+ 76	+ 2,203	14·7	14 7	,, 31	1 2,881	35,102 836	2,556,854	·769	10·96	4,407	6·79
Wolverhampton Corporation	,, 5	805	715	+ 90	+ 516	20	20	,, 31	43,823	9,276,023	966,133	—	10 886	2,159	6·095

* 1905-6 figures. † And 88 miles of interlacing track. *c* Train mile. *o* Miles of route. *h* Half-year's figures.

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THE

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THE G.E.C. ANNUAL.

The mythical merriness of olden time has long been nothing but an old wives' fable, but the newer merriness of the present time is a colossal reality. May Day has few garlands and fewer may-poles around which to dance and make merry, but the festive red-letter day of the electrical world is that annually appointed for the great gathering to wine and music which is so admirably organised by the "General Electric." Kind-hearted hosts make sympathetic guests, and appreciative masters make energetic men. There may be—probably is—business method in planning and carrying into execution such a gathering as the one referred to, but whatever the business instincts underlying the action, it is superlatively evident that the G.E. management is as eager to meet its clients in social converse as it is on purely business pursuits. The history of this company is one of continued prosperity, and that prosperity has been deserved because of the strenuous endeavour to provide goods up to standard mark, and to treat customers in the spirit as well as in the letter of the engagement. We have no desire to be too eulogistic, if that be possible in this case, as we wish to deal somewhat at length with the chairman's speech. First, however, it must be said that the Empire Hall of the Trocadero was crammed with hundreds of guests representing the best exponents of every phase of electrical science and industry, and they thoroughly enjoyed themselves with the varied pabulum put before them by their hosts. It was, indeed, a gala night. The chairman of the company, Mr. Gustave Byng, occupied the chair, and every individual in the room was delighted to see him in sufficient robust health to be in that position. He proposed the toast of "Electrical Science and Industry" in an eloquent speech, part of which was devoted to a scathing criticism of the delinquencies of the "Government." We all know Mr. Byng to be an ardent tariff reformer. He has the courage of his opinions, and embraces every opportunity of driving home the lessons of tariff reform and the criminal political party action which prevents the subject from being adequately and thoroughly investigated. We go nine-tenths of the way with Mr. Byng, and in some cases much further. For example, we profess to be absolute free traders, yet say that as the world's divisions and ruling are constituted protection is natural—far more natural than free trade—and in some form or other must prevail. Free trade never has existed in this country, and until the millennium never will. The position of the present Government in relation to tariffs is purely political. If from a few more by-elections it finds the votes going from it there will be a *volte face*—the country declares its will, and that is the will of the Government. A large number of our readers we know are so-called free traders. When that position is taken from conviction we admire them, when it is taken for granted or from their daily paper we advise study. Here is a sample going back to first principles. A. and B. are two countries. A. produces a surplus of food stuffs and a deficit of manufactured goods, while B. produces a surplus of manufactured goods and a deficit of food stuffs. Surely the natural order of things is to exchange surpluses. That exchange without artificial restriction would be free trade. Suppose, however, A. thinks fit to develop its manufactures and imposes a tariff on B.'s goods. It seems to us that as soon as that is done free trade ceases. A.'s action turns out well. Its manufactures increase, and ostensibly at its own higher cost. But is it so in reality? The food-stuff growers, finding their costs increased, will slightly increase their prices to B; and it seems to us such a simple case proves that B. really pays, and not A., and that A. builds up a

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manufacturing industry at B.'s cost. The food stuffs must be had by B.; they are subjected to fluctuation in prices, not to tariff, hence a small additional cost is put down to natural causes. But is it so really? Does it not look as if the ultimate winner develops his manufactures at the expense of his opponents? No doubt we shall be told that trade is not a simple thing like the sample we have assumed. That is so; but we venture to think that, however complicated it may be, the final result is as we have suggested. Mr. Byng was very severe upon a technical contemporary that has written somewhat casually about fiscal matters, but he ought to have remembered that sometimes one swallow is mistaken for spring, and hence one factory or mine handed over to the foreigner may have been mistaken for all. An aberration of the moment can be easily forgiven when the culprit comes into line, as he will probably do. The foreigner in particular cases may pay heavily to get in certain places and obtain certain orders, but if this be in an open market the conditions must be peculiar if this method leads to continued success; but we deal with this question elsewhere. The most pithy summary of the present phase of the fiscal system against the change of which Labour leaders protest came from a gentleman who replied for the guests. He told us that the Labour members did all they could to protect labour, but stopped short when it came to the protecting the products of labour. It was well put, and will bear thoughtful investigation. Little investigation is needed to show that if the products of labour do not under certain conditions receive protection, there will be in the course of time no products and no labour. The problem is of vast importance. It is not properly studied. It has, but ought not to have, a party imprint. It is a question involving the interests of every member of the community, and should be regarded from a strictly impartial standpoint. We emphatically thank Mr. Byng for continually keeping the question before the electrical world, and trust he may soon witness a real effort to understand the problem—one solution of which he preaches.

FOREIGN BUSINESS.

The consuls who represent Great Britain in all the principal towns abroad send home, at more or less regular intervals, reports which are of great assistance to business men. It is the policy of some to decry these reports, and to demand that these consuls should act as their particular commercial travellers. To good business firms a hint of large contracts coming forward is quite sufficient, and the subsequent steps are best left to individual effort. At the present time, when our electrical manufacturers are threatened with another spurt in German competition, it will not be amiss to see if we cannot retaliate by offensive rather than by defensive measures. The German electrical manufacturers have united to crush out the small firms, and have succeeded to such an extent that one or two groups closely allied control the whole of the large contracts in that country. They have raised prices to a point where English machines can be introduced in spite of the import duty. In cables the same applies, and here English competition has been effective, as several large contracts in Germany have been secured by our cablemakers. We should like to hear of similar conquests made by our dynamo builders. They will be hampered by the fact that so many of the large electrical supply undertakings in Germany are run by the banks who support the manufacturers' ring, but the corporations are not all so tied up, and there should be an opportunity of obtaining orders from them. There are other countries like Norway, Sweden, and Russia in which we can cut into the profits of these German firms in a way which will much more than counterbalance their feeble efforts in this country. We know, for instance, of one case in Sweden in which a German manufacturer had to submit to a reduction of 35 per cent. in order to keep out an English firm. The other argument used to keep this extension order in German hands was that the English machinery was useless for the work it had to do. This kind of statement can best be met by a freer intercourse between the engineers of these countries and our manufacturers. Thus, while our engineering institutions frequently travel to the Continent to see foreign work, visits of kindred institutions abroad to England, such as we welcomed in 1906, are unfortunately rare. We trust they may be more frequent in the future. Another and effective way of helping our industry would be to advertise abroad much more largely than we do the excellent technical colleges and schools in the United Kingdom. These, while perhaps not so elaborately equipped for purely scientific research as those in Germany, give their students a much more practical knowledge of electrical engineering. The opportunity for securing students from these foreign countries is good at the present time, because certain of the German colleges have recently doubled their fees for students from abroad. A young engineer educated in this country and conversant with our engineering progress will not succumb to loose statements, which are as prevalent as they are false, as to our backwardness of electrical engineering.

THE L. C. C. — ITS OFFICIALS AND SALARIES.

The London County Council is not one of those authorities that always does wrong—indeed, the greater part of its work deserves praise, while a smaller part is debatable. At any rate, there can be no two opinions about the justice of periodically revising the salaries of its staff. In this year's revision we are pleased to see recognition of the services of Mr. Fell, the chief of the tramway department. When Mr. Fell was appointed it was not contemplated that the northern system would have been taken over so early, hence the moderate limitation of his salary, which, however, it is now proposed to increase, and so make it a little more commensurate with his great responsibilities. Mr. Fell was appointed in 1903, in which year 126,388,845 passengers were carried, while last year, 1907, the number reached to 315,407,794. The receipts have increased from £489,339 to £1,536,196 during the same period. The mileage in operation is 115·05 miles, of which 66·93 are electrified. Increases in salary have been granted to over twenty members of his staff. We congratulate both the London County Council and its staff in that the increased and increasing responsibilities are recognised. We have often pointed out that many authorities do not pay proper salaries, and the fact is easily proved. Over and over again we see men leaving the service of an authority and taking up the risks of private practice. There are three great reasons why this goes on: (1) the expert working under and for an authority rarely gets the professional credit due to his labour; (2) he has to put up with troubles and worries beginning with men who are wholly ignorant of the things they talk about; and (3) he is not rewarded in proportion to his responsibilities. Perhaps the credit would be forgiven and the worry tolerated if the reward was ample. We have come to look upon the London County Council as

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the premier local authority, and it is but right that its officials should stand in the forefront of their profession, and their treatment in all ways be an example to other authorities.

THE ELECTRICAL CONTRACTORS' ASSOCIATION AND ITS CRITICS.

In one of his writings Burke assures us that those who are habitually employed in finding and displaying faults are unqualified for the work of reformation. Though this may seem paradoxical, it is undoubtedly true in general; and we offer the observation for the reflection of those who have not been remiss in their criticism of the above association. We do not pretend that the Electrical Contractors' Association is beyond criticism, nor, for that matter, do its leaders think so. But all who realise what golden potentialities there are before such an association will join in the wish that such criticism were of a constructive character, instead of being, as at present, aimless, and possibly destructive. If it is the serious intention of the critics to render the effectiveness of the association greater than it now is, they would surely have the opportunity of realising that wish by entering the fold, and employing their acuteness in the promotion of the common aim. And the present executive of the association, who to their credit have never attempted to avoid the full glare of the searchlight of criticism, offer the malcontents every opportunity for joining and taking a full share in the management. If in spite of this the latter still remain aloof, they can hardly help giving the impression that by hating the weakness of the association too much they have come to love its object too little. As matters stand, criticism from contractors who are neither members of the association nor show any inclination of becoming such serves only to reveal the difficulties under which the association has to labour, and makes it evident that these difficulties would be largely overcome by strengthening the core, while at the same time its value becomes nugatory, and it exposes the critics to the charge of insincerity. A faint outline of the past work of the Electrical Contractors' Association is given in the report of the speeches made at the annual dinner which appears in another column. True, the achievements fall far short if judged by the standard of infallibility, but if they are considered in the light of the achievements of kindred associations, we think the record is one of which the leaders may well be proud. The association aims at solidifying the interests of individual contractors and raising the status of the industry by keeping out the charlatan; it seeks to safeguard contractors' rights and privileges from those who attempt to curtail them and to encroach upon their preserves; above all, it is a vital defence against reckless cutting of prices and diminution of profits. It is surely obvious that its success in these directions will be in proportion to the support it receives from contractors, and we cannot believe that clear-headed, astute, business men fail to find in the association an effective instrument for the promotion of their welfare, and one worthy of their support.

The *Official Circular* of the Tramways and Light Railways Association for January contains a full list of all Tramway Bills, and Bills containing clauses relating to tramways, which were deposited in the House of Commons in respect of the session 1908; matters relating to light railways; a copy of the official notice of the inquiry to be held in regard to the Home Office proposed regulations; full reports of the Board of Trade inquiries into the accidents at Halifax and Birmingham.

ELECTRIFICATION OF RAILWAYS.—II.*

BY DR. GISBERT KAPP.

(*Continued from page 221.*)

THREE-PHASE ELECTRIFICATION.

As time presses I must content myself with these few examples of electrification by continuous current, and shall now proceed to three-phase work. To place before you examples of this class of work I must go abroad, for English firms have not taken up this branch of the subject. The oldest, and in a sense the most instructive, example of three-phase main-line electrification is the Burgdorf-Thun Railway, equipped nearly nine years ago by Messrs. Brown-Boveri; instructive in so far as this line has falsified all the predictions of the opponents of the three-phase system. Many of those who saw in the continuous current the only commercially possible method of electrification, predicted all sorts of trouble on this line; the small clearance of asynchronous motors, the low power factor, the inelasticity as regards speed, the complication of a two-pole trolley, and some other points were adduced to show that the undertaking must be a failure. Yet it has been a marked success. The distance between termini is 25 miles, and the total length of track 31 miles. The average weight of trains is 65 tons; there are 15 stations, and the speed for passenger trains is 23 miles per hour. The rolling-stock consists of two locomotives for goods traffic, six motor coaches for passenger traffic, and 10 trailers; in all 18 vehicles. From the power-house on the River Kander (which also supplies 1,000 h.p. to Bern) a three-phase 16,000-volt line is carried along the railway and tapped off at frequent intervals into transformer sub-stations, where the pressure is stepped down to 750 volts for the trolley wires. The cost of the transmission line, sub-stations, trolleys, and rail bonding was only £27,000, or at the rate of £870 per mile of single track. In a report of the engineer of the line it is stated that five men suffice for the repair and maintenance of the rolling-stock, electrical equipment included, and from the figures published for 1904 I find that the whole outlay on this head amounted to £1,240, which works out at 1·7d. per train mile, or 0·026d. per ton-mile. The Swiss Government Committee referred to in my last lecture has also investigated the working of this railway, and reports on it very favourably. I quote a few sentences from this report: "It is characteristic for the three-phase system that in seven years' working not a single motor had to be changed or repaired; two repairs on the locomotives were necessary in consequence of extraneous causes. Only one pair of spur wheels had to be changed, and this was caused by neglecting lubrication. The drivers consider the constancy of speed an advantage, since they are able to keep better time and devote more attention to signals. Lost time can be made up on down grades by inserting resistance into the rotor circuits."

The total consumption of energy (allowing for the amount received back on down grades and braking) is 51 watt-hours and 46 watt-hours per ton-mile for passenger and goods trains respectively.

The most important electrification which has as yet taken place in Europe is, perhaps, that of the Valtellina Railway, which has been in regular and successful service since the autumn of 1902—that is a little more than five years ago. The work was done by Messrs. Ganz, of Budapest, who, after having settled all technical details of three-phase electrification by experiments on a line laid down at their works, had sufficient confidence in the system to apply it under severe guarantees straightaway to a line 67 miles long, and presenting in the shape of tunnels and sharp curves a maximum of difficulties. Their courage has been rewarded. Not only has the Valtellina line proved perfectly successful, but, seeing this success, Continental and American engineers have been won over to three-phase traction, with the result that this system is now employed on so important an international line as that leading through the Simplon Tunnel, and the General Electric Company of America, who have done such excellent work in perfecting continuous-current traction, have now taken up three-phase working

* Lecture delivered before the Royal Institution of Great Britain, Saturday, Jan. 25.

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as well, and are at this moment equipping the "Cascade Tunnel line" on this system.

So much has already been published concerning the Valtellina line that I need not give a long description. Broadly speaking, the conditions were that 400-ton trains should be run at a speed of 22 and 250-ton trains at a speed of 43 miles per hour. Both motor coaches and locomotives are used. The motor coaches weigh 53 tons, run on two bogies, and are driven by four motors. Two are 3,000-volt motors of 250 h.p., and two are cascade motors wound for 300 volts. The 3,000-volt current is supplied by two trolley wires and the rails at 15 frequency, and is generated at nine transformer sub-stations, which receive 20,000-volt current from a hydro-electric power-house in Morbegno, having a total capacity of 6,000 h.p., of which 2,000 h.p. is at present to spare. Provision has been made to add another 3,000 h.p., or 4,000 h.p if required. In the motor coaches and the older locomotives the drive is direct. For the locomotives, twin motors are used. The two motors driving three axles are contained in one housing, and only one set of slip-rings is required. These are put outside the frame, the leads being taken through the crank. The speed of the motor shaft is the same as that of the drivers, but the motors are placed between the three driving axles and with their centres a little higher, so as to get a larger diameter for the rotor. The motors have cranks at right angles on each side, and the coupling is by a frame and

FIG. 52.—View of the Brigue Station.

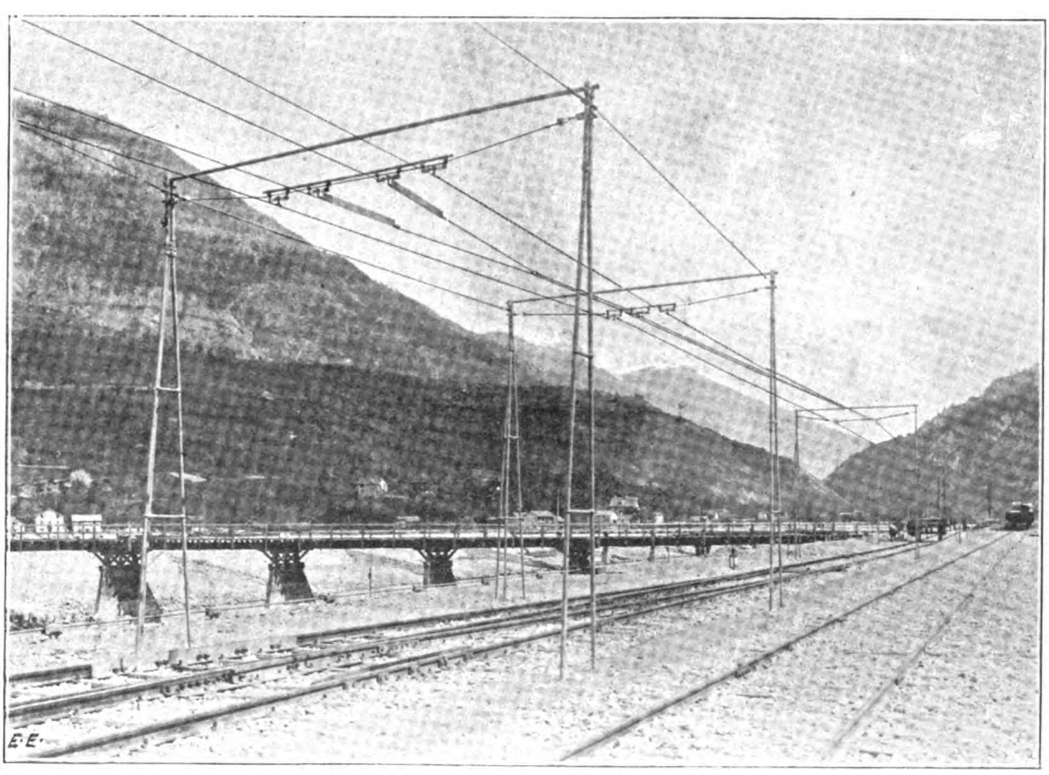

FIG. 53.—Suspension of Trolley Wires by Light Tubular Structures.

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coupling rods, the frame carrying a sliding block in the middle so as to allow for the play of the springs.

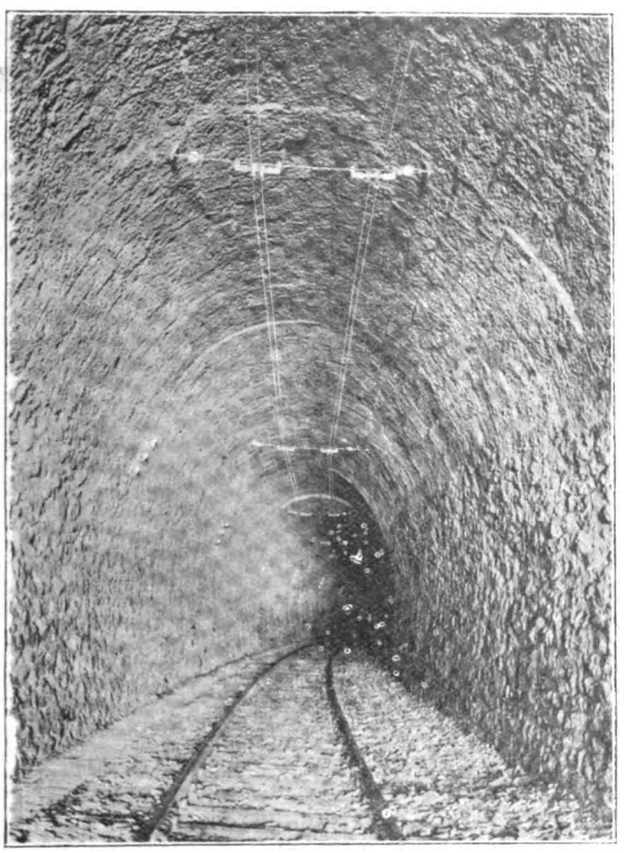

FIG. 54.—Suspension of Trolley Wires inside the Simplon Tunnel.

To ascertain the efficiency of the system as a whole, the energy going out from the power-house was metered over a period of a month and account taken of all the train movements during that time. It was found that 80 watt-hours correspond to a ton-mile. This covers losses in transmission line, trolley lines, transformers, heating and lighting, air-compressors for brakes and switchgear and traction proper. The efficiency of the latest type of three-phase motor at full load reaches 97 per cent., and its power factor also 97 per cent.—important for cascade working.

An ingenious arrangement has been adopted to prevent drivers disregarding signals. The trolley wires are interrupted by insulating pieces 330 yards on each side of a station. The intervening parts of the trolley lines are made alive by switches mechanically connected to the semaphore if this is set to "line clear," but they are dead if the signal is at danger. A driver running towards a station against the signal finds thus the power cut off and notices this in time to put the brake on, and he cannot start out of a station if the signal is against him because there is no current. To facilitate cleaning and repairs in the sub-stations, a portable sub-station is kept on a truck and run on to a siding at the sub-station to be overhauled and coupled up to the transmission and trolley lines; the permanent sub-station can then be switched off for repairs. The latest example of three-phase electrification is the line through the *Simplon Tunnel*. The total length between Brigue and Iselle is 14 miles; length in tunnel, 12¼ miles; length of track, 19 miles. Brigue lies 170ft. higher than Iselle; the steepest gradient is 10 per 1,000. The electrification was carried out by Messrs Brown-Boveri, who have also supplied the two first locomotives, three of the heavy locomotives of the Valtellina having also temporarily been taken into service on the Simplon. The power is produced by turbines at Iselle and Brigue in the shape of 3,300-volt three-phase current at 16 frequency. Both stations, working in parallel, have a capacity of 2,000 kw. The trolley circuit is divided into three main and two sub-sections—namely, the three tunnel sub-sections with two wires of 50 square millimetres area for each phase, and the approach sections on either side with only one 50 square millimetre wire for each phase. In the middle of the tunnel there is a station or passing place, the current being supplied independently to this and the adjoining sections The rails carry the current of the third phase, and a special plastic bond designed by the contractors is used. The overhead lines are carried 17ft. in the open and 16ft. in the tunnel above rail level, the horizontal distance varying between 2ft. and 4ft. Fig. 52 is a view of the Brigue Station. Fig. 53 shows the method of suspending the trolley wires by very light tubular structures well braced together. Here may also be seen an overhead switch. In passing, one bow at a time loses one phase, but never both bows simultaneously, so that the current is not interrupted. Fig. 54 shows the suspension of the trolley wires inside the tunnel. In curves the

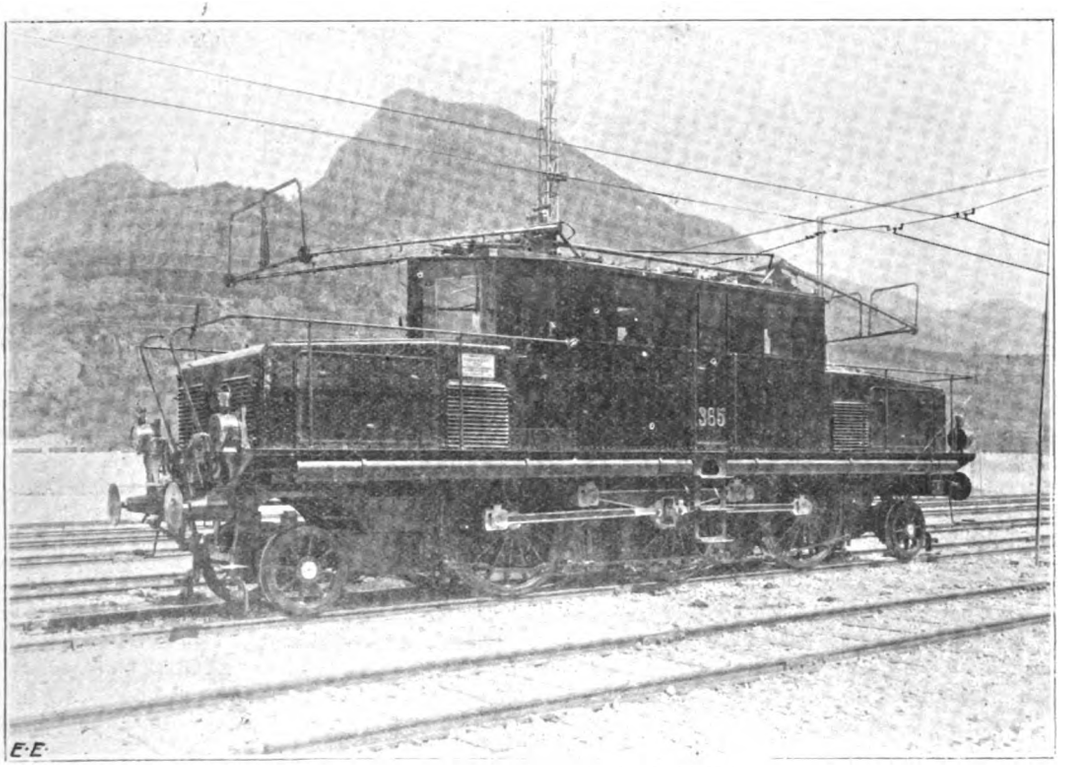

FIG 55.—Brown-Boverie Locomotive fitted with Motors.

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distance of supports is 14 yards, and on the straight parts 28 yards; in the open the greatest distance is 38 yards.

One of the Brown-Boveri locomotives is shown in Fig. 55. It is fitted with two motors, which are connected to three driving axles, the method of connection being that shown in a previous slide, by slide frames and coupling rods. The winding of the motors is of the kind which allows the number of poles to be changed from eight to sixteen, as previously explained. Both motors receive current direct from the line, and do not work in cascade. If the pole controller is set to 16 poles the speed is 22 miles per hour, and if set for eight poles it is 44 miles per hour. The total weight of the locomotive is 62 tons, of which 44 tons is adhesive weight. The locomotive has taken a passenger train of 343 tons in 22 minutes from Brigue to Iselle, and a goods train weighing 650 tons in 38 minutes. These weights are exclusive of locomotives. These performances are better than required by the guarantees. The Simplon line was opened for traffic in June, 1906. Apart from some minor insulation defects due to heat and moisture in the tunnel, which were, however, immediately rectified, the working was perfectly successful, and the whole of the traffic is now carried on electrically.

One feature of the Brown-Boveri locomotive deserves mention. It is the use of short and very light rubbing bows fixed to the top of the trolley frame instead of the rollers used by Ganz and Co. The wear on the wire is quite small, being only from 0·1mm. to 0·3mm. at the present time—that is, after 18 months' use. The bows have to be relined after 2,000 miles' service. The expense is trifling. The distance between the two collecting bows is 27ft., and at junctions in the railway one phase is interrupted for 25ft. The radius of curves at switches is 600ft.

(To be continued.)

TRIPLE-EXPANSION ENGINE AND DYNAMO FOR LUTON CORPORATION.

The success which has attended the application of the high-speed enclosed steam-engine to many and various purposes in connection with the generation of electric power is a fact now well established—especially is this true of the double-acting high-speed engine. As is well known, Messrs. W. H. Allen, Son, and Co., Limited, of Queen's Engineering Works, Bedford, have for many years obtained most satisfactory results with this class of engine, and its application by this firm in the smaller sizes in connection with marine auxiliary plant has met with uninterrupted success. During the last few years this company have greatly extended their engine business, notably in the manufacture of engines for large powers, and we illustrate herewith (Fig 1) a direct-coupled unit of 730 b.h.p. which has recently been supplied by Messrs. Allen to the Corporation of Luton, Beds, to provide part of the power required for the municipal electric trams, etc. It is almost superfluous to call attention to the exceedingly neat and compact appearance of the whole plant, not to mention the accessibility of all the parts requiring attention.

The engine is constructed to develop the above output—namely, 730 b.h.p.—when running at 350 r.p.m., with

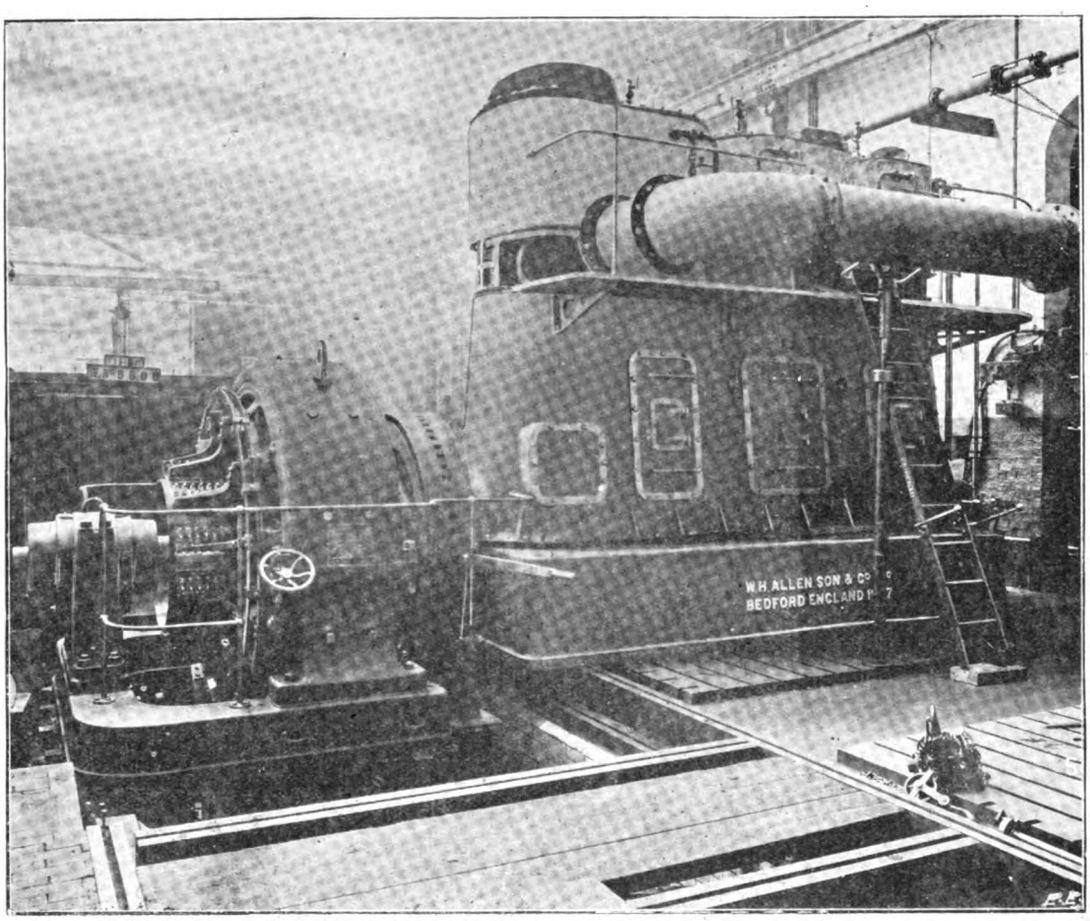

FIG. 1.—Triple-Expansion Engine and Dynamo for Luton Corporation.

130lb. steam pressure per square inch and 100deg. F. of superheat, exhausting into a vacuum of 24in. The steam consumption under these conditions was guaranteed to be 19lb. per kilowatt-hour (full load). An overload of 15 per cent. is obtained when condensing by means of an automatic by-pass valve operated by the governor of the engine. This ensures that the engine shall give its maximum economy at the normal full load, an arrangement which experience has proved most desirable, and has been demonstrated in practice to be by far the most satisfactory. The engine is further capable of giving the full load when non-condensing with steam at 140lb. pressure per square inch. The cylinders are respectively 15½in. and 22½in. and 33in. diameter, with a stroke of 14in., thus dividing the total expansion into three stages, and between these at full load the power developed is equalised, thus ensuring an exceedingly even turning moment. The governor of the engine is of the makers' well-known crankshaft type, and operates a compound double-beat throttle valve, situated as close as possible to the high-pressure valve chest. The distribution of steam

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to each cylinder is effected by means of piston valves, which receive steam at the centre and exhaust over the outer edges, thus minimising condensation and reducing the pressure on the valve-rod stuffing boxes. The high-pressure piston is of cast iron of the solid block type, and is fitted with a solid ring of rectangular section, the intermediate and low-pressure pistons being of pressed steel, fitted with "Rowan's" spring rings. The weights of all three pistons are adjusted as nearly equal as possible, to ensure a good balance of the reciprocating parts. The excellent running of this set under trial demonstrated the great care which the makers had bestowed upon the design with the object of obtaining a good balance, and the momentary speed variation when the whole load was suddenly taken off did not exceed 4½ per cent., and the steady speed variation from no load to full load was well within 2¼ per cent., there not being the slightest evidence of any tendency towards unsteadiness.

In the matter of cylinder lubrication Messrs. Allen have in this case made a somewhat unusual departure. Instead of the usual sight-feed impermeator they have fitted an automatic graphite cylinder lubricator. In accordance with their usual practice, the lubrication of all the working parts is supplied under pressure from an oil pump situated within the bed-plate of the engine, and operated by the high-pressure eccentric. In connection with the forced lubrication system there is provided an oil cooler, pressure indicator, filter, and an oil and water separator. Hand regulation is also provided by which the oil pressure can be adjusted to any desired amount, experience showing that a pressure of about 15lb. per square inch is the most suitable for this class of engine. The piston and valve rod glands are all packed with "Spherical" metallic packing, which Messrs. Allen are now fitting to all their standard engines. The governor is also provided with hand regulating gear, by which the speed can be varied over a considerable range above and below the normal speed. The main stop-valve and by-pass handles, together with the levers operating all the drain cocks, can all be operated from the same position in the neighbourhood of the governor of the engine, where the various steam and oil pressure and vacuum gauges have also been arranged, as well as the tachometer which shows the instantaneous speed of the engine. A platform of exceedingly neat proportions is also erected in front of the cylinders, and is provided with a stairway in the centre, thus giving easy access for inspection of the glands, etc., as well as to the indicator cocks and emergency cylinder lubricators. The front of the engine trunk is also fitted with three large removable doors, each having a small hinged panel in the centre, which permit of easy access to the working parts for inspection and repair.

The dynamo, which is also manufactured by Messrs. Allen, has an output of 500 kw. at any voltage between 500 and 550 when running at 350 r.p.m., and is capable of carrying an overload of 15 per cent for three hours without undue heating. The machine is of the eight-polar continuous-current compound-wound type, and is fitted with commutating poles, of which there are four, one to every pair of main poles, placed in the alternate interpolar spaces. The armature is of the usual slotted-drum type, and is wound with interchangeable coils, jointless except at the commutator. The coils are held in place in the slots by the usual wooden keys, which are fitted in notches at the tops of the slots. The ends of the windings are retained in place by bands of steel wire. The armature has a plain single-turn lap winding, the core being built up of segments, there being six of the latter to the circle. The segments are dove-tailed on to the cast-iron armature hub, which has a flanged extension for bolting direct to the engine flywheel, thus ensuring freedom from vibration due to the bending of the steel shaft. The commutator is built up of 480 hard-drawn sectors, mounted upon a cast-iron sleeve. Eight sets of carbon brushes are provided, with seven brushes per arm, each measuring 1½in. by ¾in.; the current density thus does not exceed 32 amperes per square inch. The magnet yoke is of cast steel, divided on the horizontal diameter, and is fitted with eight rectangular main poles of rolled steel, having laminated shoes. The shunt winding is divided into two sections on each main pole, a third section consisting of the series winding. Between the poles and the winding there is an air space of ⅛in, as also between each section of the winding, so that each section is entirely surrounded by air, thus enabling the heat developed in the coil to be rapidly dissipated. The distance between the pole and the core is maintained by means of wooden wedges, a method of supporting the winding which ensures perfect insulation and very cool working. Each commutating pole winding

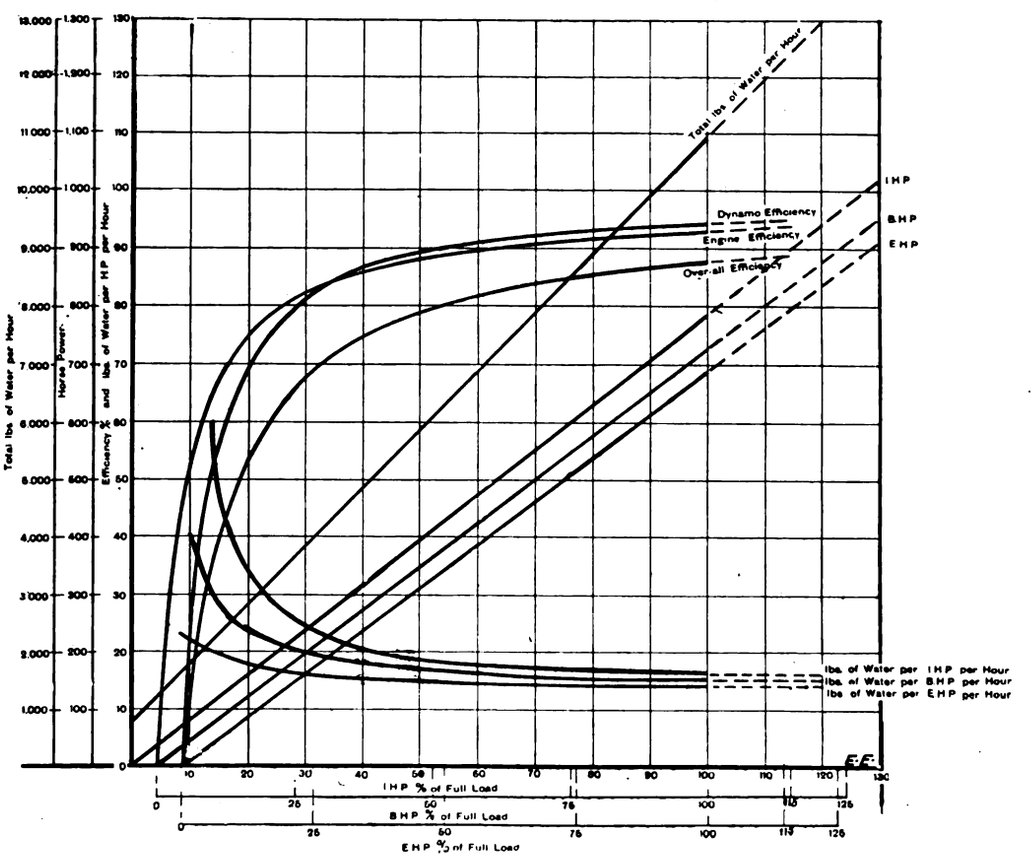
Total lbs of Water per Hour
I.H.P
B.H.P
E.H.P
Dynamo Efficiency
Engine Efficiency
Over-all Efficiency
lbs. of Water per I.H.P per Hour
lbs. of Water per B.H.P per Hour
lbs of Water per E.H.P per Hour
Horse Power
Efficiency % and lbs. of Water per H.P per Hour
I.H.P % of Full Load
B.H.P % of Full Load
E.H.P % of Full Load

FIG. 2.—Steam Consumption Curves.

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carries one-half of the main current, and is wound with 22 turns of flat copper strip. The specification required absolute sparklessness at all loads, including the emergency overload, and this requirement was strictly complied with on the test with the brushes fixed in the symmetrical no-load position.

The steam trials of this set were carried out in the makers' own works in their testing department under the supervision of their own staff, and in the presence of the consulting engineer's representative. The consumption curves deduced from these trials are shown in Fig. 2, from which can easily be read off the steam consumption at any output when the engine is supplied with dry saturated steam at a pressure of 140lb. per square inch.

THE CONDUIT SYSTEM OF ELECTRIC TRAMWAY CONSTRUCTION AND RECENT IMPROVEMENTS.*

BY FITZ ROY ROOSE, A.M.I.MECH.E., A.M.I.E.E., F C.S.
(L.C.C. ENGINEER'S DEPARTMENT).

(*Continued from page 83.*)

DIFFERENCES BETWEEN EARLY AND PRESENT CONSTRUCTION.

Conduit.—The conduit (Figs. 1 and 2) is now made 1ft. 4in. wide instead of 1ft. 2in., as with the latter it was found that there was not enough clearance between the conductor bars and the side of the conduit, mud accumulating and causing leakage of current. The filling used is 6 to 1 concrete, instead of 5 to 1, for reasons stated later.

Yokes.—The yokes are of two patterns (a short and an extended). The short one (Fig. 35), with the exception of an extra 2in. in width to ensure greater air-gap behind the conductor bars, is similar to the original pattern. It is made of cast iron, and in section takes the form of an H girder, the web being $\frac{3}{8}$in. in thickness, and the inner flange $\frac{3}{4}$in. in thickness and 3in. in width; the outer flange is $\frac{3}{4}$in. thick at the outer edge, increasing to 1in. at the web, and varies from 5$\frac{1}{4}$in. to 5$\frac{1}{2}$in. at its greatest width. The over-all depth of the section is 6in. The yoke terminates at the top in two bolting-up faces, leaving a gap of 4$\frac{1}{2}$in.; to each of these faces the slot rails are bolted. These short yokes are placed in the trench at distances of 7ft. 6in., and alternately, at distances of 7ft. 6in. apart, extended yokes, 6ft. 3in. from tip to tip (Fig. 36), are placed. The extended yokes, besides carrying the slot rails, form anchors, to which the track rails are fixed every 7ft. 6in. They are similar to the short yokes with the exception of the two extended arms, each of which terminates in a bolting-up face 14in. by 7in., each containing two slotted holes, 2in. by $\frac{7}{8}$in. The bolting-up face is recessed to take a hardwood packing $\frac{5}{8}$in. thick. After placing the yokes in the trench the slot rails are bolted on, and tie-rods are fixed between the shoulders of the short yokes and the slot rail. Track rails are laid on the extended yokes, tie-rods being used at the yokes to connect the slot and the track rails. The rails are bolted down at each extended arm by two rail clamps (Figs. 38 and 39), held in place by four $\frac{7}{8}$in. tee-headed bolts. The clamps, of cast steel, are each 5in. by 6in., and are recessed to fit the flange of the rail and to sit on the bolting-up face. They are kept tight against the flange of the rail by tapered wedges and packing pieces. To ensure that these shall not rise up when the rails are being brought to gauge, the shoulder of the extended arm is undercut $\frac{5}{16}$in. at the bottom. The wedges are also kept from slipping out by the ends being turned over. The tie-rods (Fig. 36) are of wrought iron. Taper washers are provided to compensate for the angle at which the tie-rods meet the rails, ensuring the bolt going tight up, and not binding on one edge only. When the track and slot rails are in position, the whole is packed up to line and level, and the yokes are stuck with 6 to 1 concrete.

Centering.—The centering is then put in, and its construction differs considerably from that at first used. As already stated, it was originally of wood, resulting in a rather rough surface to the conduit, which was not infrequently damaged in the removal of the centering. The centering now employed is of $\frac{1}{8}$in. sheet iron, and the methods of insertion and extraction vary. One system consists of three iron sheets, 3ft. 9in. long, which dovetail into each other, and are pressed out to the contour of the yokes by means of wooden wedges. The chief objection to this form of centering is that as it is withdrawn in separate pieces sections are apt to be overlooked, and in some cases months have elapsed before they have been discovered. Another, and in the author's opinion a better, device is that consisting of two iron sheets hinged together at the bottom and pressed out to the contour of the yokes by means of a toggle joint, the arms of which are bolted to each sheet at either end. This is extracted in one operation, the whole centering collapsing on the joint being wrenched upwards, and it can be withdrawn through gaps left for the purpose. The centering having been inserted, the rough packings are removed from under the yokes and rails. Concrete is introduced in one mass at 6 to 1 instead of, as formerly, in two operations and of different mixtures. This has the advantage of speed and saving of material.

Insulator Pockets, etc.—The insulator pockets, instead of being covered by cast-iron boxes, are now covered with a cast-iron plate (Figs. 22 and 23). This plate is 2ft. by 1ft. 8in. in area and $\frac{3}{4}$in. thick. It has strengthening ribs 2in. deep and $\frac{5}{8}$in. thick running longitudinally and transversely, and a portion of the front edge next the slot rail is recessed to clear the insulator. At its two extreme front ends it has holes, 2in. in diameter, to clear the clip bolts supporting the paving plates between the yokes and box. Also at either end, where the cover plate rests on the slot rail, it is tapered up $\frac{1}{4}$in. for the insertion of a chisel point, should it be necessary to lift the cover. Before the cover plates are bedded in position the conductor tee rail work is inserted, as previously described, two improvements having been adopted—one being that the end of each tee rail is bevelled off, minimising the chance of plough shoes being caught by foul joints; the other being that the tee rail, with the exception of the rubbing surface, is coated with a preservative paint. Paving plates (Figs. 24 and 25) are inserted between the cover and yokes to support the paving, as the concrete of the conduit next the slot-rail flange at this point is very thin and liable to crumble away. Before they were introduced the green concrete sometimes broke off, and the paving collapsed. The paving is next laid The positions of the insulator pits thus hidden are indicated by square setts known as "dumplings." These covers are considered a great improvement in some ways on the original boxes, which latter, as

Fig. 8. Plan.

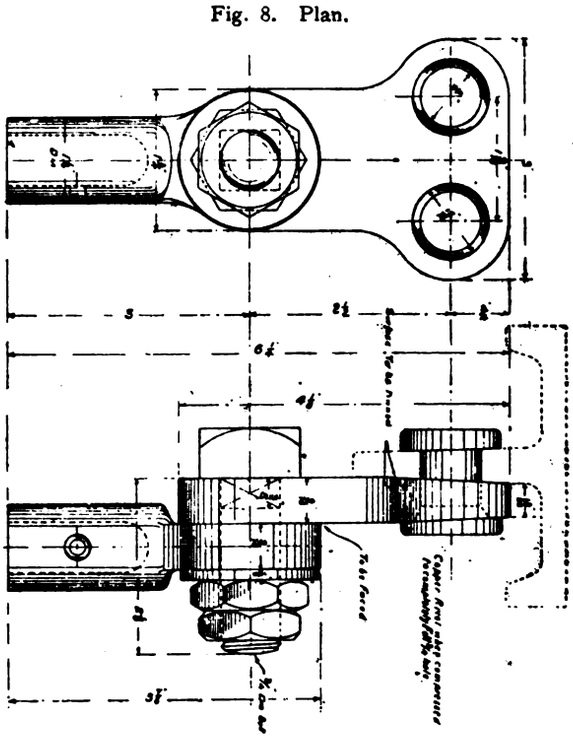

Fig. 9. Side Elevation.

* Paper read before the Junior Institution of Engineers.

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they became worn by the traffic, had to be replaced, and were also the cause of a great deal of dirt getting into the conduit. The chief disadvantage of the new covers, and

Fig. 10. Side Elevation.

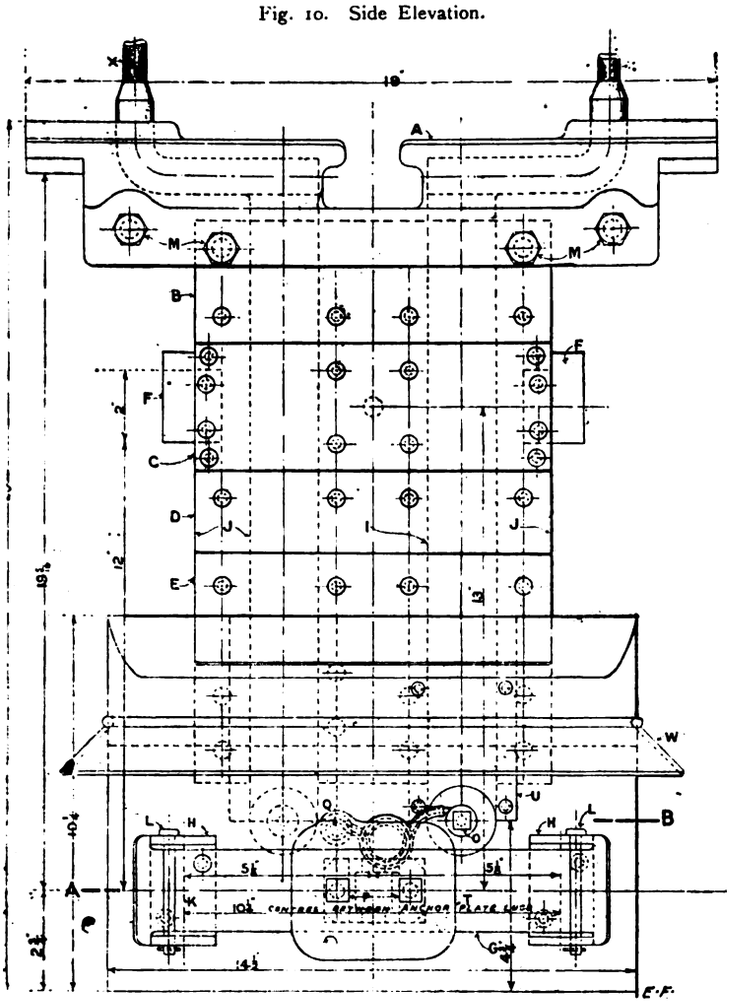
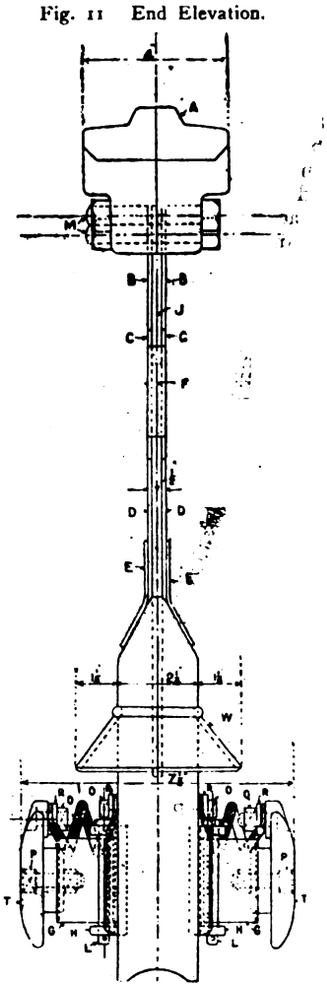


Fig. 11 End Elevation.



one which may prove most serious, is that access to the insulators can only be obtained by ripping up the paving, which takes time; and in the case of a rail dropping or an

hour. There are only a few miles laid with cover plates at the present time, and it remains to be seen whether they will be universally adopted. The anchor plates at the track rail joints, instead of being riveted to the rail flange, are now bolted, a process which saves time and cost in maintenance.

Fig. 12. Plan.

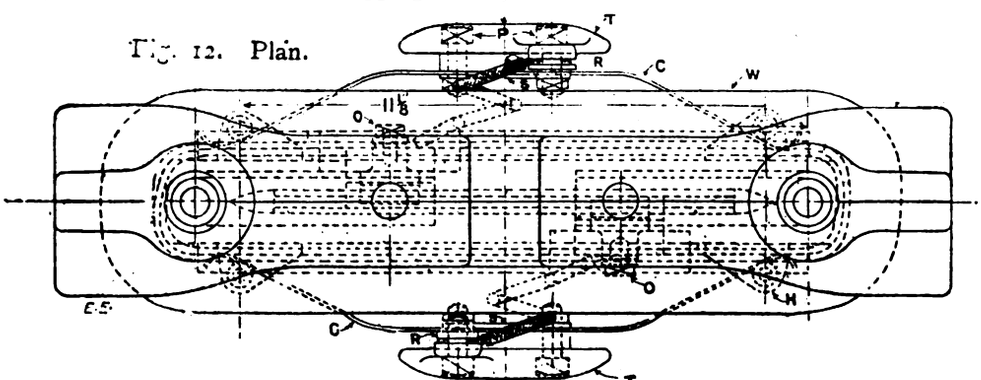
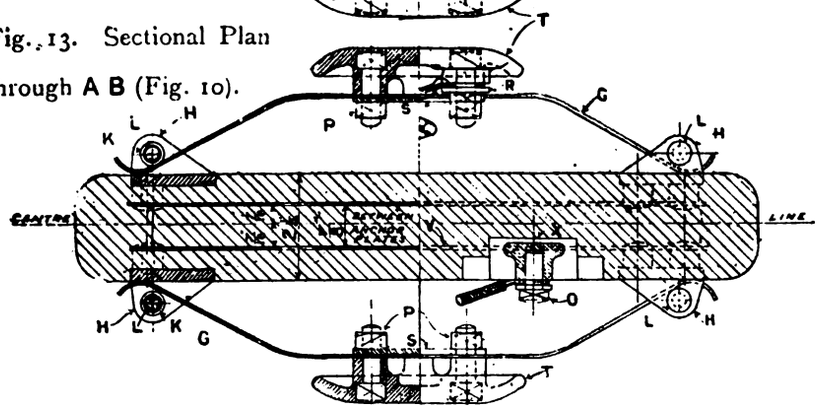


Fig. 13. Sectional Plan through A B (Fig. 10).



insulator burning out means considerable delay in the car traffic. In the older method of boxes an insulator could be taken out, examined, and replaced in a few minutes. It now takes—from experiments made—three-quarters of an

Drainage.—Drainage is effected by means of sumps (Figs. 14 to 16) spaced every 40 yards along the track, instead of 60 yards, as was formerly the case. The sump consists of a concrete pit 7ft. 9in. deep, built in the clear

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way. At a height of 3ft. 6in. from the bottom a concrete shelf or benching branches off under each tube. The conduit does not run continuously through the sump, but ends flush with each wall, enabling mud to be drawn and dropped on to the shelf in each sump, from which it can be removed periodically. A flushing box is provided over each shelf, access to which is obtained through an ordinary insulator frame and cover, and the sump is entered through a manhole 1ft. 6in. square, step-irons being provided. The catch-pit thus formed is connected to the sewer by a 9in. pipe, the sill of which is 2ft. 5in. above the bottom of the catch-pit. The mouth of this pipe is sealed with an iron hood, which extends 5in. below the water-line, thus preventing escape of sewer gas. In outfall sewers liable to flooding, iron non-return valves are inserted to prevent water, etc., getting back into the conduits in the event of the sewer becoming surcharged. This form of sump is an improvement on its predecessor, as the benchings which now replace the 12in. pipe trap the mud more readily, and are infinitely easier to clean. Rail drains (Fig. 17) are, with one or two slight modifications, similar to those originally used. The ironwork being erected in one operation is a great advantage, as a much truer line and level is obtained, and with the extended yokes placed every 7ft. 6in. the running rails have a much firmer base and are at the same time much more rigidly anchored into the concrete bed. Renewals can also be executed with greater facility.

Insulators.—One or two improvements have been adopted in the construction and erection of insulators (Figs. 26 to 29). The pin is now made with a square shoulder to prevent turning when being bolted up; there is also a piece of $\frac{3}{16}$in. galvanised iron wire threaded through a hole in the end of the pin and twisted round to prevent the bottom nut working loose and falling off, in which case the conductor bar, losing its support, would become detached from its proper position. The usual split pin is not employed here, as any shock tending to loosen the insulator pin in its cement setting must, of course, be avoided. The cement filling is now only inserted to within $\frac{3}{4}$in. of the top of the porcelain cup, instead of $\frac{3}{8}$in., as formerly, as it was found that moisture collected here, and leakage of current occurred, sometimes resulting in a burnt-ou insulator. With the exception of these slight alterations, the insulators retain their original design. When the insulators are assembled, they are left to set for eight weeks, and before being erected in the road they are submitted to a mechanical and electrical test. The former consists of bolting the insulator to a beam and leaving a weight of about 1cwt. suspended to the pin for a certain time. If the pin remains rigid, the insulator is taken to

Fig. 14. Vertical Section of Sump at A B (Fig. 16).

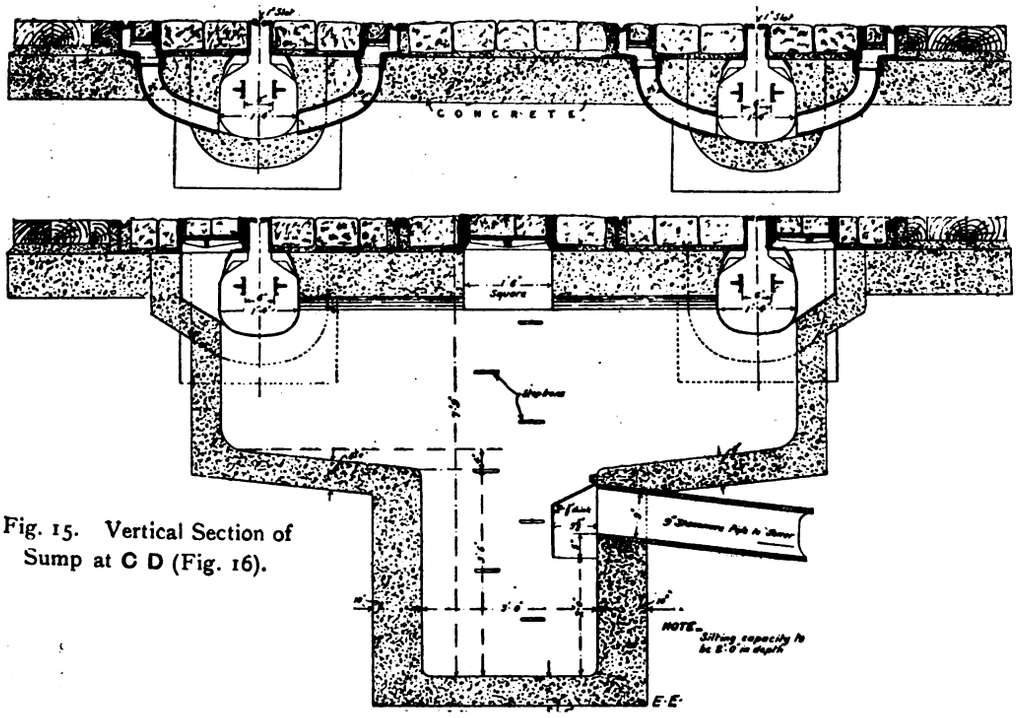
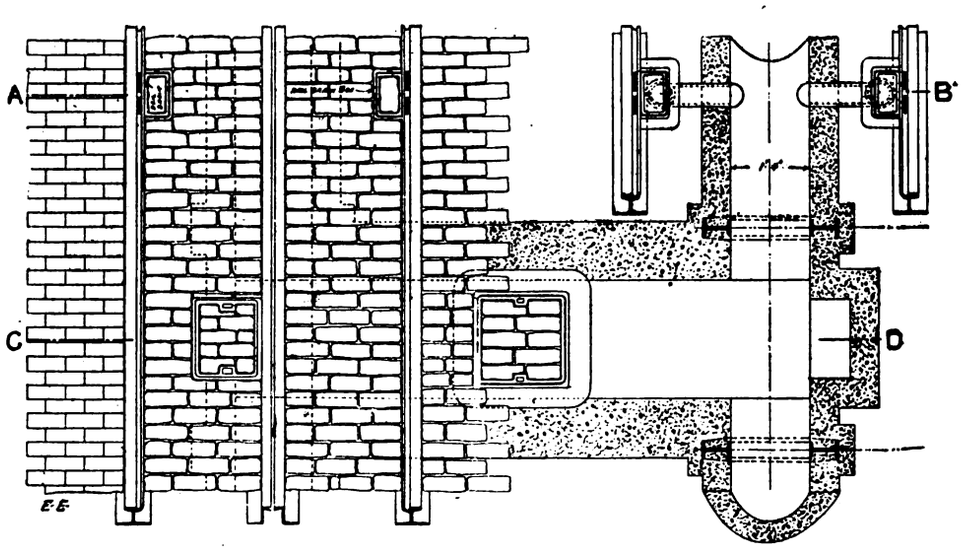


Fig. 15. Vertical Section of Sump at C D (Fig. 16).

Fig. 16. Plan of Sump.



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a sub-station to undergo the electrical test, which is effected by first immersing it in water, and then placing it with a number of others upside down in tanks of water to half the height of the casting and connecting the pins in circuit with a pressure of 2,000 volts. Should no leakage occur after 15 minutes the insulators are considered fit for use.

Cable Connectors (Figs. 8 and 9).—These consist of brass castings riveted to the stalks of the conductor bars with two copper rivets, and to which are bolted the lugs of the cables. The connectors now in use are 2in. longer than

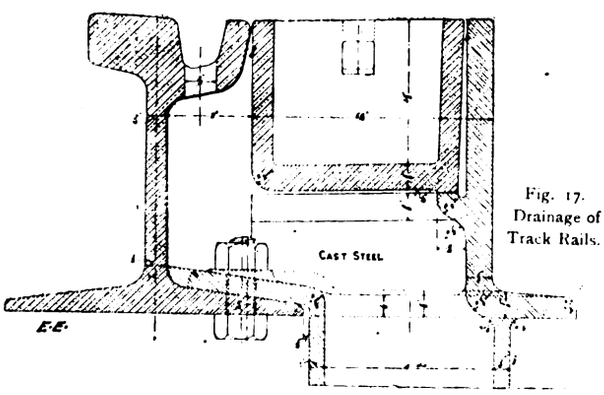

Fig. 17. Drainage of Track Rails.

those formerly employed. This increase in length was found necessary for connecting and disconnecting the cable when the current was on the line. With the shorter type it was difficult to avoid short-circuiting by the box spanner coming in contact with the slot rail or insulator casting.

SPECIAL WORK: CROSSOVERS AND JUNCTIONS, ETC.

Crossovers.—These are placed at intervals to permit cars being transferred from one track to the other. They are arranged centrally at the point where the two conduits divide, and is bolted to the inside bottom flange of the two yokes, forming a dividing wall known as a gusset post. The two castings containing the movable point tongues are bolted in position on the arms of the first two yokes. The rest of the special castings are bolted on, forming, when assembled, two complete tracks, one branching off from the other, and thus making one end of a crossover, the other end being a duplicate, and joining up in the clear way. The crossover is about 600ft. from toe of point

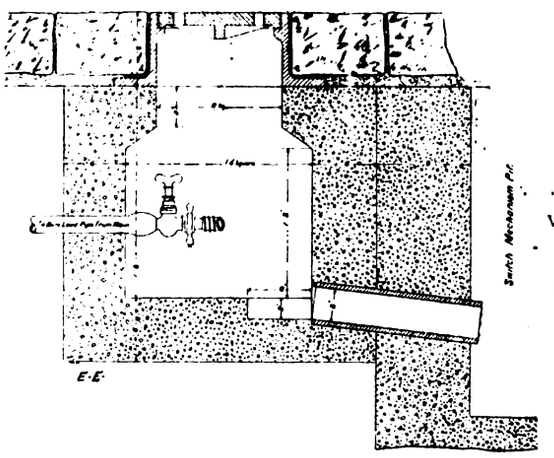

Fig. 18 Water "Box for Cleansing Points.

casting to toe of point casting, and the one track leaves the other at a radius of 100ft. The concrete conduit is formed and the conductor bar work is installed in the way already described, cable being provided to bridge the physical breaks. Extensions of the point mechanism to the foot-path (Figs. 33 and 34) and water-boxes (Fig. 18) are now only provided at terminal crossovers and facing

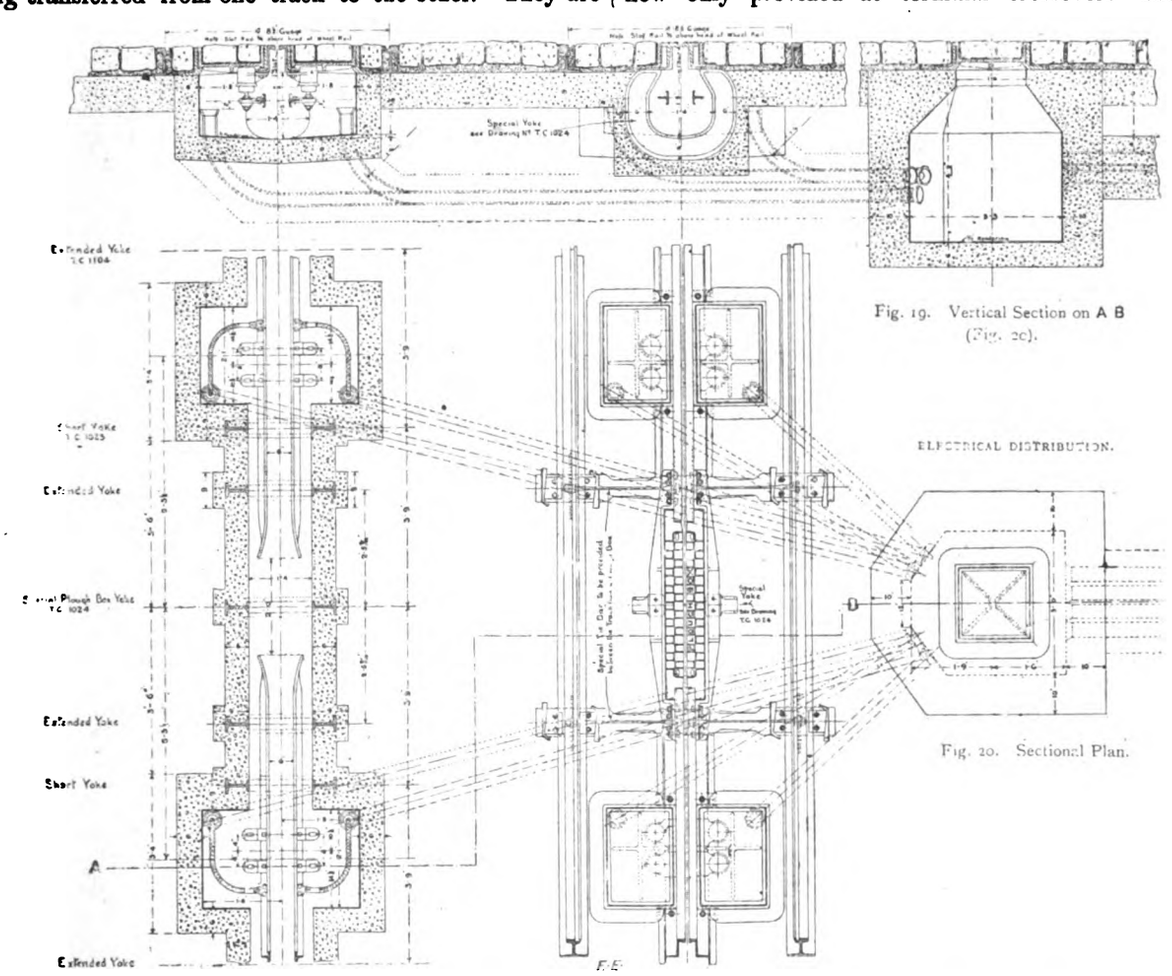

Fig. 19. Vertical Section on A B (Fig. 20).

Fig. 20. Sectional Plan.

similar in construction to those originally used, and are made in massive separate parts, which can be divided into special yokes, and top castings (Figs. 30 to 32). The yokes, spaced 4ft. 6in. apart, are of cast iron with machined bolting-up faces, and are considerably heavier in section than the ordinary yokes. A special large casting is

points of junctions. The mechanism for actuating the points has been slightly modified and strengthened. The slot tongues being connected to their corresponding point tongues, are in turn connected by two vertical bars dropping down clear of the conduit and riveted to a horizontal bar, gussets being riveted at the angles for rigidity. The

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modified design has had the effect of eliminating a number of the original pin joints, thus decreasing the risk of lost motion due to wear at such points.

Twin Slot.—Twin slot (Fig. 37) is adopted when the road is not wide enough for a double track. The two tracks have track rails in common, but instead of one slot converging into the other a second conduit is carried along parallel to it. This, beyond simplifying the slot point construction, has practically no advantages over the single-line method of construction, and has the great disadvantage that should it be necessary to run a car backwards, and the track points happen to be set against its returning to the line it has just left, the plough would follow the conduit of one track whilst the car might run on to the other track, thus separating the car and the plough.

(To be continued.)

THE NEW METAL-FILAMENT LAMPS: THEIR QUALITIES AND THEIR COMMERCIAL IMPORTANCE.*

BY H. REMANÉ.

There is hardly a doubt that the incandescent lamp always has been a factor of the greatest importance in the development of the whole of the electrical industry. When the competition of the incandescent gas increased more and more, the necessity for more efficient sources of electric lighting grew in importance, not only for the incandescent lamp manufacturers, but for the whole of the electrical industries. Some 30 years have passed since the invention of the incandescent lamp, and only to-day we hold in our possession the high-efficiency lamp which we have been aiming at for such a long time. It must not be thought that this is a sign that we have not worked hard enough on the improvement of the incandescent lamp; on the contrary, it is a proof of the difficulties of the problem which had to be solved. If one considers Edison and Swan as the inventors of the carbon-filament lamp, we have to thank Auer in the first place for the invention of the electric metal-filament lamp, for he has first shown in his osmium lamp patents new and practical ways which later on led to the success of the wolfram and Osram lamp.

Auer's invention, the osmium lamp, has no forerunner; one, therefore, may consider Auer as the inventor of all the metal-filament lamps, the incandescent bodies of which are produced by sintering together small particles into a more or less homogeneous filament. In the osmium filament the principle of sintering small particles into a filament of nearly metallic density has been carried out for the first time. In the Osram lamp one starts likewise with small tungsten particles, which are sintered together into metallic filaments. The extremely difficult work and the long time which it took to complete this work and to produce such a filament from tungsten was not caused by any different fundament principles, but because the mechanical and physical qualities of the material necessitated a precise, careful, and very tedious study of the conditions under which it is possible to get a similar final product when starting from tungsten as when starting from osmium. The tungsten lamps, which include the Osram lamp, can be made in two ways, either after the paste process of Auer, or after the flashing process of Just and Hanamann, who cover a thin carbon filament with a layer of tungsten, and heat the filament to such a temperature that the carbon inside is absorbed by the tungsten, so that a hollow tungsten-carbide filament is produced, from which the carbon is removed afterwards. The final product—the tungsten filament—made in either way, consists of finest particles of tungsten sintered together during a high state of incandescence. The electrical qualities of the filaments produced after the paste process and those produced by the flashing process are equal. Whether one of the two methods of manufacturing has any advantage over the other, will not be considered in this paper. No doubt the paste process is used to the largest extent at the present moment, and since the filaments of the Osram lamp are produced in this way this process will be described.

The different changes which the Osram filament has to undergo during its manufacture are in principle similar to those of the osmium filament, though the method of manufacturing and the various processes themselves, as well as the reactions, of course, differ from those used with the osmium filament. It can easily be understood why it is not possible to give here an exact description of the method in which the Osram lamp is manufactured. I will, on the other hand, describe the manufacture of the osmium filament after the paste principle. This process will give a good insight into the production of the tungsten lamp. In the first place, a paste is made by mixing fine osmium powder with suitable binding agents. This paste is pressed through diamond orifices by means of high pressure into fine filaments, which, after they have been dried and the binding agent carbonised, are ready for the forming process. During the forming process the filaments are heated up to incandescence, first at a low temperature, later at a higher one, as high as the filament will stand it, and much higher than the temperature which is reached later on in the lamp. The heating up of the filaments is done in an atmosphere of gas containing water and hydrogen. During this process the carbon is entirely removed, and the metal powder of the filament is sintered together to an almost absolutely homogeneous filament which can hardly be distinguished from one made out of molten metal. The osmium filament (likewise the Osram filament) is materially altered through the processes which it has undergone. Already during the drying and heating process its diameter and its length have been reduced considerably, and during the forming process its dimensions have still further decreased in consequence of the sintering. If, for instance, the diamond orifice through which the filament has been passed had a diameter of ·0925mm., the diameter of the filament after the heating process is ·076mm., and after the forming process is ·030mm. After the forming process osmium and Osram filaments are treated in a similar way. They are sorted in accordance with their resistance, because, of course, only filaments of the same resistance can be used in the same kind of lamp. After the filaments have been connected to the leading-in wires by a kind of welding process and have been fitted in their holders, they are put in the bulbs in a similar way to the ordinary carbon filaments. The bulbs are pumped out in the usual manner. It is only necessary to work with more care and accuracy. After the vacuum is obtained the Osram lamps are tested in order to remove those which show faulty manufacture. Afterwards the lamps are measured photometrically, the caps are put on, a second test takes place after the capping, and the lamps are finished ready for dispatch.

It is obvious that the enormous sub-division of labour which is necessitated by the fairly complicated method of manufacture requires a well organised and complicated system for the control and inspection which has to take place during and after every separate process in each department. This control is carried out to such an extent that every detail of the machinery used and of the process of manufacture can be re-established afterwards by the control marks which are on the lamp.

Tantalum behaves in a different way to osmium and tungsten. It can be drawn into wire just like iron, since it does not possess the toughness of wolfram. On the other hand, it has a commercial disadvantage as against tungsten—namely, that only lamps with a consumption of from 1·8 to 2·1 watts per English candle-power can be manufactured from tantalum—that is to say, lamps which consume over 50 per cent. more current than the new Osram or tungsten metal-filament lamps, which have a consumption of about 1·1 to 1·2 watts per candle-power. Tantalum lamps, apart from this, have a considerable further disadvantage (as against Osram and tungsten lamps) through their short life when used on alternating current. No decrease in candle-power takes place in Osram and tungsten lamps, provided that they are burnt on the proper voltage, while, of course, all other incandescent lamps show a considerable decrease in candle-power. Carbon-filament lamps decrease

* Abstract of paper read before the Elektrotechnische Verein in Leipzig.

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in candle-power about 20 per cent. on an average after 400 to 500 hours (this figure varies with the watt consumption per candle-power of the particular make). The corresponding decrease with the new metal-filament lamps is very much less.

The accompanying curves will show results obtained in three different tests which were carried out by the Reichsanstalt (Imperial German Testing Laboratory) on Osram lamps. Fig. 1 shows the variation in watts per candle-power during the life of the lamp. The tests were carried out with alternating current taken from a municipal electric supply company. No special precautions were taken to keep the voltage constant during the life test, so that the lamps were burning under actual supply conditions. The variation of voltage during the tests was ± 2 per cent. The watt

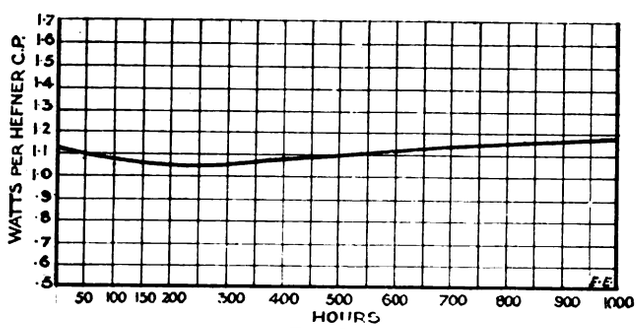

FIG. 1.

consumption of the 16 lamps tested in April, 1906, was 1·11 watts per H.C. at the start of the test. The efficiency slightly increased during the first 100 hours and reached again exactly the original value after 500 hours' burning. After 1,000 hours' burning the watt consumption per candle-power came to an average of 1·18 watts; the initial candle-power was 30·3 H.C., and after 1,000 hours 28·2 H.C. The decrease in candle-power, therefore, amounted to 6 per cent. The 16 lamps tested by the same institution in June, 1906, showed similar figures. Their candle-power curves are given in Fig. 3. No official figures of other metal-filament lamps are obtainable so far.

The temperature coefficient of tungsten is positive. The resistance, therefore, increases with increasing temperature, while, as is generally known, carbon has a negative temperature coefficient—that is, the resistance decreases with increasing temperature. This peculiarity of the tungsten

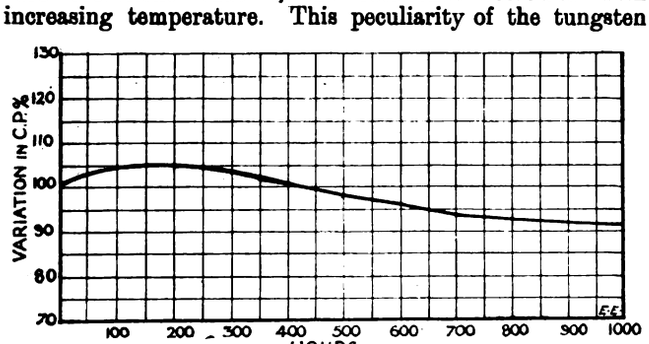

FIG. 2.

filament is of considerable importance and advantage for lighting purposes. Firstly, with increasing voltage the current increases at a much smaller rate than in carbon-filament lamps, which means that the lamps are less overrun—that is to say, less overheated. Secondly, voltage variation effects a much smaller variation in candle-power with metal-filament lamps than with carbon-filament lamps. This means that fewer complaints about variation in light will be received even where the supply voltage varies considerably.

Fig. 4 shows the variation in candle-power with varying voltage (both given in per cent.) in Osram and carbon-filament lamps. This curve shows that if the voltage increases 10 per cent. the candle-power of the carbon-filament lamps increases 85 per cent., the candle-power of the Osram lamp 42 per cent. The watt per candle-power increase with carbon-filament lamps is 35 per cent.; with Osram lamps only 10 per cent. with an increase in voltage of 10 per cent. Since the life and the constancy of candle-power of a lamp (as is generally known) mainly depend upon how much the lamp is overrun, the above figures show again the superiority of the metal-filament lamps. Tungsten, like all metallic incandescent bodies, gets soft at a high temperature, and most of these lamps, therefore, only burn in a vertical position. On the other hand, it is, of course, possible to make special lamps for burning in any other position, as has been shown by the Osram Company on special occasions, already a year and a half back.

It is evident that because the demand for these lamps increased at such a tremendous rate the Osram Lamp Company had to tackle the easier and more urgent problem of the vertical lamp first, in order to be able to manufacture in quantities and cope with the demand. To-day, when the rate of production is 17,000 to 18,000 lamps per

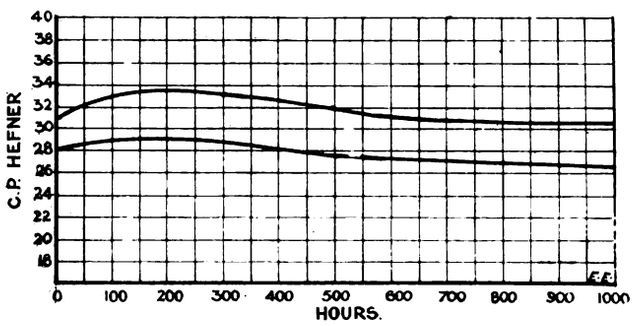

FIG. 3.

day, more time can be spared for the other problems, and it is pretty safe to assume that lamps will be on the market during the next season which can burn in all positions. Osram lamps are manufactured at present for 25, 32, 50, and 100 candle power (for voltages of 100 to 150). There is hardly any demand for lamps of less than 25 c.p. (H.C.). Their life would naturally be less than that of the higher candle-power lamps. The fact that none are manufactured is, of course, of considerable advantage as well for the supply companies. Since the efficiency of the Osram lamp (and tungsten lamp) is about one watt per H.C.—that is to say, 70 per cent. better than the efficiency of the carbon-filament lamp—it is unnecessary to dwell on the importance of the lamp in regard to making electric lighting more general. The lamp can well compete with gas lighting where favourable prices for the current can be obtained

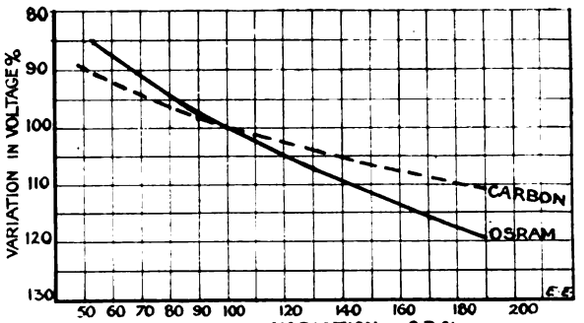

FIG. 4.

and the lights are properly distributed. It is cheaper than petrol, as shown in the table given herewith, which is taken from "Practical Photometry," by Dr. Liebenthal.

COMPARISON BETWEEN THE DIFFERENT METHODS OF LIGHTING.

Method of lighting.	Mean hemispherical candle-power in H.C.	Per 1 H.C. mean hemispherical candle-power and one burning hour. Average consumption.	Equiv. energy Watt-hours.	Kg. calories.	Price in pfg.
Ordinary incandescent gas light with hanging incandescent burner	60-150	1·5 litres	8·9	7·6	0·020
With upright incandescent burner.....	60-90	1·9 litres	11·3	9·7	0·025
Osram lamp	20-40	1·4 watt-hours	1·4	1·2	0·070
Petrol lamp	10-30	3·4 grammes	44·0	37·0	0·085
Osmium lamp.....	25	1·9 watt-hours	1·9	1·6	0·10
Nernst lamp	20-200	2·4 watt-hours	2·4	2·1	0·12
Acetylene.....	8-180	1·0 litre	17·0	15·0	0·15
Carbon-filament lamp	8-40	3·4 watt-hours	3·4	2·9	0·17

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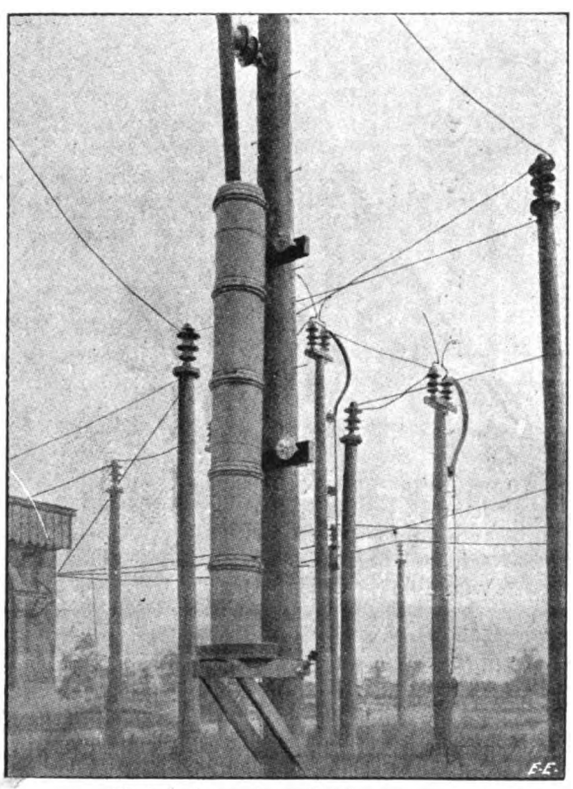
It is interesting to note that the percentage of energy emitted as light is larger with tungsten lamps than with incandescent mantles, and that further marked improvement in the efficiency of the new lamp is, therefore, hardly to be expected.

ON PROTECTIVE DEVICES FOR HIGH-TENSION TRANSMISSION CIRCUITS.*

BY J. S. PECK.

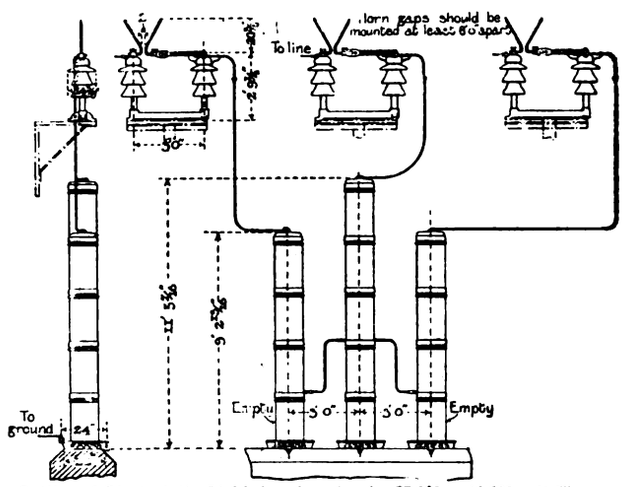
The author described three reasons for lack of interest in England, as compared with America and the Continent, in regard to protective apparatus for high-tension transmission systems against lightning or other high-voltage discharges: (1) there were very few systems working at pressures above 11,000 volts; (2) the great majority of transmission systems were laid underground, and, therefore, not subjected to lightning disturbances; (3) severe thunderstorms were of very rare occurrence. He then went on to explain the theory of static disturbances, concentration of potential on end turns of transformer and high-voltage windings, reflected waves, resonance, and



Electrolytic Arrester on 60,000-volt Circuit.

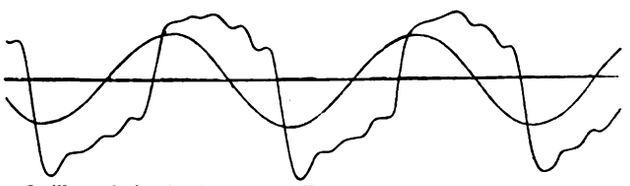
other static phenomena, using many interesting diagrams and analogies. He then went into the question of lightning effects on transmission lines, and said, regardless of the source of the static disturbances, there were at least two dangers to electrical apparatus on transmission systems: (1) concentration of potential on the end windings, causing shorts between adjacent turns; (2) excessive voltage between wires and ground, causing breakdowns to ground over insulators, bushings, or through the insulation of the windings. The remedies for the former lay in extra insulation of the end windings or by choking coils in series. The remedy for the latter lay in using lightning arresters.

The author then went on to describe the many types of arresters in use: the horn-type arrester, the non-arcing multi-gap arrester, the low equivalent multi-gap arrester, the multiplex arrester, the water-jet arrester, arresters in parallel, and, finally, the electrolytic arrester. Of this latter, he said that it had been found that aluminium in certain electrolytes formed a non-inductive film on its surface. This film, though extremely thin, would withstand about 400 volts. At higher voltage the film was punctured with countless small holes, and a large current was permitted to pass; but when the voltage dropped below the critical value the film was re-formed, and prevented further passage of current. A sufficient number of these cells might be placed in series to withstand almost any voltage desired. It was evident that the aluminium cell possessed almost ideal characteristics for a lightning arrester, as it permitted very little current to pass at normal voltage, but broke down at higher voltage, and resealed itself as soon as the high voltage had passed and the line had been relieved. When voltage was applied to the cell, a small current, partly capacity and partly leakage current, flowed through it; and for a lightning arrester it was advisable to use a gap in series with the cell in order to prevent that current flow. In order to obtain a large number of cells in series the aluminium plates were pressed into tray form. These trays



Outline of Electrolytic Lightning Arrester for 53,000 to 66,000 volt Three-Phase Circuits with Underground Neutral.

were set one inside the other, and separated by suitable insulating washers. They might thus be built up into a column comprising a large number of cells in series. The columns were enclosed in suitable earthenware jars and the trays filled with the electrolyte. After the trays had been filled the jar was tipped slightly, so that a small amount of the electrolyte ran out of each tray, and a small amount of transformer oil was then poured into the top tray and permitted to run over into those below. This oil prevented evaporation of the electrolyte. A number of jars might be mounted one above the other for high voltages, and as the edges of the trays did not touch the jars current passed from tray to tray. For voltages not exceeding 13,500 a gap consisting of the usually non-arcing metal cylinders was placed between the line and the electrolytic unit. For higher voltages the horn-type gap was used.



Oscillograph showing Current and Voltage on Electrolytic Unit, 12,500 volts, 25 cycles, 0·41 ampere.

The gap used must have sufficient power to suppress the arc which existed after the static disturbance had passed. The current in that arc was quite small. It was not advisable to use a horn-type gap on the lower voltages, as it had to be set so close that the arc did not rise properly and extinguish itself. The electrolytic arrester was manufactured for voltages from 4,000 to the highest in commercial use, and, unless unforeseen difficulties arose, it should practically solve the question of protection from lightning discharges. Many illustrations were given in the paper showing this electrolytic arrester.

The author concluded his paper with a few observations on the method of protecting a transmission line from lightning by stringing up above it a wire which was grounded at intervals, and on the question of testing lightning arresters. Reference was made in the paper to the great work of Wurtz, Elihu Thomson, Steinmetz, and

*Abstract of paper read before the Institution of Electrical Engineers.

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Thomas, the latter in particular for his practical application of his scientific studies.

DISCUSSION IN MANCHESTER.

Mr. M. B. FIELD (chairman), in proposing that a hearty vote of thanks be given to Mr. Peck for his interesting paper, said that, no doubt, the members knew that the parent Council had requested Mr. Peck to read his paper in London. He considered this a great compliment to Mr. Peck and to the Manchester Section.

Mr. C. D. TAITE (Lancashire Electric Power Company) congratulated Mr. Peck on his very interesting paper on a subject of which there was so little known in this country. There had been no standard book on the subject, and there was no standard practice in regard to the question of protecting transmission lines. He had occasion recently to write to several engineers who were in charge of overhead work for their views on the question of lightning arresters. Most of them tried the use of them ; some did not believe in them ; others simply used them on account of convention, but no one seemed to have a fixed idea of them. He thought that the reason of lightning arresters not being universally used and understood was that there was little work for them to do in England. The pressures were not very high, and there were comparatively few thunderstorms. The lines that were in use, however, were difficult to protect owing to the mixture of underground and overhead work. At villages and by-roads, or at any sign of habitation, they had been compelled to stop overhead transmission and continue by means of underground cables. He understood the cablemakers to advocate protection at all these points. In the Lancashire Electric Power Company's system they had three overhead lines (11,000 volts), and he was glad to say that as yet they had experienced no trouble with their plant at the generating station. He could not say they had gone into the question of protecting these lines in a scientific manner. One line was protected by horn arresters set for action at a voltage of 25,000 volts, and there was evidence of this action on occasions ; another line was protected by the multi-gap type of arresters, which were enclosed in boxes, but he could not say whether or not these had come into action. The third line was not protected at all. The least trouble had occurred on the line where there was most overhead work ; on this line horn arresters were used. He suggested that the freedom from trouble might be due to rain, which was very prevalent in Lancashire. The line which was the most affected was the line with the least overhead and the most underground work. This was protected by the multi-gap type of arrester. The trouble always occurred at the end of the line on the underground portion. They had now remedied the trouble by putting a multi-gap arrester at the end of the line. He thought that this example of trouble well bore out Mr. Peck's pretty analogy of the springs on railway wagons. Mr. Peck's description of the electrolytic meter was very interesting. It seemed cheap, and if it actually was so there seemed a future for it.

Mr. W. A. CHAMEN (South Wales Power Company) said they had very little overhead work in South Wales, but hoped to have a great deal more in the future. They had one line which went over the mountain top, and there were occasions when they had trouble due to storms. On one occasion a transformer at one end was found to be broken down, and he had no doubt as to its cause. They had horn arresters and water resistances as protections at one end of their lines. These had worked frequently at the generating station and two substations, and had certainly saved them trouble. They were all under cover.

Mr. W. CRAMP asked one or two questions. Mr. Peck at the beginning of his paper assigned as one of the three reasons of the lack of interest in protective apparatus on transmission lines that "the great majority of transmission systems are laid underground, and, therefore, not subjected to lightning disturbances." Surely, however, all high-tension underground systems came to the surface at certain points, and there was, therefore, need for protection. Another point in which he would like more information was in Mr. Peck's statement in reference to the horn arrester : "It is now customary to install a high resistance in series with this arrester in order to limit the current which flows on short-circuit, but this resistance retards the static discharge. This arrester requires a much higher resistance in series with it than certain other types." Surely the lightning discharge, oscillating with such frequency, caused a self-induction reactance so much in excess of the resistance that the latter was of a negative character. He also referred to the possibility of accumulative static charges due to Hertzian waves from wireless telegraphic stations. He would also like some more particulars as to the curve showing oscillograph of current and voltage on electrolytic lines. Mr. Cramp, in conclusion, fell foul of the author in his terminology.

Mr. M. B. FIELD (Ferranti Limited) remarked that, as he understood Mr. Peck's paper, there were two kinds of potential strains possible on high-tension transmission lines : (*a*) causing a limited rise in potential ; (*b*) causing unlimited rise in potential. Switching on evidently came under the former heading, causing reflected waves, which would raise the potential to twice the normal voltage. This was a very comforting thought to those who had high-pressure cables and apparatus under their charge. The excess of pressure was merely transitory, and there was very little fear of breakdown with a transient voltage of double the normal voltage. It was a well-known fact that breakdown depended mainly on the time the apparatus was under tension. For instance, a cable might stand 50,000 volts for a minute or so, but might break down under a pressure of 10,000 volts if such pressure were maintained for half an hour. Such transient high pressures did not produce dead shorts, and would probably not strain the insulation unduly, though they might spark through. Should the distances of transmission be greater, the results would appear not to be different. Breaking circuits, lightning, power surges, and atmospheric effects would appear to come under (*b*) (unlimited rise in potential). Here, again, they would appear to be fortunate as regards breaking circuit on alternating currents in possessing the automatic oil switch, which broke circuit at zero potential. Power surges, atmospheric effects, and lightning were the most serious troubles. They seldom, however, had trouble from the former, at all events in this country. As regards atmospheric effects, he had some experience a few years ago with a water-power station having overhead transmission on which they had arresters of the horn type. These used to frequently spark, and the sparking generally occurred about five in the evening. After giving the matter consideration, he came to the conclusion that the reason of the sparking at this time was due to atmospheric condensation, as the wires passed over a river. Sometimes there was a vicious spark on the horn arresters, at other times short-circuits occurred. As regarded trouble due to lightning he had no experience, and could, therefore, say nothing. He then went on to the concentration of potential upon the outer turns of the windings of electrical apparatus. Why did not this effect travel inwards ? They were not affected. At one time there was a proposal to put initial turns outside the coil. The remedy was found to be in introducing sideways capacity by means of choking coils. Was the type of choking coil in Fig. 7 the best ? It did not appear to him to introduce any sideways capacity. He had himself found the windings of high-tension motors broken down on the initial turns ; when these turns were properly examined the insulations were found riddled with holes. After consideration he made choking coils designed to stop the trouble. They were turns of copper strip insulated by paper. They, however, did not act, and he came to the conclusion that the reason was due to their possessing no sideways capacity. He then used water switches. Going on to the effect of grounding a circuit, Mr. Field took the example of a three-phase cable, and showed that it was possible by grounding one core to earth suddenly a pressure 3½ times that of the normal might be put across the other cores, so one had need to be careful. Coming to the question of arresters, he said that the horn type of arresters had been known for years, but it was not until 1896 that they were satisfactory ; previous to that their action was erratic. Formerly the line connections had been put on sometimes at the narrow extremities of the horn and sometimes at the middle points. An American engineer having trouble with the arresters with the line connected at the middle points altered the connections to the lower extremities and had no further trouble. The reason was not obvious, and it might be worth explaining. The drawing out of the arc was due to two effects : (1) thermal effect, heat causing the arc to rise upwards ; (2) the magnetic effect. If the current was brought in above the narrow gap—that is, at the middle point—this magnetic effect caused the arc to have a downward tendency, and there was, therefore, trouble, as the arc could not be broken, the drawn-out horns being useless. When the current was brought in at the extremities of the gap, the magnetic effect aided the thermal effect in giving the arc an upward tendency, to finally be drawn out by the horns. Mr. Field by means of diagrams then went on to explain in detail the action of the gaps in the multi-gap arrester, and to show cause for the variation in the number of gaps required on different circuits and the cause of the trouble due to ground potential being brought near the arrester. He showed that the ionisation of the air between the cylinders had little or nothing to do with the phenomena, but that it was due to increase of current due to the resistances of the supports. Without supports the gaps were uniform, and the current across uniform. The supports, however, were of a certain resistance, and it was easy to see how the current would increase in the first gaps and a discharge occur. This explanation enabled one to easily see the reason and effect by putting a metallic grounded shield connected to the line adjacent to the portion of the gaps next the line and farthest away from the ground. Sparking across the first gap was due to the total leakage across the lot, and this effect had caused many breakdowns. When in America he had a talk with Mr. Steinmetz, who told him that he considered that it was most essential that high-tension cable systems should be protected by arresters. The moment one

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core went to earth wholesale trouble would arise. It seemed curious that on the Manchester system, where arresters were used, trouble had occurred due to the arresters. In conclusion, Mr. Field wished to point out that the credit for the invention of the electrolytic meter was due to Mr. Ferranti, who took out a patent in 1901. This patent was completely worked out by Dr. Garrard, but, unfortunately for the company, it was dropped.

Mr. H. W. WILSON could only speak of one overhead system of which he knew possessing arresters, and this belonged to the North Wales Power Company, and was certainly situated in a part of the kingdom which probably had more storms than any other part. Spark-gap arresters were used on the lines and horn breaks at the generating stations. They were frequently in operation. The objection he had to Mr. Peck's paper was that, while he described every type of arrester, he did not say which was the most suited to conditions in England; what type should be used for the various voltages, say for 10,000 and under; and with what frequency on the line should they occur.

Mr. R. B. SLACKE asked whether, if once filled with water, the water-jet arrester described would not act just as well as if continually supplied. He also inquired how the number of gaps in the multi-gap arrester were calculated for various voltages.

Another Speaker, inquiring *re* static charge accumulated on some lines by the wind, remarked that this effect would be greater on disused lines.

Mr. J. S. PECK, in replying to the discussion, said that the cost of the electrolytic arrester would probably come out about the same as the multi-gap type; it must be remembered the actual cost of the arrester bore no great relation to the price charged. Years of experimental work had to be paid for. Regarding the curve given of oscillograph, this was upside down; it showed the current breaking through at the high points due to excess voltage. Regarding Mr. Cramp's remark of the danger on underground cables coming to the surface, these points were seldom in open spaces, and were practically protected against chance of lightning. Regarding question of inductive resistance in series resistance with horn arrester, there was, of course, inductance, but with a straight wire and carbon, as this resistance was composed of, there was very little. Jackson, in the States, had gone into the question deeply, and was able to work out a critical resistance. As regards static effect due to wind, he did not know much, but it was worse on disused lines. The horn arrester had to be set for arcing higher than the normal voltage it was necessary for the insulation to stand on account of vagaries. The higher pressure was only momentarily, and modern insulation did not suffer. With the electrolytic meter it would be possible to set the gap nearer without undue interruption. The idea of enclosing arresters was good. He pleaded guilty to bad terminology. He questioned Mr. Field's statement *re* oil switch breaking arc at zero potential. The reason why effect of potential concentration did not travel inwards to the inner turns of a transformer or motor winding, was that the self-induction of the outer turns acted as a choking coil and allowed a more gradual potential to be attained nearer the centre of the coil. He doubted whether the choking coil shown was the best, and he saw that there was no sideways capacity. He referred to the many creditable experiments carried out by Thomas on this question. He knew that Mr. Ferranti had patented the electrolytic meter, but considered the greatest credit for its perfection was due to Mr. Jackson. Mr. Steinmetz had said that the film formed disappeared within a week unless recharged, but Jackson said his treatment must be wrong, as after a year the film on his arresters was quite perfect. He considered that probably the best type of arrester was the electrolytic, and after that the low equivalent multi-gap type. The former could work on voltages from 2,000 to anything, the latter 2,000 to 100,000. The frequency per mile for arresters mainly depended on funds. The number generally used, however, was founded on Wurtz's original experiments, who found by the cut-and-try again method, or the process of elimination, that the correct number was four to the mile. In long transmission lines, however, arresters were usually only put at the sub-stations and generating stations. He thought that it was necessary to have running water in the water-jet arrester. As regarded the calculation of the number of gaps necessary, there was a standard of six cylinders and five gaps per 1,000 volts, but he thought it was a case of cut-and-try, though Thomas had worked out some elaborate calculations on the question.

DISCUSSION IN LONDON, FEB. 6, 1908.

Prof. GISBERT KAPP considered that the author's endeavour to explain his method by mechanical analogy was a particularly happy one. What he wanted to know, however, was what the electrolyte with which the electrolytic lightning arrester was charged consisted of. Was the electrolyte an alkali or an acid, or what? He would also like to know the limiting voltage per tray. It seemed to him that in the arrangement the electrolytic protector really took the place of a dead resistance, while the protector was the horn. He asked the author whether the electrolytic protector described by him could be used without the horn. He showed a part of a horn-type arrester designed by Zapf. In this type of arrester the horns were placed about 1in. apart for 20,000 volts. A trigger arrangement was adopted in order to set it off. The earth was connected with a high-resistance box, provided with a platinum point with a screw adjustment, which formed a spark-gap. This arrester would work perfectly for long periods. He then described a method of cable charging to avoid the danger of piling up the volts on the first few portions of an apparatus by throwing the volts on gradually. This was done by an auto-transformer, the secondary of which was picked off from points which could be shifted. He had tried this combination for paralleling dynamos, and had been able to do so without synchronising. This process could be done in 10 seconds instead of many minutes required where synchronism was necessary.

Mr. W. B. ESSON endorsed what the author said about the coils giving way. It was always the coils nearest the line which gave way, and was due to the fact that the coils simply acted as choking coils, and made the current jump between the terminals instead of going through the wire to find the earth point of the machine. They found, however, that if choking was to be done, a remedy could be found by choking outside the alternator instead of inside. With regard to line surges, the devices described by the author and Prof. Kapp had been in use a great many years. What concerned the power engineer was the trouble which came on in an unforeseen and quite unexpected way. They did not get surges in the lines when they switched on to anything like the same extent as when a short-circuit took place in the line. It was generally much easier to work at high pressures, say from 50,000 to 60,000 volts, than to work at from 25,000 to 30,000 volts. As the current was only half in the one case, the surge pressure was very much less. With regard to lightning arresters in America, Mr. Bond had pinned his faith to the horn arresters; multi-gap and other forms of arresters could not be got into line for fusing up. Mr. Esson questioned whether lightning arresters were any use at all on lines of 50,000 and 60,000 volts pressure.

Mr. ALEXANDER RUSSELL said the author assumed static charge to be due to atmospheric potential. It was, however, necessary to have some knowledge of the fundamental laws of atmospheric electricity in order to discuss the relative merits of the various lightning arresters. The water-jet arrester as used in the South of France seemed to him a suitable device for getting rid of static charge, but it was not of much use for limiting the pressure between the lines. The air-gap in the electrolytic type of arrester rendered the latter objectionable. The ideal type of arrester would be one of the coherer type, if some powder were invented which offered practically no resistance to the current when the voltage was greater than the normal.

Mr. W. H. PATCHELL said they had not yet reached finality in lightning protective devices, which were still in a transition stage. Of the various types there were no best, because some that would suit one condition might not suit another. He referred to the methods of cable protection adopted by the Charing Cross Company on their system, which were described in his paper before the Institution two years ago. He pointed out that the crux of the question was the necessity for limiting the current. The horn arrester without a resistance would occasion trouble. It was not when the arrester was kept going that troubles occurred, but when it stopped going. The flow of current did the damage, and he had tried dry and liquid arresters and carborundrum and coke. Mr. Mershon said the best resistance for 60,000 volts was a concrete pillar. With regard to the testing of arresters, he thought this should be done with a big machine behind them. The expense of protecting protective devices was an important item.

Mr. H. BRAZIL confined his remarks to underground cables, and spoke favourably of the horn type of lightning arrester. He had tried arresters having two horns, one of carbon and the other of copper, and found that these could be set to a remarkable degree of accuracy, which could be maintained for a long time. He recommended the use of indicators on the switchboard to record surgings in the line.

Mr. W. M. MORDEY asked whether Mr. Peck thought there was any advantage in the use of barbed wire as a protection line, also whether there was any experience in the case of long transmission lines making the buildings lightning dischargers?

Mr. L. ANDREWS remarked that the electrolytic arrester was referred to in a paper read two years ago before the American Institute of Electrical Engineers as having then been in use two years, and it appeared to give satisfactory results. The electrolytic arrester was something in the nature of a coherer. He objected to Mr. Peck's theory of the cause of the breakdown of the horn arrester—*i.e.*, that it was due to heated air.

Mr. V. A. FYNN referred to the concentration of potential, and when making some tests three or four years ago in connection with a 40,000-volt, three-phase, 400-kw. transformer he had great difficulty in arriving at any definite results.

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The discussion was wound up by a few remarks from the CHAIRMAN (Colonel Crompton), who related some of his troubles with lightning arresters in India, and Mr. PECK briefly replied to a few of the points raised.

THE WESTINGHOUSE TYPE-S.P. POST BRAKE FOR ROLLING-MILL SERVICE.

The latest addition to the Westinghouse Electric and Manufacturing Company's list of apparatus for rolling mills is an improved brake, designed to meet the severe requirements of motor service in iron and steel mills. It is of the solenoid post type, designed as Westinghouse type

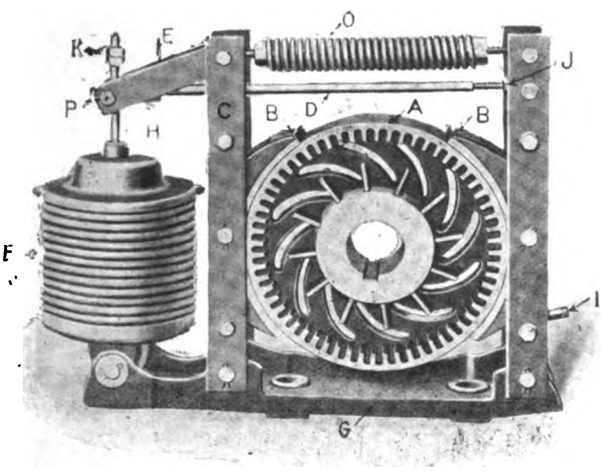

FIG. 1.—Front View of Westinghouse S.P. Brake.

S.P. post brake. It is simple in construction and effective in operation, its principal parts being a brake wheel and two friction shoes, which are mounted within a structural frame supported by a steel base. These are controlled by a heavy steel spring and a totally enclosed solenoid in a cast-steel frame. The brake is built of cast iron and steel, cast iron being used in the wheel and shoes, as its better wearing qualities and cheapness of renewal make it preferable. The shoes and wheel are operated dry, and cast iron is found best for metallic surfaces unlubricated. The wear on the wheel is about one-sixteenth of that on the shoe. The maintenance cost is low, and all repair parts are easily made in any ordinary shop. The open construction permits easy inspection of all parts. The shoes are clamped to the wheel during the braking period by means of a steel spring, and are released by the solenoid. The full force of the brake is applied at the moment of contact between the shoes and the wheel, and as soon as contact is made the spring ceases to contract. Thus the braking force is never above its normal value, and the stress on the brake parts and motor shaft is much less than is the case with ordinary brakes. Likewise the load is stopped in a much shorter time. To obviate the hammer-blow effect experienced in other types of brakes, the plunger is provided with lost motion to permit of over-travel. There is practically nothing in connection with the brake to get out of order, and the only attention needed is an occasional adjustment to take up the play due to the iron of the shoes. All parts needing adjustment are easily accessible. No lubrication of either shoes or wheel is required.

In the design of the brake special attention has been paid to heating tendencies, and ample provision made to counteract their effect. The rim of the wheel is corrugated on the under-side for the double purpose of increasing its strength and affording a maximum radiating surface. The arms are numerous and curved to permit expansion of the rim, due to heating, without producing undue stresses in the arm or rim. On either side of the arms and extending from the hub are vanes, which produce a current of air directed against the corrugations inside the rim while the wheel is running. This increases the radiation of heat generated and keeps the heat away from the motor bearing. The shoes are of cast iron with a solid thick face to permit long wear. On the rear of the shoe is a series of narrow ribs which strengthen it and increase the radiating surface. In operation the shoe is free to turn on a pivot and find its true seat on the wheel, the pressure against the wheel being thus uniformly distributed, and unusual wear in any one part of the shoe prevented. The magnet is of cast steel, the frame completely enclosing the winding. It is pivoted at the base, which prevents any tendency to bind as it follows the wear of the shoe. The coil may be either series or shunt wound for a direct-current circuit of 110, 220, or 500 volts. The series winding is preferable to the shunt, due to its quicker action, and is considered as standard. The series coils will release the brake at ·6 of the full-load current of the motor, and will hold it open at ·1 full-load current. The brake is secured to the motor by means of suitable brackets, which may be made integral with the motor frame, when so specified. This arrangement is strongly recommended, as it precludes all possibility of the brake ever getting out of alignment.

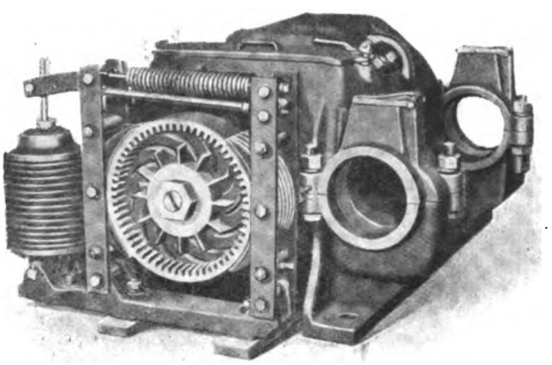

FIG. 2.—Westinghouse S.P. Brake fitted to Mill Motor.

These brakes are at present made in five sizes for 25, 50, 75, 100, and 150 h.p. motors, and may be applied to any type of motor used in mill or crane service. A front view of this brake is seen in Fig. 1, where A is the wheel; B, shoe; C, beam; D, compression member; E, tension member; F, casing enclosing solenoid; G, motor frame supporting the brake; H, connecting rod; I, screw fo adjusting clearance; J, screw to take up wear of shoe K, nut for adjusting travel to beam; O, pressure spring; F, fulcrum of lever. Fig. 2 shows a Westinghouse type S.P. brake fitted to mill motor.

AN AUTOMATIC CUT-OUT.

The automatic cut-out shown in Fig. 1 has been recently patented by the Allgemeine Elektricitäts-Gesellschaft. Its

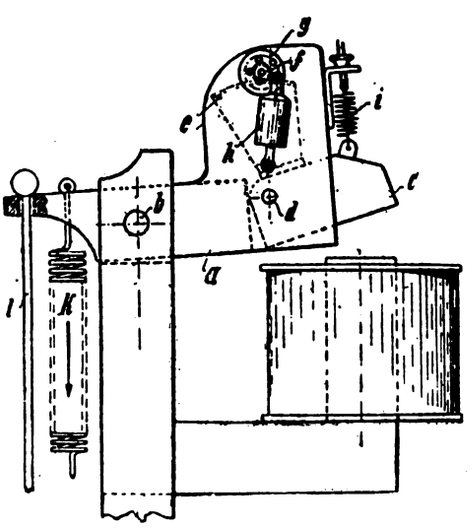

FIG. 1.

distinctive point is that it releases the switch instantaneously for heavy overloads but introduces a time element for small loads. The armature, *c*, is connected to the part *a* through a dash-pot, *h*, and an adjustable spring, *i*. The part *a* actuates the switch in opposition to an adjustable

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spring, *k*. With small forces (small overloads) *c* and *a* are connected elastically through the spring *i* and the dash-pot, but with heavy loads this connection is converted into a rigid one.

RECEIVING WIRELESS SIGNALS PHOTOGRAPHICALLY.

Some interesting experiments described by Herr J. Rieder in *Der Elektrotechniker* seem to indicate that electric waves can be made to affect a photographic plate so as to allow the latter to take the place of the ordinary coherer. Starting from the assumption that coherer action consists in the passage of minute sparks between the metallic particles, followed by partial melting together of the particles and a lowered resistance, Herr Rieder supposed that the passage of the sparks might be recorded photographically. He, therefore, tried the experiment of marking a glass plate with a sign in shellac varnish, and sprinkling it before drying with aluminium powder. The plate was then placed in contact with a silver-bromide dry plate in a light-tight box, and subjected to the action of electric waves. On developing the plate a clear copy of the sign was found to have been produced, and the same result was obtained repeatedly, whilst in the absence of electric waves no trace of the powdered sign could be obtained. The record was found to be clearest in that part where the metallic powder was least thickly strewn. No decohering action was found necessary—the sign was printed off as long as it was under the action of the waves, and the longer the action continued the clearer was the record. The action was enhanced if the back of the marked plate was covered with metal. Further experiments were made with the photographic box in the road some 70m. away from the room in which the spark-gap was placed. The sparks were obtained from a small influence machine with 7in. plates, and giving a length of spark of 1·2in. A small antenna 20in. high was used. The results were quite satisfactory, and showed that the limit of distance was not nearly reached. For the purpose of taking up actual messages the author suggests a dot of the metallic powder on a glass plate along which a photographic strip is moved, and to the metallic backing of which the end of the antenna is connected. Dot-and-dash messages would then be recorded as dots and dashes on the strip. No particulars as to the time taken to record a sign legibly are given.

ELECTRICAL ACCIDENTS IN AUSTRIA IN 1907.

The Elektrischer Verein was notified of 65 accidents in 1907 (against 33 in 1906), 11 being fatal (against two in 1906). The accidents were divided up as follows: in mines and smelting works, 15 (six fatal); in generating stations, six (three fatal); in factories and building operations, 11 (two fatal). There were 32 accidents on the Vienna trams, but in most cases the injured persons could resume work almost immediately.

The fatal accidents were almost all due to personal carelessness, and occurred at the following voltages: one with three-phase currents at 220 volts, three with three-phase currents at 300 volts, three with single or three phase currents at 480 to 550 volts, two with single or three phase currents at over 1,000 volts, and one with direct current at 320 volts. The accidents at such low voltages as 220 volts three-phase and 320 volts direct current are somewhat remarkable, but appear to be well authenticated.

"RATS."

A curious instance of interference by a rat with the electric lighting of a town is given in the following account sent by the Berlin correspondent of the *Daily Telegraph* yesterday. The town of Charlottenburg, which is physically continuous with, though administratively separate from, Berlin, was suddenly plunged into darkness at an advanced hour on Tuesday evening by a failure of the electric current. Three railway stations, several theatres, and innumerable restaurants were affected by the sudden deprivation, and some extraordinary scenes of confusion were revealed by the light of hastily-sought lamps and candles. The stoppage, which lasted half an hour, was caused by a rat which had jumped in among the 'bus bars at the power station. It is the second occasion on which Charlottenburg has been deprived of light by such a cause.

FORTHCOMING EVENTS.

FRIDAY, FEB. 21.

Royal Institution of Great Britain.—At 9 p.m., "The Ether of Space," by Sir Oliver Lodge.

Electro-Harmonic Society.—At 8 p.m., concert (ladies' night) at the Bechstein Hall, Wigmore-street, London, W.

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate, St. James's Park, S.W., "Tests of a Live-Steam Feed-Water Heater," by Prof. John Goodman and Mr. D B. MacLachlan.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Lit. and Phil., Westgate-road, Newcastle-on-Tyne, discussion on Mr. H. R. Jarvis's paper on "Floating Docks;" discussion on Mr. J. Hamilton Gibson's paper on "Torsion Meters;" "Notes on the Form of High-Speed Ships," by Mr. A. E. Long.

SATURDAY, FEB. 22.

Institution of Electrical Engineers (Manchester Students' Section).—Visit to the works of Messrs. Ferranti Limited, Hollinwood.

Birmingham and District Electric Club.—At 7 p.m., at the Municipal School of Technology, "The Electro-Deposition of Silver," by Mr. T. J. Baker.

Association of Engineers-in-Charge.—Social at St. Bride's Institute, Fleet-street.

MONDAY, FEB. 24.

Institution of Electrical Engineers (Students' Section).—At 7 p.m., annual dinner at the Holborn Restaurant.

Institution of Electrical Engineers (Newcastle Local Section). At 8 p.m., at the Armstrong College, "Electric Power in Docks," Mr. C. E. Taylor.

TUESDAY, FEB. 25.

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., at the Municipal School of Technology, discussion on "Gas *v.* Electricity."

Faraday Society.—At 8 p.m., at the Institution of Electrical Engineers, 92, Victoria-street, S.W., papers by Dr. H. V. Veley and Dr. Joseph Knox.

WEDNESDAY, FEB. 26.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., at 92, Victoria-street, S.W., "Wattmeters and their Connection," by Mr. J. C. Connan.

Optical Society.—At 8 p.m., at 20, Hanover-square, annual meeting.

FRIDAY, FEB. 28.

Royal Institution of Great Britain.—At 9 p.m., "Explosive Combustion, with special reference to that of Hydrocarbons," by Prof. William Arthur Bone.

Society of Arts.—At 8 p.m., at John-street, Adelphi, W.C., "The Removal of Dust and Fumes in Factories," by Dr. J. Scott Haldane.

Physical Society.—At 5 p.m., in the Physics Laboratory of the Royal College of Science, Imperial Institute-road, South Kensington, "Contact Potential Differences determined by Means of Null Solutions," by Mr. S. W. J. Smith and Mr. H. Moss; "An Experimental Examination of Gibbs's Theory of Surface Tension as the Basis of Absorption, with an Application to the Theory of Dyeing," by Mr. Lewis.

SATURDAY, FEB. 29.

Institution of Electrical Engineers (Students' Section).—At 10 a.m., visit to Brimsdown power station.

Institution of Electrical Engineers (Manchester Local Section). At 6.45 p.m., annual dinner at the Midland Hotel, Manchester.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, Feb. 29.

MONDAY, FEB. 24.—"A" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

TUESDAY, FEB. 25.—"B" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

WEDNESDAY, FEB. 26.—"A" badge examination, 6 p.m.

THURSDAY, FEB. 27.—"C" Coy.—Infantry drill (recruits), 6 p.m.
Technical drill, 7 p.m.

FRIDAY, FEB. 28.—"D" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

SATURDAY, FEB. 29.—Week-end run at Portsmouth for "A" and "B" Companies.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—The recent very numerous and influential deputation to the Postmaster-General has not produced any effect. Mr. Buxton's reply was in such general terms and so completely ignored what the speakers had urged, often with great force and directness, that it would almost appear that it had been prepared beforehand and was fired off unmodified. Thus, Mr. Buxton for the greater part of his speech argued in favour of measured rates just as though the deputation had objected to them, whereas the position taken up was that both measured rates and flat rates were necessary, as the application of measured rates to large users would constitute a tax on commercial communication and act in restraint of trade. Mr. Buxton made a pretence of pleading for small users, ignoring the fact that the deputation had pointed out to him beforehand that the measured rates he was imposing in common with the National Telephone Company constituted an increase and not a decrease even for that class, and were really sufficient to provide a flat rate all over the country except in London. One of the most objectionable features in the reply was the distinct statement by the Postmaster-General that, although the National Telephone Company's system of charging and recording calls might be fallible, he did not think the same objection could be pleaded to the system of the Post Office, because their recording apparatus was "automatic." One cannot, of course, imagine that Mr. Buxton intentionally stated what he knew was not true, but this only shows how easily a gentleman in his position can be misled by information from subordinates which he is not competent to sift. So far from the Post Office system of recording being automatic, it allows an operator to record as many calls as she may choose against any subscriber, and to mark none against any other—a fact which I, amongst others, have already pointed out in the Press. The fancied immunity of the Post Office system from complaints of overcharging is ridiculous in view of the columns of indignant letters which have appeared in the London Press during the past year, and the fact that on Feb. 13 it was stated in the City of London Court that "there were so many witnesses ready to testify that their telephone bills were too high that there was not time to hear them." Mr. Buxton made no reply whatever to the complaints of inefficient service and the forcing of obsolete types of instruments on subscribers.

The objection to the appointment of a select committee will not bear investigation, and is clearly a device to delay and gain time. Mr. Buxton says that the Post Office has not yet sufficient experience to lay trustworthy statistics of cost of construction and working before a select committee, and will not be in a position to do so for some time to come; but the work of a select committee would not be to decide upon evidence provided by the Post Office, which has ever proved, in telephone matters, absolutely untrustworthy. A select committee would take up the question of municipal telephone exchanges, and look at the matter by means of the light they afford. It could be clearly proved to a select committee that municipalities can give a flat rate of £5 to £6 per annum to the busiest subscribers, and measured rates of from £1. 10s. to £3. 10s. per annum. Municipal exchanges have been subjected to constant attacks in the Press and otherwise by officials of the Post Office and others, but it could be shown to a select committee that, as a rule, they have given satisfaction to their subscribers, and that, so far from being failures, they have been carried on in the face of competition of the most unfair character, and in spite of special difficulties created by the Post Office, with the connivance of the Local Government Board, the very obvious intention being to compel the municipal systems to sell their businesses, and, by thus branding them with the stigma of failure, to discount their efforts and clear the road for increased charges and curtailed privileges. This the Post Office will succeed in doing unless telephone subscribers organise and make themselves heard in Parliament. As one of the oldest telephone engineers in the country, and one possessed of a more extensive and varied experience than most, I can affirm that there is no sort of justification in the new charges and restrictions, and that the municipal tariffs and regulations are amply sufficient for all legitimate purposes.—Yours, etc.,

A. R. BENNETT.

ELECTRIC RAILWAY OPERATION.

SIR,—Having perused in the last issue of the *Electrical Engineer* an article on "Problems of Electric Railway Operation," might I ask on what lines, if any, are series compensated motors run on a frequency of 125 cycles per second, as given in one table? Why does the author state that the single-phase motor is not suited for heavy load traction when it is considerably employed for such on the Continent and in U.S.A.? Also, absolutely no recognition is taken of the higher line voltage and, in consequence, longer distance of transmission that is possible for single-phase alternating current than with continuous current. No consideration is taken of the fact that, owing to the use of transformers for control on alternating currents, it is considerably more efficient than rheostatic control on continuous current.—Yours, etc.,

GREASEPOT.

THE STAFF OF SMALL CENTRAL STATIONS.

SIR,—The letter of "A Central-Station Man" merely proves that he is undoubtedly amateurish. That he has done so little springing is due to the above fact, and I can quite believe that he has "gone through" the usual training in the way that many others do—viz., with their eyes shut. The usual excuse of the incompetent chief is trotted out when he speaks of unfeeling corporation committees. If

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"A Central-Station Man" will make his station pay, the committee will always accede to a reasonable request for an increase for his assistants. This habit of blaming the committee for everything connected with assistants' salaries is very frequently met with, is seldom true, and is always despicable. Let "A Central-Station Man" staff his station as recommended by "Electricity Supply," and let him pay a *reasonable* salary to his assistants to begin with, and give them to understand that there will be no increases until the station does pay. As regards the slads he mentions in so flippant a manner, he has no right to take advantage of their ignorance of the real state of the central-station profession in order to try to cut down his expenses; in fact, that he tries to do so is sufficient evidence that he does not understand how to manage a small station. The injury he does to his own profession by turning into it half-trained youths is considerable; moreover, he must know it to be so, but he does not care about the injury he may do his fellows as long as he fancies his methods will serve his purpose I shall be pleased to help "Electricity Supply" in any way possible in the formation of an assistants' union, and for that purpose, Mr. Editor, you may forward my name to him if he desires it.—Yours, etc., DRASTIC.

SIR,—"Drastic" in the *Electrical Engineer* advocates an examination to be held by the Board of Trade for assistant engineers engaged in electricity supply. The idea is very good. At present assistant engineers have absolutely to rely on their chief for their testimonials, and, though the applicant may be a very good man, sometimes a chief may let personal spite, or in many cases a want of knowledge of what his assistant is capable of, affect the testimonial. So many chiefs suffer from "swelled head" that they honestly think no one is any good but themselves. An examination would place us on a very different footing, and weed and keep out those who were not competent for the work, and the certificate would at once show a man's worth and give him more self-reliance. That the present system of testimonials is an absolute failure is, I think, the opinion of nearly everyone.—Yours, etc., SHIFT ENGINEER.

Feb. 16, 1908.

ELECTRIC LAMPS.

SIR,—All interested in the manufacture or distribution of the above must be aware of the useless cutting in prices that is going on, to the detriment of the maker and distributor alike. The manufacturer who allows his lamps to be sold at any price, and says it is no business of his to prevent the reckless cutter playing ducks and drakes with his business, is no true friend to the trade, who ask for a fair living profit when handling any maker's goods.

Certain manufacturers have agreed to maintain fixed retail prices, and are announcing the same to their customers, and those firms will be supported by the members of the Ironmongers' Federated Association, Incorporated, and the Electrical Contractors' Association, Incorporated. The above associations will do all in their power to prevent the reckless cutting of prices, which only means ruin to the distributing trade.—Yours, etc.,

R. H. SMITH,
General Secretary, Ironmongers' Federated Association.
LEONARD G. TATE,
Hon. Secretary, Electrical Contractors' Association.

QUESTION No. 1,044.

SIR,—I beg to call your attention to a slight error in wording of query No. 1,044 appearing in your last issue. The full stop should be a comma and the query mark omitted. As it is printed it is unintelligible.—Yours, etc.,

G. D. A.

ELECTRICAL CONTRACTORS' ASSOCIATION.

The seventh annual dinner of the Electrical Contractors' Association was held on Monday last, Feb. 17, at the Holborn Restaurant, London. Mr. A. Rashleigh Phipps, the president of the association, was in the chair, and among the 150 guests present were many gentlemen prominently connected with the electrical manufacturing industries. The dinner passed off most successfully, very little evidence of any depression in the business of electrical contracting being discernible in the cheerful gathering. After the loyal toasts were duly honoured,

Mr. W. R RAWLINGS, A.M.I.E.E., past-president, proposed "The Houses of Parliament," to which toast Mr. HERBERT NIELD, M P., responded The latter urged that municipalities should keep their "hands off" electricity undertakings, on the ground that it was unfair to invest large sums of public money in plant that might soon become obsolete.

Mr. LEON GASTER, M I E.E., submitted the toast of "The Electrical Contractors' Association," and in doing so commented upon the growth of the association, which, though started in 1901, now numbered 300 members. He claimed that the fact of the association practically sc utinising its members would tend to raise the status of the electrical contractor, so that membership of the association would be synonymous with honesty, integrity, and good work. He urged upon them the importance of following up developments in connection with metallic-filament lamps, and to equip themselves with a view to refuting the absurdly exaggerated statements of the gas people. He had just learned that the American Institute of Electrical Engineers had consented to receive a joint deputation representing the electric and gas lighting interests to discuss the question of nomenclature and standards of rating.

Mr. A. R. PHIPPS (the president) in his reply explained the constitution of the association, and referred to the exceptional activity among the provincial branches. The Scottish section displayed remarkable energy, and new branches had been formed during the past year in Aberdeen, Ayr, and Dundee. Compared with the provincial section, the London section was very much behind, a membership of 115 being but a small proportion of the total number of electrical contractors in the district. Mr. Phipps then alluded to the task of the Electrical Contractors' Association in opposing those clauses in the London County Council General Powers Bill which were inimical to the interests of electrical contractors, and he paid a tribute to their hon. solicitor, Mr. R Tweedy Smith, for the way he had managed to get inserted in last year's Bill a clause whereby all electrical contracting work that a municipality intended to carry out should be done through an electrical contractor. The association had checked certain trade abuses, and had been instrumental in doing things which had benefited member and non-member alike He appealed to those who stood outside the association to come in and support them, instead of criticising them from aloof. He threw out a challenge to those contractors who were not yet members, that if they joined the association the present office-holders would resign their positions and give to the new comers their whole-hearted support. Mr. Phipps paid a tribute to Mr. E. J. Hogan for the able way he had organised the dinner, and he wished him success in his new business venture.

The toast of "The Institution of Electrical Engineers and Kindred Associations" was proposed by Mr. E. L. BERRY, who pleaded for a little more consideration from the Institution for the work of the contractors; and Mr. HUGO HIRST, who responded, assured them that during his tenure of office he had taken much trouble to bring to the notice of the scientific members of the Council the existence of the electrical contractor. Touching upon the status of the electrical contractor, he said that, in spite of the threatened decay of electrical engineering in this country, in the use of the incandescent lamp we were far ahead of any other country, and the popularity of electric lighting here was due to the electrical contractor. Mr. W. DAVENPORT also responded to this toast on behalf of the Electrical Manufacturers' Association. The toast of "The Chairman" was proposed by Mr. J. MCDERMOTT, J P. A programme of music was gone through during the course of the evening.

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A pleasing feature of the proceedings was the presentation by the president, on behalf of the members, of a cheque to Mr. Leonard G. Tate, the hon. secretary, as a tribute to his whole-hearted devotion to the association and in recognition of his arduous work during the past three years. This testimonial has been generously subscribed to, but it has been decided to keep the list open for the next two weeks in order to give other members an opportunity of subscribing. This is an excellent policy, for never was an honorary officer of an association more worthy of such a tribute than is Mr. Tate.

The arrangements for the dinner were admirably carried out by Mr. E. J. Hogan.

TEST RESULTS OF PRIMARY CELLS.

The commission instituted in 1906 by the Association des Industriels de France contre les Accident du Travail for competitive tests between various cells has recently published its report. Messrs. Leclanché and Co. and Messrs. Rousselle and Tournaire received prizes for cells of the Leclanché type giving the following results. The cells were in each case discharged until the voltage fell to ·5 volt:

Type of cell.	Weight.	Volume.	E.M.F. At start.	E.M.F. Average.	Amp. hours.	Watt hours.	Capacity — Watt hours per lb.	Resistance used in external circuit.
Leclanché type	lb.	cub. in.						
A E	2·8	41	1·55	·8	63·19	50·87	18·2	10
A P	7·75	122	1·5	·79	197·37	154·91	19·5	5
A P / E T	10·0	167	1·57	·87	218·48	180·07	18·0	5
Rousselle and Tournaire dry cell	3·1	56·5	1·5	·83	69·96	58·07	18·8	10

A number of other fluid and dry cells were also tested, but all show lower results than the above.—*Centralblatt für Accumulatoren.*

AN IMPROVED SPARK-GAP.

When condenser circuits with spark-gaps are used for measuring purposes it has often been noticed that in spite of every care the sparks behave very erratically. Repeated complaints on this point have appeared in the literature of the subject. A writer in the *Physikalische Zeitschrift* describes a simple method of overcoming the difficulty.

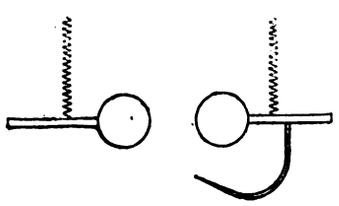

Fig. 1.

A pointed wire is attached to one pole of the spark-gap, preferably the negative one, in the way shown in Fig. 1, and if its distance is properly adjusted the sparks will continue to pass between the balls with practically the same average voltage as before, but their regularity will be extraordinarily increased.

EXPERIMENTS WITH BREAKING HIGH VOLTAGES.

Some interesting experiments have recently been conducted at the works of Dick, Kerr, and Co., at Preston, to determine the ability of the Von Zweigbergk metallic shield blow-out for breaking high-voltage direct current, and incidentally the practicability of high-voltage direct-current railway operation. The tests were made with a specially-designed blow-out coil 6½in. in diameter, and weighing about 35lb. Direct current at 3,200 volts was applied, with 12 40-h.p. 500-volt railway motors connected in circuit, two in parallel and six in series, in order to give an induction discharge similar to that which would be produced by two 175-h.p. 1,500-volt motors in series. A current of from 75 to 100 amperes was broken several hundred times, but hardly any traces of wear could be detected on inspecting the contacts. The results have been so successful that an equipment for 4,000 volts direct current is now being built by Dick, Kerr, and Co. The equipment will consist of two motors each of 1,900 volts, but capable of working up to about 2,000 volts, and of about 200 h.p. capacity each. These motors will be connected permanently in series to allow for a line voltage of about 4,000. The Von Zweigbergk Controller Company, whose headquarters are in Cleveland, Ohio, is now manufacturing blow-outs for this voltage.—*Street Railway Journal.*

GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The monthly meeting of the Glasgow Local Section of the Institution was held on Feb. 11, Prof. Baily being in the chair. The adjourned discussion on Mr. Snell's paper on "The Cost of Electrical Power for Industrial Purposes" was continued.

Mr. F. A. Newington (Edinburgh) said the paper showed that suction gas plant was not the serious competitor it was expected to be a few years ago, because the figures showed that suction gas plant could not be run any cheaper than town gas. Electric motors displaced town gas every day of the week, and probably the same thing would happen with suction gas plant after it had been running a bit longer. He could not agree with Mr. Snell that Greater London cleared of factory chimneys would be a very much better place to live in. He thought the ordinary house was more the cause of fog and smoke than factory chimneys. He did not think that cheap supply of power would assist to prevent the migration of power users, because land, wages, and rates were very much lower in other places, and, therefore, large works were bound to leave London. There were many towns where high-tension transmission was not necessary. In Edinburgh they had 90,000 h.p. of motors connected to a low-tension system throughout. For combined lighting and power they wanted a diversity factor of 1 during the greater number of hours of the day, and as high as possible during one or two hours of peak load. It was never during these hours that it would be of any use to them. Mr. Snell had shown that the London companies were all drifting into bankruptcy, and as a remedy it was proposed that a large power station must be erected at a minimum of cost, but without prejudicing the present capital involved in the existing undertakings. He (Mr. Newington) should like to know how it was to be done. Mr. Snell seemed to think that London was urgently in need of 400,000 h.p. of plant electrically driven. The speaker would ask him not to be too hurried. At the end of 42 years London would make a clean sweep and start afresh.

Mr. Raphael (London) said it would pay the London companies to put in larger plant and to remodel their stations at once if it were not for the terrible purchase clause, and they would then be ready to supply at even smaller rates than at present.

Mr. Parsons (Govan) said, in connection with the docking of vessels, Mr. Snell took an unfair method of comparison. In the case of a vessel of 2,600 tons, 3,875 tons of water were pumped. In the case of the gas-engine, when Mr. Snell had a vessel of 1,760 tons he pumped 10,632 tons of water. If they took the foot-tons of water pumped in the case of the electric dock they had 62,000 foot-tons, and that worked out at ·0135d. per foot-ton pumped, whereas the gas-engine pump worked out at a figure 33 per cent. less than this. That figure could be made much worse if it had in the electrically-operated dock a vessel of 4,000 tons and in the other a vessel of one ton. Mr. Snell said it would have been better if some of the smaller local stations had been prevented from putting down their own plant. The speaker found from the *Electrical Times* that such places had come out particularly well. So far the examples of places being supplied in bulk were not very favourable.

Prof. Baily (Edinburgh) said there was a number of ways in which alternating currents were by no means so convenient as low-tension current, and the small user, who was the most important factor in the clientele of a city supply undertaking, could most conveniently use the latter in many cases. He could not see how the large power companies advocated in the paper were to oust the small local concerns without taking from the latter their goodwill and all the experience they had built up and paying them nothing in return. It was only by such confiscation that the large power companies could give supplies at the low figures mentioned.

Mr. Snell, in reply, strongly defended the main contentions of the paper, but as the hour was late he asked that he be allowed to communicate his reply.

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BRUCE AND THE SPIDER.

(Revised Version.)

BY SIMPLEX.

Sunderland Corporation have christened their new 2,000-kw. turbo-alternator "The Bruce," in compliment to the chairman of the Electricity Committee. If any piece of apparatus were more fit than another to be designated by a number rather than a name, it is the perfectly standard production of Messrs. Willans and Robinson and Dick, Kerr, and Co. However, if Robinson be willin', why should Dick care? The following is a prophetic peep into futurity:

The Bruce of Sunderland shut itself down
In a lonely mood, to think.
As it was at that period lighting the town
It induced all the lights to blink.

The switchboard attendant, he tore at his hair,
The driver condemned his soul;
The greaser shot down the condenser pit stair,
And the station was up a pole.

The engineer spake as an E.-in-C. can,
The station cat fled for its life.
The pupil to sit on the safety-valve ran,
And the stoker went home to his wife.

They signalled up spares by the dozen or more,
They wrestled with switches and lamps.
They synchronised madly for two hours or more,
And the volts had a row with the amps.

And when they had got through this dreadful turmoil
And searched for the true reason why,
They found that a spider had drowned in the oil
And blocked the main bearing supply.

BRUCE PEEBLES AND CO., LIMITED.

A circular was issued on Saturday last by the secretary of Bruce Peebles and Co., Limited, informing the shareholders that it has become necessary to call a meeting for the purpose of putting the company into voluntary liquidation, with a view to reconstruction. The circular goes on to state that this step has been rendered necessary owing to the need for additional working capital. A further issue of debentures was sanctioned by the shareholders in April last, but owing to the extreme stringency of the money market it was found impracticable to make such issue, and for the same reason it has not been possible to realise advantageously the securities in which the company is interested. The directors are already considering plans for the reconstruction of the company, which have been submitted to and favourably received by some of the larger creditors and representatives of the preference shareholders. Proxies are asked for a meeting convened for the 24th inst., when a resolution will be proposed to the effect that it having been found that the company cannot by reason of its liabilities continue its business, it is advisable to wind up voluntarily.

The company was registered in 1903, and the authorised capital is £300,000, divided into 30,000 ordinary and 30,000 preference shares of £5, of which £291,905 in 28,381 ordinary and 30,000 preference shares have been subscribed and called up.

TRADE NOTES AND NOVELTIES.

D.P. Batteries.

An illustrated list has been prepared for the "D.P." Battery Company, Limited, Lumford Mills, Bakewell, Derbyshire, in which is set out in three languages—English, Japanese, and French—the uses and advantages of the well-known D.P. battery, the types produced, their adaptability, and other useful information.

Morganite and Battersea Carbon Brushes.

The Morgan Crucible Company, Limited, Battersea Works, London, S.W., have issued a new brochure giving full information respecting their Morganite and Battersea carbon brushes. Not only are the special Morganite brushes made at the works in Battersea, but the special Battersea carbon brushes, which have been introduced to meet the demand for high-grade ordinary carbon brushes for those sizes and types of dynamos for which Morganite brushes are not considered suitable, are now being made at this large, well-equipped factory, so that it is no longer necessary for English firms to buy the imported carbon brushes, which have hitherto been the only ones obtainable.

Electrical Instruments.

Messrs. Isenthal and Co., 85, Mortimer-street, Cavendish-square, London, W., have just listed some of their latest specialities, comprising stationary and portable instruments of the electromagnetic, moving-coil, hot-wire, and dynamometric types, as well as a series of insulation testers and special switchboard instruments.

Messrs. F. Darton and Co., Clerkenwell Optical Works, 142, St. John-street, London, E.C., have placed on the market a number of interesting electrical novelties, including small electric motors and dynamo sets, such as are especially useful for demonstration purposes.

Arc Lamp Lowering Gear.

Apropos of the experimental installation of street-spanning arc lamps in the City, some similarly suspended lamps have recently been converted by the London Electric Firm, Croydon, to the lowering principle for Mr. Brydges, the borough electrical engineer, Eastbourne. Hitherto the lamps were fixtures, and the usual laborious business of trimming with the tower wagon was resorted to. The distance between the span-wire poles is

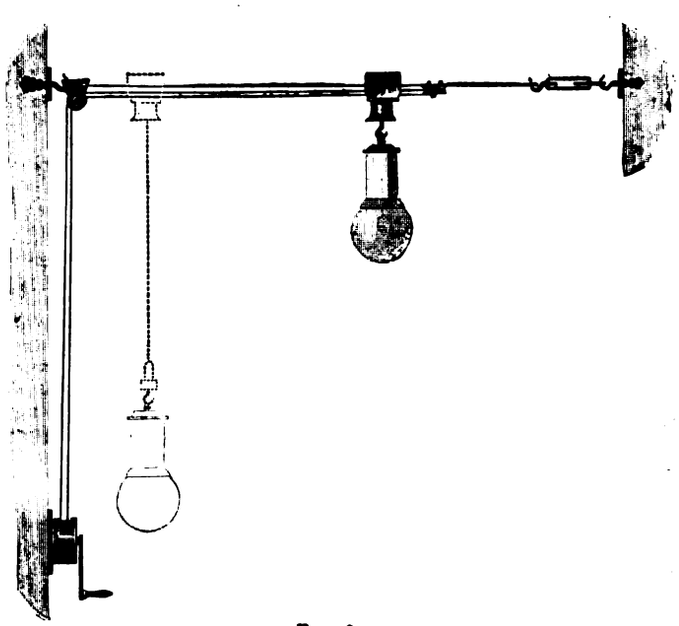

FIG. 1.

about 64ft., and the winch is secured by wrought-iron straps to the outside of one of these, the wire rope running from it over a guide pulley to the contact and suspension device. Fig. 1 shows a modification of this gear with a special winch arranged for drawing the lamp with its gear horizontally along the suspension wire, and then down to the footpath, clear of the traffic in the centre of the road. The gear at Eastbourne is of the company's well-known positive action type, and the winch of the self-sustaining type, both being patented.

Grease Cleaner.

Messrs. Beanland, Perkin, and Co., School Close Works, Neville-street, Leeds, have just put on the market in new form and sizes their well-known preparation for cleaning from the hands machine grease, paint, ink, etc. A trial tin of this preparation, which is known by the name of "Gre-Solvent," has reached us, and, according to the test to which it has been put, it admirably fulfils the claims which are made for it.

Catalogues and Lists.

Messrs. Baxendale and Co., Miller-street Works, Manchester, have issued an illustrated catalogue of telephones, fire-alarms, switchboards, wires, cables, switches, etc.

The Walters Electrical Manufacturing Company, Limited, Kensal-road, London, W., have sent us a copy of their latest catalogue, which covers an extensive field of electrical manufacturing.

The catalogue just issued by Messrs. Hodgson and Stead, Egerton Ironworks, Windsor-street, Regent-road, Salford, Manchester, embraces the latest specialities in weighing machinery suitable to the electrical trades.

The Warner Engineering Company, Limited, Dartmouth-street, Westminster, have sent us a price-list of Warner-Solio arc lamps for direct and alternating current, which are claimed to give the economy of flame arc lamps without coppered carbons or metal core.

The Allgemeine Elektricitäts-Gesellschaft, Berlin, have just

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issued three booklets: "Die Elektrizitaet im Druckereien," "Der Glüh- und Härteofen," and "Elektrische Lokomotiven im Berg- und Hüttenbetreib." These are obtainable from the company's London house, from which has also been issued within the last few days price-lists dealing with transformers, meters, and metallic-filament lamps.

The Foster Arc Lamp and Engineering Company, Limited, Worple-road, Wimbledon, London, S.W., have just issued a new price-list which covers all the requirements of the arc lamp trade and all conditions of supply. Particulars are also given of an auto-transformer of specially high efficiency for use with metallic-filament lamps. The prices of this are extremely reasonable. The efficiency is from 96 to 98 per cent. at full load.

THE ELECTRIC LIGHTING ACTS

In the House of Commons this week, Mr. Lloyd-George, the President of the Board of Trade, in reply to a question, stated that he hoped to introduce a Bill amending the Electric Lighting Acts as soon as there seemed to be a reasonable prospect of time being available for its discussion.

PERSONAL.

Mr. C. S. Davidson, electrical engineer to the Ealing Town Council, has received an increase of salary of £25 per annum.

The Postmaster-General has appointed Sir John Gavey, C.B., late engineer-in-chief, to be consulting engineer to the Post Office.

Mr. A. L. C. Fell, the tramways manager of the London County Council, has been granted an increase of salary of £250 per annum, making his salary £1,750.

Mr. R. M. Carr, the resident engineer of the Leek Urban District Council, has been appointed consulting engineer for the erection of the producer plant and other extensions at the electricity works.

The *London Gazette* announces that the partnership between J. H. Barker, W. Hall, and E. P. Harvey, carrying on business as civil and electrical engineers at 2, Collingwood-street, Newcastle-on-Tyne, has been dissolved.

The London County Council have increased the salary of Mr. E. L. Pope, the resident electrical superintendent of the tramways, from £400 to £425, and that of Mr. G. Dickens, superintendent of stores, from £250 to £300 per annum.

Mr. E. Shorrocks, of Leeds, has been appointed chief clerk in the Stockport Corporation tramway office, rendered vacant by the resignation of Mr. Harry C. Allin on his appointment as assistant secretary to the Reading Electricity Supply Co.

We regret to record the death of Mr. William Robson Smith, a retired Post Office electrical engineer. He joined the Post Office staff of mechanicians under Mr. A. W. Heaviside in Newcastle-on-Tyne shortly before the invention of the telephone. In due course he became one of Mr. A. W. Heaviside's ablest assistants in the pioneer work of practically applying the telephone in the first Post Office exchange at Newcastle-on-Tyne. Mr. Smith, being of the progressive order, gradually qualified in most of the branches of electrical engineering, always acquitting himself with credit. He became a lecturer under the City and Guilds science classes, and advanced in the service to the position of assistant superintending engineer-in-charge of the London Central Post Office Exchange. In 1902 he retired through failure in health amidst the regrets of those who knew him and appreciated his excellent qualities. Mr. Smith probably made the first telephone, from a description of the principles described in the *English Mechanic*, in England in May, 1877. Prof. Bell visited Newcastle in September of that year, and expressed his surprise and gratification in using them.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Bolton.—Electrical appliances are being installed in the spinning mills of Messrs. Ainsworth and Co.

Pendlebury.—Additional electric motors are being put down at the bleaching works of Messrs. Sackville and Swallow.

Worsley.—Electric motors have been installed at the cotton goods manufactory of Messrs. Burgess, Ledward, and Co.

Shrewsbury.—During the past year the units sold from the Corporation works show an increase of 48,103 compared with 1906.

Gravesend.—The Local Government Board have sanctioned the borrowing of £7,075 for the purpose of extending the electricity mains.

West Moors.—The Telephone Co. are now actively pushing forward the work of installing the telephone in West Moors and district.

Bonnyrigg.—The gas company have declined to accede to the request of the Town Council for the use of modern burners in the public lamps.

Rochdale.—On Feb. 25 the Local Government Board will hold an inquiry into the Town Council's application for power to borrow £22,175 for electric lighting.

Buxton.—The Local Government Board have sanctioned the borrowing of £1,550 by the Urban District Council for an extension to the electricity undertaking.

Umbogintwini (S.A.).—Messrs. Kynoch, Limited, have decided to erect a factory for the manufacture of explosives and other products. Electrical appliances will be installed.

Leek.—The Local Government Board will hold an inquiry on Feb. 26 into the Urban District Council's application for sanction to borrow £8,250 for the electricity undertaking.

Eastbourne.—The Local Government Board will hold an inquiry on Feb. 28 into the application of the Corporation for sanction to borrow £7,000 for their electricity undertaking.

Barking.—An inquiry will be held on Feb. 27 by the Local Government Board into the application of the Urban District Council for permission to borrow £2,400 for their electricity undertaking.

Ballyshannon.—At the last meeting of the Urban Council permission was given to Mr. J. S. Myles, J.P., to install electric lighting in the town as a private enterprise, subject to public rights being secured.

Hornsey.—An inquiry will be held on Feb. 28 by the Local Government Board into the Urban District Council's application for sanction to the borrowing of £10,000 for purposes of the electricity undertaking.

Paris.—Fire broke out in the wireless telegraphy station of the Eiffel Tower on the 18th inst., and caused considerable damage. All except the actual receiving apparatus and the wires to the tower has been gutted and wrecked.

Walsall.—The Town Council have decided to apply to the Local Government Board for their sanction to the borrowing of £2,600, with which, together with a sum of £1,400, they propose to install a condensing plant at the electricity works.

Bournemouth and Poole Electricity Supply Co.—The directors recommend a final dividend on the ordinary shares at the rate of 9 per cent. per annum for the half-year ended Dec. 31, 1907, making 7 per cent. for the year, less income tax.

Addingham.—The Parish Council have passed a resolution that they are of opinion that in the interests of the ratepayers of Addingham some alteration in the gas supply is necessary, and that the present supply is unsatisfactory in quality and price.

King's Lynn.—At the last Electricity Committee meeting the engineer reported that since the previous meeting applications had been received from two additional consumers for 89 lamps of 8 c.p. or equivalent, making a total of 29,250 lamps and 616 connections.

Dunfermline.—The Town Council have rejected a proposal to sell their provisional order to a company, and have agreed to appoint an engineer to prepare actual estimates of alternative schemes—a municipal generating station and electricity in bulk from the Fife Power Co.

Baildon.—The District Council have decided to resist the astounding demand of the Shipley District Council for an increase in the charges of gas for street-lighting from 2s. 8d. per 1,000ft to 3s. 4d., and are considering a scheme of electric lighting proposed by an electrical company from Bradford.

Ashton.—The Board of Guardians having applied to the Local Government Board for power to borrow £2,000 for electric lighting plant at the workhouse hospital, the last-named authority have declined the sanction as they previously did in October, 1905, stating they see no reason for altering their decision on that occasion.

Kidwelly.—At a meeting of the Council on Monday last it was resolved to consider the matter of lighting the town with electricity, and electric lighting firms have been invited to forward proposals for erecting plant, the machinery to run by suction gas power. A committee has been appointed to go thoroughly into the matter.

Falkirk.—A staff of workmen are at present engaged in the outskirts of Falkirk inserting the cable containing telegraph wires into the underground pipe which had been previously laid for the purpose. The work is in connection with the scheme of the Post Office authorities for connecting Edinburgh and Glasgow with an underground telegraphic system.

Ayr.—The Town Council have authorised an extension of the electricity mains from the burgh boundary to Newark Castle. They have also received a lengthy report from the engineer dealing with proposed extensions and alterations of plant. This report is to be printed and issued to each member for full consideration before it is discussed in committee.

Grimsby.—At the last Corporation Electricity Committee meeting the electrical engineer (Mr. W. A. Vignoles) reported that during the month 216,715 units of current had been sold, an increase of 78,855 units on the corresponding period of last year. The engineer was authorised to fix an overhead shaft in connection with the automatic stokers at an estimated cost of £130.

Huddersfield.—At the last meeting of the Town Council the yearly statement of the electricity department was presented. The gross receipts were shown to have been £30,353, and the expenditure £19,369. After interest on loans, contribution towards redemption of debt, and other sums had been deducted, there was a net balance of £985, which was placed to the depreciation and contingencies fund, which now stands at £11,874.

City of London Electric Lighting Co.—The directors have declared a dividend of 6s. on the preference shares for the half-year ended Dec. 31, making a total distribution for the year of 12s., or 6 per cent. per annum, and 7s. on the ordinary shares, which with the interim of 5s. paid in July makes the total distribution 12s., or at the rate of 6 per cent. per annum. After making allowance for reserve, £20,000 is carried forward.

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Holywood.—With regard to the proposed electric lighting of the town, Messrs. Wilkins and Purdon have written the Urban District Council stating that a generating station for the supply of electricity sufficient for both public lighting and private customers could be instituted in Holywood for £2,000, excluding the cost of building and the laying of the mains. The Council adjourned the whole matter for full consideration to the mid-monthly meeting.

Long Eaton.—The manager of the electricity works has reported to the Electricity Committee that for the month 106,787 units were generated, as against 99,378 in the corresponding period of last year, showing a large increase; and that considerable saving had been made in using certain lamps for public lighting. In view of the opposition at the inquiry last week these figures are considered very satisfactory. In spite of bad trade the demand for electricity is increasing.

Hollinwood.—An alarming fire broke out at the gasworks on Saturday morning last. At the time a number of workmen were engaged in the retort house of the water-gas plant, when suddenly a huge flame of fire shot forth from the vicinity of the retorts, and quickly the place was ablaze. The whole of the building, which is of two storeys, was enveloped. The flames attacked the roof, and all the panes of glass in the windows were broken by the heat. The glare was seen for some distance around.

Belfast.—At the last meeting of the Electricity Committee the engineer stated that he had received an application from Campbell College which would mean an extension of the cable in that district at a cost of something like £255. The governors of the college merely intended to have 24 lamps at the present time, but he was almost sure that if they got the electric current into the building they would continue to increase their order, and that ultimately they might use 1,600 lamps, which would mean a very valuable account for the Corporation.

Battersea.—The report of the electrical engineer for the quarter ending Dec. 31, 1907, reveals a further addition of the steady progress which has been continuous under the management of Mr. Bond. The units sold for private lighting show an increase of 15 per cent. over the number sold in 1906, power shows an advance of 50½ per cent., and public lighting 7 per cent. The total number was 967,890 units for 1907, against 816,740. Whilst the total units sold have been increased by 18½ per cent. and the income by 15½ per cent. over the corresponding period of last year—the revenue being up £1,279—the additional cost of generation in respect of the increase only amounts to £242.

West Ham.—At the last Town Council meeting the Electric Lighting and Tramways Committee presented a report of the electrical engineer containing estimates of capital requirements for the electricity undertaking to last until March, 1910, for which it was proposed to make application to the Local Government Board. The total estimated capital required amounted to £71,925, including a sum of £7,045 spent in excess of the previous application. Alderman Littler asked leave to take the report back in order that more information might be supplied. He thought that both the Tramways Committee and Finance Committee should go into the matter. The report was adopted.

Buralem.—The engineer reported to the last meeting of the Electric Lighting Committee that the units generated during January were 76,687, compared with 38,577 during the corresponding month of last year; that the number of 8-c.p. lamps in use was 11,413, compared with 7,252; and that the number of motors in use was 85, compared with 74 in December. The Chairman pointed out that in the last 12 months the output of the electric lighting works had been doubled, and, in addition, 85 motors were now in use in the town, representing something over 400 h.p. They had already spent on the works a sum of £32,000, but the increased demand would necessitate their installing a new boiler and other plant in the near future.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Cuban Central Railway's further issue of 10,000 5½ per cent. preference shares of £10 each, fully paid, and to allow the following securities to be quoted in the official list: Buenos Ayres Central Railway's £600,000 4½ per cent. first mortgage debentures in lieu of the scrip now quoted; Rio de Janeiro Tramway, Light, and Power Co.'s 250,000 shares of 100dol. each and 23,926,900dol. first mortgage 30-year 5 per cent. gold bonds, Nos. 1 to 5,000 of 1,000dol., 5,001 to 29,261 of 500dol., A 1 to 34,964, A 35,001 to 53,000, and A 58,001 to 73,000 of 100dol. each (special application); Shawinigan Water and Power Co.'s further issue of £49,455 4½ per cent. perpetual consolidated mortgage debenture stock; and Western Union Telegraph Co.'s 10,000,000dol. convertible 4 per cent. redeemable gold bonds, series "A," for 1,000dol. each, Nos. 1 to 10,000 (1936).

Cheltenham.—On the 10th inst. the students attending the electricity and engineering classes at the Gloucester technical school visited the Cheltenham Corporation electricity works. The headmaster of the science schools, Mr. R. Leach, B.Sc., and Mr. H. F. Northcote, the teacher of electric light and power, accompanied the party, which was met by Mr. W. J. Bache, M.I.E.E., the Cheltenham borough electrical engineer. The last-named first of all lucidly explained the general arrangement of the plant, and referred to the special features of the various machines. He then conducted the students through the buildings, where they were given ample opportunity of examining the boilers, engines, dynamos, and switchboards. At the end of the visit Mr. Leach proposed a vote of thanks to Mr. Bache, who in reply dwelt on the fact that most recent developments were the work of quite young men who possessed the mathematical, theoretical, and laboratory knowledge on which the improvements were based.

Bury St. Edmunds.—At the last meeting of the Council the Electricity Supply Committee reported that the town clerk had submitted to them a copy of the Great Eastern Railway (General Powers) Bill, by Clause 19 of which the company sought powers "from their works at Parkeston or elsewhere to supply, either in bulk or otherwise, electrical energy not required for their own purposes to any tenants of the company or occupiers of premises connected by siding with any railways of, or leased to, or worked by the company, and to any local or sanitary authority, or to any company authorised to supply electrical energy." The town clerk pointed out that, although the Corporation had no monopoly with regard to the supply of electricity within the borough, such a clause would injuriously affect their rights and interests under their electric lighting provisional order of 1897. The committee directed the town clerk to take steps to oppose the clause. Councillor Fenton, who moved the adoption of the report, stated that the town clerk had received a letter from the railway company stating that the clause had been withdrawn.

Lowestoft.—The Electric Lighting Committee reported at the Council meeting with reference to the Great Eastern Railway (General Powers) Bill that the town clerk had submitted a letter from the solicitor of the company, enclosing a suggested clause in substitution for Clause 19 of the Bill. The town clerk also submitted correspondence with the Council's parliamentary agents on the matter, and stated that he had been in communication with other town clerks of boroughs affected, and it had been suggested that a meeting should be held, at the office of the Council's parliamentary agents, of the town clerks of those boroughs to arrange for opposing the Bill by two or three boroughs, so as to minimise the costs. It was resolved that the town clerk be directed to attend such a meeting. The town clerk submitted correspondence with the clerk to the Oulton Broad Urban District Council as to the supply of electricity to Oulton Broad, and reported that the following objections had been deposited with the Board of Trade to the Town Council's application for a provisional order for the supply of electricity to Oulton Broad: the Lowestoft Water and Gas Co., the Great Eastern Railway Co., the Oulton Broad Electricity Co., and the Oulton Broad Urban District Council. The town clerk said they had given an undertaking to supply the Great Eastern Railway with electricity at Oulton Broad, and also for the Oulton Broad sewerage scheme.

Commercial Vehicle and Motor-Boat Exhibition.—Active preparations are now being made for the second International Commercial Motor-Vehicle and Motor-Boat Exhibition, to be held at Olympia from March 26 to April 4. The plan for the laying-out of the stands has been completed, and the ballots for places have taken place, whilst over 80,000 square feet of space have been allotted to intending exhibitors. These include the following firms: Argylls Motors, Clarkson, Daimler, De Dietrich, Dennis Bros, J. E. Hutton, James and Browne, Lacre, J. A. Lawton, J. Liversidge, Milnes-Daimler, New Arrol-Johnston, John I. Thornycroft, Wolseley, De Dion Bouton, Straker and Squire, Allday and Onions, Armstrong-Whitworth, Maudsley, Sturmely Motor, Howes and Son, Belsize, Commercial Cars, Darracq, Darracq-Serpollets, J. and E. Hall, Austin Motor Co., Fiat Motors, Thames Engineering Works, Lindsay Motor, Horley Motors, Greenwood and Batley, E. H. Bentall, Atkey, Durham Churchill and Co., Halley's Industrial Motors, Hillman-Coatalen, and Valveless, Limited. The motor-boat section is also well patronised, the exhibitors including Brook, Wolseley, Thornycroft, Immisch, Collis, and many other well-known boat builders. All the best-known tyre makers and components manufacturers will fill the gallery. There can be no doubt, in view of the immense development of the trade in commercial motor vehicles, that the second exhibition will prove an even greater success than that of last year.

Hanley.—Mr. H. R. Hooper, an inspector of the Local Government Board, conducted an inquiry on the 18th inst. into the application of the Corporation for sanction to borrow £18,000 for extending the town's electrical undertaking. The town clerk explained to the inspector that the town's electricity undertaking had made rapid progress in the period since the last inquiry, in 1903, when the units sold were 812,038, rising in 1906 to 1,102,192, and in 1907 to 1,425,406. The increase in 1906 was the largest recorded in any one year since the plant started. The gradual increase had rendered a further provision of generating plant absolutely necessary. After hearing the evidence of Mr. Yeaman, electrical engineer, the inspector said an important consideration affecting the inquiry was the question of federation, and, therefore, the question of further expenditure in connection with the electricity undertaking, if the scheme for federation was sanctioned by the Local Government Board, would have to be regarded in an altogether difference aspect than it was to-day. Various matters of detail were discussed, and Mr. Yeaman, in the course of examination by the inspector, said that federation could not alter the fact that Hanley's present consumers had to be supplied. Even when federation came about, he said, they would be able to go on just as they had been doing. After a consultation the application was amended as follows: for excess expenditure, £9,431; new plant, £5,000; new mains, £4,000; new transformers, £1,000; enlargement of sub-stations, £2,000; instruments, boosters, etc., £538—giving a total of £21,969. It was stated that a resolution of the Council would be necessary for the difference in the amount of the application. The inquiry was then closed.

Tunstall.—As briefly stated in our last issue, the town hall is now electrically illuminated throughout. The installation consists approximately of 224 tantalum lamps, wired two in series. The work has been carried out on the distribution multiple-circuit looping system, and is placed on either side of the supply company's three-wire system. This is advantageous owing to the fact that should a safety fuse blow the public room affected would not be left in utter darkness, because each room is so arranged that it is lit from both sides of the supply. The assembly room is lit from eight 10-light fittings and six two-light fittings, and there are, in addition, four stage plugs for stage lighting and any temporary work of such like character. The hall is also fitted with biograph mains, the pressure for these being 440 volts and the current available about 50 amperes. The Council-

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chamber is lit by one 10-light fitting and four two-light fittings, each on its own individual switch. The court-room has one eight-light and four four-light fittings, and also has two plugs for stage-lighting, etc. The main stairs is provided with one 10-light fitting, and the anterooms, offices, and basements are all fitted up for the use of the light. Two small arc lamps of the British Thomson-Houston make have been fixed on either side of the entrance porch to the town hall, and it is intended that these shall be permanent. The ventilation of the hall has been improved by the introduction of electric fans. A 21in. Arctic fan has been placed above one of the old ventilators in the assembly room, and cased up in such a manner than when it runs at its full speed of 500 revolutions it removes 3,500 cubic feet of air per minute while consuming not more than an equivalent of three ordinary lamps. Another 24in. fan has been installed in the court-room and boxed in, with ducts leading from it to the open air.

TRACTION.

Rochester.—The Town Council have negotiated a loan of £11,000 for extensions to the tramways.

Ealing.—A scheme for municipal tramways is being considered by the Town Council with a view to linking up the southern districts with the Broadway.

Madras Electric Tramways (1901).—The receipts for the fortnight ending Feb. 15 totalled Rs.19,820, against a total of Rs.16,518 for the corresponding period of 1907.

Ossett.—The Board of Trade have sanctioned the borrowing of £22,856 by the Council in respect of the Ossett to Dewsbury tramway. The work is to be put in hand immediately.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Feb. 10, 1908, converted to gold were £3,805, corresponding period 1907, £3,482, increase £324. Aggregate from Jan. 1, 1908, £22,026; aggregate from Jan. 1, 1907, £21,971; increase £55.

Rio de Janeiro Tramway, Light, and Power Co.—This company has received a cable stating that the approximate gross earnings of the companies owned or controlled by the undertaking for the sixth week of 1908 were 123,431dol., compared with 112,031dol. for the corresponding period of 1907.

Montreal.—The Grand Trunk Railway has deputed officials to negotiate for the control of the Niagara electrical development plant. Should the deal be carried through successfully, it will foreshadow a very important development in railway enterprise in Canada. It is known that the company desired to electrify its eastern division lines as soon as feasible, and such a step would cover a wide territory with electric lines.

Hackney.—In connection with the electrification of the tramways from Whitechapel-road to Stamford-hill the Hackney Borough Council have decided to contribute £17,000 towards the necessary widenings in Mare-street and Clapton High-road The total cost of the improvements is estimated at £51,000. To avoid the widening of Mare-street at its narrowest point a loop line is to be constructed along the lower portions of Amhurst-road and Dalston-lane.

Ryde (N.S.W.).—The Government have authorised the construction of an electric tramway from Drummoyne to Hatton's Flat, Ryde. Its length will be 3 miles 50 chains, and the estimated cost is £39,669. The proposal referred to the Public Works Committee comprised the construction of a line from Drummoyne *via* Ryde to the Field of Mars 7 miles 50 chains long, but after inquiry the committee recommended that the line be only carried as far as Hatton's Flat.

London County Council Tramways—The traffic receipts on the London County Council tramways for the week ended Feb. 8 amounted to £29,670, against £25,360 in the corresponding period of last year. The number of passengers carried was 6,850,215, against 5,790,796. The total traffic receipts from April 1, 1907, the beginning of the financial year, to Feb. 8, 1908, amounted to £1,400,384, against £1,173,251 in the corresponding period of the previous year.

Merton.—Writing in answer to a letter from the surveyor to the District Council, the tramway company stated that their solicitors were dealing with the matter of the widening opposite the Dog and Partridge, and were preparing to make the necessary application to the licensing justices. With reference to the complaint of noise from the cars they might say that at all times the company endeavoured to reduce it to a minimum, and they did not see that there was any cause for complaint.

Dumbartonshire.—Considerable progress is being made with the work of laying the Dalmuir to Balloch line of tramways in Western Dumbartonshire. Already the overhead poles have been erected on the roadway between Dumbarton and Renton, and in the course of next week it is expected a start will be made with the causewaying of the roadway and the rail-laying. Messrs. J. G. White and Co., London, are the contractors, and will employ between 400 and 500 men on the work once it is in full swing.

Surrey.—The Finance Committee have recommended the County Council to assent to the application of the London United Tramways Co. to be released from their annual payments in respect of the tramways authorised in 1902 for the Lower-road from Richmond to Barnes, powers to make which had now lapsed; but they recommended that it should be made a condition that both parties should be unfettered in respect to this main road in the future. This was agreed to by the Council at their last meeting.

Taunton.—The Tramways Committee have reported to the Council that the Taunton Electric Traction Co. have made overtures for the renewal of the agreement which expires in August next, under which the British Electric Traction Co. guarantee to the Corporation a minimum payment for the supply of electricity for the trams, and they have intimated that, if satisfactory terms can be arranged, the extension of the trams to Rowbarton will be at once proceeded with. The committee hope to be able to report to the Council satisfactorily at the March meeting.

Derby.—On the 13th inst. a somewhat serious collision occurred between two Corporation electric cars at Alvaston. It appears that a thick fog prevailed at the time, and one motorman, who was in charge of an outgoing car, over-ran his loop, with the result that the car coming in the opposite direction crashed into him near Brighton-road. The fronts of both cars suffered considerable damage, and traffic was delayed for upwards of an hour. The car for the town contained one passenger, but neither he nor the men in charge suffered anything beyond a shaking.

Tramcars for Women.—The great crush at the termini of the suburban tramways in the early mornings has led to a suggestion being made by the chairman of the Highways Committee of the London County Council to provide a special car for the use of women and girls. The first trial was made on Feb. 17 from Tooting to the Embankment of the women's tramcar. It left the terminus soon after seven o'clock, and carried almost a full complement of women and girl workers. As the car started a large number of workmen and others gave it a hearty send off.

Brixton.—The proposal of the London County Council to electrify the tramway from Brixton-road *via* Gresham-road and Coldharbour-lane to a point near Camberwell Green came before that authority on Tuesday last, and was adopted without discussion. The length of line to be dealt with is about 1¼ route miles, and the estimated cost of the reconstruction and equipment of the lines for the overhead trolley system of electric traction is £31,910. The Council will communicate with the Lambeth and Camberwell Borough Councils to obtain their sanction to the overhead trolley system.

Doncaster.—The Tramways Committee of the Town Council have received a deputation from the motormen on the tramways with reference to their recent application for an increase in the maximum wage per hour, and it is recommended that in the case of every motorman with five years' continuous service as motorman under the Doncaster Corporation the maximum wage be raised from 6d. to 6¼d. per hour, with uniform and allowances as at present. The committee have also considered and agreed to a suggestion by the deputation with regard to dispensing in future with whistles on the tramcars.

Swansea—Mr. David James, general manager of the Swansea Tramway Co., at a dinner of tramway employés stated that last year his company paid £4,300 in rates in Swansea; they had paid the Corporation £7,200 over the extensions, and £2,500 for current. Some 300 men were employed in the company's concerns, and the wages paid out in 1907 amounted to £23,000. It was the intention of the company to establish a parcels service, which would satisfy a long-felt want, and the company intended to pursue a progressive policy with regard to summer entertainments on Mumbles Pier.

Lowestoft.—The Tramways Committee reported to the last meeting of the Council that the total receipts from Oct. 1, 1907, to Jan. 21, 1908, were £2,714. 7s. 3d., as against £2 638. 17s. 10d. for the corresponding previous period. The town clerk also reported that he had taken the opinion of the counsel to the Association of Municipal Corporations on the cost of the upkeep of the road on which the tramway track is laid, and submitted that on the whole he is of opinion that these costs may be paid out of the general district fund. It was resolved that a joint meeting of this committee and the Roads Committee be arranged as soon as convenient to discuss the above opinion. The report was adopted.

Keighley.—At the Council meeting the Tramways Committee reported that it was not anticipated that there would be any need for assistance from the rates for the year ending March 31, 1909. The chairman of the committee said that this was the first time it had not been necessary to apply for assistance from the rates. For the present financial year they had already received £280 more since July than in the corresponding period of the previous year, and it was likely that for the full year there would be a net surplus of £500 to £600. In addition they would have £400 which was received from the rates last year, making altogether, they anticipated, about £1,000 to carry forward to a renewals fund.

Table Mountain Railway.—The scheme for the construction of a railway from Cape Town to the top of Table Mountain has now assumed the definite stage, and alternative projects are to be made the bases of tenders. The proposals put forward are for the construction of a railway and hotel on the summit of the mountain, but no limitations are to be imposed on tendering firms as to the system which their engineers may advise should be adopted. The construction may be of the rack-and-pinion, funicular, or other approved type, but a concession is not to be granted in respect of the line for a longer period than 25 years, the municipality reserving the right to purchase on the expiration of that term.

Metropolitan Association of Electric Tramway Managers.—The quarterly meeting of the above association was held at the Municipal and County Club, Whitehall, S.W., on Feb. 14, when the following members attended: Messrs. H. E. Blain (chairman, West Ham), A. Coveney (Erith), T. B. Goodyer (hon. secretary, Croydon), W. E. Hammond (Metropolitan Electric Tramways), G. H. Hulme (South Metropolitan Tramways), H. L. Howard (Barking), C. Mittelhausen (Bexley), F. Schofield (Leyton), H. Shaw (Ilford), W. C. Ullman (East Ham). Sir J. Clifton Robinson (London United), A. L. C. Fell (L.C.C.), G. K. Bruce (L.C.C.), W. Murray (Walthamstow), G. R. Spurr (Walthamstow), and A. G. Balfour (Dartford), were prevented from being present. A number of subjects of interest to managers in the metropolitan area were discussed at the meeting.

Darlington.—At the monthly meeting of the Electricity and Light Railways Committee of the Town Council it was reported that

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for the four weeks ending Jan. 25 the total revenue of the tramways was £750. 7s. 9½d.; the number of passengers carried was 195,291; the car mileage run was 28,085·7; and the revenue per car mile was 6·41d., against 7·06d. during the corresponding period in December of last year. The amount drawn compares favourably with 6 34d. per mile drawn during the corresponding period in January, 1907, an increase of ·7d. per mile. The electrical engineer, Mr. J. R. P. Lunn, reported that during the month of January 62 yards of distribution cable had been laid in Uplands-road.

Hanley.—The Town Council at its quarterly meeting considered a resolution of the General Purposes Committee recommending that the town clerk should write to the Potteries Electric Traction Co. protesting against the company's action in increasing workmen's fares and the price of weekly tickets, and likewise calling the company's attention to the continued overcrowding of the tramcars. The mayor announced that he had received a memorial, signed by something like 50 ratepayers, asking him to call a meeting of ratepayers on the subject. His worship, however, suggested that the memorialists should await the company's reply to the town clerk's letter. The recommendation of the General Purposes Committee was adopted, and other authorities in the district are to be communicated with a view to joint action.

Delhi.—The system of electric trams by which Delhi benefits through English capital should have been completed and trams running by July last, but various causes, including labour difficulties and late arrival of plant, have combined to retard the completion. Now over nine miles of a total permanent way of 10 miles is laid, and the entire work, including overhead connections, should be finished by end of next month, permitting contractors (Bruce Peebles and Co., of Edinburgh and London) to transfer the charge to the Delhi Electric Tramways and Lighting Co., of London. Possibly another month may be required in organising the service, including the training of native drivers (recruited locally), so that the electric trams will be running throughout the main thoroughfares of the city by March, when the hot weather sets in.

Liverpool.—The municipal electricity undertaking and the tramways system show such large surpluses from last year's working that it is proposed to relieve the general rate by over £50,000 out of these profits. The total income from the electricity concern amounted last year to £274,105, and, after deducting the cost of generating and distributing the current, a balance of £158,449 is left. Out of this sum large amounts have to be set aside for the sinking fund and reserve and renewals funds, but after these have been met there is still a surplus of £27,500, which it is proposed to contribute to the relief of the general rate. On the tramways the income came to £598,364, and the expenditure was less by £199,631. Deducting the capital charges from this figure a surplus of £27,793 is shown, which it is proposed to utilise in the same manner as the electricity profit, making a total of £55,293.

Walsall.—At the Town Council meeting the adoption of the report of the Tramways Committee, which showed a net profit for the year of £4,305 against £4,389 for the previous year, was moved by the chairman, who stated that the total increase of income from all sources had been £410. There had been a loss upon the work of reconstruction, which upset the general traffic, amounting, it was estimated, to £867. Notwithstanding that, however, there had been a gross profit of £1,200. Out of that they had to meet further responsibilities in the shape of increased payments in respect of interest and loans. After meeting that they had still a net profit to the amount of £4,305, the whole of which it was proposed to carry to the reserve fund. When they considered that they had increased their capital expenditure by £31,000, the undertaking, he thought, was more satisfactory than it had ever been in its history. The report was adopted.

Falkirk.—A deputation appointed at a recent public meeting of the ratepayers of Laurieston, near Falkirk, waited upon the directors of the Falkirk and District Tramway Co. in Edinburgh on Tuesday afternoon last week for the purpose of urging upon them the advisability of proceeding with the extension of the tramway system to Laurieston, for which powers were some time ago got by the tramway company. The deputation brought under the notice of the directors the population of the village of Laurieston, the prospect of increase by building in the event of increased travelling facilities, and the extent of the district to the east and the south, such as Polmont, Redding, and Reddingmuirhead, from which a considerable number of people would avail themselves of the cars. The deputation were well received by the directors, but no decision was given. It is understood that the deputation will continue to prosecute their labours with the view of obtaining the desired extension, and it is considered that not only Laurieston and the surrounding district, but the inhabitants of the burgh of Falkirk, would be benefited by the improved facilities for travelling which the cars would furnish.

Manchester.—A description of the Manchester tramways system formed the greater part of an address given by Alderman E. R. Wilson at the Longsight Public Hall on Tuesday. He stated that the cost of the undertaking to the Corporation had been £1,750,000, and that of the 143,264,000 passengers carried last year those who paid a penny fare formed 69 per cent. The committee paid £25,000 a year as rates, compared with £8,000 by the old company, while the deduction in fares had been as from 2d. to 1·19d. The reduction of the hours worked by their employés and the increase in the rates of wages cost £50,000 a year, and their 4,174 workpeople took £5 400 a week in wages. The average cost of laying down a mile of track was £5,270, with an addition of £1 090 for overhead equipment, and he was pleased to say that all the material was English except certain "points" at junctions, which until three years ago were not manufactured in this country. The average takings per day amounted to £1,950, which meant that five tons of coppers had to be counted in the offices daily. Each car travelled about 100 miles a day, and in the near future the 550 cars on the service would be increased by 250.

Italy.—H.M. Consul-General at Naples reports that a mountain line is proposed from Castellammare to Amalfi to cross the spur of the Appennines, which is best known as the Sorrentine peninsula. The line will be about 12 miles in length, and will go directly across the mountains serving the villages of Agerola and San Lazzaro and the rich agricultural district in which they are situated. Castellammare and Amalfi are both populous towns, and though geographically near to one another, are, in fact, only accessible to each other by a journey of several hours by road and rail, Amalfi being some 17 miles of hilly road from its nearest railway station. The hill villages through which the new line will pass are much resorted to in the summer on account of their altitude and coolness, and as the new line will place them in easy and rapid communication with Naples, an impulse will be given to building villas for summer quarters in the neighbourhood of the line. There will be only five tunnels, of which one will be of 608m. and the others about 100m. each. There will be 10 bridges from 5m. to 10m. span. The line will be electric, the motor force being largely supplied by water power. The total cost of the line is estimated in round figures at £120,000, including rolling-stock, and the cost of the motive force would be £6 per horse-power per annum.—*Board of Trade Journal.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

Bremerhaven.—Tenders are invited by the Harbour Authorities for 27 electric cranes. Tenders by March 2.

Manchester.—Tenders are invited for the supply of four water-tube boilers and accessories. Tenders by Feb. 25.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy including electrical machinery. Tenders by May 30.

Isere (France, S.).—Tenders are invited for the construction of permanent track and appliances. Tenders by Feb. 29.

Glasgow.—Tenders are invited by the Maryhill School Board for electric wiring and fitting Colston School. Tenders by Feb. 29.

Bukharest.—The Municipality of Craiova invite tenders for the construction of tramways. Deposit, £200. Tenders by March 13.

Cassel.—The Prussian State Railways invite tenders for a three-ton travelling crane, together with electric motor. Tenders by March 27

Hackney.—The Borough Council invite tenders for the annual supply of arc lamp carbons. Tenders to the Town Clerk by March 12.

Manchester.—The Tramways Committee invite tenders for the supply of stores and materials. Tenders by Feb. 24. See advertisement.

Paris.—The Post and Telegraph Department invite tenders for the supply of various materials for a period of three years. Tenders by Feb. 28.

Hornsey.—The Town Council invite tenders for meters and fuse boxes, cables, troughing, etc. Tenders to the Town Clerk by March 16.

Brazil.—The Government invite tenders for the installation of electric light and power supply in the city of Florianopolis. Tenders by March 5.

Oporto.—The Municipality invite tenders for the construction, maintenance, and working of tramways in Nova de Gaya. Tenders by March 11.

Acton.—The Urban District Council invite tenders for meters, cables, steel tubing, etc. Particulars from the Electrical Engineer. Tenders by Feb. 29.

Villach (Austria-Hungary).—Tenders are invited by the Austrian State Railways for telegraph cables, insulators, and copper conductors. Tenders by Feb. 28.

Heston and Isleworth.—The Urban District Council invite tenders for the annual supply of electrical stores and electric cables. Tenders by March 2.

Madrid.—The Public Works Department invite tenders for the construction and working of electric tramways in Barcelona and Seville. Tenders by Feb. 29.

South Australia.—The Postmaster-General, Adelaide, invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Hackney.—The Borough Council invite tenders for the supply of coal to the electricity works. Particulars from the Town Clerk, to whom tenders must be sent by March 12.

Handsworth.—The Urban District Council invite tenders for 315-kw. engine and dynamo and switchgear, and feed pump, economiser, and pipework. Tenders by March 4.

Ilford.—The Urban District Council invite tenders for one 1,000-kw. steam dynamo and one water-tube boiler and accessories. Tenders by Feb. 25. See advertisement in last issue.

Birmingham.—Tenders are invited by the Electric Supply Committee for alterations and additions to existing offices and generating station, Dale-end, Birmingham. Tenders by March 3.

Hull.—Tenders are invited for the supply and erection of three 500-kw. 2,250-volt continuous-current dynamos. Tenders to the Chairman of the Electric Lighting Committee by Feb. 27.

Brussels.—Tenders are invited for the construction of an electric railway at Namur. Tenders to the Société Nationale des Chemin de Fer Vicinaux, rue de la Science 14, Brussels, by Feb. 25.

Bury.—The Corporation invite tenders for the supply and erection of two 2,000-kw turbo-alternators, with exciters and condensers Tenders to the Town Clerk by March 16. See advertisement.

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Finchley.—The Urban District Council invite tenders for the supply and erection of one 700-kw. high-speed engine and dynamo combined. Tenders to Mr. E. H. Lister, clerk to the Council, by March 2.

Stockport.—The Electricity Committee invite tenders for the labour and materials required in erection and completion of stores, offices, etc., in Millgate, adjoining the electricity generating station. Tenders by Feb. 27.

Barking.—The Urban District Council invite tenders for the annual supply of stores for the electricity and tramways departments. Particulars from the Engineer at the electricity works. Tenders to the Clerk by Feb. 25.

Gothenburg.—Tenders are invited for the supply and delivery of 2,780 tons of steel rails, weighing 24 8 kilos per metre. Tenders to the Varberg Atrans Jernvägsaktiebolag (Varberg-Atrans Railway Co.) at Varberg by March 1.

Manchester.—Tenders are invited for the supply and erection of cooling towers at the generating station. Particulars from the Chief Electrical Engineer. Tenders to the Chairman of the Electricity Committee by March 10.

East Ham.—The Corporation invite tenders for the installation of an approved generating plant with distributing pipes and radiators, and all other requisites, at the isolation hospital extensions. Tenders to the Town Clerk by Feb. 24.

Beckenham.—The Urban District Council invite tenders for battery of accumulators, one reversible booster, milking booster, and switch-gear, and automatic stokers with driving gear and accessories. Tenders to the Clerk by March 9.

London, N.E.—The London County Council invite tenders for the installation of electric lighting and fans at the Hackney Downs secondary school extension, Downs Park-road, N.E. Tenders by Feb. 26. See advertisement in last issue.

Belfast.—The Tramways and Electricity Committee invite tenders for the supply of low-tension insulated vulcanised bitumen cables during 12 months ending March 31, 1909. Tenders to Mr. T. W. Bloxam, city electrical engineer, by Feb. 25.

Islington.—The Lighting Committee invite tenders for the supply of one 1,500-kw. steam turbine, condensing plant, switchgear, alternator, exciter, etc., and also for water-tube boilers and coal-conveying plant for the electricity works. Tenders by Feb. 25.

Whitehaven.—The Town Council invite tenders for the annual supply of stores, including water and electric fittings, glass, etc., electric incandescent lamps, oils, bitumen, and coal-tar pitch, leather and rubber hose. Tenders to the town Clerk by Feb. 24.

Burnley.—The Corporation invite tenders for the supply of uniforms for drivers, conductors, inspectors, etc. Particulars from Mr. Henry Mozley, general manager, Queensgate, Burnley. Tenders to the Chairman of the Tramways Committee by Feb. 25.

Bristol.—Tenders are invited for the supply of cables and appliances for conveying electrical energy to the Avonmouth Docks, and for construction and maintenance for 12 months. Tenders to the Secretary of the Docks Committee, 19, Queen-square, Bristol, by Feb. 27.

Birmingham.—The Electric Supply Committee invite tenders for extension to main flues, economisers, boiler and engine foundations, etc., at electric generating station, Summer-lane, Birmingham. Tenders to the Chairman of the Electric Supply Committee by March 3.

Ilford.—The Urban District Council invite tenders for the supply of stores to the electricity and tramway departments required during the year ending March 31, 1909. Particulars from Mr. A. H. Shaw, M.I.E.E., Electricity Works, Ley-street, Ilford, Essex. Tenders by March 10. See advertisement.

Castlerea.—The Rural District Council invite tenders for suction gas plants, gas-engines, dynamos, battery, switchgear, overhead distribution lines, arc lamps, and service connections, in connection with the electric lighting scheme for the town of Ballaghaderreen. Tenders to Mr. P. A. Flanagan, clerk of the Council, by Feb. 22.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 525 tons of steel girder tramway track rails and fastenings required for the reconstruction on the overhead trolley system of electric traction of the existing tramways from Brixton-road to a point near Camberwell Green. Tenders by March 3.

Melbourne (Australia).—The Postmaster-General invites tenders for the construction and laying complete of two submarine telegraph cables between the State of Victoria and the State of Tasmania. Tenders must be accompanied by a deposit of £1,000. Tenders to the Secretary, Postmaster-General's Department, 51, Spring-street, Melbourne, by April 14. See advertisement.

Wimbledon.—Tenders are invited for the annual supply of stores for the electricity department, including (1) engine-room stores; (2) joint boxes and jointing material; (3) transformers; (4) meters; (5) oils; (6) incandescent electric lamps, carbons, and accessories; (7) castings; (8) firebricks and fireclay. Particulars from the Chief Electrical Engineer. Tenders to the Town Clerk by Feb. 29.

Sydney (N.S.W.).—The Municipal Council invite tenders for the supply and delivery into their stores of maximum demand indicators of the thermal pattern. Specifications, etc., may be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W., on payment of a deposit of £1. 1s., which will be refunded on receipt of a *bona fide* tender. Tenders to Messrs. Preece and Cardew by March 5. See advertisement.

Wrexham.—The Town Council invite tenders for the supply of stores to the Electricity Department, including engine-room stores, tools and ironmongery, cables, cable-jointing requirements, double-pole service cut-outs, meters, incandescent lamps, arc lamp carbons, lubricating oils, coal, wood troughing etc., boiler scale solution, consumers' installation materials, special firebricks for Meldrum's refuse destructor. Particulars from the Borough Electrical Engineer, Willow-road. Tenders to Mr. Lawson Taylor, town clerk, by March 6.

RESULTS OF TENDERS.

Hanley.—The Town Council have accepted the tender of the Rhodes Motors, Limited, for a 5-h.p. motor of the commutator repulsion type for £33. 10s.

Derby.—The Electricity Committee have accepted the tender of the Otis Elevator Co. for the supply and fixing of an elevator at the new power station for £150.

Lowestoft.—The Town Council have accepted the tender of the Lahmeyer Electrical Co., at the average rate of £248 per mile, for the supply of service cables for the ensuing year.

Bermondsey.—The Electricity and Street Lighting Committee have accepted the tender of Everett and Edgecumbe for the supply of a recording ammeter for 50 and 100 amperes.

Grahamston.—Messrs. J. E. Cuthbertson and Co., Falkirk, have received the contract for installing electric light in the new central premises of the Grahamston and Bainsford Co-operative Society.

Portsmouth.—The Tramways Committee have accepted the tender of the Hadfield Steelfoundry Co., Sheffield, for the renewal of points, crossings, and junctions for the system during the ensuing 12 months for £4,496.

Buxton.—The Urban District Council have accepted the offer of the D.P. Battery Co., of Bakewell, to put their batteries into good condition and maintain them in such condition for a period of 10 years for a yearly premium of £65. 8s.

Cardiff.—The Corporation have accepted the tender of the British Insulated and Helsby Cables for the supply of an extra high-tension three-phase feeder cable for £593, and that of the British Westinghouse Electric Co. for one 700-kw. motor-generator for £1,345.

Bristol.—The Corporation have accepted the following contracts: Siemens Bros. and Co., extra high-tension trunk cables, £21,787. 17s. 4d.; C. and A. Musker, 10-ton hand travelling crane, £221; R. Wilkins and Sons, sub-station superstructure, £2,939; Ashton Vale Iron Co., supply of coal to the electricity works, £1,281. 5s.

OPENINGS FOR CONTRACTORS.

ABERDARE—Forty houses, Cwmdare-road, Windsor Building Club.
ADLINGTON—Elementary school, Lancashire Education Committee.
ALNMOUTH—Additions, "The Cottage," Mr. W. S. Vaughan.
ALNWICK—Two houses, Christon Bank, Mr. M. Appleby.
ANSTRUTHER—Retort-house at gasworks, Town Council.
ARDLEIGH—Restoration of St. Mary's Church (£200), Ecclesiastical Commissioners.
ATHERTON—Spinning mill; Mr. J. W. Cowburn, builder, Leigh. Hotel, Bolton-road, Messrs. Magee, Marshall, and Co., brewers, Bolton.
AUDENSHAW—Two houses, S. Barlow, Ashton Hill-lane.
AVIEMORE—Motor garage, Aviemore Station Hotel Co.
AYRSHIRE—Extensions, Glenafton sanatorium (£6,000), Ayrshire County Council.
BAGWORTH—School-house (£674), Leicester County Council.
BARKING—Electricity undertaking (£2,400), Town Council.
BARNBYGATE—Elementary school (£9,000), Council.
BARNSLEY—Laundry to Beckett Hospital, Governors; stable, coach-houses, etc., Lune-street, Messrs. Atkinson Bros.; four houses, Old Mill-lane, Mr. W. Beevers.
BERMONDSEY, S.E.—Buildings, Tower Bridge-road, Messrs. Thompson Bros.
BERMONDSEY, S.E.—Buildings, Upper Grange-road, Mr. T. Sloman.
BETHNAL GREEN, E.—Twelve corn-grinding mills, Board of Guardians.
BEVERLEY—Twelve houses, Grovehill-road, Mr. A. Smith.
BIRKBY—Elementary schools, Huddersfield Education Committee.
BIRMINGHAM—Alterations and additions to existing offices and generating station, Dale End, City of Birmingham Electric Supply Committee.
BISHOPRIGGS—Elementary school, Maryhill School Board.
BLACKFORD BRIDGE—Unionist club and buildings (£700).
BOLTON—Art and crafts school, Education Authority; electricity installation at Messrs. Ainsworth's spinning mills; hippodrome, Mr. T. Hargreaves; New Fleece Hotel, Bradshawgate, Messrs. J. Sharman and Son, brewers.
BOLTON-ON-DEARNE—Additions to elementary schools, West Riding County Council.
BOSTON—Additions to warehouse, Rosegarth-street, Mr. C. Day; two houses, Hartley-street, Mr. A. Crick; house and shop, Tawney-street, Mr. G. W. Black.
BO'NESS—Church for parish of Carriden, Ecclesiastical Commissioners.
BOSTON—Elementary school, Boston Education Committee.
BOWCOMBE—Chapel and schools, Wesleyans.
BROADSTAIRS—Rebuilding house, High-street, Mr. Marsh.
BURNHAM—Hotel at golf links (£20,000), Mr. C. E. Pearson.
BURTON—Establishment for the treatment of imbeciles, Guardians.

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BURY—Additions to Daisyfield spinning mill.
BURY—Elementary school in the East Ward, Corporation.
CALSTOCK — House, West Harrowbarrow. Mr. L. Scantlebury, architect.
CAMBERWELL, S.E.—Additions, 9, Brief-street, Messrs. P. Arundell and Sons.
CARDIFF—Extensions, Theatre Royal, St. Mary-street, Managers.
CARDIFF—Additions to premises, Messrs. Rapport Bros.
CARLISLE—Church, Warwick Bridge, Trustees of Primitive Methodist Fund.
CARLTON—Additions, provided school, West Riding County Council.
CASTLEBLANEY — Workmen's dwellings (£31,000), Rural District Council
CHANDLER'S FORD—Elementary school, County Council.
CHATHAM—Houses, Gundulph-road, Trustees of St. Bartholomew's Hospital; building, Richard-street. Messrs. Truman, Hanbury, and Co.; house, Purbeck-road, Mr. H. Hobart; two houses, Maidstone-road, Mr. G. Hornsby.
CHEADLE HEATH—Cotton doubling mill (£100,000), Mersey Mills, Limited.
CHELTENHAM—House, Morris Hill, Midland Railway Co.
CHICAGO—Hotel, La Salle and Madison streets, (£700,000).
CHICHESTER—Secondary school, West Sussex Education Committee.
CHOPWELL—Shop, Mr. W. H. Bendle.
CLANE—Workmen's dwellings, Naas Rural District Council.
COALVILLE—Secondary school (£1,030), Leicester County Council.
CRADLEY HEATH—Goods shed, G.W.R. Co.
CRAMLINGTON Mortuary chapel, Urban District Council.
CREEBRIDGE—Additions and alterations, Holm Park House. Mr. D. K. Park, architect.
CROSSMAGLEN—Workmen's dwellings (£19,057), Rural District Council.
CROWBOROUGH—Police station, East Sussex County Council.
CWMDARE—Thirty houses, Bwllfa Building Club.
DARLINGTON—Pavilion, Bank Top Park, Corporation.
DORCHESTER—Council school, Trinity-street, Town Council.
DOWNPATRICK—Two hundred and ninety-four houses, Rural District Council.
DROITWICH—Alterations and additions, St. Andrew's Brine Baths, Town Council.
DROITWICH—Additions, Grand Pump-room, Hotel.
DRUMCONDRA—Schools and schoolmaster's house in connection with parish church.
DUNDEE—Theatre and hippodrome to accommodate 3,000 people, site in Cowgate, Managers.
DUNGARVAN—Housing scheme (£47,603), Rural District Council.
EARLSHEATON—Institute connected with Highfield Congregational Church.
EASTBOURNE—Church, Hampden-park, Ecclesiastical Commissioners.
EBBW VALE—Workman's hall. Mr. H. Waters, architect.
ECCLES—Additional offices, electricity works, Council.
EDINBURGH—Restaurant and club, Saughton Park, Scottish National Exhibition Committee; extension of law courts, H.M. Works and Public Buildings Commissioners.
ELIE—Villa. Messrs. J. and T. W. Currie, architects.
EPPLEBY — Rebuilding Travellers' Rest Hotel. Mr. F. Martin, Darlington, architect.
ERITH—Electric lighting purposes (£5,000), Urban District Council.
FARNWORTH—Secondary school, Joint Education Committee.
FULWELL—Elementary school, Durham County Council.
GAYWOOD—Elementary school, Norfolk Education Committee.
GELLILYDAN—Elementary school near Maentwrog, Welsh Campaign Committee.
GOLCAR—Residence, Station-road. Mr. J. Berry, architect.
GOSFORTH—Terrace of houses and 28 villas, western portion of the Graham Park Estate. Plans passed by Council.
GOSPORT—Council school, Town Council.
GOVAN—Workhouse, Merryflatts.
GREAT BARR—Alterations, Malt Shovel Hotel, Newton, Mr. H. H. Jackson.
GREAT HARWOOD—Weaving shed, Windsor-road.
GREENWICH, S.E.—Additions, 21, Wellington-road, Old Charlton, Mr. J Rowland.
GRIMSBY—Iron building at the fever hospital, Little Coates; additions at Scartho, Hospital Committee.
GUISBOROUGH—Sixteen houses, Hedley-street, Co-operative Society; two houses, Westgate, Mr. J. Harding.
GWERSYLLT—Elementary school (£9,084), Denbigh County Council.
HACKINGTON (NEAR CANTERBURY)—Addition, St. Stephen's County School, Kent Education Committee.
HALIFAX—Semi-detached houses, Skircoat Green. Messrs. Jackson and Fox, architects.
HAMILTON — New town hall and municipal offices (£25,000 to £28,000), Town Council.
HARROGATE—Concert hall and theatre, Commercial-street. Mr. J. House, architect.
HEAP BRIDGE—Papermaking works, Messrs. Yates, Duxbury, and Co.
HIGHER INCE—Rebuilding Anderton Arms, Ince Green, Mr. W. S. France.
HIGH WYCOMBE—Mills, Priory-road, Mr. G. E. Stevens.
HINDLEY—Additions to 5, Hill Top Fold; outbuilding to St. Paul's Schools, Chapel-street, Trustees.
HOOLE—Cycle shop and stable, Messrs. Bell Bros.
HORKINSTONE—Elementary school, Worth Valley Education Committee.
HORNSEY, N.—Electricity undertaking (£10,000), Urban District Council.
HUNSLET MOOR—Elementary school, Leeds Education Committee.
HUNSTANTON—Elementary school and cloakrooms, County Council.
HUTTON-LE-HOLE—Houses. Messrs. Ridgway and De Bock Porter, architects.
IDAHO—Machine shops (100,000dol.), Idaho and Washington Northern Railway Co.
INCE—Two houses, Wray-street, Mr. W. Bithell; three houses, Gordon-street, Mr. J. Gilmour; five houses, Bird-street, and four houses, Caroline-street, Mr. H. Dickinson.
INVERURIE—Shop, Market-place, Messrs. J. Mackie and Co.
KIBWORTH—Alterations at grammar school (£500), Leicester County Council.
KILCULLEN—Housing scheme, Naas Rural District Council.
KILDARE—Workmen's dwellings, Naas Rural District Council.
KILKENNY—Electric power-house, Kilkenny District Asylum.
KING'S LYNN—Alterations to shops, etc., Norfolk-street, Mr. J. Medwell; alterations to Stanley House, Mr. W. S. V. Miles; alterations to shop, Tower-street, Mr. A. Spinks; alterations to grammar school, St. James-street, Education Committee.
KINGSTON—Elementary school, Town Council.
KINGUSSIE—Church and hall, Congregation of United Free Church; houses, High-street, Council.
KIRBYMOORSIDE—Alterations and improvements, Council school, North Riding Education Committee.
LAFAYETTE—Electric light installation for the town (100,000dol.).
LAMBETH, S.E.—Additions to mortuary, Borough Council.
LEEDS—Residence, Waterworks Committee.
LEEK—Electricity undertaking (£8,250), Urban District Council.
LEIPZIG—Municipal electric light and power works (£1,000,000), Council.
LEOMINSTER—General post office, Commissioners of Public Works.
LEWISHAM, S.E.—Additions, 316, High-street, Mr. H. Knight; three houses, Ardgowan-road, Catford, Mr. R. Stewart.
LEXDEN—Addition, workhouse, Guardians.
LICHFIELD—Extensions to workhouse, etc. (£9,279), Guardians.
LIMERICK—Technical institute, working class houses, etc.
LITTLE HOOLE—Two houses, Mr. Jas. Gill.
LIVERPOOL—Housing scheme (£7,859), City Council.
LLANDOVERY—Elementary school, Carmarthenshire Education Committee.
LLANDRINDOD WELLS—Police station, petty sessional court, etc., Radnorshire County Council; additions to Rock House Hotel.
LLANDRINDOD—County buildings, County Council.
LLANELLY—Seventy workmen's dwellings, Messrs. Williams and Davies.
LLANFIHANGEL-GLYN-MYFYR—Elementary school (£1,005), Board of Education.
LLANTYSILO—Elementary school (£1,808), Denbigh County Council.
LOANHEAD—Twenty-four houses, Shotts Iron Co.
LONDON, W.—Additions, 47, South Audley-street, Messrs. Balfour and Turner.
LUDLOW — Alterations at The Castle and East Hamlet School; houses, Julian-road; houses, Chapel Fields. Plans passed by Council.
LUTON—Sunday school in connection with the Wellington-street Baptist Church (£5,000).
LYALLPUR—Provision of building for the office of the Directors of Agriculture (Rs.20,280), Punjab Government.
LYMINGTON—House, Belmore-lane. Mr. John Bevir, architect.
MANCHESTER — Transforming plant, etc., Corporation Electricity Committee.
MANCHESTER—Power station, Water-street, Town Council.
MARLBOROUGH—Twelve houses adjoining common, Mr. H. Richardson.
MIDDLESBROUGH—Free library (£15,000), Town Council.
MIDSOMER NORTON—Seven houses, steam-mills, reading-room, Westfield, Mr. S. Smith.
MILWAUKEE — Scheme for establishing electric lighting plant (100,000dol.).
MINERA—Elementary school, Denbigh County Council.
MIRFIELD—Shop, Eastthorpe-lane, Mr. F. H. Thompson.
NAAS—Housing scheme, Rural District Council.
NAGPUR—Construction of quarters for the superintendent of the Secretarial Press (Rs.12,500), Indian Government.
NANTWICH—Cottage hospital (£1,500), Hospital Committee.
NESTON—Elementary school, Cheshire Education Committee.
NETHERTON—Elementary school, Dudley Town Council.
NEWBRIDGE—Workmen's dwellings, Naas Rural District Council.
NEWMILL — Alterations at Council schools, Holmfirth Education Committee.
NEWPORT—Additions to Durham-road schools (£11,652), Town Council.

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NORTHALLERTON—Secondary school (£5,366), North Riding Education Committee.
NORTHAM—Terrace of houses, Lewis Hill-gardens. Plans passed by Council.
NORTH BROOMHILL—School-chapel, Trustees of Primitive Methodist Church.
OADBY—Elementary school (£3,245), Leicester County Council.
OBAN—Additions to Argyllshire Gathering Hall, County Council.
OLDBURY—Elementary schools, Abbey-road, Borough Education Committee.
OLDHAM—Sixty-eight houses, Building Committee.
ORRELL—House, Chapel-street, Mr. J. Houghton; two houses, Bell-lane, Mr. Hurst.
PALMER'S GREEN, N.—Elementary school, Hazelwood-lane, Middlesex Education Committee.
PENTYRCH—Residence. Mr. Fred. C. Stibbs, architect.
PENWORTHAM—Fifteen houses and shop, Mr. W. Morris.
PENYCAE—Elementary school (£3,735), Denbigh County Council.
PENYWERN—Fifty houses, Merthyr Corporation.
PERTH—Chapel to south-east corner of St. Ninian's Cathedral (£2,000).
PETERBOROUGH—Parochial building to St. Mary's Church, Churchwardens.
PENZANCE—Public lavatories at the recreation ground, Town Council.
PONTADOG—Elementary school (£1,250), Denbigh County Council.
PORTH—Post office, near Rhondda, H.M. Commissioners.
PRESTON—Two houses, Longton, Mr. Tyson.
PRESTON—Six houses, Mr. Knight Master.
PUTNEY, S.W.—Elementary school, Hotham-road (£12,929), London County Council.
RAMSBOTTOM—House, Helmshore-road, Mr. Hutchinson.
RATHDOWN—Twenty-five houses, Rural District Council.
RATHMORE—Housing scheme, Naas Rural District Council.
RAWTENSTALL—Elementary school (£8,060), Education Committee.
REDBOURN—Infectious diseases hospital, St. Albans Council.
RICHMOND—Twenty houses, Town Council.
RISHTON—Fire station and Council offices.
ROBERTSTOWN—Workmen's dwellings, Naas Rural District Council.
ROCHDALE—Electricity undertaking (£22,175), Town Council.
ROCHFORD—Board-room (£600). Mr. W. Wiseman, architect.
ROTHERHAM—Business premises, Westgate-lane, Masbrough Equitable Pioneers' Society.
ROWLEY—School, Doulton-road, Education Committee.
RUGBY—Additions to slaughter-house, Urban District Council.
ST. ANNES—Hydropathic establishment and hotel, Syndicate.
ST. AUSTELL—Residence, Truro-road. Mr. B. C. Andrew, architect.
ST. MARYLEBONE, W.—Houses, Albert-road, Mr. J. Tatchell.
ST. PANCRAS, N.W.—Extension and additions to premises, Angler's-lane, Mr. A. J. Perriam.
SCHOLES—Elementary school, Holmfirth Education Committee.
SEAFORD—Baptist chapel, Broad-street, Trustees.
SEAFORTH—Sanitary convenience, recreation ground, Urban District Council.
SHARDLOW—Laundry block, union workhouse, Board of Guardians.
SHEFFIELD (U.S.A.)—Municipal electric lighting plant, Council.
SHIPLEY—Additions to Westfield Works, Wrosa Hill, Messrs. M. Kellett and Sons.
SKIPTON—Additions, Water-street Provided School, West Riding County Council.
SLOUGH—Workshop, Stoke Poges-lane, Messrs. Horlick and Co.; house, Uxbridge-road, Mr. A. Lidstone; four houses, Victoria-road, Mr. A. Woolsey.
SOUTHAMPTON—Central fire station (£5,200), Council.
SOUTH BANTACKIM—House, Mr. M. Wilson.
SOUTHMOLTON—Extensions to school, Devon Education Committee.
SOUTHSEA—Extensions and additions, Queen's Hotel (£23,000).
SOUTHWELL—Extensive alterations and additions to Collegiate Grammar School, Governors.
STALYBRIDGE—Additional plant at the generating station (£20,223), Electricity Board.
STIRLING—Fifteen houses, Public Health Sub-Committee; four houses, Mr. J. Mathers.
STOCKPORT—Cotton mill, Lower Bredbury, Pear Cotton Mill Co.; doubling mill, Mersey Mill Co.
STONE—Additions and alterations to Alleyne's Grammar School, Governors.
STREETLY—Church, Ecclesiastical Commissioners.
SWALEDALE—Literary institute, Low-row, Urban District Council.
SWANAGE—Additions, house, Queen's-road, Mr. T. Shelton; additions, houses, Ulwell-road and Durlston-park, F. W. Pond, Esq.
TANDRAGEE—Housing scheme (£3,514), Rural District Council.
TANYFRON—Elementary school (£1,370), Denbigh County Council.
TATTINGSTONE—Additions, school, Manager, Tattingstone Schools.
TAUNTON—Shops, etc., Station-road. Mr. J. H. Spencer, architect.
TINGLEY—Sunday schools in connection with Wesleyan Church, Trustees.
TORONTO—Installation of electric light plant (2,750,000dol.), Board of Control.
TRURO—Additions to stores, Messrs. Edwards and Sons.
TWICKENHAM—Secondary school, Education Committee.
TYNTYLA—Residence. Messrs. Evans Williams Evans, architects.
UNSWORTH—Church, Unsworth North, Local Wesleyans.
VANCOUVER—Sanatorium at Kamloops (50,000dol.), Municipality.
WALSALL—Condensing plant to electricity station and wooden cooler tower (£4,000).
WALTON—Extensions, Provided School, West Riding County Council.
WATERLOO—Secondary school, Lancashire Education Committee.
WATFORD—Public offices, Rudolph-road, Bushey Council.
WELFORD—Additions, Welford and Sulby Endowed Schools, Education Committee.
WEYMOUTH—Pavilion, Town Council.
WHISTON—Extensions and additions, nurses' home and workhouse, Board of Guardians.
WHITBY—Temporary school, Cheshire Education Committee.
WHITECHAPEL, E—Building, Cable-street, Mr. B. J. Capell; building, Half Moon-passage, Mr. Wright.
WHITCHURCH—Additions to Ty-clyd House, Mr. W. Harpur
WHITWORTH—Extension, Facit Workmen's Club.
WIMBLEDON, S.W.—Extensions, central fire station, Town Council.
WINCHESTER—County school, Hants County Council.
WINDSOR—Two houses, Bailey Estate, Mr. Candell; two houses, Springfield-road, Mr. Bond.
WINTON—Depôt, Bournemouth Borough Council.
WOKINGHAM—Two detached houses, Sturges-road, Mr. H. Culver; shops, Peach-street, Councillor W. T. Martin; workshop, Cross-street, Mr. J. Hopkins; motor-house, Milton-road, Mr. W. Alban.
WOODSIDE—Elementary school, Dudley Education Committee.
WOLVERHAMPTON—Electric cables (£2,500), Town Council.
WOMBWELL—Twelve houses, Park-street, Messrs. Johnson and Co.
WOOLDALE—Alterations at Council schools, Holmfirth Education Committee.
WOOLWICH—Houses, Charlotte-street, Mr. J. E. Edwards.
WORCESTER—Electric lighting purposes (£10,000), Corporation.
YARDLEY—Elementary school, Golden Hillock-road, Education Committee.

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING.

The adjourned general meeting of holders of the 4½ per cent. perpetual debenture stock of the Brush Electrical Engineering Co. was held on the 12th inst. for the purpose of considering an extraordinary resolution to modify the provisions contained in the trust deed made between the Brush Electrical Engineering Co. and the Electric and General Investment Co., authorising the former to create an issue of £350,000 first debenture stock, carrying interest at the rate of 4½ per cent., such stock to be secured by a specific first charge upon the freehold lands and buildings of the Company at Loughborough. Mr. L. G. Braithwaite (one of the trustees) presided.

LORD VAUX OF HARROWDEN said that the Board had had an opportunity of communicating with several of the holders of both classes of debenture stock, and certain suggestions had been made whereby the stockholders might possibly look upon the scheme in a more favourable light. The Board had proposed to raise new stock to carry 4½ per cent. interest, and, in addition, that a sum equivalent to ½ per cent. per annum should be provided for a sinking fund. Several shareholders considered that the sinking fund was not large enough, and the directors, after careful consideration, had agreed to increase the amount to be set aside for the purposes of that fund up to 1 per cent.

After some discussion, the resolution was proposed by Lord Vaux and declared by the chairman to be lost. One of the directors then demanded a poll, which was arranged should be taken on the 27th inst.

EDMUNDSONS' ELECTRICITY.

An extraordinary general meeting of Edmundsons' Electricity Corporation was held on Tuesday for the purpose of receiving the report of the committee appointed at the meeting last July. Mr. F. E. Gripper presided.

The committee's report stated that the non-success of the Corporation was attributable to injudicious capital expenditure, unwise management, and imprudent finance, aggravated by the fact that electricity supply undertakings had undoubtedly sustained a check to their profitable development during the last three or four years. The installations generally appeared to have been carried out with insufficient regard to their prospective earning capacity. It was doubtless true not only that more sanguine expectations in regard to the profits of electric lighting prevailed at the time than the event had justified, but, also, that the competition of gas, especially in provincial towns, had proved more injurious than appeared likely, until recently, to be the case. It was especially to be regretted that, when this disappointment was realised, the Corporation was not only already committed to its extended programme, but also that it indulged in lavish expenditure of capital in the hope of thereby securing a commensurate return on its outlay. In conclusion, the report stated that what was wanted to restore the Company's fortunes was commercial management and business aptitude rather than

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engineering skill, and suggested the appointment of a new Board, consisting of Mr. Tuckett, Mr. Campbell Swinton, Mr. Stanley Becton, and Mr. Gripper, and that Mr. Highfield be also asked to assist in the reorganisation of the business.

Mr. TUCKETT, the chairman of the committee, stated that the root cause of the whole trouble was undoubtedly to be found in the sanguine anticipations which were entertained with regard to the prospects of electric supply undertakings during the earlier years of the Company. He could see no reason why, with careful and energetic management, the position of the Company should not be materially improved, for whatever the vicissitudes the industry might still have to pass through, the superiority of electricity over any of its rivals was now generally conceded. At present they were overburdened with the dead weight of excessive capital, and for some years they would undoubtedly have to exercise patience. In view of the inadequacy of the reserves, the present unremunerative character of much of the expenditure represented by investments, the absence of any provision for depreciation, and the existing financial position, it must be some years before there could be any expectation of a resumption of dividends, even on the preference shares. After consulting the best advice obtainable, the directors were satisfied that a minimum amount of £250,000 would be needed, which they proposed to raise by issuing prior lien debenture stock. It was not, however, suggested that the whole amount should be raised at once. He moved a resolution approving of the committee's report, and instructing the directors to carry out the recommendations in the report.

Mr. G. KITCHIN seconded the motion, which was carried.

HASTINGS AND DISTRICT ELECTRIC TRAMWAYS.

The ordinary general meeting of the shareholders of the Hastings and District Electric Tramways Co. was held on Monday, Mr. E. O. Morgan, chairman of the Company, presiding.

The CHAIRMAN said the expenses were about 60 per cent of the receipts, a proportion which they hoped to reduce, but they could hardly hope to emulate the figures of other lines where the conditions of working were less onerous than those of their own undertaking. They had two serious difficulties with which to contend, one being the very heavy gradients on certain portions of the line, and the other the high price which they had to pay for their coal and water. Their takings amounted to £54,128, which had been earned by the carriage of 9,530,345 passengers. He asked them to bear in mind, however, that the climatic conditions during the year under review were singularly unfavourable to an undertaking such as theirs, and it was not unreasonable to suppose that with more normal conditions the number of passengers would be materially increased, apart from the natural growth in traffic, which was the almost invariable experience of all tramway undertakings. The figures showed that the tramways had taken firm hold of the people, and left no doubt as to their supplying an actual want. No comparison had been made between the years 1906 and 1907 because the conditions were not similar, the front line only having come into operation at the beginning of the latter year. This was a very important addition to their system, not only for the facilities which it gave to the inhabitants of Hastings and St. Leonards, but also by the direct link which it created between Hastings and Bexhill. The concession required that that line should be constructed upon a plan other than the overhead system, although that had been adopted with so much success throughout the remainder of the route. They, therefore, had to fall back upon one of the surface-contact systems (the conduit being impossible), although very little was known as to their merits, and practically nothing as to the particular system which they had put into operation. They were, therefore, pioneers of the Dolter system, and at first, and for a considerable period, they experienced many difficulties which did not tend to improve their traffic. By patience and perseverance, however, they had surmounted most of the difficulties, and the line was now working in such a manner as to lead them to hope for fairly good results. With regard to the proposals for the construction of a line passing through the old town, these had made little, if any, progress during the year, but there were many of the inhabitants of the old town who were very anxious that that extension should be carried out, and the directors were quite willing to favourably consider it if they could obtain conditions which would justify them in so doing. Tentative proposals had also been made as to extensions in the Bexhill district, but at present nothing definite had been arrived at. He added that their relations with the municipal authorities continued to be of a friendly character, and that their cars, overhead line, permanent way, buildings, and plant had been maintained in a first-class state of efficiency by their able manager, Mr. Holliday, who had done so much to popularise the undertaking. He moved that the report of the directors and statement of accounts to Dec. 31, 1907, as submitted to the meeting be received and adopted.

Mr. GEORGE KITCHIN seconded the motion, which was carried unanimously.

The CHAIRMAN next proposed: "That a dividend at the rate of 8 per cent. per annum on the preference shares for the half-year ended Dec. 31 last, making, with the interim dividend at the rate of 4 per cent. per annum already paid, a total payment of 6 per cent. per annum, being the full preference dividend for the year 1907, be and is hereby declared, such dividend to be paid on Feb. 18, less income tax."

Mr. J. C. WILLIAMSON seconded the motion, which was carried unanimously.

BRISTOL TRAMWAYS AND CARRIAGE.

The annual meeting of the Bristol Tramways and Carriage Co. was held on the 17th inst., Sir George White presiding.

In moving the adoption of the report (*Electrical Engineer*, Feb. 14), the CHAIRMAN stated that on the income side of the revenue account the returns from the tramways department were £210,690, or a decrease of £392 as compared with 1906. The carriage department receipts were £48,360, or a decrease of £2,097, while the sundry receipts were £4,638, or less by £591. The large decrease in the carriage department arose wholly from having discontinued the working of a number of motor omnibuses, especially those which had been unremunerative. The total receipts for the year were £263,689, which showed a net decrease of £3,080. On the expenditure side there was an increase of £631 under the head of wages. The directors had effected a rearrangement of the car service and made a considerable reduction of car mileage—namely, from 6,178,866 to 5,727,943—and brought up their receipts per car mile from 8·68d. to 9·27d. Coal cost £1,400 more than in 1906, but they anticipated a decreased coal bill in 1908. The total expenditure was £178,342, against £176,461, and the balance of profit was £85,347, or £5,000 less than last year, made up as to about £3,000 in less receipts and £2,000 more expenses. The number of passengers carried was 46,585,050, as against 46 902 257.

Mr. J. H. HOWELL seconded the motion, which was adopted.

BAKER STREET AND WATERLOO RAILWAY.

The half-yearly general meeting of the Baker-street and Waterloo Railway Co. was held on the 17th inst., the chairman, Sir George Gibb, presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, Feb. 14), said that the Company was making steady progress. The gross receipts on revenue account amounted to £69,249, which showed an increase of £24,659, or 55 per cent. over those of the corresponding period of the previous year. After providing for interest and rents, and crediting to net revenue account the amount receivable from the Underground Electric Railways Co. of London, Limited, under their guarantee agreement, there remained a balance of £17,670 available for dividends, and they recommended dividends of 4 per cent. on the preference shares and 3 per cent. on the ordinary shares. That was the first half-year in which they were able to compare their position with the corresponding period of the previous year. They had carried 10,662,876 passengers, an increase of 3,868,981, while the traffic receipts were £66,536, an increase of £22,272. The first weeks of 1908 fulfilled the promise of the past half-year, for during the first five weeks the receipts per week showed an increase of 15½ per cent.

Mr. A. WILLIS seconded the motion, which was carried.

IMPERIAL TRAMWAYS.

The annual meeting of the Imperial Tramways Co. was held on Monday, Sir George White presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, Feb. 14), said the past year's experience in the Company's working had been without any special feature. At Middlesbrough the gross receipts had amounted to £54,747, a decrease of £375 as compared with the previous year, and the number of passengers carried 10,700,643, an increase of 26,885. These figures, taken in conjunction, indicated a larger proportion of short-distance passengers. The net profit at Middlesbrough was £16,884, against £16,711. With regard to the revenue from other investments, in the London United Tramways he might point out that the dividends amounted to £21,112, being the same amount as at the corresponding period. The London United Tramway Co.'s report was likely to be issued a little late, but the secretary informed him that the receipts had again exceeded those of the previous year, being £345,570 against £327,896. The sundry receipts of the Imperial Tramways Co. were as nearly as possible the same as last year, and it would be seen in the result that the net revenue account showed a divisible balance of £41,574. The reserve funds had been increased from £126,271 to £128,771.

Mr. S. WHITE seconded the motion, which was adopted.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT.

The annual meeting of the St. James's and Pall Mall Electric Light Co. was held on Tuesday, Mr. W. Leaf, the vice-chairman, presiding.

The CHAIRMAN, in moving the adoption of the report, said the last 12 months had fully borne out the forecast of improvement given last year, the sales of electricity showing an increase by £7,000, while the number of units sold was higher by about 10 per cent. The increased price of coal had made the working expenses higher, but there had been a saving in rates and taxes of £1,300. He had been asked by shareholders what effect metallic-filament lamps would have. He had no doubt that a sensible loss of revenue had been felt due to these lamps, as was only to be expected, considering that such lamps gave two or three times more light with the same amount of current. The new lamps, however, would eventually be better for the Company, and they would be able with their present plant to supply more consumers, and thus save capital expenditure.

The report was unanimously adopted.

GREAT NORTHERN, PICCADILLY, AND BROMPTON RAILWAY.

The nineteenth ordinary half-yearly general meeting of the Great Northern, Piccadilly, and Brompton Railway Co. was held on Tuesday at Hamilton House, Victoria-embankment, E.C., Sir George S. Gibb (chairman of the Company) presiding.

The CHAIRMAN, in moving the adoption of the report, said that the capital expenditure during the half-year had been £20,727;

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£43,600 of debenture stock had been issued, which left a balance of over £300,000 issued to the contractors. The revenue account for the six months included the full debenture interest, part of which appeared under the head of interest on debenture stock and part under the heading of general interest. As they had just completed the first year's working of the undertaking, comparison with the corresponding half-year was impossible. The nearest approach they could make was by taking the receipts for the first seven weeks of the current year, when the receipts were £585 per mile, as compared with £410, or an increase of about 43 per cent., which was a most satisfactory showing. During the six months they had carried 13,914,779 passengers, from whom £115,008 was earned, or an average of 1·89d. per passenger. Sundry receipts amounted to £4,263, so that the gross revenue had been £119,271. The working expenses totalled £70,753, and there was a balance, after payment of all rents, debenture interest, etc., of £7,114 available for dividend, which enabled the directors to pay the full 4 per cent. dividend on the whole of the shares held by the public.

Lord GEORGE HAMILTON seconded the motion, which was unanimously adopted.

The proprietors afterwards approved the agreement with the Underground Electric Railways Co. of London, and also two Bils now pending in Parliament conferring on the Piccadilly Co. further powers with reference to capital, and making further provision respecting the capital and undertaking of the District Railway Co., and authorising the abandonment of works authorised by the Metropolitan District Railway Acts, 1897 and 1903.

LONDON ELECTRIC SUPPLY.

The report of the London Electric Supply Corporation for 1907, to be presented at the meeting on the 27th inst, states that the profit on the working for the year is £46.319, to which has to be added the amount brought forward, £4,170, less interest on temporary loan and expenses incurred in Parliament last session—namely, £900—making a total of £49,589. Out of this the interest on debenture stock to Dec. 31—namely, £14,975—has been paid, leaving a balance of £34,613. The Board proposes a dividend of 6 per cent. on the preference shares for the year (of which an interim dividend of 3 per cent. was paid on Sept. 1, 1907), a dividend of 2½ per cent. on the ordinary shares for the year, the placing to reserve account (making a total of £57,500) of £2,500, and the carrying forward of £2 836. The diminution in the revenue account is caused by the large decrease in the receipts from the London County Council for their tramways as compared with last year, together with a considerable increase in the price of coal. On the other hand, the power supplied for industrial purposes shows an increase from 840,634 units to 2,111,921, and the general business (excluding that of the London County Council) shows an increase of over 30 per cent.—namely, from 5,420,258 to 7,118,513 units. It is expected that a commencement will be made in May next to supply power to the London, Brighton, and South Coast Railway Co. for working the trains on their South London line between Victoria and London Bridge.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

The report of the Kensington and Knightsbridge Electric Lighting Co. for the year 1907, to be presented at the meeting on the 27th inst, states that the renewal account now stands at £69,602, being an increase of £3,223 over the amount of the account at the end of the previous year. After providing for the amount placed to renewal account, and after paying the dividends on the 6 per cent. first preference shares to June 30, 1907, on the 5 per cent. second preference shares to Sept. 30, 1907, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1907 is £9,854. The directors draw attention to the fact that the rate of dividend has been maintained, despite the high price of coal and the large amount paid in respect of local taxation, which latter item alone now amounts to a sum equivalent to about 6 per cent. on the ordinary shares. Of the above sum £1,500 has been appropriated to the payment of the first preference dividend to the end of the year, and £625 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date. It is proposed to pay out of the balance of £7,729 a further dividend on the ordinary shares at the rate of 10 per cent. per annum, for the past half-year, making, with the interim dividend paid on Aug. 1, 10 per cent. for the year. This will leave £2,479 to be carried forward.

NOTTING HILL ELECTRIC LIGHTING.

The report of the Notting Hill Electric Lighting Co. for 1907 states that expenditure on capital account at the date of the last balance-sheet stood at £231,358, and this has been increased during the past year by £2,168, making a total to date of £233 526. Expenditure on capital account exceeds receipts by £25.526. The cost of the joint station to date has amounted to £184.049, and joint debenture stock amounting to £180,790 has been issued. The number of consumers is now 2,673, and 98 per cent. of these are supplied at 200 volts. The gross revenue for the year was £38 055, an increase of £1,131, and the total net profit was £19,007, a decline of £1,000. From the sum mentioned the directors have written off for depreciation, renewal, and reserve fund £2 000, and debenture and other interest has absorbed £2,586; Kensington and Notting Hill joint debenture stock interest £2,216, sinking fund £1,154, reserve for bad or doubtful debts £50, leaving a balance available for dividend of £11,000. The directors recommend the usual dividend of 6 per cent. (less income tax) on both the preference and ordinary shares, and that the balance be divided in accordance with the articles of association, one-half being credited to the founders' shares and the other half to the ordinary and preference shares. This will enable a further 1 per cent. to be paid on both ordinary and preference, with a distribution of £2 15s. per share on the founders' shares An interim dividend of 3 per cent. was paid to the holders of the ordinary shares on July 1, and the balance of 4 per cent. will be paid forthwith, together with the distribution on the founders' shares. The preference shares having received their full 6 per cent., the 1 per cent. bonus will be added to the interim dividend on these shares, to be paid on July 1 next. The reduction in the net profit is more than accounted for by the increased costs at the Wood-lane works during the latter half of the year. This was occasioned partly by the increased price of coal, but mainly by the cost of exceptionally extensive repairs which had to be carried on under unfavourable conditions, owing to the impossibility under the existing Electric Lighting Acts of obtaining current by joining up with neighbouring companies. The rates paid to the local authorities (including this Company's proportion of those charged in the Wood-lane supply) amounted to £3,475, approximately equivalent to a dividend of 2½ per cent. on the share capital.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING.

The report of the Newcastle and District Electric Lighting Co. for 1907, to be submitted to the meeting at Newcastle-on-Tyne on the 25th inst., states that the number of units sold during the year was 9,282,370, an increase of 14·92 per cent. The increase has not been in proportion to the estimate which was formed in the beginning of 1907, due to the falling off in the demand for electrical energy for power and other purposes in the engineering and other trades, owing to leasened work, and this, combined with the increased cost of coal, has had a depreciatory effect upon the anticipated profits for the year. The gross profits for the year for Newcastle amount to £18,501 and for Newburn to £857, which, together with the sum of £9 received for transfer fees and £2,248 brought forward from last year, makes the total £21,615. After deducting directors' and trustees' fees, income tax, etc., and making provision for leasehold redemption fund, there remains a net balance of £19,922. After providing for all interest on debenture stock, etc., the directors recommend a dividend at the rate of 4 per cent. per annum for the half-year ended Dec. 31 (less income tax), which, together with the interim dividend makes 4 per cent. for the year. To accomplish this it will be necessary to draw upon the reserve fund to the amount of £1,222. An arrangement has recently been made with Messrs. John Spencer and Sons for a term of years to utilise their exhaust steam, and thus "the current" will be produced at a very low rate, which will assist the profits of the station considerably during this and future years. From these circumstances, and from possible economies generally being effected in various ways, and with the anticipated reduction in the price of coal, the Company's position during the current year will, the directors confidently feel, be much improved. The directors very much regret the death of Sir John D. Milburn, Bart., who had been chairman of the Company since its inception. During the year Mr. Frank R. Simpson has been elected a member of the Board.

WESTMINSTER ELECTRIC SUPPLY.

The report of the Westminster Electric Supply Corporation for the year 1907, to be presented at the meeting on the 26th inst., states that the supply of current, which on Dec. 31, 1906, was provided for the equivalent of 839,004 lamps of 8 c.p., had increased by Dec. 31, 1907, to the equivalent of 929 529 lamps, the largest addition in any one year. A considerable part of this addition is forpower and heat, for which there has been an increasing demand during the last few years. A Bill is being promoted in Parliament by this Company in conjunction with other West End supply companies to enable economies to be made in the supply of electricity, and the directors are taking the necessary steps to safeguard the Company against other Bills which have been promoted and which might affect its business. An interim dividend at the rate of 10 per cent. per annum on the ordinary shares and the dividend on the 4½ per cent. preference shares for the half-year ended June 30, 1907, has been distributed. After allowing for depreciation, sinking fund, and other charges, the net balance is £36,996, from which must be deducted the second half-year's dividend on the preference shares, which absorbed £8,666, leaving £28,313. Out of this the Board recommends the payment of a dividend at the rate of 10 per cent. per annum, less income tax, for the past half-year, carrying forward a balance of £2,185. Although the output has increased during the current year, the amount available for net revenue has diminished, principally owing to the heavy amount paid in the city of Westminster for rates, which now amount to £16,000 (equal to nearly 3 per cent. dividend on the ordinary share capital). Other contributory causes are the large increase in the price of coal and the investment of a sum of £243,000 in first-class securities on account of depreciation and reserve.

MATHER AND PLATT.

The report of Mather and Platt for the year ended Dec. 31 last, to be presented at the meeting on the 27th inst., states that the net profits for the year, after charging depreciation and making provision for directors' remuneration and expenses, are £125,676, to which must be added £15,380 brought forward, showing an available total of £141,057. The directors recommend a dividend at the rate of 10 per cent. per annum on the ordinary shares for the year, less interim dividend paid in September, a bonus of 5 per cent. on the ordinary shares, to transfer to reserve account (bringing up the amount to

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£340,000) £40,000, to transfer to employés' benefit fund, to be administered as the Board deem expedient for the employés' benefit, £5,000, leaving to be carried forward £16 057.

SOUTH METROPOLITAN ELECTRIC LIGHT AND POWER.

The report of the South Metropolitan Electric Light and Power Co. for the year 1907, to be presented at the meeting on the 26th inst., states that the revenue account shows a credit balance of £27.067, which, with £7,103 brought forward, makes a total of £34,171. After deducting £9,792 for interest on debenture stock paid and accrued, and for other interest, and £4,128 for interim dividend paid on the 7 per cent. cumulative preference shares, there remains a balance of £20.250. The directors recommend payment of final dividend to Dec. 31, 1907, upon the 7 per cent. cumulative preference shares; the carrying to credit of depreciation account of £5.500; the payment of dividend to Dec. 31, 1907, upon the ordinary shares at the rate of 2½ per cent. per annum; and that £7,182 be carried orward.

CHATHAM AND DISTRICT LIGHT RAILWAYS.

The report of the Chatham and District Light Railways Co. for the half-year to Dec. 31 last, to be presented at the meeting on March 5, states that the receipts were £2),207 and expenses £12,799. Deducting the interest on debentures and the amount written off, £5 555, and adding the balance brought forward, £4,492, there is £5,111. Of this £3,000 has been transferred to reserve for depreciation, and the directors recommend a dividend at the rate of 3 per cent. per annum on the preference shares for the half year, and the carrying forward of £317 to revenue new account.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS.

The report of the Yorkshire (West Riding) Electric Tramways Co. for 1907 states that the operations, after providing for all expenses, including repairs and renewals, resulted in a net income of £27,377. Adding the balance brought forward. £4,443, the available profit is £31,820. This profit has been dealt with as follows: debenture interest (less income tax) on 4½ per cent. stock, £11,756; debenture interest (less income tax) on 6 per cent. bonds, £744; sundry reserves as per appropriation account, £9,856; and carried forward, £9,463.

NEW COMPANIES REGISTERED.

Electrical Fittings Co., Limited.—Registered Jan. 18. Capital, £15,000 in £1 shares (3,000 6 per cent. cumulative preference). Objects: to acquire the business of electrical engineers and fitters, manufacturers and sellers of electrical fittings, etc., carried on by Samuel Heath and Sons at 38, Conduit-street, W., as the Electrical Fittings Co.; and to carry on the said business and that of electricians, suppliers of electricity for light, heat, motive power, or otherwise, manufacturers of and dealers in electrical apparatus, etc. No initial public issue. Registered office: 38, Conduit-street, W.

Liens Registered.

Hexham and District Electric Supply Co., Limited.—Lien Feb. 1, £2,450 5 per cent. debentures, part of £5,000 authorised. No trustees.

Northern Copper (B.S.A.) Co., Limited.—A memorandum of satisfaction to the further extent of £3,700, of charges dated May 18, 1903, securing £100,000, has been filed.

Appliances and General Engineering Co., Limited, London, E.C.—Lien Feb. 6 £300 7½ per cent. debentures, part of £2,000. Amount previously issued, £1,000. No trustees.

Bristol Tramways and Carriage Co., Limited.—Trust deed Feb. 5, for securing £250.000 4½ per cent. mortgage debentures. Trustees: Sir George White and S. White, J.P. Specific mortgage on certain freehold and leasehold properties, together with a floating charge on the undertaking and other assets, present and future, including the unpaid and uncalled capital.

LEGAL INTELLIGENCE.

LONDON ELECTRIC SUPPLY CO. v. PARKINS.

In the Divisional Court, King's Bench Division, before the Lord Chief Justice, Mr. Justice A. T. Lawrence, and Mr. Justice Sutton, the case was concluded of the London Electric Supply Co. *v.* Parkins, which came up on an appeal by the plaintiff company from the decision of the stipendiary magistrate sitting at Clerkenwell Police Court convicting the appellants of an alleged contravention of the provisions of the London Building Act of 1894. Mr. Danckwerts, K.C., and Mr. J. A. Simon appeared for the appellants, and Mr. Horace Avory, K.C., and Mr. R. O B. Lane appeared for the respondent.

Mr. Danckwerts, in opening the case, said that the point raised by the appeal was as to what was the definition of the word "structure" in the Act of 1894, and was the thing in question a structure.

From the special case which was read, it appeared that the respondent was the district surveyor to the borough of Holborn. The appellants were summoned before the stipendiary magistrate at Clerkenwell for having on the eastern side of Leather-lane, Holborn, laid a "street box" without having previously served a building notice under the provisions of the Act At the hearing of the summons before the magistrate it was admitted that the appellants on or about July 1, acting under the powers of their electric lighting order, constructed beneath the footway the thing described as a street box, which was used in connection with the repair of the appellants' cables. On behalf of the respondent it was contended that a building notice should have been served under Section 45 of the Act. On behalf of the company it was contended that the thing in question was not necessarily a building structure or the work within the meaning of the Act, and that the company were under no obligation to serve such notice. The magistrate held that the thing in question was a building or structure within the meaning of Section 45, and that the notice was required to be served. He held, therefore, that the company had been guilty of an offence under the Act, and fined them 40s, and ordered them to pay £10. 10s. costs. The question raised on the appeal was whether the magistrate's determination was right in point of law.

Mr. Danckwerts submitted that the box was not a structure within the meaning of the Act. It was a very small thing, being only 22½in. by 24in. and 30in. deep. He considered that it would be very difficult for anyone to say that was a structure within the meaning of the London Building Act. He wished to point out that all these structures had to be made in accordance with a scheme of plans approved by the local authority, the highway authority, the London County Council, and the company, subject to an appeal by the Board of Trade. The only function of the district surveyor was to see that the provisions of the London Building Act were carried out. In the present case the Act had nothing whatever to do with the matter. The County Council had an inspector whose duty it was to watch the laying of these boxes, and who, in fact, did so. He contended that the structures about which notice must be given to the district surveyor were structures which had to be constructed and executed according to the London Building Act, and no other structures.

Mr. Avory, K.C., having supported the conviction on behalf of the respondent,

The Lord Chief Justice gave judgment, and stated that in the present case he was unable to see the unreasonableness of the district surveyors having notice of construction of these boxes under the footway, although he agreed with Mr. Danckwerts that the line must be drawn somewhere. He was of opinion that it was quite impossible to hold that because the structure in the present case was smaller than that in the Woodthorpe case, it should not be followed. As to the other point as to notice being given to the County Council under Section 13 of the northern extension order, he need only say that the reason of the County Council having notice was so that they should see that the things should be put right from their point of view, and to protect their interests It was clear that the County Council protected public interests quite independently of the public interests the district surveyor safeguarded. He thought that in the circumstances of the case notice should have been given to the district surveyor under the Act, and that the conviction was right.

Mr. Justice A. T. Lawrence and Mr. Justice Sutton concurred, and the appeal was accordingly dismissed, with costs.

ELECTRIC POWER COMPANY'S METER.

In the King's Bench Division of the High Court, the Lord Chief Justice, Mr Justice A. T. Lawrence, and Mr. Justice Sutton, sitting as a Divisional Court, had before them the case of the Mayor, Aldermen, and Burgesses of Gillingham, Kent *v.* the Kent Electric Power Co., which came before their Lordships on a case stated by the arbitrator.

It appeared that some time ago the defendants' electric power station was destroyed by fire, and in consequence they desired to purchase electric current pending erection of a new station. By an agreement of June 6, 1905, between the plaintiffs and defendants the former agreed to supply the latter with a supply of electricity in bulk for a certain period on the condition that the defendants should pay the plaintiffs a certain sum per unit for all current supplied, the current to be metered at the defendants' power station through a meter to be approved of and properly calibrated and checked by both parties from time to time as might be agreed. A further condition of the agreement was that any difference between the parties concerning the agreement or its construction should be referred to a single arbitrator, who should be an engineer to be agreed on by the parties or to be nominated on the application of either party by the president for the time being of the Institution of Electrical Engineers and the Arbitration Act, 1899. By the supplemental agreement the supply of current was extended, and the calibrating and checking by both parties were continued, but some question having arisen between the parties at the date of this extension agreement as to the accuracy of the meter, and certain deductions having been made by the defendants from the plaintiffs' accounts for the current supplied, it was provided in the agreement that the deductions in the accounts should be referred to the Electrical Standardising Institution, Faraday House, Southampton-row, for their decision, and that all sums found due by either party to the other should be discharged within 10 days from the delivery. A test of the meter was carried out by the institution in question, and Hugh Erat Harrison, principal of the institution, was appointed sole arbitrator to determinute the dispute. The meter was tested by the manufacturers at Berlin before it was delivered to the plaintiffs in England. Defendants, however, made a test of their own of the meter, which gave results materially different from the results given by the test of the Electrical Standardising Institution and the Berlin test. At the request of both plaintiffs and defendants, an official test was carried out by the Electrical Standardising Institution on Aug. 31 and Sept. 1, 1906, the result of this test considerably differing from the result of the prior test taken by the defendants. On taking evidence before

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the arbitrator, plaintiffs maintained that no evidence of the test made by the defendants alone on Oct. 24 and 25, 1905, and at which the plaintiffs were not present or represented, was admissible, and that the only tests which should be admitted by the arbitrator as evidence should be the test made by the Electrical Standardising Institution. The defendants, on the other hand, contended that the arbitrator was bound to accept evidence of the test taken by the defendants on Oct. 24, 1905. Having considered all the circumstances, the arbitrator determined that he would accept evidence of the test so taken on Oct. 24 and 25, 1905, and considered it in conjunction with the evidence which might be placed before him of the Berlin test and the test by the Electrical Standardising Institution; whereupon the plaintiffs informed him that they desired to take the opinion of the Court as to whether evidence of such a test made in October, 1905, was admissible or not. On these grounds he stated a special case for the opinion of the Court for the purpose of obtaining the Court's decision as to whether he should accept evidence of the test in question or not.

Arguments having been heard by counsel on both sides,

Their Lordships decided that the case should be sent back to the arbitrator for the admission of the evidence referred to.

POSTMASTER-GENERAL v. WATFORD URBAN DISTRICT COUNCIL.

The Railway Commission, composed of Mr. Justice A. T. Lawrence, Mr. A. E. Gathorne Hardy, and Sir J. Woodhouse, last week allowed the appeal of the Postmaster-General from the decision of the county court judge at Watford, who had held that the action of the Urban District Council in refusing to consent to the Postmaster-General carrying telephone wires along Queen's-road, unless they were placed underground, was not unreasonable. The case raised an important question as to whether local authorities could insist on the Postmaster-General placing telephone wires underground.

Sir J. Woodhouse said that the cost of putting the wires underground would be £112, whereas if the poles were used the cost would be about £17, so that there would be a saving of £95. People, he said, had a natural antipathy to posts being put up in the footway, but while he shared that feeling he did not think that it was a sufficient ground for the objection taken by the Council to the proposed overhead system. It was admitted that the character of the locality was such that the erection of telephone poles would not depreciate the value of the adjoining house property. It was the duty of the Postmaster-General to improve and extend the telephone system as much as possible, and, of course, the question of expense had to be considered. In his opinion, in this case the Postmaster-General was entitled to succeed.

Mr. A. E. Gathorne Hardy and Mr. Justice A. T. Lawrence concurred.

PROVISIONAL PATENTS, 1908.

Feb. 7.

2727. Improvements in or relating to electric accumulators. Van Raden and Co., Limited, and Max Metz, High-street-chambers, Coventry.

2728. Improvements in or relating to electrodes for secondary batteries and to the manufacture of the same. Van Raden and Co., Limited, Carey Bert Robinson, and Max Metz, High-street-chambers, Coventry. (Application for patent of addition to No. 21,719/06.)

2733. Improvements in or relating to primary galvanic cells. Thomas Meakin Blockley and Francis Statham Fletcher, 55, Market-street, Manchester.

2769. Improvements in prepayment electricity meters. George Hookham and Sydney Holmwood Holden, 4, New Bartholomew-street, Birmingham.

2795. Improvements in party-line telephone systems. Cyril Arthur Soans and Albert Henry Graves, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

2797. Improved electric incandescent lamp. William Edward Lake, 7, Southampton buildings, London. (Rudolf Jahoda and Elektrische Glühlampenfabrik "Watt" Scharf, Loti und Latzko, Austria.)

2823. Improvements in and relating to electric switches. Frederick Hagger Headley, 322, High Holborn, London.

2824. Apparatus for producing ringing currents in telephone systems. Erwin Falkenthal, 322, High Holborn, London. (Date applied for under Section 91 of the Act, Feb. 22, 1907, being date of application in Germany.) (Complete specification.)

Feb. 8.

2838. Double-revolving dynamo-electric machines with internal and external field magnets which, keyed together in shafts, rotate in an opposite direction to that of their armatures. John Coombe Amphlett and Herbert Paul Amphlett, 49, Hilmarton-road, Camden-road, London.

2871. Improvements in appliances for use with telephone transmitters. Edward Francis Hutton, 7, Southampton-buildings, London. (Complete specification.)

Feb. 10.

2893. Improvements relating to electric detonator fuses. The Thames Ammunition Works, Limited, and Hugh Gorham Ticehurst, Erith, Kent.

2895. Improvement in secondary batteries. Lothar Fiedler, 1, Grazebrook-road, Stoke Newington, London.

2901. Improvements in electrical fuse boxes. Edwin John Selby, Carlton-buildings Paradise-street, Birmingham.

2904. Improvements in continuous-current machines. James Wagner, 25, North-lane, Headingley, Leeds.

2910. Improvements in the apparatus for testing and checking the correct or incorrect working of the electric ignition device used in connection with internal-combustion engines. Thorold Hastings Schultess-Young, 12, Semley-place, Westminster, London.

2923. Improvement in and relating to coherers for wireless telegraphy and telephony. Hans Knudsen, 12, Cyril-mansions, Battersea Park, London.

2926. Revolving coherer for every kind of wireless transmission. Ferdinand von Madaler, 61, Stanley-street, Battersea, London.

2927. Improvements in luminous electric heaters. William Frank Howard and Alban Bertie Cousins, 23, Park-place, Merthyr Tydfil.

2955. Improvements in or relating to wireless signalling. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Feb. 11, 1907, being date of application in United States.) (Complete specification.)

2968. Improvements relating to wireless telegraphy and telephony. Charles Herbert Demuth, 18, Southampton-buildings, London.

Feb. 11.

3049. Improvements relating to electric connections. Horace David Bowden How and William Woodroffe Partington, 27, Chancery-lane, London.

3063. Improvements in and relating to electric motors and the control thereof, more especially applicable to motors for driving locomotive vehicles. Emile de Valio and Robert Campbell Baker, 77, Chancery-lane, London.

3069. Improvements in insulators for electrical conductors. Siemens Bros. and Co., Limited, and William Dieselhorst, Birkbeck Bank-chambers, Southampton-buildings, London.

3076. Improvements in and relating to incandescent electric lamps. Joseph Abraham Leon, 60, Queen Victoria-street, London.

3096. Improvements in and relating to the control of alternative electric current motors of the commutator type in their application to the driving of machine tools and other similar drives. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.) (Complete specification.)

Feb. 12.

3109. Improvements in quadruplex telegraph arrangements. John Peter Gorton, 12, Richmond-street, Weston-super-Mare.

3130. Improved type of starter, rheostat, or controller for electric motors. Norman Russell Booth, 7, Harrison-road, Halifax.

3141. New or improved electrical water-gauge. James A. Hartwell and Horace E. Hartwell, 8, Breams-buildings, Chancery-lane, London.

3154. Improvements in and relating to electrical signal apparatus with wireless transmission. August Mund, 345, St. John-street, London

3160. Improvements in cathodes for use in the electro-deposition of iron and other metals. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

Feb. 13.

3200. Illuminated electric "night and day" sign. Joseph Hugh Evans, 188, Fountain-street, Manchester.

3229. Improvements in electromagnetic speed-gear control. Benjamin Heselton Mallinson, Wrentham, Warwick-road, Acocks Green, Birmingham.

3248. Improvements in or relating to supports for filaments in electric incandescent lamps. Harry Hoge and the "Z" Electric Lamp Manufacturing Company, Limited, 111, Hatton-garden, London.

3250. Improvements in or relating to electrically-heated apparatus, particularly applicable to vulcanising apparatus for tyre tubes and covers. Walter Henry Welch and Harvey Frost and Co., Limited, 111, Hatton-garden, London.

3266. Improvements in electric arc lamps. Johnson and Phillips, Limited, and Sydney Paterson, Birkbeck Bank-chambers, Southampton-buildings, London.

3283. Improvements in electrodes for electric arc lamps. Allgemeine Elektricitats-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Feb. 16, 1907, being date of application in Germany.) (Complete specification.)

3284. Improvements in and relating to electrical power-transmission systems. The British Thomson-Houston Company, Limited, Thomas Edward Robertson, and Frank Holden, 83, Cannon-street, London. (Complete specification.)

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3282. **Improved automatic electric switch device.** William Simpson Hough, jun., 6, Lord-street, Liverpool.

3295. **Device for producing or generating varying electric currents of high frequency.** Edward Charles Robert Marks, 18, Southampton-buildings, London. (Jonas Albert Johnsen, Denmark.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on Feb. 27.)

1906.

24923. **Control of the electric circuits in systems of electric traction or haulage.** Raworth.

1907.

440. **Methods of regulating alternating-current electric motors of the commutator type.** British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

2652. **Electric batteries.** Joel.

2675. **Method of insulating electric conductors.** Connolly.

2720. **Lighting by electricity of miners' safety lamps in coal mines and other places.** Patterson.

2930. **Devices for operating electric circuit breakers.** Sugden and Rodway.

2963. **Electric arc lamps.** Wellington and Daniell.

2964. **Electric arc lamps.** Wellington and Daniell.

3000. **Electrolytic apparatus.** Boult. (Elektrizitäts Akt.-Ges., vorm. Schuckert und Co.)

3000A. **Electrolytic apparatus.** Boult. (Elektrizitäts Akt.-Ges., vorm. Schuckert und Co.) (Date applied for under Rule 13, Feb. 6, 1907.)

3029. **Device for simultaneously bolting doors and switching on electric lights.** Wynn.

3060. **Electric arc lamps.** Jones.

3693. **Electric safety fuses or cut-outs.** Hepke and Diener.

3881. **Variable-speed electric motors or variable-voltage generators.** Torda.

5537. **Magneto-electric ignition devices for internal-combustion engines.** Banes.

6455. **Tumbler switch.** Lea.

6751. **Magnetic clutches or brakes.** Ravenshaw, Middleton, and Townsend.

6925. **Electric controllers or switches.** Atkinson.

7449. **Electricity meters.** Thorpe.

8612. **Mounting incandescent electric lamp filaments.** British Thomson-Houston Company. (General Electric Company.)

8706. **Interrupters for electric circuits.** Schmidt.

9294. **Automatic electric switches.** Holden and Elphinstone.

9345. **Electric pendant lamps for indoor lighting and for other services.** Elliott.

9686. **Machines for winding or spooling wire thread or the like.** British Thomson-Houston Company. (General Electric Company.)

11071. **Electrically-operated winding gear.** Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, May 12, 1906.)

11873. **Method of and means for altering the working speed of polyphase motors.** Siemens Bros. Dynamo Works, Limited, and Poynder.

14100. **Lightning arresters and like protective devices for electric conductor systems.** British Thomson-Houston Company. (General Electric Company.)

16574. **Electric switches.** Lundberg, Lundberg, and Lundberg.

17388. **Interrupters for electric circuits.** Wappler and Fayer.

17410. **Electric switches.** Siemens-Schuckertwerke Ges. (Date applied for under International Convention, Sept. 24, 1906.)

19794. **Detectors for wireless telegraphy.** Ges. für Drahtlose Telegraphie. (Date applied for under International Convention, Sept. 8, 1906.)

19856. **Means for connecting alternating-current generators to their prime movers.** Siemens Bros. Dynamo Works, Limited. (Siemens-Schuckertwerke Akt.-Ges.)

20676. **Electrically-operated switching and other devices.** Conrad. (Date applied for under International Convention, Sept. 20, 1906.)

21035. **Method of electric motor control and apparatus therefor.** Yates and Lum. (Date applied for under International Convention, Sept. 22, 1906.)

21119. **Electric indicators.** Von Pecz.

22746. **Manufacture of incandescence filaments for electric incandescence lamps and apparatus therefor.** Siemens und Halske Akt.-Ges. (Date applied for under International Convention, Oct. 16, 1906.)

24706. **Electric arc lamps.** Johnson and Phillips, Limited, and Tubbs.

24862. **Integrating train for double-tariff electric energy meters.** Arcioni.

27933. **Testing apparatus for magnetic-electric spark ignition apparatus.** Unterberg and Helmle. (Date applied for under International Convention, Oct. 17, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price.
	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	½-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	23/32-27/32
—— Ordinary, Nos. 1 125,000	1 ..	½-⅝
British Aluminium Co., Ordinary, 2 001-40,000	5 ..	3¾-4¼
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4¾-5¼
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	5 5¼
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 103
—— 5½ per cent Loch Leven Deb. (Reg.). Red., 1-3 000	100 ..	97 100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-7⅛
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5¼-6
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85 89
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275 001-475 000	3 ..	½-⅝
—— 4 per cent. Mortgage Debenture Stock	100 ..	42-47
Brush Electrical Engineering, Ordinary, Nos. 1-105 751	2 ..	0-¼
—— Non Cum., 6 per cent., Pref.	2 ..	5/16-9/16
—— 4½ per cent 1st Debenture Stock	100 ..	79 82
—— 4½ per cent. 2nd Debenture Stock	100 ..	63-66
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	11-12
—— 5 per cent. Pref.	5 ..	5⅜ 5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1¼-2¼
—— 5 per cent Debentures	100 ..	92-95
Dick, Kerr and Co., Ordinary, 1 260 000	1 ..	1-1¼
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102
Edison and Swan United, "A" Shares, 1-99 261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1¼-2½
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112 100	2 ..	5/16-9/16
—— 7 per cent. Cumulative Pref.	2 ..	1⅜-1⅝
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	65-69
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7¾-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	11¾-12⅜
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15-15½
—— 4 per cent. Debentures	100 ..	99-101
National Electric Construction Co., 1-170,000	1 ..	¼-⅜
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	33-35
—— 4 per cent Bonds	100 ..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9

Electric Lighting and Supply.—

Name.	Amount paid.	Last price.
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅞-5¼
Bournemouth and Poole, Ordinary	10 ..	10¼-11½
—— 4½ per cent. Cum Pref., 7,501-15 000	10 ..	10-11 xd
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	10 10¾
—— 4½ per cent. Debenture Stock, Red.	100 ..	100-103
Bromley (Kent) Electric Light and Power Co	5 ..	4⅞-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	96-98
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6¾-7¼
—— Nos. 80,000-100 000	5 ..	5¾-6¾ xd
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¼-13¼
Canadian General Electric Co., Common Shares	$100 ..	98-102
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	4⅜ 4¾
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	4⅜-4¾ xd
—— 4 per cent. Debenture Stock, Red.	100 ..	97-100
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	4¼-4⅜
—— ditto (1905) 40,001-80,000	5 ..	4⅜-4¾
Chelsea Electricity Supply	5 ..	3⅝-4⅛
—— 4½ per cent Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	10-11
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼
—— 5 per cent. Debenture Stock	100 ..	122-125
—— 4½ per cent 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	99-102
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0 ..	50-53
Corfe Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3¼-4
—— 5 per cent Preference, 1-50,000	5 ..	4⅜-4⅝
County of London Elec. Supply, Ordinary	10 ..	7⅛-8
—— 6 per cent. Cum Pref.	10 ..	11¼-11⅝
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100 ..	105-108
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	¼-⅜
—— 6 per cent. Cum Pref.	5 ..	¾-1¼
—— 4½ per cent. First Mort. Deb	100 ..	70-80
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	— ..	70-73 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm Pf., 1-30,000	5 ..	2¼-2⅝
—— 5 per cent Debenture Stock, Red.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	92-95
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4⅜-4⅝
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	6¼-6⅝
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	98-101
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	9/16 1"/16
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100 ..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4⅛-5¼
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	91-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100 ..	92-95
Metropolitan Ordinary, 100 001- 00,000	5 ..	5¼ 6½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	106-110
—— 4½ per cent. Cum. Pref.	5 ..	4⅞ 5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	85 90
Mexican Electric Light Co., 6 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1 000	— ..	77-79 p c.
Mexican Light and Power Co., Capital Stock	$100 ..	49½-51½
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	84-86 p.c.
Midland Electric Power Dis., 4½ p c 1st Mort. Deb.	—- ..	98 101
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	6¼-6⅜
—— do., 57,010-75 000	5 ..	6¼-6⅜
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5 ..	6-6½
—— 5 per cent., Pref., 1-57,009	5 ..	5-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5 ..	5-5½
Notting Hill Electric Lighting	10 ..	11½ 12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅜ 6⅛
—— 4 per cent. Debenture Stock	100 ..	95-96
River Plate Electricity Co, Ord., 1-119 687 & 120,501-120 507	1 ..	27/32 31 32
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red	100 ..	96 99
Rosario Electric Co. 6 per cent. Cum. Pref., 1-20 000	5 ..	4⅜ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15,000	5 ..	4⅜ 5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co, 5 p.c. Cons. 1st Mt. Bds.	— ..	101-103 p c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	½-1½
—— 4 per cent. Debenture Stock	100 ..	70-74
South London, Ordinary	5 ..	2½-3
South Metropolitan Electric Light and Power, Ord.	1 ..	⅜-⅝
—— 7 per cent Cum Pref.	1 ..	⅝-⅞
—— 4½ per cent 1st Mort. Deb.	100 ..	101 104
St. James's and Pall Mall, Ordinary, 101-20,000	5 ..	7⅜ 8⅜
—— 7 per cent. Pref.	5 ..	6½-7¼
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 8-30 007	5 ..	1½ 2½
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	2-2½
Westminster, Ordinary	5 ..	8-9
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	5-5¼

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260 00?	5 ..	6-6¼
—— 10 per cent. Non-Cum 2nd Pref., 2?0,008-280,0??	5 ..	8 1/16-8 5/16
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	129-132
Auckland Elec. Trams, 5 p.c. 1s Mor. Deb. Stk, Red.	100 ..	103-106
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1 10 000	10 ..	—
—— 5 per cent Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-100,606	1 ..	⅝-¾
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1 ..	13/16-15/16
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk, Red.	100 ..	93-96
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Bombay Elec. Supply and Trams Co, 6 per cent. Cum. Pref.	10 ..	9½-9⅝ xd
—— 4½ per cent. Deb Stock, Red.	100 ..	95-97
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	?⅜ ?⅞
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜ 4⅞
—— 4½ per cent Deb. Stk, Red., Prov. Certs. all pd	100 ..	97-101
British Columbia Electric Railway Co., Ord Def.	100 ..	127-130
—— Ord. Pref.	100 ..	106 110
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	104 107
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	101-104
—— 4½ per cent. Vancouver Power Deb.	100 ..	100-103
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10 ..	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	5⅜-5½
—— 5 per cent. Perpetual Debenture Stock	100 ..	96-100
—— 4½ per cent 2nd Deb. Stock	100 ..	72-76
Bueno Ayres and Belgrano Trams.	5 ..	4⅜-4½
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27 500	5 ..	4⅜-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110-116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	95-93
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	100-104
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	90 93
Calcutta Tramways, Ord., Nos 1-137.610	5 ..	6⅜-7¼
—— 5 per cent. Cum. Pref., Nos. 1 30.000	5 ..	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	101 105
Cape Electric Tramways, Nos. 1-480,000	1 ..	3.16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4⅜-7⅛
—— 4 per cent 1st Mortgage Deb, 1-3 000 (1917)	100 ..	98-101
City of Buenos Ayres Trams. Co. (1?04), 1-248,000	5 ..	5¼-5⅜
—— 4 per cent Deb. Stock, Red. 1?85	100 ..	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	91-95
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos 1-60,000	10 ..	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12½-13½
—— 3½ per cent. Mort. Debs., 1-3.000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p c. Deb. Stk, Red.	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	80 85
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref, Nos. 30 001-60.000	5 ..	⅜-1⅜
—— 4 per cent. 1st. Mt. Db Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250.000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10- 0½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296.500 2nd Mort. Deb. Stock	— ..	—
—— £83,?30 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	⅜-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1 ..	⅜-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7⅛-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	81-85

Name.	Amount paid.	Last price.
	£	£
Madras Elec Trams. (1904) 5 per cent. Deb. Stk, Red.	100	96-98
Manila Elec. R. R. and Lightg. Corp, 5 p c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 ..	84-88 xd
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,625 and 23,436 25 000	5 ..	4½-5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100 ..	92-95
Metropolitan Elec Trams., Defd., 1 000.001-1 314 016	1 ..	1/16 3/16
—— 5 per cent. Cum Pref., 500,001-1,000 000	1 ..	13/16- 5/16 xd
—— 4½ per cent. Deb. Stock, Red.	100 ..	97-100
Mexico Trams. Co, Gen. Cons. 1st Mort 50-year 5 per cent. Gold Bonds	— ..	85-87 p.c.
Milwaukee Electric Rail and Light. 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7 001-8,000	$1,000 ..	103-105
Montreal Street Rail, 4½ per cent. Sterling Deb., 601-2,000 1922	100 ..	100-102 xd
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5 ..	⅜-1⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W.A.). 5 per cent. 1 Mrt. Deb. Stk.	100 ..	101-105
Potteries Electric Traction, Ordinary, 1-245.000	1 ..	¼-½
—— 5 per cent Cum Pref., 300 001-545 000	1 ..	¼-½ xd
—— 4½ per cent Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary 1-24 912	10 ..	4½-5
—— 6 per cent. Cum. Pref., 1-10 000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref., 1-30,000	5 ..	5-5½
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	95½-97½
Sao Paulo Tramway, Light, and Power Co.	$100 ..	120-124
—— 5 per cent. 1st Mort Deb, Red. 1929. 1-11,000	$500 ..	96 98 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum Pref., 19,571-169 570, Prov. Certs.	1 ..	⅞-1⅛
—— 4 per cent. Deb Stock. Red. 1-40	100 ..	78 82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs, Red., 1-1 600	100 ..	60-70
Yorkshire (West Riding) Elec Tram. Co, Ord., 70 001-110,000	5 ..	1-1½
—— 6 per cent. Cum Pref., 1-46,261	5 ..	3⅛ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	65-68 xd
—— 4 per cent. Pref.	100 ..	82-84 xd
—— " " deferred	100 ..	44-47
—— 4 p c Deb. Stock (Prov. Script Certs, fully paid)	100 ..	100-103
City and South London, Consolidated Ordinary	100 ..	38 40
—— 4 per cent Debenture Stock	100 ..	101-104
—— 5 per cent. Pref Stock '91	100 ..	114-117
—— " " " '96	100 ..	112-115
—— " " " '01	100 ..	110 113
—— " " " '03	100 ..	108-111
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10⅛
—— Ordinary, 1-50 000	10 ..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	— ..	45-49

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28.000 and 53 001-78.000	$1 000 ..	86-88
Anglo-American Telegraph Co., Ordinary	100 ..	56-59 xd
—— 6 per cent. Preferred Ordinary	100 ..	99-101 xd
—— Deferred Ordinary	100 ..	14-14⅛ xd
Anglo-Portuguese Telephone Co, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co, 1-44,000	5 ..	7-7½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	87-90
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	6¼-7½
—— 10 per cent Preference, 1-6 000	10 ..	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-7½
—— 10 per cent. Cum. Preference	5 ..	8¼-9¼
—— 4½ per cent. Debs, 1 600	50 ..	99½-102½
Direct United States Cable Co.	20 ..	13⅛-14⅛
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	98 101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	99-101
Eastern Extension, Australasia and China, 1-300 000	10 ..	12⅜-13½
—— 4 per cent. Mort. Deb. Stock, Perp	100 ..	99-102
Eastern Telegraph Co., Ordinary Stock	100 ..	13·-136
—— 3½ per cent. Preference Stock	100 ..	84-87
—— 4 per cent. Mortgage Debenture Stock	100 ..	10·-103
Great Northern Telegraph Co. (of Copenhagen)	10 ..	33-35
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs, within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	51-57
Marconi's Wireless Telegraph Co, Nos. 255,128-284,190	1 ..	⅛-⅜
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	⅛-1
National Telephone, Preferred	100 ..	111-113
—— Deferred Stock	100 ..	111½-113½
—— 6 per cent Cum. First Pref.	10 ..	11-13
—— 6 per cent Cum. Second Pref.	10 ..	10½-12½
—— 5 per cent Non Cum. Third Pref.	5 ..	5 7/16-5 11/16
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-99
—— 4 per cent Deb. Stock, Red.	100 ..	100½-102½
Oriental Telephone and Electric Company	1 ..	1⅛ 1⅛
—— 6 per cent. Cum Pref	1 ..	1 3 33-1 7 32
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100 ..	98-101
United River Plate Tele. Co, Ordinary, 1-100.000	5 ..	6½-7
—— 5 per cent Cum. Pref., 1-40,000	5 ..	4⅜-5½
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10⅛
West Coast of America, 1-30 000 and 53 001-53,008	2½ ..	1⅜-2
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	98 101
West India and Panama Telegraph Co., Ordinary	10 ..	17/32-21/32
—— 6 per cent. Cum. 1st Preference	10 ..	8-8¼
—— 6 per cent. Cum 2nd Preference	10 ..	8-8¼
—— 5 per cent. Debs., Red., 1-800	100 ..	100-103
Western Telegraph Co., 1-207,930	10	13 3/16-13 7/16
—— 4 per cent. Debenture Stock, Red.	100 ..	98¼-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week			Increase or decrease.		Miles of track open		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-senger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Feb. 12	1,202	1,114	+ 57	—	27½	27½	May 31	72 605	17,676 000	1,529 682	0 98	1·39	4,987	6·34
Ayr Corporation	,, 8	175	157	+ 18	—	8	8	,, 15	15,28	3,003,78	378,894	·97	9·28	1,917	5 35
Baker Street and Waterloo Ry.	,, 15	2 950	2,410	+ 540	+ 5,153	6½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 16	945	944	- 1	+ 186	43 53	2 53	March 31	55,408	11 696,691	1,324 743	—	—	—	6·1
Birmingham Corporation	,, 1	6 295	5,0 5	+1,291	—	56	5 ½	,, 3	18 557	5,152,0 8	215 345	87	.6·2	9,228	—
Blackburn Corporation	,, 1	894	814	+ 90	+ 3,451	23 80	23 80	,, 25	54,951	10 093,028	1,002 372	1 25	12 64	2,309	8·02
Blackpool Corporation	,, 6	355	303	+ 48	- 1,211	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	54,819	2 707,9 8	625,110	3·09	12 903	—	7·795
Bolton Corporation	Feb. 16	2,07	1,901	+ 174	+ 103 815	42	42	March 31	11 981	23,410,690	2,411,809	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 5	1,2 3	1,131	+ 1 2	+ 1 9 3	23¼	24½	,, 31	85,655	13,503,010	1,765,098	1·48	11·37	2 860	7·28
Bradford Corporation	,, 1	4 0 8	3 890	+ 208	+ 4,738	8	95	,, 31	232 427	46 728,977	5,167,26	1·193	10 79	2 421	—
Brighton Corporation	,, 16	681	679	+ 2	- 3,157	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 14	4 5 7	4 473	+ 93	—	53½	51½	,, 3	265,769	6 903,257	6 178,886	—	—	—	—
Burnley Corporation	,, 15	1,112	1 066	+ 46	—	19½	19½	,, 31	62 659	11,967,4 8	1,205,830	1 31	12 48	5,825	8 21
Burton Corporation	,, 16	231	253	- 27	- 645	9½	8½	,, 31	15 576	3,383,627	421,317	·07	8·87	1,7 8	6·14
Cardiff Corporation	Jan. 11	1,834	1 9 8	- 24	—	32·26	32·26	,, 31	106,550	24,438,764	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	Feb. 15	4	1 0	+ 8	+ 5	8·5	8·5	Dec 31	10 251	2 790 699	350,417	—	—	—	7·96
Central London Railway	,, 15	5 9 1	6,328	377	- 1 611	6	6	,, 31	249 2 8	43 057,597	1,279 69 a	1·85	52 22a	55,357	15 22a
Charing X, Euston, & Hamp. Ry	,, 15	3,0 5	—	—	—	7½	6½	—	—	—	—	—	—	—	—
City and South London Railway	,, 6	3,2 8	3 12	+ 117	+ 2,205	9	6½	h June 30	92 45	10 048 780	—	—	—	—	—
Colchester Corporation	,, 12	160	146	+ 14	—	8	8	* March 3	10,588	2 457,653	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 13	38	38	6	181	15½	15½	Dec 3	5,03	5 966 364	891 9 8	—	6·74	—	4 78
Croydon Corporation	,, 14	1 242	—	—	—	12 c	12 c	March 3	64,065	13,31 9 8	1,102 408	1 08	9·76	3, 25	6 67
Darwen Corporation	,, 7	229	224	+ 5	- 43	7 23	7 23	—	—	—	—	—	—	—	—
Dover Corporation	Jan. 28	181	159	+ 12	- 1,124	4½	4½	,, 3	12 468	3 178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Feb. 14	89	83	+ 10	+ 12h	6½	6½	—	—	—	—	—	—	—	—
Dublin U.T.	,, 14	4 802	4 604	+ 198	+ 582	54½	48½	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 5	1,091	976	+ 105	+ 1,893	22	22	March 1	7 6 2	15 554 906	1,162 792	·878	11·9	4,352	7 3
East Ham Corporation	,, 15	771	851	- 6	+ 485	14	14	March 31	47 140	15,049,240	1 062,151	·74	10 49	3 6 6	7 14
Glasgow Corporation	,, 15	16 8 0	16 045	+ 775	+18,658h	177½	169	May 1	87 78	21,163 0 8	20,350 367	95	0·47	6,035	5 21
Gloucester Corporation	,, 5	209	209	—	—	15	15	March 31	15, 33	3 182,01	579,996	1·06	6 94	1,002	5·1
G.N., Piccadilly and Brompton	,, 15	5 189	—	—	—	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·57	37	,, 31	77 996	8,89 ,249	1 624 275	—	11·52	—	8·5
Huddersfield Corporation	,, 9	1,437	1 356	- 81	+ 3 285	35½	35	,, 3	8 ,196	15 282,150	1 804 745	·82	0 79	2,770	5·92
Hull Corporation	,, 15	2 346	2,3 3	+ 43	+ 6,402	26	26	,, 31	21.186	29 61,543	2 956,406	1	9·84	—	—
Ilford Corporation	,, 1	361	380	+ 1	—	10½	10½	,, 31	25,499	5,58 ,754	6 5,117	89	9 58	2 925	6 5
Ilkeston Corporation	,, 12	126	120	+ 6	+ 411	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 13	238	233	+ 5	—	7½	7½	May 15	13,70	4 640,618	466,919	6·2	7 55	1 723	1 5
Lancashire United Tramways	,, 5	1,1 9	1 016	+ 113	+ 401	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 1	5,977	5 606	+ 372	+12,1 2	96½	96½	March 3	3 7,791	73,(24,853	7,358,185	1 06	10 69	3,352	5 58
Leicester Corporation	,, 15	2 032	2 01	+ 50	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 8	10,423	9,947	+ 476	+ 1,081	104	104	Dec. 31	6 793	1 2 094 528	2 115 934	1·108	1 17	5,421	7·75
Liverpool Overhead Railway	,, 16	1,396	1,318	+ 78	+ 75h	9 25	6 6	June 30	77 568	10,957 148	1 102 809	—	—	—	—
London County Council	Jan. 25	28 2 1	24,057	+4,154	+2 7,879	98	98	March 31	1 78,71	311 227 030	30 170 987	1 15	10 98	—	8 56
Lowestoft Corporation	,, 11	144	150	- 6	+ 101	3½	—	Sept 30	11 09	2,6 2 922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	Feb. 3	44	69	+ 75	—	3½	2	March 31	5,91	1 186 5 6	157,050	1·1	8 6	2 956	6·2
Manchester Corporation	,, 2	13,828	12 9 9	+ 869	+ 43 661	172	161	,, 31	719,673	143 264 501	5,523,45	1·19	11 2	4 556	7 03
Metropolitan District Railway	,, 15	8 8 3	8 153	+ 710	+ 6 426	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 16	14,07o	14 634	+ 42	+ 361	23½	23½	June 30	6 7,794	87 639,334	—	1·39	—	—	—
Nelson Corporation	,, 15	128	129	- 1	- 24	2½	2½	March 31	7,7 9	2 035 300	203,203	86	8 64	1,892	8 69
Newcastle-on-Tyne Corporation	,, 15	3,753	3 890	- 137	+ 1,175	59½	57½	,, 31	2 0 491	45,5 6 468	4,263,174	1 11	11·65	3,660	6·64
Newport (Mon.) Corporation	,, 8	546	523	+ 1	+ 2 033	14½	14½	,, 31	32 421	7 760 403	772 753	1 03	10 01	1 525	6 87
Oldham Corporation	Dec. 8	1 805	1,744	+ 61	+ 4,150	35½	35½	,, 25	4 948	18,647,7 1	1 818,444	1 19	12·53	2 603	7·2 9
Portsmouth Corporation	Jan. 18	1,470	1 4 6	+ 54	—	28½	28½	,, 31	68 911	21 668 825	2 99,823	1 15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32 651	8,120 179	918 825	9·	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1 201,364	1·12	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	25,816	5 745 298	618 211	1 12	10 45	2,691	7·38
Salford Corporation	Feb. 3	4 225	3 971	+ 254	+ 6 215	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec 31	7,779	1 537 845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 16	5 302	5 177	+ 125	+11 804	65½	65½	March 25	276 907	73 966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	,, 12	876	787	+ 89	+ 2,904	18	18	,, 31	49,185	9 437,356	1,143 085	1 25	10 71	—	7·7
Southend-on-Sea Corporation	Jan. 29	233	2 1	+ 32	+ 106	9	9	,, 31	20,07	6,431 ,98	390,518	1 07	12 33	3,156	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8 617,127	1,248 656	—	9 464	—	4 849
Sunderland Corporation	Feb. 16	1,016	1,267	- 221	- 2 040	20	20	,, 31	72,396	17 483 132	1 575 425	1·006	11·261	3,687	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,175 221	224,417	·8	9 94	1,968	7 79
Torquay Tramways	Feb. 15	183	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 15	712	708	+ 4	+ 691	12 68	12·43	,, 31	43,607	7,985,451	862,123	1·26	12·14	3,439	7 6
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19 2 4	4,965 236	429 785	—	10 724	1 989	6 95
West Ham Corporation	,, 6	2,056	1,974	+ 76	+ 2,203	14 7	14 7	,, 31	1 2,881	35,102 836	2,556 854	789	10 96	4,407	6·79
Wolverhampton Corporation	,, 5	805	715	+ 90	+ 516	20	20	,, 31	43,823	9 276,023	966,133	—	10 886	2,159	6·035

* 1905-6 figures. † And 98 miles of interlacing track. c Train mile. e Miles of route. h Half-year's figures.

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LIVERPOOL PARTY POLITICS.

In our issues for Feb. 7 and 14 we gave particulars of an attack made by the Radicals on the Liverpool Council on the electricity undertaking. The resolution then moved called for an investigation into the working of the Westinghouse turbines at Lister-drive, and suggested that an outside expert opinion on the same should be obtained. This motion, after an acrimonious discussion, was defeated by an overwhelming majority, showing that the Corporation, as a whole, had faith in their consulting and resident electrical engineers, and also in the Electricity and Tramway Committee. We are not a political paper, and we fail to see what effect the political opinions of the councillors can have on the working of steam-turbines. In fact, the vice-chairman of the Electricity and Tramways Committee of Liverpool, Alderman F. Smith, is a Liberal, and until last week was the deputy leader of the party. From his long connection with the electricity supply undertaking in Liverpool he knew that the charges brought against the undertaking were unfounded, and hence he opposed the motions brought forward by his own party. We should have thought little of him if he had not done so, as it would sap the strength of all municipal government if party loyalty is to be put before truth and the interests of the community. This view, however, is evidently held by the extreme Liberals on the Liverpool Council, as at the next meeting of the party the following resolution was passed: "Having regard to the unfortunate attitude which Mr. Alderman Fred Smith has frequently adopted at the meetings of the Council to various members of the Liberal party, and particularly to our respected and trusted leader, Sir Wm. Bowring, at the Council meeting on the 12th inst., this meeting of the Liberal members of the City Council, while acknowledging the valuable services Alderman Fred Smith has rendered to the party for many years, record with very great regret that in their opinion his further retention of the position as deputy leader would be injurious to the interests of the party, and they accordingly resolve that he has from this date ceased to occupy that position." We consider this resolution a great compliment to Alderman Smith, and hope he will continue to render valuable services to the city of Liverpool. The chairman of his committee, speaking at the meeting held on the 21st inst, said: "Every member of the committee who had worked with Alderman Smith, he felt sure, had the greatest confidence in him. They felt that he had always done what was in the best interests of the citizens, and that if he had done anything against the wishes of some of his colleagues by upholding the decisions of the committee they ought, so far as the committee was concerned, to make it clear that they placed the fullest confidence in him. He was sure the ratepayers would be of the same opinion—that he had never done anything contrary to the interests of the city." These remarks were not received with unanimity, as one Liberal member of the committee objected to the internal troubles of his party being referred to. We repeat that there can be no connection between the politics of the councillors and the efficiency of the plant installed at Lister-drive. It reminds one of the lady in Mr. Robert Louis Stevenson's incompleted story, "Weir of Hermiston," who chose her cooks in accordance with their religious beliefs and without any regard to the way they could boil potatoes. We would refer our readers to this book for the pertinent remark of her husband, the "hangit judge," on the subject. We hope the date is far distant when the politics of the members of the staff of the electricity works at Liverpool will be considered as more important than their engineering skill.

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THE L.G.B. AND ELECTRICITY LOANS.

The Local Government Board inquiry into the application of the Hanley Borough Council for sanction to borrow £18,000 for extending the electricity undertaking is interesting, as foreshadowing the policy of the Local Government Board to grant lump-sum prospective sanctions subject to an undertaking to show exactly thereafter how the moneys have been spent. Such a practice has been adopted by the London County Council for the Metropolis, and it is not unlikely that its extension to the country will be to give similar satisfactory results to those in London. The Hanley inquiry was conducted by Mr. H. Ross Hooper, and in the application were included a new 500-kw. steam generator, £5,000; mains, transformers, meters, instruments, and tools, including overdraft mains at December, 1904, and expenditure under all these heads to December, 1906, amounting to £5,358, and future extensions from that date of £12,642. Owing to the new requirements of the Local Government Board that the expenditure under each head should be given separately and in detail, the inspector was furnished with full particulars of the expenditure from the commencement, and he decided to deal with the application as at the 12th inst. (the inquiry being held on the 18th inst.), at which date the expenditure in excess of previous sanctions amounted to £9,431; while, to avoid the necessity for a further sanction at an early date, he also allowed prospective sums to be included of new plant, £5,000; new mains, £4,000; new transformers and substations, £3,000; and instruments, boosters, etc., £538; making a total of £21,969, or nearly £4,000 on suspense account for the next two years or thereby beyond the amount applied for. The inspector emphasised the point made in several recent inquiries that meters and testing instruments, having short life, should be provided out of revenue; also that independent ledger accounts must be kept of the expenditure against each sanction. Mr. Yeaman, the electrical engineer, pointed out that while he entirely agreed with the principle of paying out of revenue for all small items, these made a large annual sum at the aggregate, and an undertaking adopting this virtuous policy suffered in its cost sheet in comparison with one not doing so, unless such charges were made upon a depreciation and reserve fund into which surplus balances or profits were paid annually.

JOHANNESBURG ELECTRICITY SCHEME.

The latest South African mails have brought some further particulars concerning the troubles occasioned by the gas plant at the municipal electricity works of Johannesburg. We gather that the Municipality have been considering a scheme for disposing of the undertaking to Messrs. Beardmore and Co., who will carry on the same and give a bulk supply to the Corporation. Some interesting information recently appeared in the *Johannesburg Leader*, from which we make the following extracts. The figures given by our contemporary may be subject to alteration, but they are claimed to constitute an accurate reflex of the general proposals.

It is proposed to give Messrs. Beardmore the right to form two distinct companies, one for lighting and the other for power. The lighting company is to be provided with a minimum working capital of £250,000, and is to purchase the gas producers, gas-engines, and accessory equipment supplied by Messrs. D. Stewart and Co, the purchase price payable to the Municipality being stated to be £175,000. Only £50,000 of the purchase price is to be paid in cash, the remaining £125,000 being in the form of debentures. The lighting company proposes to lease the property on which the plant is situated at the rate of 4 per cent. on the capitalised value, and to acquire an additional five acres.

The company, it is further stated, will supply the Municipality with a maximum of 10,000,000 units per annum, the latter guaranteeing to purchase a minimum of 9,000,000 units per annum for a period of 10 years. The price at which the company will agree to supply is 1¼d. per unit. The price is subject to certain modification, according as the load factor varies either way from 25 per cent.

There is a system of fines provided for, framed in similar fashion to the clauses in the running contract of Messrs. D. Stewart and Co. Beyond this there is the provision that the Council shall have the right to throw up the contract if the interruptions aggregate two or three hours during a month as regards lighting, and less in the case of tramways supply. The company is to have the right of erecting other generating plant of approved type for the purpose of supplying power to mines within the municipal area, but to no other consumers. This additional plant, as well as the main gas plant, may be acquired by the Council on arbitration terms.

The second venture is to be termed the Power Company, which is to be formed with a capital of £200,000. The exact functions of this undertaking are not stated, though it is understood that one of its objects is to be the erecting and equipping of a power station. It will also guarantee the principal and interest of the £125,000 debentures. The whole scheme is without prejudice to the Council's claims under the Stewart's contracts and the Beardmore guarantees.

ELECTRIFICATION OF RAILWAYS.—II.*

BY DR GISBERT KAPP.

(Concluded from page 258.)

SINGLE-PHASE ELECTRIFICATION

The oldest proposal to use single phase current for railway haulage is that made by Mr. Ward Leonard and patented by him in 1891. In this system the locomotive was to carry converting plant consisting of a synchronous motor, a continuous-current generator, and an exciter, besides the continuous-current train motor proper. Fig. 56 is a diagrammatic representation of this system as given by Messrs. Mordey and Jenkin in their classic paper before the Institution of Civil Engineers six years ago, the only difference being that they have replaced the synchronous by an asynchronous motor so that there should be no difficulty in starting the converting plant. If it were not for the extra weight, the system would be perfect, inasmuch as no power whatever need be wasted in rheostats, and the regulation is extremely simple. By adjusting the excitation of the generator any desired voltage can be thrown on to the train motors, from zero at starting to maximum at high speed, the "maximum current demand" on the line being much smaller than in the continuous-current system, as no power is wasted in resistances. The objection raised against the three-phase system that, owing to the "skin effect," the voltage drop in the rails will be excessive applies to this system also, but it is not a very serious objection, since with the now customary low frequency of 15 or 16 the skin effect is very slight; and with the use of high pressure, which is possible by putting the transformer on to the locomotive, it becomes almost negligible. In this system, although single-phase current brings the power to the train, that which actually propels it is continuous current.

With the advent of the single-phase commutator motor it has, however, also become possible to use the alternating current itself as the propelling power, and this is the direction which at present single-phase electrification takes. Inventors have of late years been busy developing types of motors specially suitable for railway work, but, broadly speaking, the two types shown diagrammatically in Fig. 57 (or some modification of their principle) are mostly used. The one is the so-called "compensated repulsion" motor and the other the "compensated series" motor. The first-named is also known under the name Latour-Winter-Eichberg, and is being used by the Allgemeine Elec-

* Lecture delivered before the Royal Institution of Great Britain, Saturday, Jan. 25.

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tricitäts-Gesellschaft, of Berlin, in the electrification of the Victoria to London Bridge line of the London, Brighton, and South Coast Railway, and the other type of motor has been adopted by the Westinghouse Company (in the form perfected by Mr. Lamme), Messrs. Siemens-Schuckertwerke (the design being got out by Mr. Richter), the Oerlikon Works, and others. The speed regulation is effected by changing the transforming ratio—that is, the voltage on the motors—so that no energy is wasted in resistances.

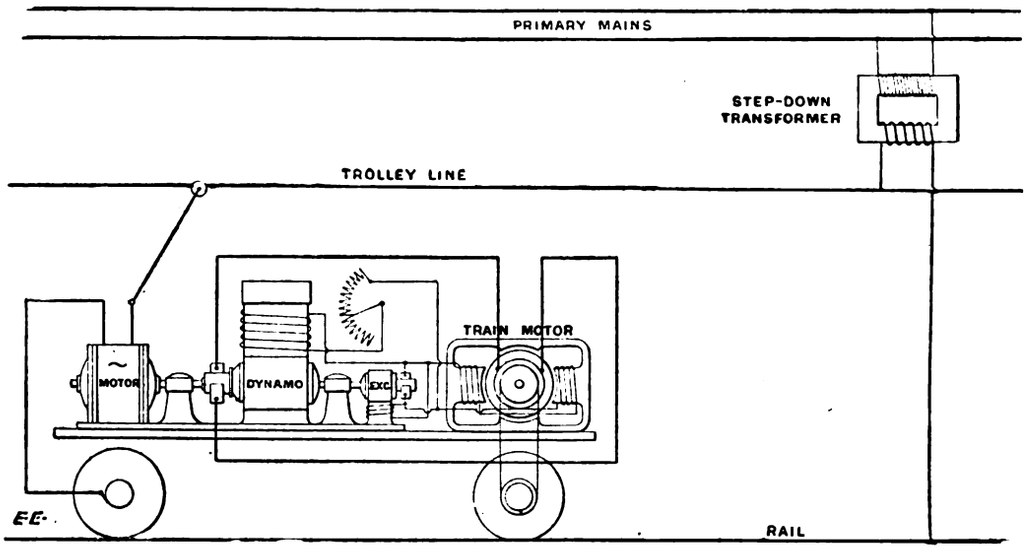

FIG 56. - Single-Phase Variable-Ratio System (Ward Leonard).

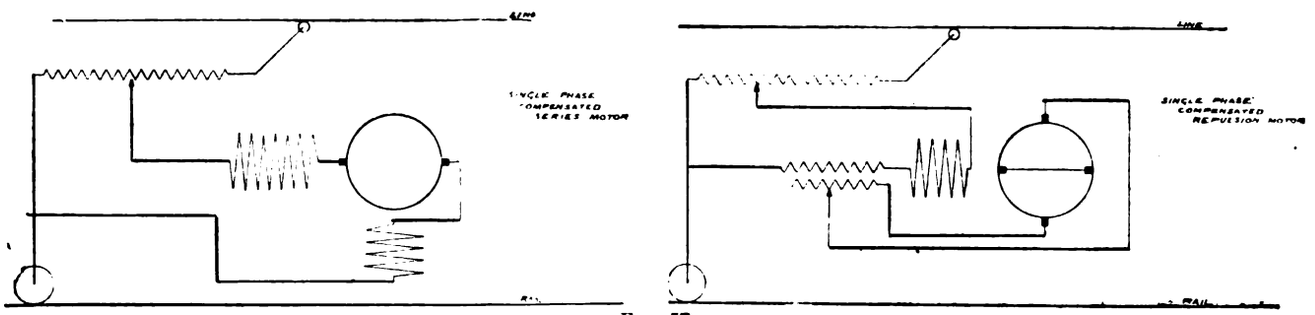

FIG. 57.

line is 12½ miles long, and passes through five stations. Steepest gradient, 12 per 1,000. The first locomotive built for this line in 1904 had converting plant (Fig. 59), all three rotors (Fig 60) on one shaft and double bogies. The two axles of the bogie are driven by a continuous-current motor of 200 h.p., as shown on Fig. 61. The pressure in the trolley wire was 15,000 volts, and the frequency 50. The transformer was carried on the locomotive, and the regulation was by the Ward Leonard system with certain improvements made by the Oerlikon Works. Fig. 62 is a view of this locomotive. It weighed 46 tons, and could take a train of 190 tons with a speed of 22 to 44 miles per hour over the line. An important feature of the Oerlikon system is the curved trolley rod on a movable support

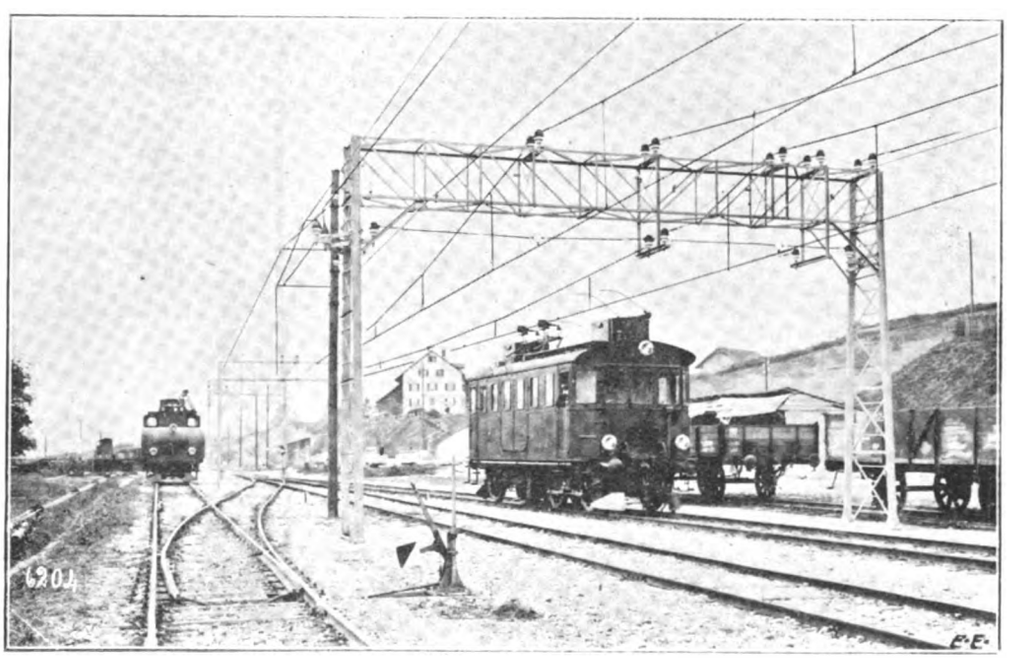

FIG. 58.—View of Locomotives Nos. 1 and 2 on the Seebach-Wettigen Line.

A very interesting example of electrification both by converting plant and direct use of single-phase current is the Seebach-Wettingen line (Fig. 58), which has been equipped by the Oerlikon Works on their system. The

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shown in better detail in Figs. 63 and 64. The first illustration shows the rod pressing against the underside of the wire like an ordinary bow, and the latter the rod pressing from above and sideways. By this method of collection, great flexibility in the placing of the wire is obtained. It may be placed by the side of the line (Fig. 65) at road crossings, it may be put at still a greater distance so as to let the curved rod touch it right above and leave room for an earthed safety net below, and in tunnels (Fig. 66) the wire can be brought over the centre of the car, the rod bending then right inwards. This is also the position assumed by the rod at crossings and turn-outs in the yards, where the rod acts like an ordinary bow collector.

Subsequently to this first locomotive two more were built for this line. These were fitted with single-phase motors of the compensated series type, also of 200 h.p., and placed between the driving wheels, the arrangement being the same as that already shown. The power of these locomotives is the same, but they are six tons lighter, weighing only 40 tons, the reduction in weight being due to the use of unconverted current in the motors. The pressure in the trolley wire was maintained at 15,000 volts, but the frequency was dropped to 15 per second. Fig. 67 shows one of these locomotives. The saving in weight due to the absence of converting plant is partly lost again by the heavier transformer and motor, but there is still a gain of six tons, and the efficiency and power factor are higher.

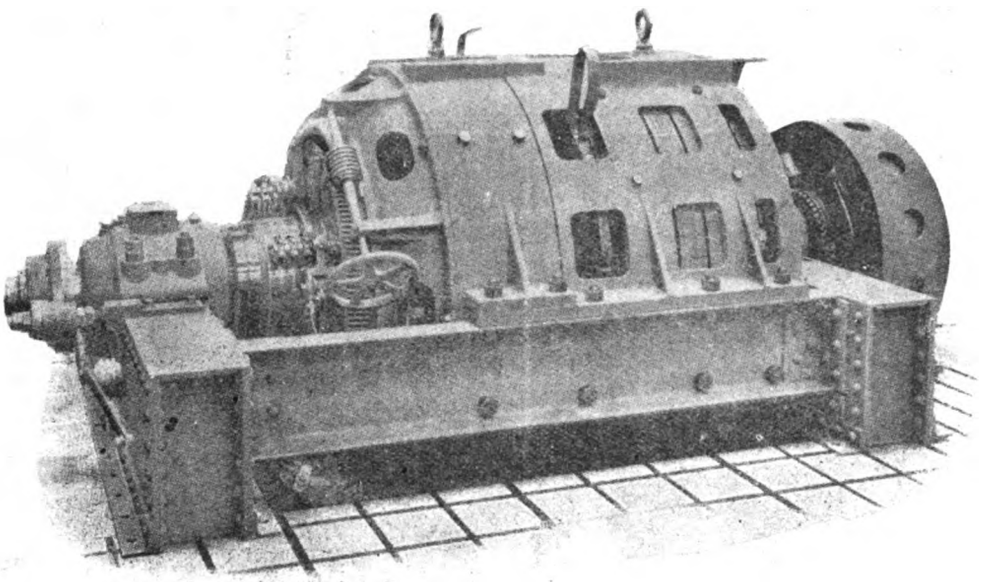

FIG. 59.—Rotary Converter on No. 1 Locomotive.

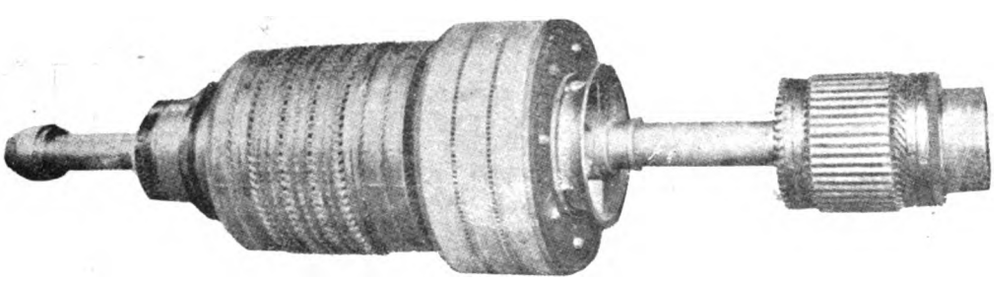

FIG. 60.—View of the three Rotors of the above Converter.

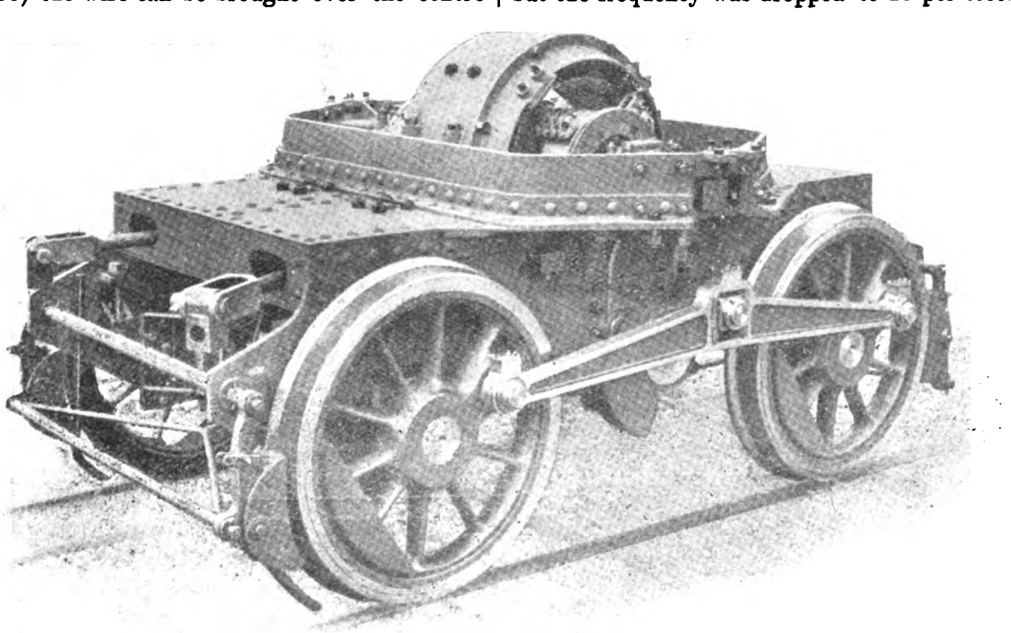

FIG. 61.—View of Bogie with 200-h.p. Continuous-Current Motor.

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At full load both are well over 90 per cent, and taking the efficiency of the locomotive as a whole, the makers claim

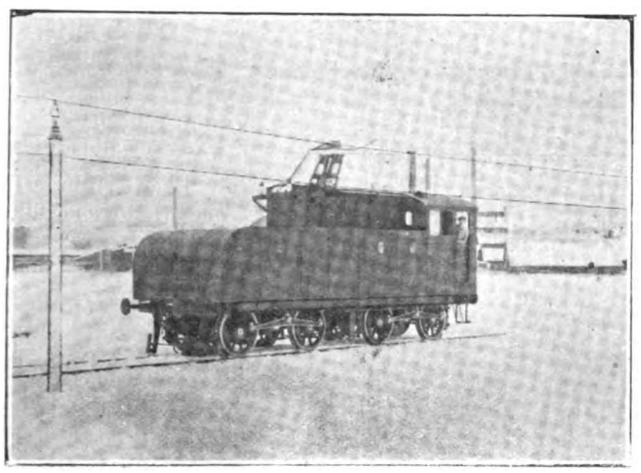

FIG. 62.- Oerlikon Locomotive.

that of the power taken from the trolley, 80 per cent. are transmitted through the drawbar to the train. Owing

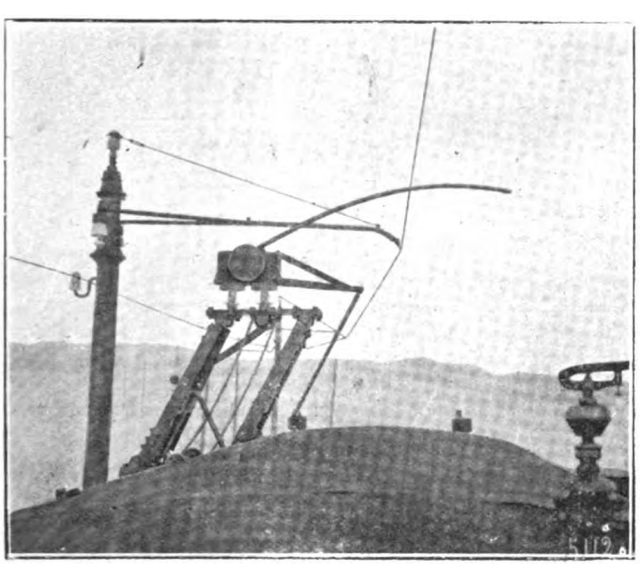

FIG. 63.—Oerlikon High-Voltage Under-running Collector.

to these favourable results, the first locomotive has now been changed to direct use of alternating current, and the

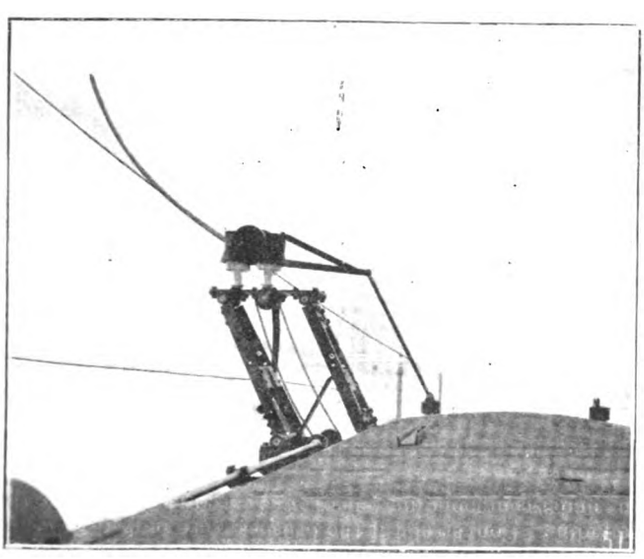

FIG 64.—Oerlikon Collector pressing downwards on trolley wire.

line has been taken over by the Swiss State Railways, and is now being worked with the three electric locomotives in regular traffic.

An important single-phase electrification has recently been carried out by the Westinghouse Company on the New Haven Railway in America. The trolley pressure is 11,000 volts, and locomotives weighing 76 tons and developing 1,000 h.p. at the one-hour rating and 800 h.p. continuously are employed. Fig. 68 shows one of these

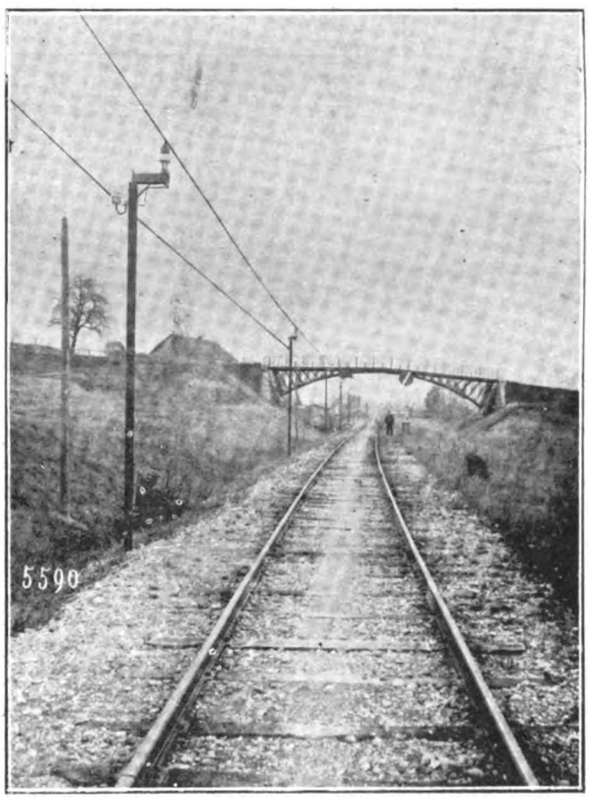

FIG. 65.—Overhead Construction for the Oerlikon Collector.

engines, and Fig. 69 a pair of drivers with motor direct connected. The trolley wires are suspended from bridges 300ft. apart by double catenaries, and every two miles anchor bridges of heavier construction are used, whereon oil-break switches are mounted (Fig. 70), so that the line may be made dead in sections if required for

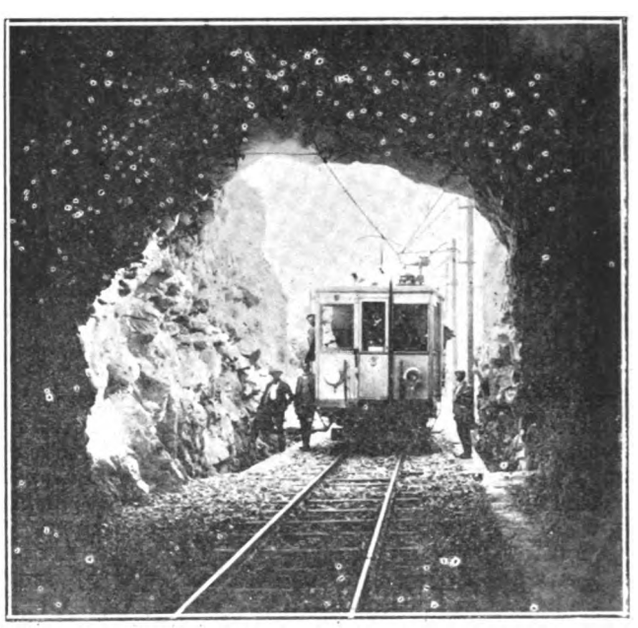

FIG. 66.—View of the construction at entrance to a tunnel.

repair. The locomotives are fitted with pantograph collectors for the high-pressure current and with shoes for third rail, because they must work over lines electrified on the continuous-current system.

In England, there are at the present time two lines under electrification with single-phase current. The one is the line adjoining Victoria and London Bridge Stations in

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London, and the other a section on the Midland Railway Company's system—namely, Lancaster to Morecambe and Heysham. I am indebted to Mr. Philip Dawson, the consulting engineer to the first-named line, for the following particulars The system chosen is single phase, with Winter-Eichberg motors made by the Allgemeine Elektricitäts-Gesellschaft, Berlin. It was important to select the most simple possible overhead equipment because the e are many junctions, low tunnels and bridges, and there also is a considerable traffic of steam express trains over the same metals. The drop in the rail return will be limited to 20 volts. The trains will consist of three coaches, of which the first and last will be motor coaches each fitted with four 115-h.p. motors, the middle coach being a trailer. The coaches are 60ft. long and 9ft. wide; they rest on two trucks with 8ft. wheel base and 41ft. between king pins. The maximum speed will be 42 miles an hour, and the seating capacity 188 passengers. The weight of the empty train is 136 tons. The normal acceleration will be 1·24ft. and the maximum 2ft. per second per second. From tests made with the motors it is expected that the consumption of energy per ton-mile exclusive of lighting will be 79 watt-hours. The voltage will be 6,700 volts, and the trolley wire is ½in. in diameter with catenary suspension, the hangers being 9ft. apart.

On the Midland Railway about nine miles of double track are being electrified The trolley wire is suspended by double catenary on the Siemens principle, and the rolling-stock is being supplied partly by the Westinghouse Company and partly by Messrs. Siemens-Schuckertwerke. The trolley pressure will be 6,000 volts. I am also indebted to Mr. Sayers, the telegraph superintendent of the Midland Railway, who has kindly supplied some photographs to show the present state of the overhead work The trolley wire is suspended by Siemens's double catenary, the supports being fixed to a gantry spanning the tracks. In Fig. 71 one of the trolley wires is already erected, the other is in course of erection. Fig. 72 shows the gantries spanning four tracks. That in the foreground is of special construction, adapted for carrying the signals. The same photograph shows a party of workmen engaged in bonding the rails.

The few examples of main-line electrification which I was able to put before you in the limited time at my

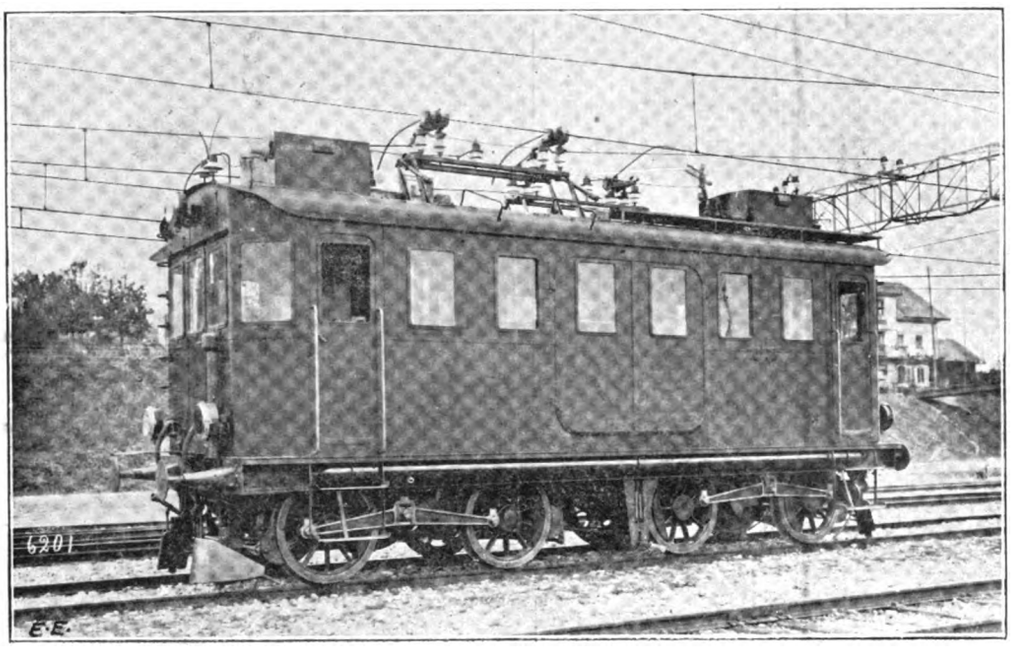

FIG. 67.—An Oerlikon Locomotive Equipped with 200-h.p. Single-Phase Motors

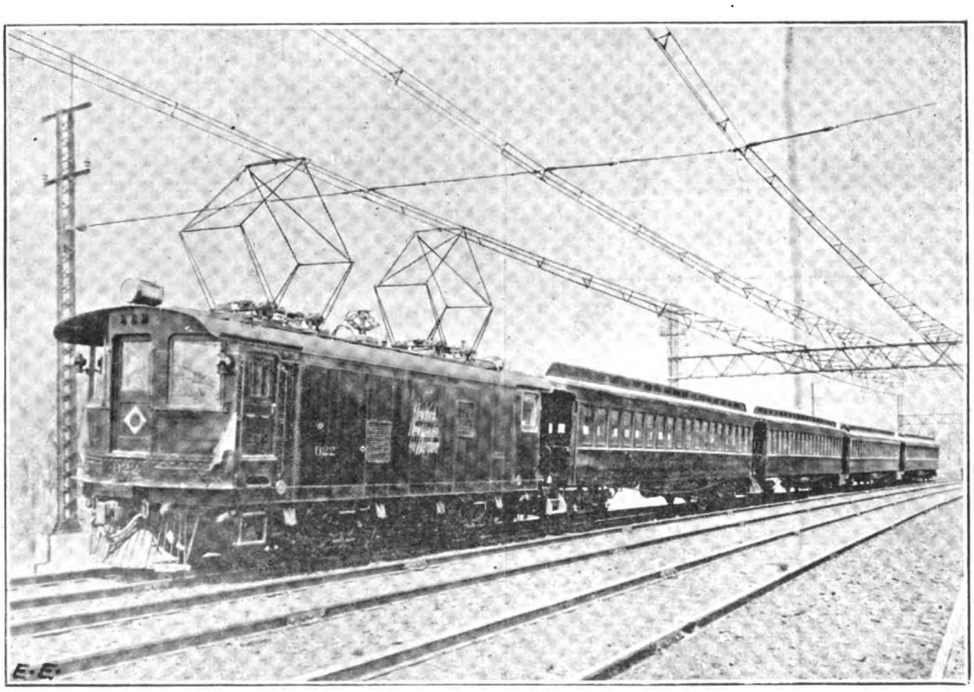

FIG. 68.—An 800-h.p. Single-Phase Westinghouse Locomotive.

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disposal will, I think, show you that in the present state of the industry electrification is not an uncertain experiment, but a reliable achievement resting on a scientific basis. It is no longer a question whether main lines can be electrified, but simply a question whether it will pay to do so. The answer to this question must largely depend on local conditions and on the system chosen. Each of the three systems—continuous, three-phase, and single-phase current—has its particular merits, and for this reason we cannot expect that any one of these systems will always be the best, but we are quite certain that at least one of the three will be. The technical problem is solved. As regards the financial side of electrification, there is strong probability that it will be found quite satisfactory if undertaken on a reasonably large scale.

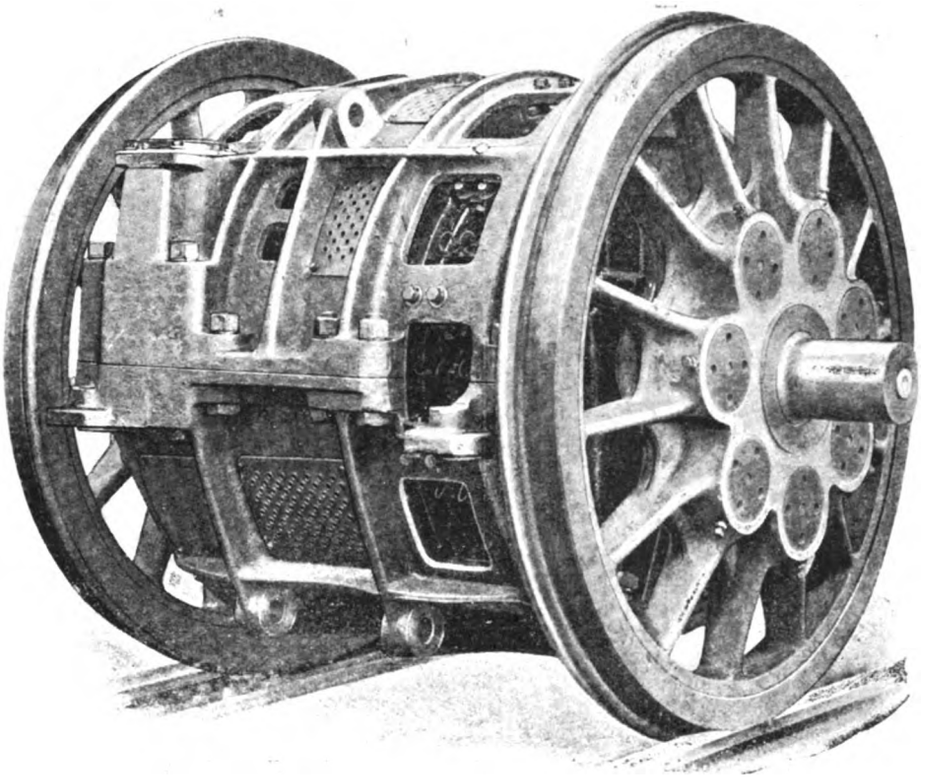

FIG. 69.—A Single-Phase Motor and Driving Wheels from a Westinghouse Locomotive.

LUTON ELECTRIC TRAMWAYS.

The latest addition to the long list of municipally-owned electric tramways was made on Friday last with the inauguration of the Luton Corporation undertaking. An electric tramway service has long been regarded as a necessity, but it was not until the year 1900 that the matter reached a practical stage. In October, 1901, the first tramways committee was appointed for the purpose of considering any scheme which might be submitted for providing tramways in Luton Various schemes were considered, and on March 19, 1907, the Council accepted the offer of Messrs. J. G. White and Co., Limited, to construct, equip, and lease tramways for a period of five or fifteen

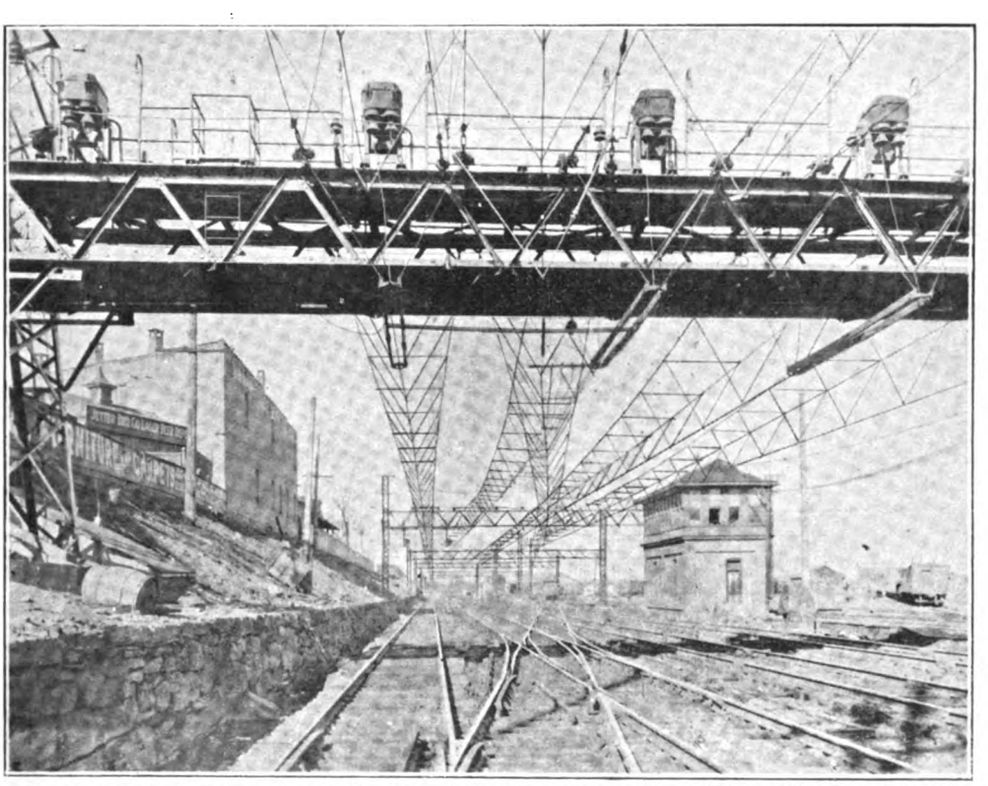

FIG. 70.—Isolating Switches used on the New Haven Railway for Splitting Up the 11,000-Volt Trolley Wires into Sections.

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years, at the option of the Council, the Corporation providing the capital, and Messrs. J. G. White and Co., Limited, within the stipulated time—viz., 4½ months. The total capital cost of the tramways, including the necessary altera-

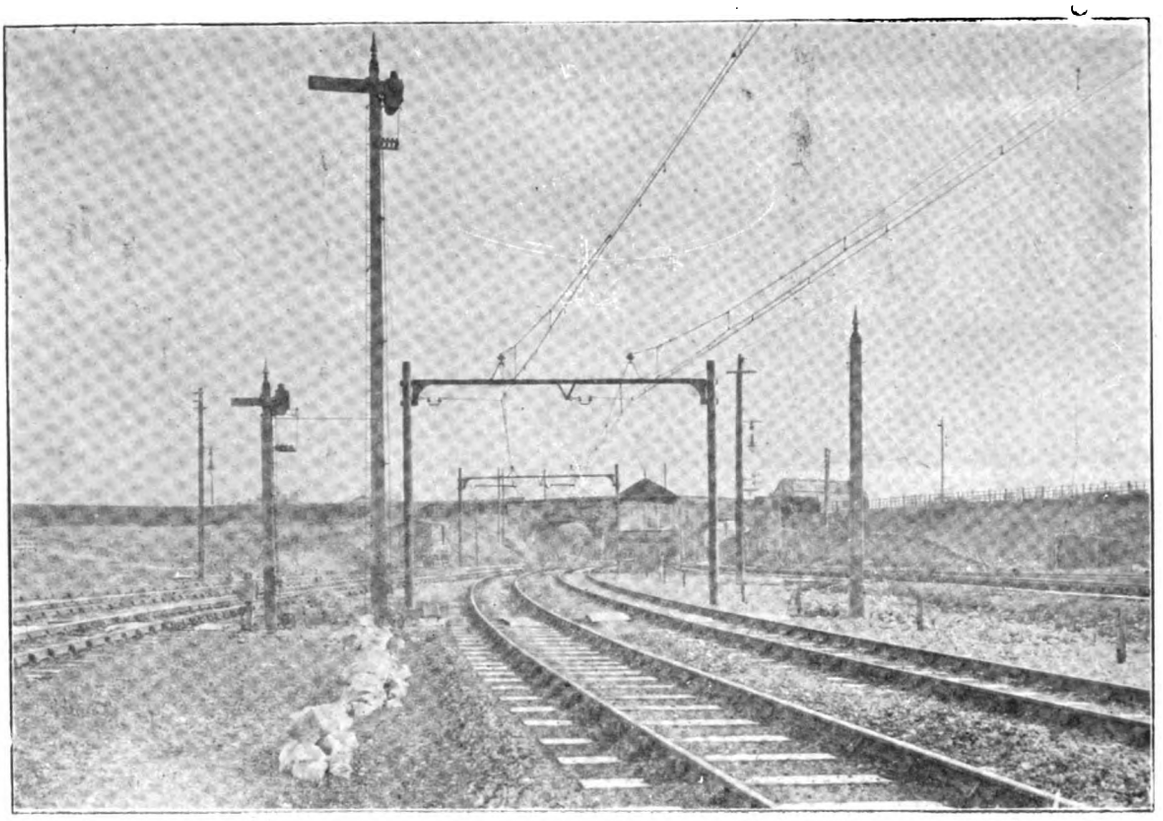

FIG. 71.—View of the High-Tension Overhead Construction on the Midland Railway.

paying rent equivalent to the interest and sinking fund charges during the term of lease. In the same year the Board of Trade sanctioned the loan to the Council of £65,000, granting an equated period of 27 years for tions to roadways, gas and water mains, amounts approximately to £63,000

The tramways are constructed on the overhead trolley system. The total mileage authorised by the order is

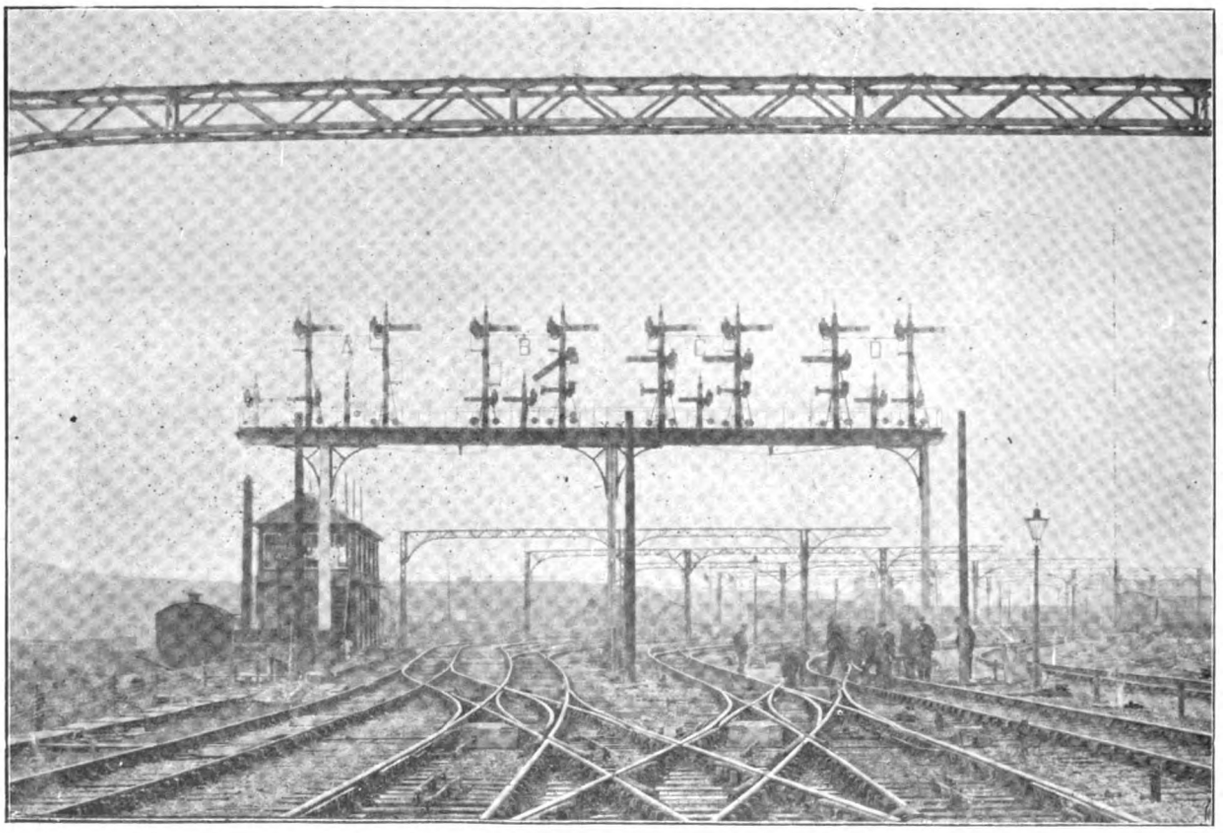

FIG. 72.—The Electrification Work at an important Junction on the Midland Railway.

repayment of the full amount. The work of construction was only commenced on Oct. 17 last, so that it is worthy of note that the contractors (Messrs. J. G. White and Co., Limited) have completed the contract well 6½ miles, of which there are now in operation about 5¼ miles of route, equivalent to 6¼ miles of single track. The population of the district served is approximately 40,000. Excepting for a very short gradient of 1 in 11

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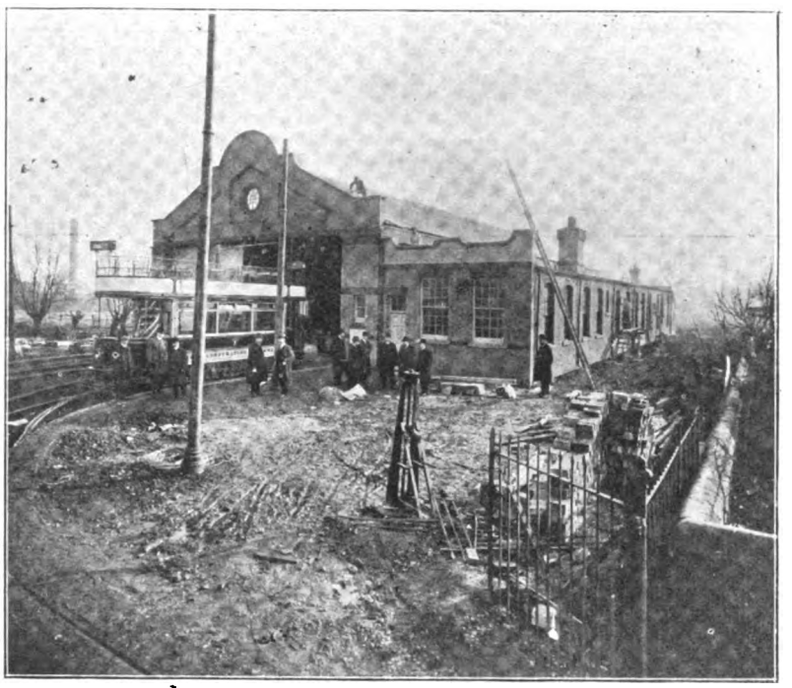
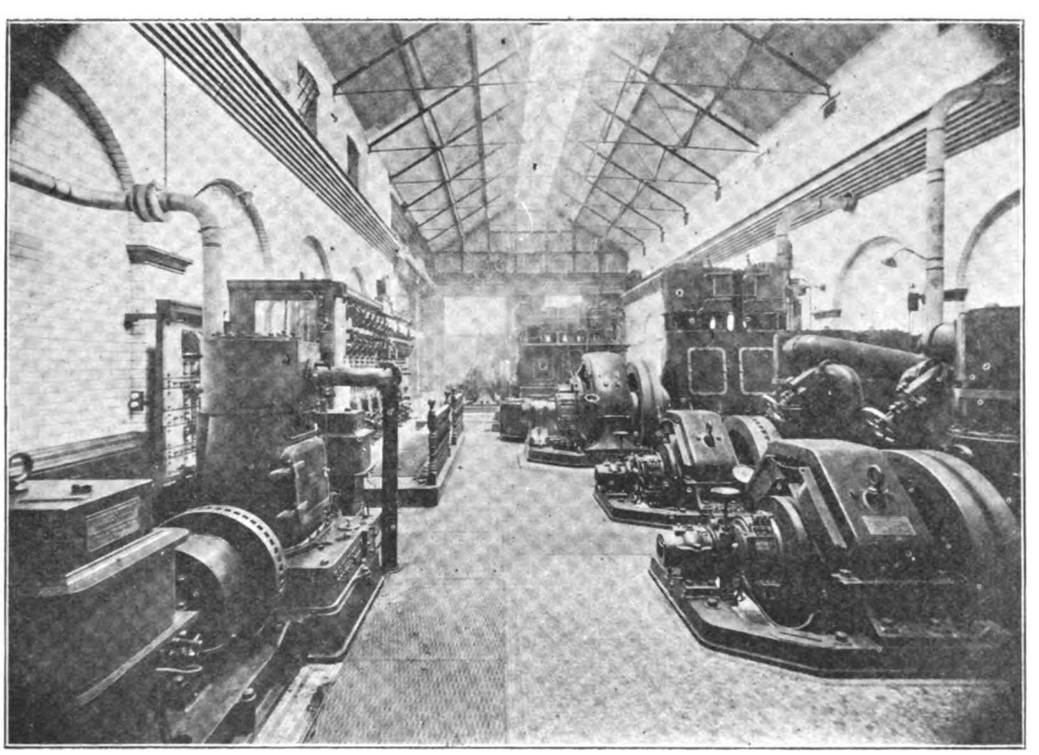
and 1 in 12½, and a fairly long gradient of 1 in 14½, the inclinations are comparatively easy. The curves having a radius of less than 50ft. are five in number, and vary from 36ft. to 49ft. The gauge is 4ft. 8½in. The rails, which were supplied by the North-Eastern Steel Company,

With regard to the overhead equipment, on all sections side poles weighing 700lb., 900lb., and 1,100lb., supplied by Messrs. John Spencer, Limited, have been erected. The bracket arms have a length varying from 8ft. to 16ft., and in 11 cases wall rosettes were employed. The pole



Exterior of Car Shed, Luton.

are British standard section No. 2 for straight track and No. 2 C for curves, weighing about 95lb. and 101lb. per yard lineal respectively. They are of the girder pattern, and in 45ft. lengths. The rails are laid on a bed of concrete 6in. thick, and are joined by means of continuous rail joints 24in. long, weighing 100lb. per pair. The length of the bases were supplied by Messrs. Wm. Boydell and Sons. The trolley wire is of grooved copper, 2/0 B. & S. gauge, suspended by means of flexible supports of $^{7}/_{14}$ S.W.G. The mechanical ears were supplied by the Electric Tramway Equipment Company. They are made of gunmetal, and for the greater part are 6in. long, but in some cases



Interior of Generating Station, Luton.

points is 12ft., and they are made of manganese steel with 150ft. radius. These as well as the crossings were supplied by Messrs. Edgar Allen and Co. The special track work was constructed by Messrs. J. G. White and Co. No automatic point shifters are employed. The rails are bonded by concealed bonds supplied by the Forest City Electric Co. The track is cross-bonded at every 80 yards. 14in. and 18in. ears are used. The feeder pillars, furnished by Messrs. Estler Bros., contain two 300-ampere quick-break knife switches, four 100-ampere knife switches, and lightning arrester, test and telephone terminals, all of which are mounted on a marble slab polished on both sides. The guard wire is of $^{7}/_{16}$ galvanised steel, supplied by Messrs. F. Smith and Co. The total length of cable used is

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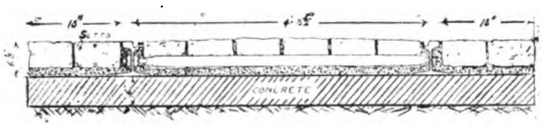
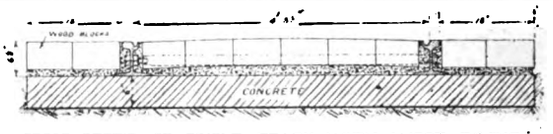
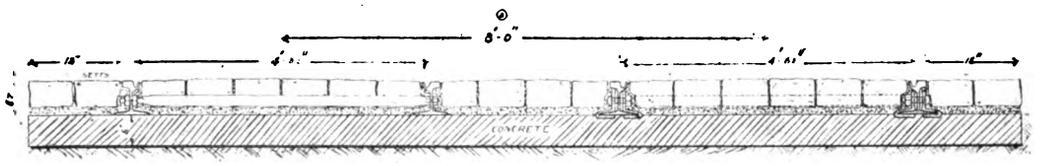


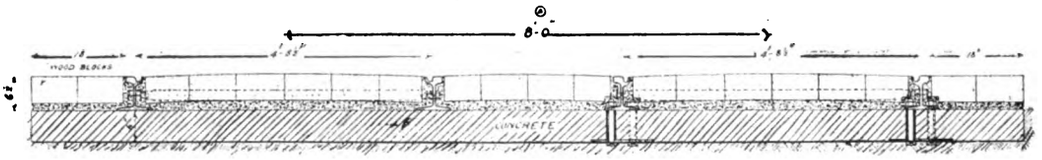
CROSS SECTION OF SINGLE TRACK WITH SETT PAVING



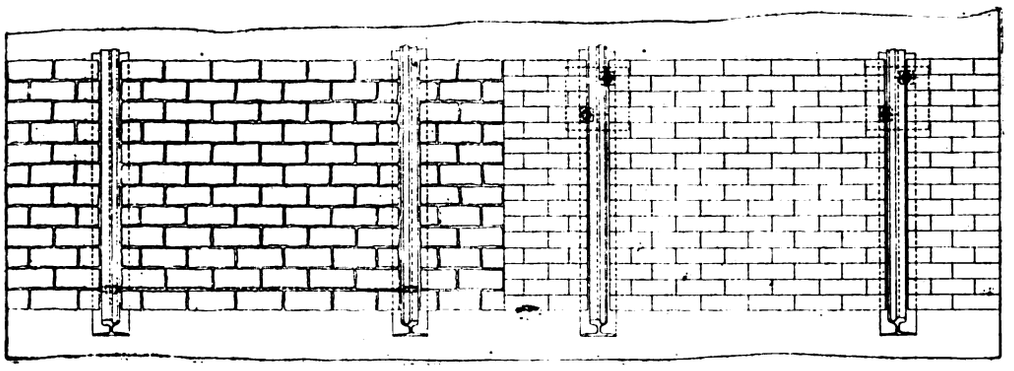
CROSS SECTION OF SINGLE TRACK WITH WOOD PAVING



CROSS SECTION OF DOUBLE TRACK WITH SETT PAVING

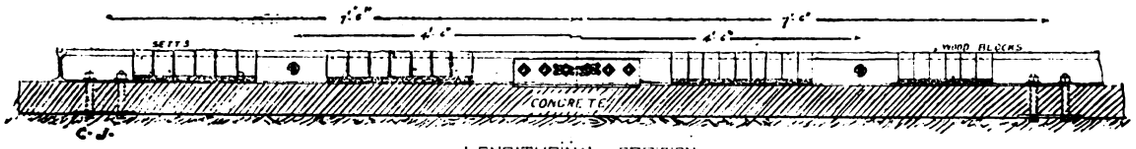


CROSS SECTION OF DOUBLE TRACK WITH WOOD PAVING



HALF PLAN, SETT PAVING

HALF PLAN, WOOD PAVING



LONGITUDINAL SECTION

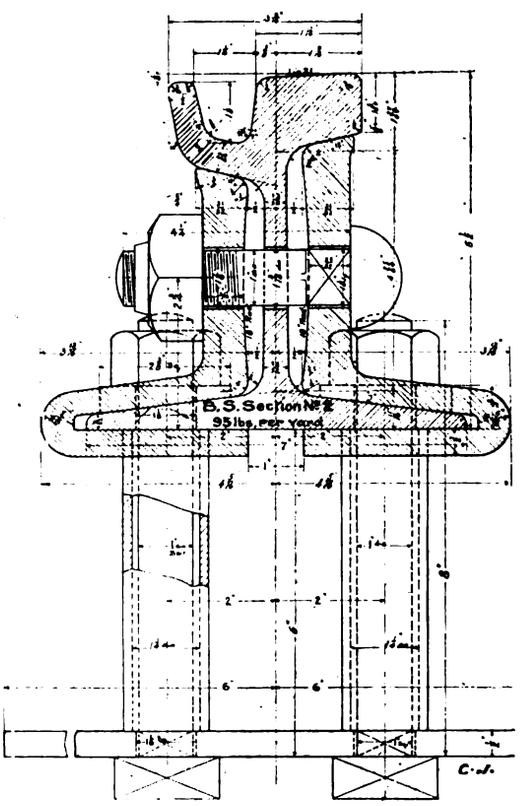
Permanent Way Sections, Luton Corporation Tramways.

1·17 miles, supplied by Messrs. Henley, and laid solid in wood troughs.

The car-shed is 121ft. 6in. long and 48ft. 6in. wide, and accommodates 16 cars. It has four tracks, each supplied with a pit, and there are, in addition, a repair shop, stores, and offices. There are 12 double-decked cars, which have been supplied by the British Thomson-Houston Company, of Rugby. The bodies are by the United Electric Car Company, and are mounted on single trucks supplied by Messrs. Mountain and Gibson. The equipments of the cars include two four-pole 500-volt series B.T.H. motors of 30 h.p. each per car, with controllers, etc. The trolleys are of the swivelling-arm type, with detachable heads.

The electrical energy for operating the tramways is supplied by the Electric Light and Power Committee from their power station in St. Mary's-road, the first section of which was opened by the late Lord Kelvin in 1901. A full description of the plant appeared in the *Electrical Engineer* for July 12, 1901 (vol. xxviii.), and the various extensions have been described as they were made. The tramways are supplied by one of the 85-kw. generators (Messrs. W. H. Allen and Sons), which has been fitted with change-over switches, working in conjunction with a D.P. battery and a reversible booster by the Lancashire Dynamo and Motor Company. The total capacity of the station is now 1,147 kw., and the capital expenditure about £56,000.

Mr. W. H. Cooke is the Corporation electrical engineer, and Mr. J. W. McInnes the tramways manager. The construction work has been superintended on behalf of Messrs. J. G. White and Co. by Mr. C. Don. The following is a list of the contractors: Rails, Messrs. J. G. White and Co., Limited (North-Eastern Steel Company, Limited, Middlesbrough); permanent way, Messrs. J. G. White and Co., Limited; overhead equipment, Messrs. J. G. White and Co., Limited (poles by John Spencer, Limited, Wednesbury); feeder cables, Messrs. J. G. White and Co., Limited (W. T. Henley's Telegraph Works Company, Limited);



Section of Rails used at Luton.

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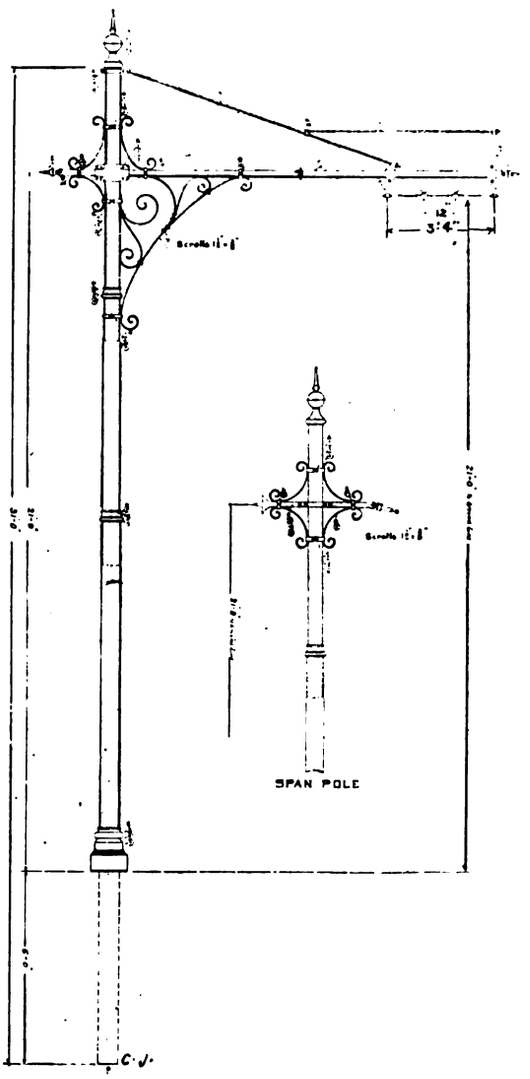
cars, Messrs. J. G. White and Co., Limited (car bodies, United Electric Car Company, Preston; trucks, Messrs. Mountain and Gibson, Bury; equipments, British Thomson-Houston Company, Limited, Rugby); traction switchboard, Messrs. Johnson and Phillips, Limited, Charlton, Kent; traction battery, D.P. Battery Company, Limited, Bakewell, Derbyshire; reversible booster, Lancashire Dynamo and Motor Company, Limited, Manchester; car-shed and



Poles and Fittings, Luton Corporation Tramways.

workshops, Messrs. J. G. White and Co., Limited (Mr. W. G. Dunham, Luton).

DIRECT-CURRENT TURBO-GENERATORS.

BY WILFRED HOULT, ASSOCIATE MEMBER.

The following is an abstract of the above paper read before the Manchester Section of the Institution of Electrical Engineers on Feb. 18:

Mr. Hoult referred at the beginning of his paper to the early history of the turbo-generator, which was first brought out by Messrs. C. A. Parsons and Co., of Newcastle, who up to six years ago were the only manufacturers. Now the British Westinghouse, Siemens, Brown-Boveri, and British Thomson-Houston were notable instances of manufacturers who had taken up these machines. Referring to the earlier difficulties of design, the author mentioned the fact that until the last few years the brushes had to be adjusted for variation of load. He described Messrs. Parsons's automatic brush control gear, which was actuated by the initial pressure of steam in the turbine. Nowadays special windings were used to obtain a fixed brush position with varying loads. There were three methods: (1) by compensating windings; (2) by commutation poles; (3) by a combination of compensating windings and commutation poles.

The author then described in detail the various methods, and gave curves (Fig. 1) showing the flux distribution due to the various windings. In this, Curve A shows the flux distribution of the main shunt field and the commutation field separately excited with normal full-load current.

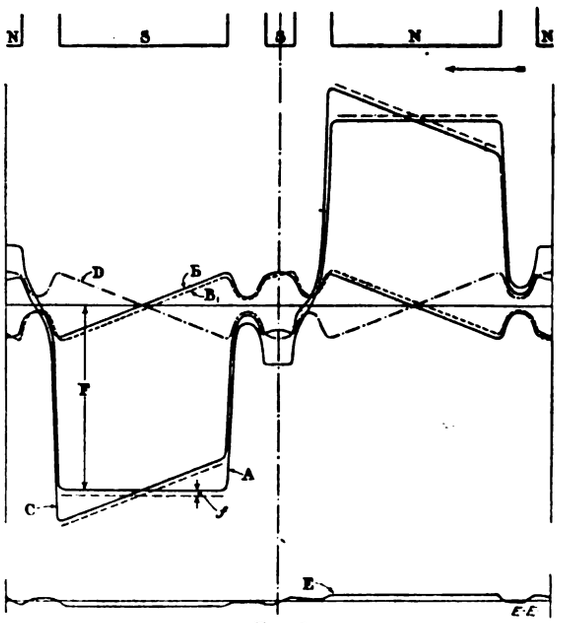


FIG. 1.

Curve B shows the flux distribution due to the current in the armature. Curve C shows the resultant flux distribution of Curves A and B. Curve D shows the flux distribution due to the compensating winding, which for the purposes of making the diagram clearer has been assumed to exactly neutralise that due to armature reaction.

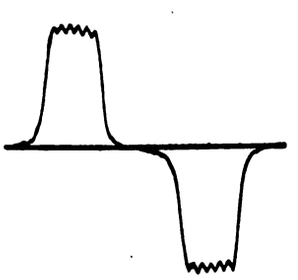


FIG. 2.

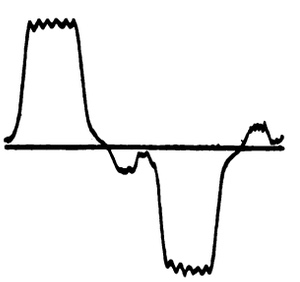


FIG. 3.

Curve B being neutralised by Curve D, the resultant field is that shown by Curve A, except that the commutation pole flux is much smaller, as in this case ampere-turns are not required on the commutation pole for the armature ampere-turns. Figs. 2, 3, and 4 are flux distribution curves of a 700-kw. 600-volt generator running at

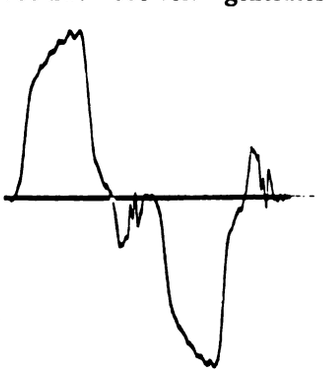


FIG. 4.

1,500 r.p.m., and fitted with commutation poles. The curves were taken by a Duddell high-frequency oscillograph, which was connected to an armature coil by brushes pressing on two of the steel binding rings on the commutator, which in turn were connected to two adjacent commutator segments.

Photographs were also shown in the paper of a field-magnet system of a Siemens 750-kw. machine (Fig. 5),

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a Westinghouse 1,000-kw. 600-volt set (Fig. 6), and a Dick-Kerr 600-kw. 550-volt set (Fig. 7). The diagram (Fig. 8) shows the general scheme of connections for a generator with compensating windings and commutation poles. The author then referred to the drawback of machines fitted with commutation poles in their tendency to flash over when approaching full load where there was dust on the commutator. Absolutely sparkless commutation could be obtained from no load to large overloads without movement of the brushes. Machines fitted with commutation poles could be made 10 to 15 per cent. cheaper than those fitted with compensating windings, and for machines in which the maximum voltage per segment could be kept below 30, and in some cases below 45, they were perfectly satisfactory. Methods for preventing flashing and getting the correct reversing field depended on the adjustment of the air-gap of the commutation pole, or on the use of a diverting resistance in parallel with the commutation pole windings. The former method was that now mostly in use, especially with machines fitted with compensating windings.

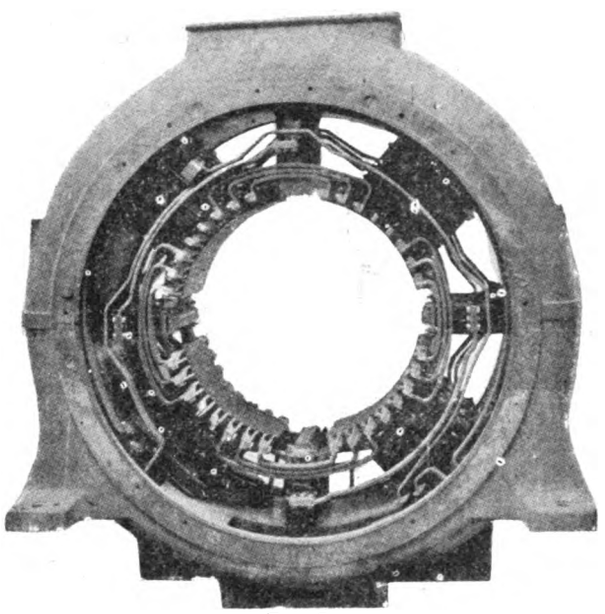

FIG. 5.

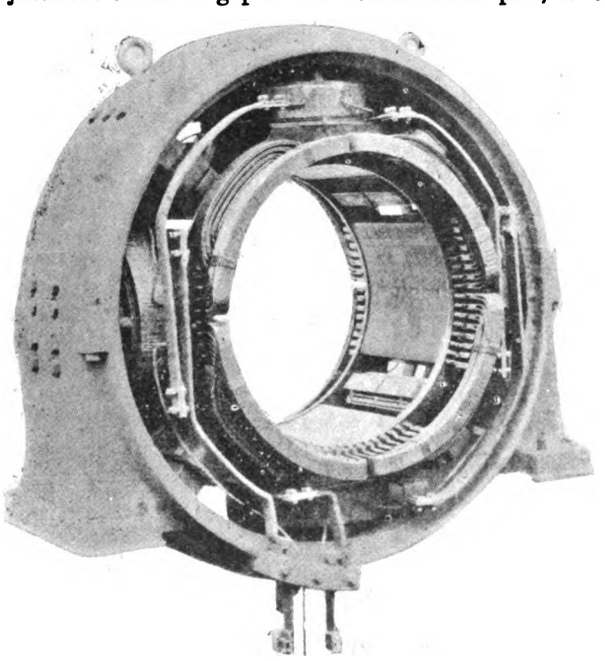

FIG. 6.

The author then referred in detail to the application of these methods. Referring to the drop in voltage on an ordinary shunt-wound generator for the same position of field rheostat on increase of load due to the demagnetising action of the armature on the main field, the author stated that with a turbo-generator having compensating windings the field was hardly weakened at all. Consequently, unless special methods were used, such as placing back series turns on the main poles, the regulation was extremely good. If, instead of having the brushes in the neutral position, they were moved backward, a compounding effect was produced. The smaller the air-gap the greater the compounding. Conversely, if the brushes were moved forward, an under-compounding effect was produced. When the generator worked on a circuit itself, the compounding effect was good, but if, as usual, it was required to work in parallel with other machines, it would take the peaks on a fluctuating load, and thus have to withstand heavier duties than the ordinary shunt machine. Difficulties had also been experienced with compensated machines working in parallel on traction loads, and Messrs. Parsons took out a patent in 1900 to improve the stability, by bringing the equalising connection to tappings on the compensated winding instead of the junction of the compensating winding and the compound winding.

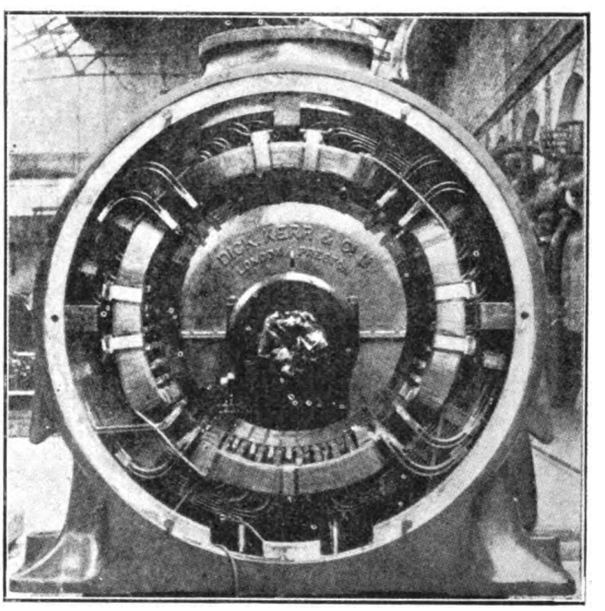

FIG. 7.

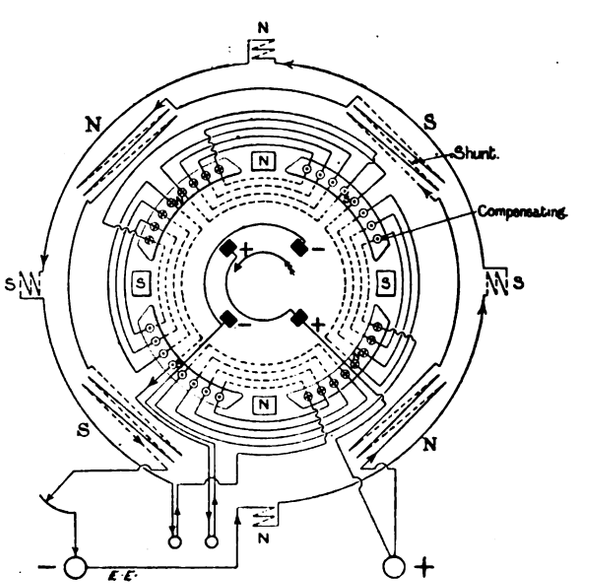

FIG. 8.

The author then referred to the brush question, and stated that though nothing but metal or a combination of metal and carbon brushes were used on direct-current turbo-generators till two years ago, carbon brushes were gradually superseding metal brushes. Prejudice against carbon brushes was caused by their being used on unsuitable commutators, causing undue heating. It was essential that carbon brushes should be kept cool, and, therefore, the commutator should be well ventilated and of sound mechanical construction. The

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author spoke of the successful efforts of the Morgan Crucible Company to obtain suitable carbon brushes. He had made many experiments with carbon, metal, and graphite brushes. The only type of graphite brush capable, however, of being used on a high-speed machine was one in which the layers were in the direction of the running of the commutator, and consequently having the cross resistance in an axial direction instead of tangential. The brushes then did not break away so easily. Endrueit brushes with carbon brushes slightly in advance of them were used largely on turbo-generators. These brushes were made by wrapping layers of copper foil and paper together, the whole then being baked, so as to form the paper into carbon. Parsons used a brass wire brush, which usually worked on a corrugated commutator.

The author then gave a description of a specially-ventilated commutator (Fig. 9) for use with carbon brushes. The Westinghouse new radial commutator (Fig. 10) had a large radiating surface, which, it was claimed, kept the commutator cool; also there were no exposed shrink rings to increase liability to flash over. Carbon brushes once adjusted gave no trouble and required no attention, whereas the metal type of brush needed constant attention on load. The author described the Brown-Boveri dynamos, which had the field system built up of a number of soft-iron core plates, in the slots of which the windings were fitted. This allowed a continuous inner cylindrical surface,

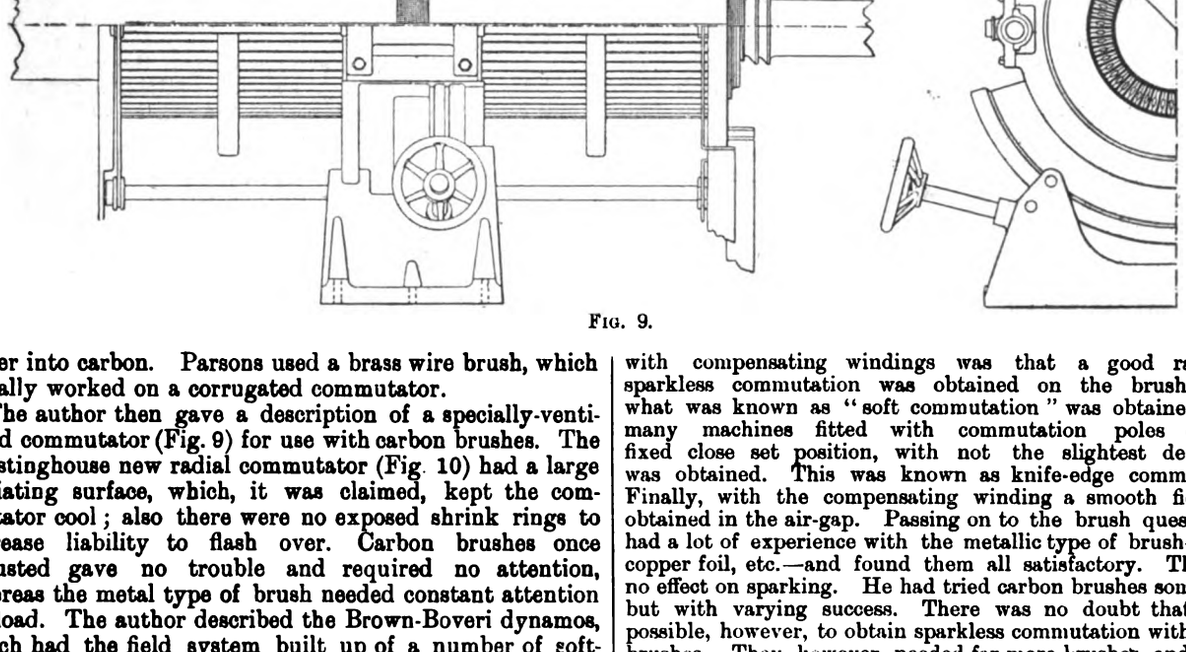

FIG. 9.

which had the advantage of decreasing windage resistance and allowing silent running. These machines were also fitted with a direct-coupled exciter, to prevent the machine reversing its polarity.

The author concluded his paper by a few remarks on the mechanical construction of the machine and the methods he had used to obtain correct balancing of the armature.

DISCUSSION.

Mr. G. C. STONEY (Messrs. C. A. Parsons and Co.), in opening the discussion, congratulated Mr. Hoult for having put the case of direct-current turbo-generators in such a fair way. Mr. Hoult had described three methods of special windings used to obtain a fixed brush position at varying loads. He considered compensating windings necessary to obtain constant sparkless commutation. Machines fitted with commutation poles alone were not satisfactory, owing to their tendency to flash over when reaching full loads or on sudden loads, due to the combined action of armature reaction increasing the current density per segment of the commutator and dust from carbon brushes on the commutator. The combination of compensating windings and commutation poles improved matters, but he had no doubt that compensating windings alone gave the best commutation, the field in the air-gap being smooth and uniform. As far back as 1885 his firm (Messrs. Parsons and Co.) were using compensating windings only, and in those days the same number of ampere-turns were used on the field magnets as in the armature. This arrangement did not give full satisfaction, and later on the ratio was increased to 2 and 2¼ to 1 with better results; the newer machines were built with this ratio. An advantage the compensating windings possessed over commutation poles was that there was no lag in the compensation when sudden loads came on. Another advantage was that diverter resistances were unnecessary. A further advantage with compensating windings was that a good range o sparkless commutation was obtained on the brushes, and what was known as "soft commutation" was obtained. In many machines fitted with commutation poles only a fixed close set position, with not the slightest deviation, was obtained. This was known as knife-edge commutation. Finally, with the compensating winding a smooth field was obtained in the air-gap. Passing on to the brush question, he had a lot of experience with the metallic type of brush—brass, copper foil, etc.—and found them all satisfactory. They had no effect on sparking. He had tried carbon brushes sometimes, but with varying success. There was no doubt that it was possible, however, to obtain sparkless commutation with carbon brushes. They, however, needed far more brushes, and careful attention was required. He was satisfied that there was as much trouble and expense in keeping carbon brushes in order as

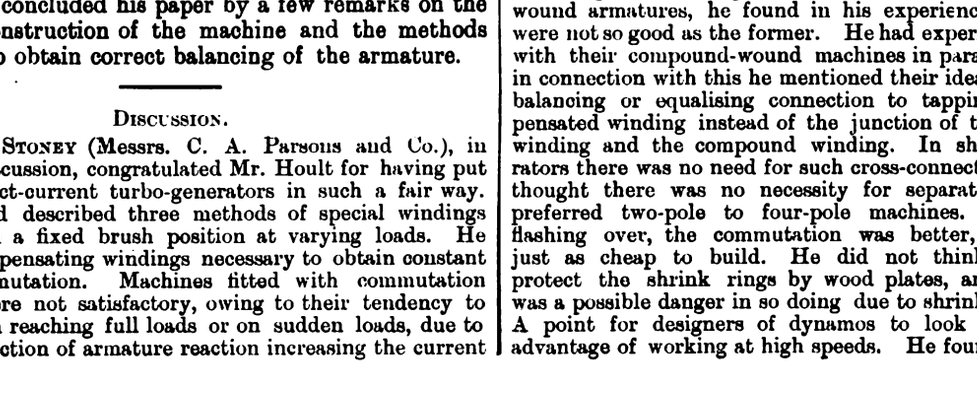

FIG. 10.

with metal brushes, and as regarded the number required he instanced a 2,000-ampere machine fitted with compensating windings and interpoles which needed 96 brushes; he would have used only 20 metal brushes with a similar size of machine. With regard to the question of surface-wound *versus* socket-wound armatures, he found in his experience that the latter were not so good as the former. He had experienced no trouble with their compound-wound machines in parallel running, and in connection with this he mentioned their idea of bringing the balancing or equalising connection to tappings on the compensated winding instead of the junction of the compensating winding and the compound winding. In shunt-wound generators there was no need for such cross-connection. He further thought there was no necessity for separate exciters. He preferred two-pole to four-pole machines. There was no flashing over, the commutation was better, and they were just as cheap to build. He did not think it necessary to protect the shrink rings by wood plates, and thought there was a possible danger in so doing due to shrinking of the wood. A point for designers of dynamos to look at was the great advantage of working at high speeds. He found that a 500-kw.

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Brown-Boveri generator ran at 2,100 revolutions; a 400-kw. Siemens, however, only ran at 1,800 revolutions, while a 500-kw. Parsons set ran at 2,000 revolutions. High-speed machines were not cheaper, but they allowed a cheaper and more efficient turbine to be used. With this higher speed also the advantage lay again with the compensating winding and surface-wound armature.

Mr. S. L. PEARCE said he had two classes of turbo-generators under his charge, one with compensating windings and the other with commutation poles only. The machines which were installed six years ago had neither. They were of 1,800-kw. capacity—two generators, each of 900 kw., on either side of one shaft. The machines were of the smooth-core type, and the coils were held in by binding wire. Brass-wire brushes were used. The peripheral speed of the commutator was 6,500 revolutions. Automatic brush-rocking gear as described by Mr. Hoult was attached. The machines did not run satisfactorily, and subsequently compensating windings were put in as far as possible. After this alteration a fixed position of the brushes was obtainable for all loads from nothing to half load. Before the compensating windings were added the brushes had to be moved 4in. from no load to full load. Afterwards the range from no load to full load was 1in. With regard to the question of brass-wire brushes *versus* carbon, he had expected to find that his bill for brushes would be reduced after the compensating windings were added. This, however, was not the case, and the same rate of wear and tear prevailed. He thought that Mr. Hoult was right in his statement that, though apparently sparkless, there was a wear and tear underneath the surface of the brush due to sparking. The commutators of these machines had, however, stood very well; they had only been turned up once in six years. The makers would only give a guarantee for 10 years, but he saw no reason why they should not be good for 20 years or more. On these machines the expense with the brushes was so considerable as to entirely neutralise the economy due to less oil consumption. They had to renew the brushes every 336 hours. With regard to the second type under his charge—with commutation poles only—he had not been free from trouble, as flashing over had occurred. These machines had smooth cores and carbon brushes, and the inside faces of the shrink rings were lined with wood. They had experienced no trouble as yet with the shrinking of the wood, as Mr. Stoney feared. The flashing over had occurred with traction loads, but this had been cured by the use of a diverting resistance in parallel with the commutation poles. They had experienced no difficulty with lighting loads. He had tried all kinds of brushes, and he considered the best type to be a combination of one eudrueit and one carbon brush. He fully agreed with Mr. Hoult that the only graphite brush capable of being used on a high-speed machine was one in which the layers ran in the direction of the running of the commutator. He thought that the most satisfactory running of smooth armatures and carbon brushes was obtained by ventilation. He had got satisfactory running by means of external blowers. Mr. Hoult's device would have the same effect. With both types of machines he had experienced no difficulty in parallel running. There were various types of direct-current turbo-generators running with success at the present time, but he did not think that sufficient credit had been given for the great and pioneer work of Messrs. Parsons and Stoney.

Mr. MCCOWEN said that he had little experience of running direct-current turbo-generators of this country, but he had been enabled to observe several machines running on the Continent. He had been greatly surprised by the Brown-Boveri machines. In Rotterdam he saw a set working traction loads in conjunction with batteries. He put down the smooth running and sparkless commutation to that cause, but for his benefit the batteries were taken off the load. No difference was perceptible in the behaviour of the machine. He ordered two machines for Belfast, and had since ordered one for Salford, and they had been free from troubles. He acknowledged, however, that the cost of brush repairs was high. He had worked out the cost of brushes, etc., on a month's run, and found that the cost was equal to ·003d. per unit. These Brown-Boveri machines were arranged with separate exciters, and he had found no difficulty in parallel running. He had just seen a machine with a radial commutator and carbon brushes running on test, and he must confess that he had not as yet seen anything quite so good. This machine stood a sudden change from no load to full load without any sparking occurring.

Mr. J. S. PECK thought that the carbon brush had come to stay. Copper brushes were advanced years ago for ordinary speed generators in the same way as they were now for the higher speeds of turbo-generators, but carbon brushes gradually superseded them. The same relation held good in regard to the smooth and slotted armatures; the latter would supersede the former. He asked Mr. Hoult whether the ventilating duct shown in Fig. 9 would reduce the wearing depth of the commutator.

Dr. ROSENBERG thought that Messrs. Parsons and Stoney's success had possibly induced a certain conservatism that made them stick to the surface-wound armature and the copper brush. He considered the copper brush impossible with the slot-wound machine in large sets. With slot-wound and commutation poles a fixed position of brush could easily be obtained by the use of carbon brushes. He thought it necessary, however, to ventilate. He thought the Siemens method of ventilating ducts as shown by Mr. Hoult in the paper was at a disadvantage compared with the Westinghouse radial-type commutator. He agreed with Mr. Hoult's remarks on graphite brushes, but thought there was no law governing the behaviour of brushes, as the Morgan Crucible Company had recently brought forward a brush which was quite in opposition to that theory and yet it worked well.

Mr. BAILEY expressed the opinion that the heavy wear of brushes on Mr. Pearce's machines was due to insufficient compensating windings. When machines were fully compensated there was little wear. With regard to Mr. Pearce's criticism of unsound mechanical construction in reference to binding wire on Parsons machines, he might say that they considered this trouble negligible, so very seldom did it occur. The best piano wire was used. Mr. Hoult referred in his paper to the necessity of keeping carbon brushes cool, and the consequent necessity for ventilation. He, however, did not consider this ventilation necessary. Incidentally, he mentioned that on some small sets he had seen manganese brushes working very successfully, due probably to their high contact resistance. Regarding chattering, this did not occur if the gravity type of brush-holder were used. As regarded attention and replacement, he knew of many machines working at collieries which were not touched for months.

Mr. BARKER went back into history to show how carbon brushes had replaced copper brushes on ordinary slow-speed generators. The parallel was now taking place with high-speed generators. Referring to the possibility of danger due to the shrinking of the wooden protection of the shrink coils, he said that mica was placed between the two. He also referred to the fact that the commutator with carbon brushes need not be longer than with metal brushes, as, though the current density was lower, the arc of contact was greater in the same proportion.

Mr. MILES WALKER thought that, however much they were satisfied with the use of piano wire for binding the armature coils, they would never convince the user of the machine that it was good. The same with the metal brush. There was no doubt sparkless commutation could be obtained with this type of brush, but attention was wanted, and the user preferred to have something which did not require attention. He thought the voltage per segment would be lower in the future. The user would find that the machines with high voltage per segment would not be so successful, and would demand the lower voltage, as machines so built would be certainly safer when sudden loads were thrown on. He thought the standard would come down to something like 20 volts per segment. If that were so, machines with commutation poles would be quite safe even when sudden loads were put on. They were cheaper than machines with compensating windings, and would be used largely.

Mr. HOULT, in reply, voiced the gratitude of all designers to Messrs. C. H. Parsons and Co. Machines would certainly have not reached such a high state of development had it not been for their earlier efforts. Referring to commutation poles, he said that there was no trouble with machines fitted with these poles provided the poles were large enough. He agreed, however, that it was possible to have machines with compensating windings which worked sparklessly. He did not believe, however, in metal brushes. His experience was unfortunate, and he might tell them in regard to Mr. Stoney's praises of metal brushes of a visit he paid to the "Mauretania," where Parsons turbo-generators were installed. He said to the fitter in charge, "Well, I suppose you don't have to shift the brushes about like you had in the old days." He replied, "No, only when the load comes on." He thought metal brushes were sparkless up to a certain period—then sparking occurred. Referring to Mr. Peck's question as to ventilating duct in armature shown in the paper, he said there was a depth of §in. for turning purposes, and he thought that was quite satisfactory. In answer to Dr. Rosenberg, they had no trouble due to dirt on the commutation poles. Referring to Mr. Bailey's remarks regarding attention required for metal brushes, he said that he certainly would never leave them six hours, let alone six months. With regard to Mr. Shaw's remarks as to sparking due to vibration, the vibration was due to the armature being out of balance, and the cure was in balancing properly. He had seen machines fitted with commutation poles having 45 volts to the segment working sparklessly even when the load was thrown on suddenly. In conclusion, he thanked the members of the section for their reception of his paper.

Gillingham.—The Education Committee have decided to install electricity for lighting purposes throughout the Council schools.

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JANDUS REGENERATIVE FLAME LAMP.

The regenerative flame lamp which the Jandus Company are now introducing embodies several features which are entirely

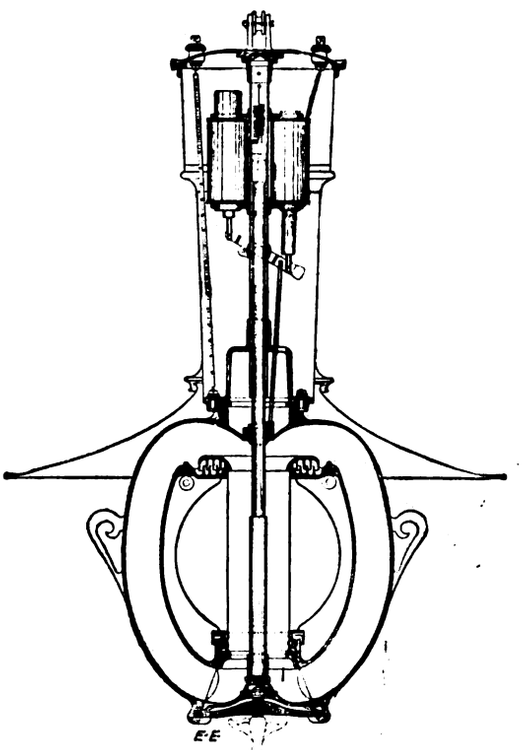

FIG. 1.—Sectional Elevation of Lamp.

new in flame-lamp design. The sectional drawing herewith illustrates the lamp in detail. The length of the lamp is 36in. over all. The positive carbon is placed at the bottom; the

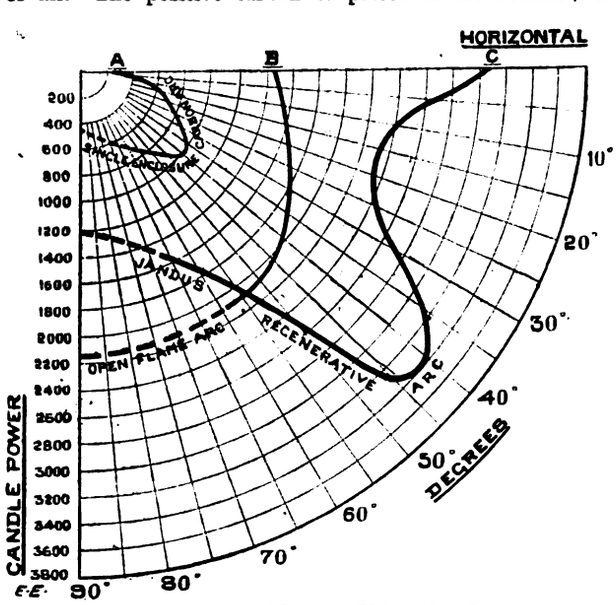

FIG. 2.—Comparison of Curves of Distribution of Light.

negative carbon vertically above this. The striking is effected by standard Jandus mechanism acting on the top (negative) carbon. The mechanism illustrated is that used for lamps burning two in series on 220 to 250 volts. It is perfectly simple, with an entire absence of clockwork and delicate parts. For burning off power or tramway circuits of 400 to 600 volts, a simple cut-out is fixed inside the lamp case. The carbons are surrounded by an inner glass cylinder communicating with two side tubes, which lead downwards and again upwards into the inner cylinder. The cylinder is surrounded by an opalescent glass globe, and concentric corrugated baffle plates are shown above the inner cylinder, which restrict the admission of air. The inner cylinder is attached by a screw neck to a conical plug clamped in position by the cross-bar and clamping screw shown at the bottom of the lamp. Half a turn of the bottom clamping screw allows complete withdrawal in one piece of the inner cylinder of positive carbon. The outer globe need not be removed, and trimming can, therefore, be effected in a few seconds.

The principle of the lamp is as follows: The chemicals from the bottom carbon are vaporised and rise through the arc, intensifying the light, the spectrum from this lamp being composed almost entirely of bands and bright lines—*i.e.*, the spectrum given by glowing gases. The chemical vapours, on leaving the arc, continue to rise through the inner cylinder, ascend upwards, descend through the side tubes, and rise again through the inner cylinder, the greater portion again entering the arc and reintensifying or regenerating the light. The inner cylinder soon becomes filled with a light cloud of chemical fumes, resulting in an intense glow and softly diffused light. These fumes are not, however, condensed upon the cylinder. A very rapid upward draught of hot gases which is produced in

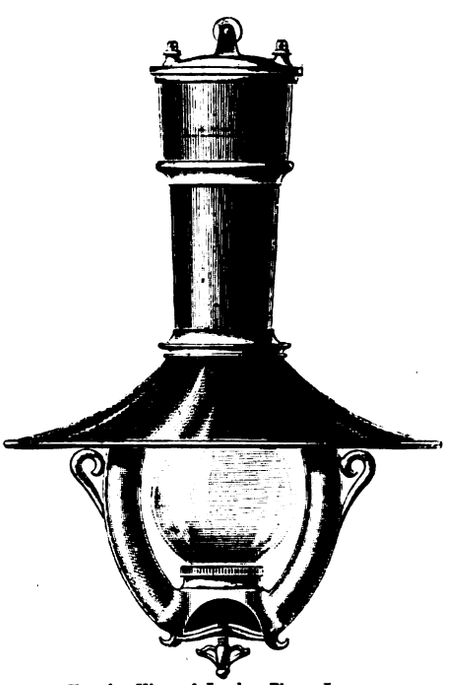

FIG. 4.—View of Jandus Flame Lamp.

the cylinder keeps the walls free from fumes. Basic patents are held for this principle. The consumption of chemicals in the lamp under normal operation only amounts to 15 grains per hour.

Turning now to the question of the chemically-impregnated carbons. It will be realised on seeing the arc of the Jandus lamp that its appearance is entirely different to any of the preceding flame arc lamps. The arc in an open flame lamp is large, and if used with converging carbons is of a fan or bulb shape, as actual combustion or flaming occurs. The arc in the Jandus lamp is comparatively small, long, and thin, and it is to this that the very high efficiency is largely due. It was found that while large arcs (which could easily be produced by certain chemicals) gave a good efficiency, a far more efficient light was given by the same energy spent upon a very small arc, provided suitable chemicals could be found to give such an arc. It was realised that as the light principally came from the arc, it was necessary to have a comparatively long arc to prevent the carbons obscuring the light. A long period of research resulted in a combination of chemicals that would give a small arc of most intense luminosity. These chemicals are applied to the carbons in comparatively small quantities. The carbons are also short and mechanically strong. One pair only is used per

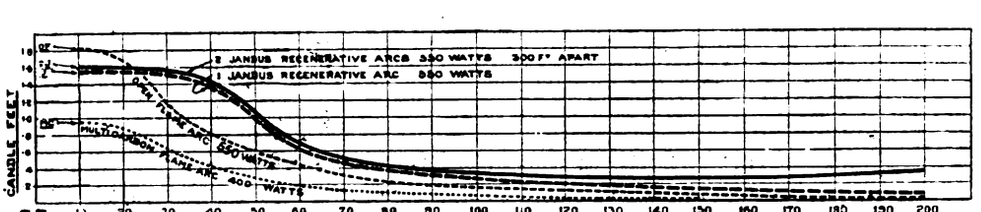

FIG. 3.—Illumination given by different types of Flame Lamps 3' ft. from the Ground.

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trimming against the 20 or so fragile carbons used in some multi-carbon lamps. The resistance is very low; the loss per pair of carbons is less than one volt. Consequently, no metal cores are required.

The arrangement of the carbons, enclosing globes, etc., gives a distribution of light at a most favourable angle, resulting in very even distribution. This feature, combined with the high candle-power of the lamp, enables one lamp to brilliantly illuminate a very large space, the distribution of the light flux being very uniform. The light is a yellow-white colour, somewhat similar to that given by an incandescent electric lamp. The chemicals used in the lamp give a spectrum containing rays all colours; consequently coloured fabrics, etc., are shown in their correct values, and no distorted colour effects are seen similar to those produced by lamps giving monochromatic light, such as mercury-vapour lamps and some forms of flame carbons. The lamps are listed as burning an average of 70 hours. Tests taken on the lamps already in use have in all cases shown longer burning hours than this.

The lamp is the invention of Mr. A. Denman Jones, the manager of the Jandus Arc Lamp Company's works. The lamps are manufactured entirely at the Jandus works in Holloway, and are put upon the market by Messrs. Drake and Gorham, Limited, 66, Victoria-street, London.

EVAPORATIVE AND EJECTOR CONDENSERS FOR STEAM-ENGINES.

The advantages of condensing as compared with non-condensing engines on the score of economy are so obvious and well known as scarcely to call for explanation, but we wish to bring before our readers the types of condensers known as "evaporative" and "ejector," as manufactured by Messrs. Ledward and Beckett, Limited, of 11, Tothill-street, Westminster. One of the most troublesome problems engineers have to deal with is the production of a vacuum with a very limited supply of water, which may have to be purchased from the water company, and it is in such cases as this that an evaporative condenser can be used, with the assurance of obtaining a vacuum equal to that obtained by either a surface or ordinary air-pump jet condenser, without the necessity of pumping or providing the enormous quantities of cooling water that these two latter types of condensers call for.

Fig. 1 shows a Ledward patent evaporative condenser as in use at the Port Talbot Steelworks, South Wales. It will be seen that the condenser consists of a number of patented and specially-constructed pipes, designed to offer a large amount of cooling surface per foot run, arranged or built up to form a series of coils. These coils are erected over a water collecting tank, and are connected at one end to the exhaust-pipe from the engines and at the outlet end of the coils to an efficient air-pump. Water is circulated over these coils at the rate of about one gallon to every pound of steam dealt with. This water passing over the coils takes up the heat from the exhaust steam inside the pipes, and being freely exposed to the air is partially evaporated, and condensation, therefore, takes place within the condenser. After this transfer of heat the steam condensed is discharged by the air-pump as in an ordinary surface condenser. The cooling water not evaporated falls back into the tank under the condenser, to be drawn upon again by the circulating pump.

In practice it is usual for the water service pipe to be connected up to this tank, a ballcock being provided, which keeps the water in the tank at a fixed level, and also allows the necessary quantity of water to pass to make up that loss by evaporation, and no more. The quantity of water used is, we are told, rather less than two-thirds the weight of steam condensed, and this, of course, is constantly varying in direct proportion to the weight of steam condensed.

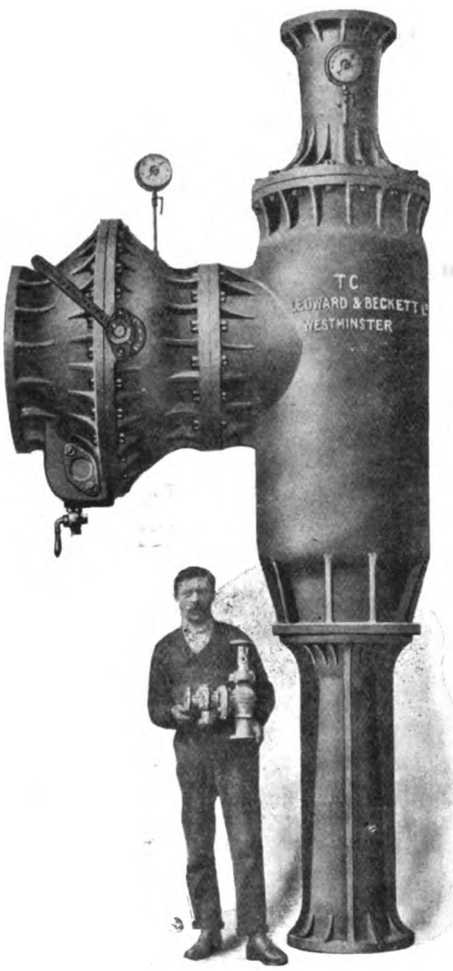

FIG. 2.—Ledward Ejector Condenser.

We understand that these condensing plants have been erected in all parts of the world, including the mining fields of Kalgoorlie, Great Cobar, Western Australia, the power station of the De Beers Consolidated Mines, Bloemfontein, False Bay, Delagoa Bay, India, etc., besides breweries, collieries, mills, steelworks, and in all descriptions of factories where steam is employed.

Fig. 2 shows the Ledward patent ejector condenser, which is only suitable in situations or cases where an ordinarily plentiful supply of water is available for condensing purposes. The

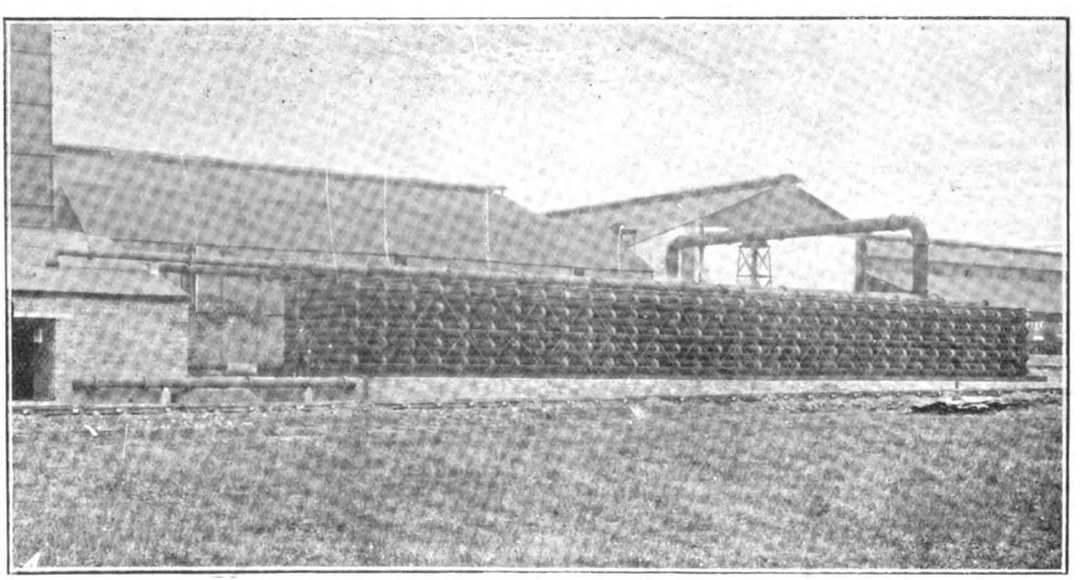

FIG. 1.—Ledward's Evaporative Condenser at Port Talbot Steel Works.

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injection water passes through the condenser in the shape of a solid round jet under a head of about 20ft. This jet of water passes through a series of co-axial cones, and in traversing these cones induces the steam to impinge upon it, thereby mixing and condensing until the water issues from the discharge pipe, a vacuum of 24in. to 28in. being recorded in the exhaust pipe from engine. A number are maintaining a very high vacuum on steam-turbines. The usual method of applying these condensers is to allow the water to flow into them under a head of 20ft., but in cases where a sufficient natural head of water is not available, then it is usual to put down a pump of the centrifugal type for supplying the water to the condenser under the required head.

The ejector condensers should recommend themselves to engineers for their simplicity, entire absence of moving parts, equal efficiency with small and large engines, and ease of connection to high or slow speed engines. The first cost also is so low that it is soon recouped in reduction of fuel consumption.

FERRANTI DIRECT-CURRENT TIME-LIMIT AND OTHER DIRECT-CURRENT RELAYS.

The question whether direct-current time-limit circuit breakers should be installed is a somewhat debatable point. As regards alternating-current circuit breakers on feeders, the question has been decided in favour of inverse time elements, but as regards direct-current circuit breakers the matter has not been definitely settled. Inverse time-element circuit breakers have been installed in many cases. In some cases these have consisted of sucker attachments to the plunger of the release solenoid. This is a very cheap arrangement, but it is doubtful whether it is entirely satisfactory, as the time element will be a function of the condition of the sucking surface. The only way a reliable inverse time element can be attained, which can be adjusted independently of the current adjustment, is by means of a separate relay. A notable installation of such direct-current relays has recently been carried out by Messrs. Ferranti Limited, of Hollinwood, on the main switchboards of the R.M.S. "Mauretania" and "Lusitania." These relays are shown in Figs. 1 and 2. Fig. 1 illustrates a combined relay. This operates on an overload with an inverse time element, but it also operates instantaneously if a reversal occurs. Fig. 2 illustrates the maximum relay, which operates after a time element inversely proportional to the extent of the overload. By reference to the illustrations it will be seen that the current strengths at which the relays work, and the time elements, are all independently adjustable. The relays are of a very strong and substantial construction, such as is necessary for the severe duties they are called upon to fulfil on the boards of such ships as the "Mauretania" and "Lusitania."

Another system of direct-current relays (in this case, however, without time elements) has been carried out on a switchboard at 2,000 volts continuous current. Fig. 3 illustrates the direct-current reverse relays for use on 2,000-volt direct-current circuits. Owing to the high voltage, it was necessary in this case to completely insulate the relay, which was mounted on a slate which was insulated from earth by means of porcelain insulators. The contactor is, however, at earth potential, and the relay operates this latter through the medium of a silk cord. On a reversal, therefore, the *modus operandi* is that the relay operates, pulls the cord, and closes the contactor, which causes the current to flow through the trip-coil circuit. The reversal necessary to operate the relay can be altered by means of a spring adjustment in the contactor box. As this latter is at earth potential it can be safely handled.

All the above relays have for their operating motor a small mercury motor, similar to that used in the well-known new type of Ferranti direct-current meter. Many thousands of these meters are in operation, and the substantial and strong construction of this little motor lends itself admirably for use as a relay motor. A considerable number of such relays are now being put on the market.

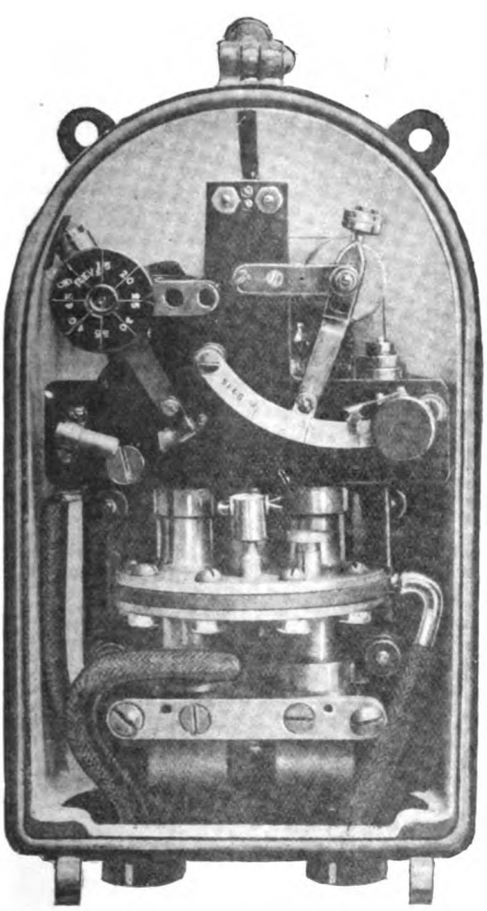

FIG. 1.

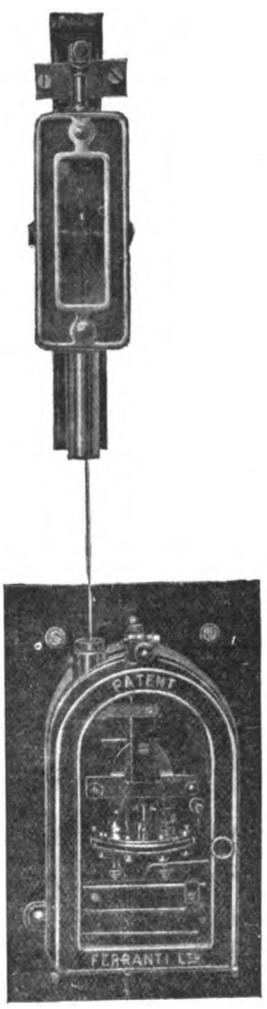

FIG. 3

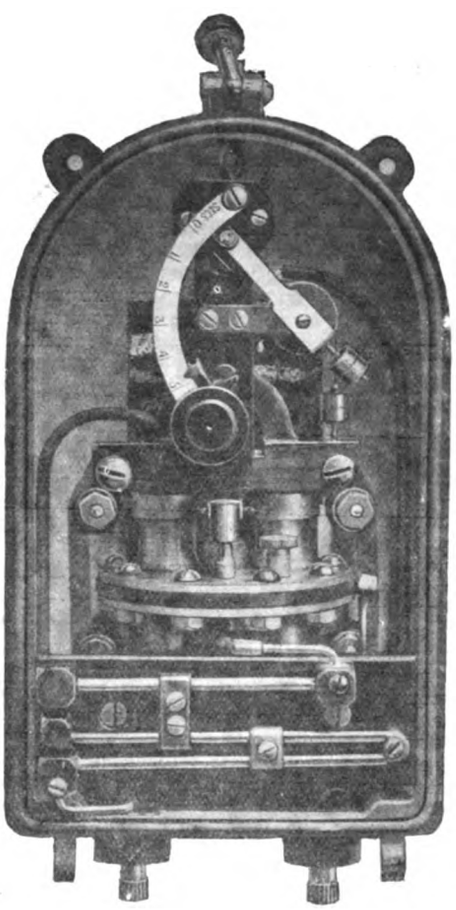

FIG. 2.

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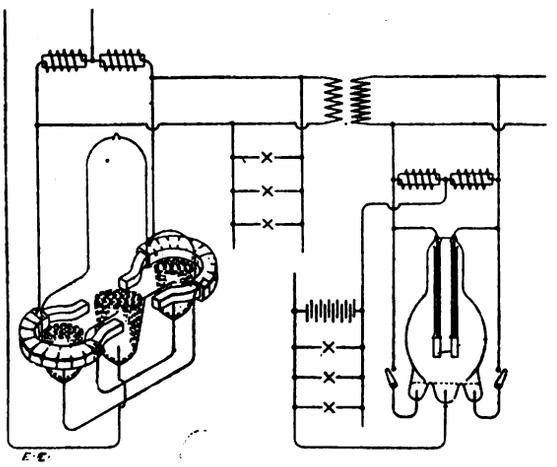
DIRECT-CURRENT TRANSFORMATION.

A patent issued to Dr. E. Weintraub discloses means for the conversion of direct current of one voltage into direct current of another voltage without the use of apparatus with parts. One of the links in the chain of transformation circuits is a circuit carrying alternating current, so that the transportation of the energy may be accomplished at high E.M.F. Use is made of two mercury-vapour converters, one of which transforms direct current into alternating current, and the other rectifies the alternating current.

Principal interest centres in the former converter, which is shown to the right hand in the accompanying illustration.



There are two mercury anodes and one mercury cathode located at the bottom of an exhausted glass receptacle. During operation the arc oscillates back and forth between the two anodes and continuously to the cathode, at a frequency of from three to ten pulsations per second. The shifting of the arcs is attributed by the inventor to the fact that when a mercury-vapour arc starts from one anode its resistance so increases as to become greater than the resistance of the path between the cathode and the other anode. The arc, therefore, shifts over to the other anode, and the phenomenon is continuously repeated.

It has been found that the rate at which the arc shifts between the anodes may be greatly increased by driving the arc which emanates from the cathode spot, by electromagnetic means, back and forth so that it is first nearer to one anode than to the other, then nearer to the latter than to the first, and so on. As indicated in the illustration, two electromagnets are so located that the magnetic field produced by each extends across one of the spaces between the cathode and the electrodes.—*Electrical World.*

SOCIETIES AND INSTITUTIONS.

Institution of Electrical Engineers.

At the ordinary general meeting of the members held on the 20th inst., the Chairman, Colonel R. E. Crompton, announced that the Council had decided that a Kelvin lectureship be established by the Institution, and that a Kelvin lecture be delivered annually. It is also proposed to raise a Kelvin memorial fund, and that the memorial take the form of a statue of Lord Kelvin to be placed in some prominent place in London, and, if possible, to establish the foundation of Kelvin scholarships. The following candidates were elected at the same meeting :

Associate Members.—W. Clark, 152, Fernhead-road, Maida-hill, W.; H. Cooch, 38, Churchill-road, South Croydon ; G. F. Dewynter, 34, Derby-road, Ponder's End, Enfield, N. ; I. H. Jenkins, Telephone House, Victoria-embankment, E.C. ; O. O. Jolly, care of Director-General, India Telegraph Department, Calcutta ; A. G. Lee, Engineer-in-Chief's Office, G.P.O., E.C. ; W. U. Lonnon, Telephone House, Victoria-embankment, E.C. ; F. Pape, 23, Lyell-street, Scarborough ; H. S. Thompson, Telephone House, Victoria-embankment, E.C. ; A. Wallis, 76, Leacroft-road, Derby.

Students.—S. M. Hills, 4, Lyndhurst-drive, Levton, Essex ; E. Pogson, 24, Little-lane, Bradford ; E. H. Webb, 37, St. David's-road North, St. Annes-on-Sea.

Physical Society.

The annual general meeting was held on the 14th inst., when the following officers and council were elected for the ensuing year : president—Dr. C. Chree ; vice-presidents—those who have filled the office of president together with Mr. W. Duddell, Mr. H. M. Elder, Prof. J. A. Ewing, and Dr. W. Watson ; secretaries—Mr. W. R. Cooper and Prof. W. Cassie ; foreign secretary—Prof. S. P. Thompson ; treasurer—Prof. H. L. Callendar ; librarian—Dr. W. Watson ; other members of council — Mr. A. Campbell, Dr. W. H. Eccles, Dr. A. Griffiths, Dr. J. A. Harker, Prof. C. H. Lees, Mr. T. Mather, Mr. A. Russell, Mr. S. Skinner, Mr. S. W. J. Smith, and Prof. L. R. Wilberforce.

In the course of his presidential address Dr. Chree alluded to the deaths of Lord Kelvin and Sir W. H. Perkin. *Inter alia*, he referred to the magnetic results obtained by the National Antarctic Expedition of 1901-4. The expedition had been furnished with magnetographs, and the reduction and discussion of the curves had been entrusted to the National Physical Laboratory. Thanks to the acquiescence of the officials of the Royal Society and the director of the National Physical Laboratory, he was able to give a general preliminary account of some of the results, a full discussion of which would appear in the official publications of the expedition.

Institution of Mechanical Engineers.

The annual report of the council shows that the total number on the roll of the institution at the end of 1907 was 5,238, consisting of nine honorary members, 2,474 members, 2,088 associate members, 68 associates, and 599 graduates, which, as compared with 4,979 at the end of the previous year, shows a net gain of 259. The report states that it is proposed to offer triennially an award of the value of about £40 for the best original paper presented to the institution dealing with "The Development of Road Locomotion." With regard to the work of the Alloys Research Committee, a systematic investigation of the ternary alloys of copper and aluminium with other metals, in the first place with manganese, zinc, and nickel, has been begun, and the investigation of the copper-aluminium manganese alloys is approaching completion. The council have made a small grant to Dr. H. C. H. Carpenter to investigate at the Manchester University the conditions which have to be observed if metal castings are to be capable of being gas-tight and steam-tight. Prof. Burstall is carrying out some experiments with a breakwater and with both optical and string indicators. The research committee on the value of the steam-jacket has met twice during the year, and designs are being prepared by Prof. T. Hudson Beare for carrying out jacket experiments with a larger apparatus than that formerly used by the committee. It is proposed to appoint research committees to inquire into (1) the features of refrigerating machinery in which further investigation is needed ; (2) the transfer of heat across metallic surfaces in contact with water and with gases ; (3) the action of steam passing through nozzles of steam-turbines.

Society of Arts.

The council of the Royal Society of Arts, acting on the report of a committee of judges, have awarded the gold medal offered by the society, under the Shaw Trust for Industrial Hygiene, to Prof. William Galloway, "in recognition of his valuable researches into the action of coal dust in colliery explosions, the outcome of which researches has been the provision of means by which the risk of such accidents is materially diminished, and a consequent great saving of human life effected."

Faraday Society.

At a meeting of the Faraday Society on Tuesday last, Dr. Joseph Knox read a paper entitled "A Study of the Sulphur Anions and of Complex Sulphur Anions," and Dr. V. H. Veley read one on "Hydrolysis as Illustrated by Heats of Neutralisation," in which he dealt with the correlation of hydrolysis and thermo-neutrality.

Royal Meteorological Society.

The papers read at the meeting of the Royal Meteorological Society on the 19th inst. were "Snow Rollers," by Mr. R. Browett, and "A Comparison of Ships' Barometer Readings with those deduced from Land Observations,' by Mr. Ernest Gold.

Royal Institution.

On Saturday, March 7, Prof. J. J. Thomson commences a course of six lectures on "Electric Discharges through Gases. The Friday evening discourse on March 13 will be delivered by Chevalier G. Marconi on "Transatlantic Wireless Telegraphy.

RUBBER EXHIBITION.

An international rubber and allied trades' exhibition is being organised by an influential committee in the interests of the industries concerned. We understand that this is the first exhibition of its kind ever held in Europe. Everything connected with rubber will be shown : first, from the seed to the tree, then from the raw material to the thousand and one articles manufactured wholly or in part from rubber. Most of the rubber-producing countries have decided to be officially represented, and displays are coming from Ceylon, Federated Malay States, Brazil, the West Indies, Mexico, Java, etc.

The exhibition will be held at the Royal Horticultural Hall, Vincent-square, Westminster, S.W., and will open on Monday, Sept. 21, and close on the 28th of the same month.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TELEPHONE QUESTION.

SIR,—It is a very distorted view of the telephone question that Mr. A. R. Bennett sets before your readers The real telephone question is how to ensure the most efficient service and how to develop the service to the widest possible extent. Both those ends are attained by a general measured-rate tariff. A general flat-rate tariff prevents an efficient service and prevents sound development. A measured rate *and* a flat rate simply mean, as Mr. Buxton told the recent deputation, that the telephone user can say to the telephone administration, "Heads I win, tails you lose." Under a general measured-rate tariff the whole body of users pay according to their use, which is a common-sense business principle. The large users have wholesale rates for calls and a cheap tariff for extra equipment—lines and stations It thus becomes easy for them to take proper telephone facilities and give their inward traffic a chance—to the great benefit of the general efficiency of the service.

Measured rates in America have not only produced an extraordinary development of the telephone, but have practically wiped out the ineffective call—which is the curse of the telephone service in every big city having a flat-rate tariff.

The National Telephone Company and the Post Office are wisely following the experience of all the most enlightened telephone administrations in the world in adopting the measured-rate tariff, and have certainly taken *the* step requisite to put the telephone service of this country on the road to high efficiency and wide development.

The defunct municipal telephone systems have proved nothing except how not to do it. This was made reasonably clear by Mr. Buxton, who told the recent deputation that after paying £305,000 for the Glasgow system he was spending another £100,000 on rebuilding it.

As a telephone engineer of far wider experience than Mr. Bennett, having not only been associated with the development of the telephone in America during the most active period of that development, but having continuously studied telephone conditions in every country in Europe, I can affirm that a measured-rate tariff is the only sound method of attaining high efficiency of service and a wide development of the telephone.—Yours, etc.,

HERBERT LAWS WEBB.

METALLIC-FILAMENT LAMPS.

SIR,—In the article by H Remané on "The New Metal-Filament Lamps" in your issue of the 21st inst., it is stated that the energy consumption of the "tantalum" lamp is from 1·8 to 2·1 watts per candle-power. Various tests which I have made on this lamp show that on the average its "inefficiency" is 1·7 watts per M.H.C.P. if the lamp is tested after it has been burning for about 25 hours.

As regards the question of life of "tantalum" lamps on alternating-current systems, I have known many cases where excellent results have been obtained, and it is difficult to understand why the manufacturers so constantly decline to recommend their lamps on alternating-current circuits. Could this disability be removed, the convenient shape of the lamp, and the fact that it may be burned at any angle, should beyond dispute render the "tantalum" the most serviceable high-efficiency lamp yet placed on the market.—Yours, etc., L. M. G.

ELECTRIC RAILWAY OPERATION.

SIR,—With reference to "Greasepot's" letter on the above subject, the 125 cycles was a misprint for 25. The particular phase of service referred to in the above paper was that of surburban work with fast schedules, heavy trains, and frequent stops. This service justifies the title of "heavy and severe," and neither on the Continent nor in the United States are systems of this nature being worked by the single-phase motor. The greater the traffic density the greater the disadvantages of the single-phase system (in the matter of increased weight and cost of train equipments) are shown. Further, the greater the number of stops per mile the lower will be the average power factor in the single-phase system due to the wattless currents taken at starting.

"Greasepot" refers to the possibility of longer transmission lines with single-phase current. Transmission is amply (and more economically) taken care of with three-phase generation and rotary converter sub stations.

The use of "potential control" in conjunction with a transformer is in reality making a virtue of a necessity. The single-phase motor regulates so badly and inefficiently on constant potential that it is necessary to vary the motor voltage according to the load and speed. There is none of the efficient "speed curve running," so valuable a feature of the continuous-current motor.—Yours, etc.,

E. V. PANNELL.

TELEPHONE RATES.

The Bradford Chamber of Commerce (Incorporated) have sent us the following for publication:

To the Right Hon. S. C. Buxton, M.P.,
His Majesty's Postmaster General.

The Memorial of the Bradford Chamber of Commerce (Incorporated).

SHEWETH—Your memorialists refer to their letter to you of the 30th November, asking you to receive a deputation on the subject of telephone rates, and to your reply stating that you had received a similar request from the Newcastle Chamber of Commerce, and asking your memorialists to join with them in such deputation.

Owing to a misunderstanding your memorialists had not an opportunity of representing their views on the occasion on which you received the deputation on the 11th instant. Your memorialists, therefore, crave leave to lay before you the following considerations bearing on the subject of the memorial presented to you by the Association of Chambers of Commerce and of your reply thereto dated 11th November, 1907.

1. The present so-called "flat-rate" system of charge is not a "system of fixed charge" under which "a fixed

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amount is paid for a telephone service by each subscriber irrespective of the use made of the telephone." It is, in fact, a measured or graduated rate—"proportionate to the amount and kind of service required by each subscriber."

The service enjoyed by a subscriber is limited in the first instance to the capacity of the one line for the use of which he subscribes. Should his requirements increase so as to exceed this capacity he must, in order that he may enjoy an increased service, apply for a second line and pay an additional subscription for it. The following are illustrations—taken from actual instances—of the working of this system:

A. B. and Co., making 20 calls per day, have one line and pay	£10	0	0	per year.
C. D. and Co., making 45 calls per day, have two lines and pay.....	18	5	0	„
E. F. and Co, making 90 calls per day, have five lines and pay.....	48	15	0	„
G. H. and Co., making 166 calls per day, have six lines and pay	59	0	0	„
J. K. and Co., making 300 calls per day, have nine lines and pay	74	0	0	„

It is clear, therefore, that the present system does not involve a "liability to provide a continually increasing service for the same price," but that the charge is actually graduated according to the extent of the service rendered to the subscriber.

2. The maintenance of this system is not inconsistent with the policy of offering to small users, as an inducement to subscribe, either the privilege of paying by the so-called "measured rate," or that of sharing a line with another subscriber.

3 In considering whether under the present system the larger "user gets his service under cost price at the expense of the smaller user," regard should not only be had to the number of calls the subscriber makes. A subscriber who has bought, say, 500 calls is not bound to spread them over the whole year or to limit his requirements to those calls, and in regulating their standing charges the company cannot assume that he will do so. Moreover, in many cases the small subscriber desires not so much to call as to be called, and the inward calls, for the sake of which he subscribes, may be very large whilst his outward calls are nominal. Accordingly, no calculation of the relative cost of the service rendered to different customers would be fair which paid regard only to the calls the subscriber himself makes.

4. The adoption of any system with the object of restricting the use of the telephone by subscribers would be a retrograde step. It would be difficult to draw the line between messages which are reasonable and those which are unreasonable or frivolous, and the subscriber ought not to be placed in the position of considering before he rings up the exchange by which adjective the message he proposes to send would properly be described. So far as overloading of the lines is concerned, it is now the practice of the company to tell any subscriber that his line is overloaded, and to bring pressure to bear on him to subscribe for an additional line in consequence.

5. In regard to the increase of charge which would result from the proposed new system, it is pointed out that the following would be the result of that system to the subscribers named in paragraph 1 above, even without adding on the proposed junction call fees:

A. B. and Co.	in lieu of	£10	would have to pay about		£18.
C. D. and Co.	„	£18. 5s.	„	„	£37.
E. F. and Co.	„	£48. 15s.	„	„	£76.
G. H. and Co.	„	£59	„	„	£126.
J. K. and Co.	„	£74	„	„	£218.

6. Your memorialists, therefore, urge that the subject of the proposed "measured rate" is one of serious import to all telephone users, and ought to be fully considered from their point of view. The use of the telephone has increased so enormously that what was at first a luxury has become a business—and to a large extent also a private—necessity. This result has been brought about by means of privileges in the nature of a monopoly granted to the company by the State, and has been achieved by them at great profit to themselves on the basis of the present system. They should not now be allowed without very full and careful inquiry and proof of real necessity to impose further burdens on the public, whom they have by the means and on the basis indicated induced to make the use of their system a practical necessity.

7. Your memorialists realise that the subject is not one which can be adequately discussed with a large and miscellaneous deputation. They respectfully urge, however, that before so great an alteration of system is finally adopted as a permanent policy means should be taken to ascertain fully and in detail the views of the telephone users of all classes.

And your memorialists will ever pray, etc.

HERBERT A. FOSTER, President.
P. ANDERSON, Secretary.

SLOW-SPEED MOTORS.

SIR,—On reading through my answer to Question No. 1,037 in your issue of Feb. 21, I regret to note that in writing the article hurriedly to catch the post I appear to have made an error in it. The second line above the table of figures should, of course, read, "For a given size of frame the more the poles the less the material, and the greater the labour." Further, I observe that in the second column, p. 272A, the explanation of the relation of various designs one to another is not entirely clear. I should have pointed out that, when speaking of the result of doubling the number of poles, I referred to the effect on a frame of fixed over-all diameter and length irrespective of horse-power and speed.

I trust you will be able to oblige me by finding space for these corrections.—Yours, etc, R.

INTERNAL-COMBUSTION ENGINES AS APPLIED TO ELECTRICAL GENERATION.*

BY H. G. BIGGS.

Internal-combustion engines may be classified as follows: (1) oil-engines, in which the fuel is supplied as paraffin, petrol, or alcohol, using these terms as class names, covering many varieties; (2) gas-engines, working on (*a*) town or lighting gas, (*b*) producer gas; (*c*) blast-furnace or coke-oven gas.

The chief value of the oil-engine in electrical work is as prime mover in small isolated plants. The amount of attendance required is very small, and in cleanliness of working, and in the time required for starting up, it is superior to steam plant. The ease with which the liquid fuel may be transported, in conjunction with its relatively small volume, renders the oil-engine well adapted to the generation of current for military purposes—namely, for searchlights, Röntgen-ray work, and the like.

Unlike the oil-engine, the development of the gas-engine has rapidly proceeded to the largest units, and sets of 1,000 h.p. and 2,000 h.p. are now in successful operation. The cost of town or lighting gas prohibits its use in any but the smaller sizes of gas-engines. It would be necessary for town gas to be supplied at 1s. per 1,000 cubic feet to ensure economical working. The gas-engine fed by means of producer-gas plant, however, is a prime mover particularly well suited to the purpose of electrical generation. Producer gas is obtained by passing air and steam through incandescent coal or coke. Two simple reactions take place, expressed by

$$2C + O = 2CO.$$

$$C + H_2O = CO + H_2.$$

That is, the oxygen of the air combines with the carbon of the fuel to form carbon monoxide, and the steam, together with more carbon, forms more of the monoxide and free hydrogen. Commercial producer plant consists of the producer, which is a cylindrical casing lined with refractory material, and charged with fuel from the top by means of a hopper, together with purifying apparatus, for delivering as the final product a cool, dry gas having a thermal value of between 130 B.Th.U. and 160 B.Th.U. per cubic foot.

* Abstract of paper read before the Northampton Institute Engineering Society, Feb. 21.

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In electrical generating plant the load changes rapidly, and in most cases full load is required only for short periods of time. With the steam-engine as prime mover, this would necessitate boilers of sufficient capacity to meet the full load. Producer plant of less than full-load capacity can run steadily all day, and store gas in a gasholder. The peak of the load curve can then be dealt with by the engine working on the stored gas. Since the gas contains its energy chemically locked up, and independently of temperature, there are no radiation losses. The question of fuel economy may be left with the statement that a good steam plant will burn from 3lb. to 5lb. of coal per brake horse-power hour, while a gas-engine with producer plant requires 1lb. of anthracite per brake horse-power hour. The stand-by losses—an important point in connection with central-station work—are remarkably small with producer plant.

The reliability of the gas-engine has been greatly increased by the incorporation into its construction of the best features of modern steam design, notably in the development of a popular type of vertical multiple-cylinder gas-engine. For running alternators in parallel, close speed regulation is essential. In the case of gas-engines this necessitates two impulses per revolution, obtained by the use of multiple cylinders with the cranks set at equidistant positions on the main shaft. The cyclical variations of turning moment are then eliminated, but irregularity in speed is liable to be caused by unequal distribution of the work amongst the respective cylinders.

An analysis of the public electricity supply undertakings of the British Isles shows that 15 stations, with outputs varying between 33 kw. and 1,600 kw., employ gas-engines as prime movers. In two stations the engines are used for generating alternating current. There still remains a certain amount of prejudice against the large gas engine as being in an experimental stage, whereas Continental experience shows conclusively that the gas-engine now takes its place as a thoroughly reliable prime mover of high thermal efficiency and of great commercial value as a means of utilising low-grade fuels.

It is calculated that for every ton of pig-iron produced per hour in blast furnaces 480 e.h.p. is available, but wasted as gas burned at the mouths of the furnaces. The pig-iron output of Great Britain for the year 1906 was 10,149,388 tons. This means that considerably over one million horse-power was continuously dissipated which could have been utilised by means of gas engines working on the waste furnace gases, and generating electricity.

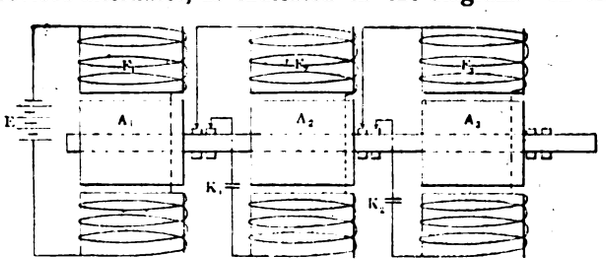
The ideal method of extracting and distributing the energy contained in coal is to centralise all sources of power over the coalfields of the country, the units being large internal-combustion engines coupled to dynamos. The utilisation of the lower-grade fuels and the high thermal efficiency of the internal-combustion engine would, undre these circumstances, permit of the supply of vast quantities of energy in its most convenient form and at very cheap rates. A really universal distribution of energy in this manner would be of great economic value in paving the way for reforms connected with manual labour and industrial conditions generally.

A HIGH-FREQUENCY ALTERNATOR.

Among the many unsolved problems in wireless telegraphy and telephony there is probably none which is of such importance as that of the construction of a high-frequency alternator. To be able to produce a continuous train of oscillations of the frequency commonly employed in wireless work would solve completely the problem of syntony—a difficulty which has not yet been overcome satisfactorily.

In his evening discourse before the British Association for the Advancement of Science on "The Arc and the Spark in Radiotelegraphy," Mr. W. Duddell makes the following statement: "If it should prove possible to construct alternators for these very high frequencies, we shall be able to obtain a sufficient number of consecutive oscillations of the current in the aerial of definite frequency to enable very sharp syntony to be obtained. Not only will this greatly reduce interference troubles in wireless telegraphy, but such alternators will be of the greatest value in wireless telephony." In the same address the author further points out the great difficulties that are in the way of constructing an alternator to give such high-frequency currents, and illustrates it by the following example: If it were required to build an alternator to work at a frequency of 100,000, and assuming that the alternator can be driven at the high speed of 30,000 r.p.m., the alternator could not have a diameter much above 6in. for fear of bursting. Now, since the alternator makes 500 revolutions per second, it will be necessary for it to generate 200 complete periods for each revolution, so that the space available for the windings and poles for one complete period will be less than $\frac{1}{10}$in.—a space into which it is quite impossible to crush in the necessary iron and copper to obtain any considerable amount of power. It would, therefore, appear that in following the principles usually adopted in the design of alternators of low-frequency currents, we cannot hope to obtain a satisfactory solution of the problem; and it follows that the design of a high-frequency alternator will have to be based upon some other principle than that employed heretofore.

Mr. Louis Cohen, in a recent article in the *Electrical World*, suggests the use of several alternators mounted on a common shaft, the first field being excited by a direct current and the field of each successive alternator by the alternating current supplied by the armature of the previous alternator, as indicated in the diagram. In this



way, if all the alternators have the same number of poles, the frequency of the second alternator will be twice that of the first, the frequency of the third alternator will be three times that of the first, and so on, increasing in arithmetical progression. The effect is clearer if the machines are supposed to be multiphase ones. The rotating field set up in alternator No. 2 by the current from armature No. 1 will revolve at the synchronous speed corresponding to the frequency of armature No. 1. If the direction of rotation of the field is arranged to be opposite to that of the mechanical rotation of the armatures, the frequency of the current induced in armature No. 2 will be equal to the sum of the frequency of alternator No. 1 and the frequency of rotation of alternator No. 2—the slip of alternator No. 2 will, in fact, be 200 per cent. relatively to the alternator No. 1.

There are, of course, some difficulties which will suggest themselves in the construction of such a machine. For one thing, the exciting current being alternating will necessitate the use of very fine laminated iron in the field magnets; and as the frequency becomes very high the use of iron may become entirely prohibitive owing to the excessive loss due to eddy currents, and this, of course, will greatly diminish the power generated by the alternators. Of course, in all such cases it is pretty hard to tell *a priori* which would be the best arrangement—the use of iron with its consequent losses or the elimination of iron entirely. This can best be determined by experiment.

SAN FRANCISCO 4,000-KW. GAS-ENGINE PLANT.

Excellent reports are received from the 4,000-kw. gas-engine-driven Crocker-Wheeler alternators in the Martin station of the California Gas and Electric Corporation. Parallel operation, which before the installation was made was thought impracticable, has been successfully accomplished. The machines remain in step even against back explosion in the engine cylinder, which is the most severe condition possible. There is one instance recorded when the back explosion was tremendous enough to throw one of the generators out of step, but even in this instance the generator regained its step instantly, and without the assistance of the station attendants.—*Electrical World*.

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INSTITUTION OF ELECTRICAL ENGINEERS.

Students' Section.

The fourth annual dinner of the above Institution was held at the Holborn Restaurant on Monday last, the whole of the evening's proceedings being carried through with great success. Unfortunately, the president (Colonel Crompton, C.B., M.I.C.E.) was unable to be present through indisposition. The speeches in connection with the numerous toast proposed were both instructive and amusing, and these, together with an excellent musical programme, helped to make the evening doubly enjoyable.

The toast of "The President and the Institution" was proposed by Mr. C. C. ABELL (vice-chairman of the Students' Section) and responded to by Mr. W. M. MORDEY, who referred to the bad attendance at the students' meetings. These meetings afforded opportunity for friendly intercourse which would otherwise not be met with. He also said that if estimating classes were installed in the colleges, it would be beneficial to the students; this subject, as well as drawing, being of particular importance to engineering students.

Mr. HAMMOND, who proposed the toast of "The Students' Section," said that curiosity was a habit which ought always to be cultivated. He made a very amusing speech which was much appreciated. This toast was responded to by Mr. E. W. MOSS (chairman of the Students' Section).

Mr. B. A. COOPER proposed the toast of "The Colleges," which was responded to by Prof. S. P. THOMPSON, who said that with regard to the remarks made by Mr. Mordey he thought that commercial engineering was better learned in commerce than in college, and that he himself had introduced the question of estimating on dynamo design into his classes with excellent results.

The toast of "The Guests" was proposed by Mr. BERNARD THOMPSON (hon. secretary, Students' Section), and responded to by A. O. LAIRD, Esq. (chairman, Mechanical Institution, graduates' section).

POST OFFICE ENGINEERING DEPARTMENT.

Fifth Annual Dinner.

The above dinner was held at the Grand Hotel, Trafalgar-square, on Tuesday, Feb. 18, Major O'Meara, C.M.G., R.E., engineer-in-chief, presiding.

The guests of the evening included the Right Hon. Sidney Buxton, M.P. (Postmaster-General), Mr. Babington Smith, C.B., C.S.I. (secretary), Mr. A. F. King, Mr. H. S. Carey, Mr. A. M. J. Ogilvie, Sir John Gavey, C.B., Sir John Cameron Lamb, C.B., C.M.G., Hon. R. D. Denman, Lieut.-Colonel Price, C.M.G., Dr. Glazebrook, Dr. Walmesley, Mr. G. Morgan, Mr. A. E. Eames, Mr. J. Kingsbury, Mr. H. Hirst, Mr. J. W. Willmot, etc.

After the Royal toasts had been duly honoured, the POSTMASTER-GENERAL (Mr. Buxton) rose to propose the toast of "The Engineering Department." In the course of a long speech he referred to the loss of Lord Kelvin and Mr. Gaine, and to the retirement of Sir John Gavey, and paid a tribute to the staff of the engineering department on the manner in which they had carried out their duties under many difficulties. On the question of wayleaves, Mr. Buxton said he was endeavouring to pass a Bill through the House of Commons giving the Post Office greater powers of dealing with the obstruction of individuals to the telegraph and telephone lines. With regard to wireless telegraphy, they already had two Post Office stations at which they were making experiments, and were about to install two commercial stations. He congratulated Major O'Meara on the great success which was following the Institution of Post Office Electrical Engineers.

Major O'MEARA responded to this toast. He said there were small grounds for anticipating in the coming years that their engineers would be less busy than in the present year. They had a great deal of work to carry out in connection with telephone trunks and telephone exchanges. They had also to carry out the completion of the western underground, and by the end of next year ought to reach the cable-landing places near Penzance. The underground line between Newcastle and Leeds would be proceeded with this year, while authority had been given to link the old northern route and the new western route.

Mr. NOBLE proposed the toast of "The Visitors," to which Mr. BABINGTON SMITH replied, while the toast of "The Chairman" was proposed by Mr. H. R. KEMPE.

A SEVERE TEST FOR LARGE GAS-ENGINE PLANT.

The *Western Electrician* describes an interesting case of the successful overloading of large gas-engine-driven railway generators during a recent heavy snow and wind storm at Milwaukee. The storm brought the traffic on most of the interurban lines and on the street railway system to a standstill for from 24 to 36 hours. The Northern Railway, however, with its power-house 20 miles away from the city, continued to run. This line was supplied with current from one of two 1,000-kw. alternators direct-coupled to Allis-Chalmers four-cycle double-acting twin-tandem gas-engines. When going through the heavy snow a single interurban car took as much as 550 h.p., whilst the snow-plough took considerably more, the result being that a load fluctuating between 280 h.p. and 2,400 h.p. was thrown on to the gas-engine. The engine acted quite satisfactorily, and met the load variations so quietly that, except by means of the watt-meters, it was difficult to notice them.

PUBLICATIONS RECEIVED.

The *Official Circular* of the Tramways and Light Railways Association for February contains the latest list of members, a large number of new members having joined on Jan. 1, 1908; matters relating to light railways; a copy of the judgment in full, delivered last July in the case of the Attorney-General *v.* Yorkshire (Woollen District) Electric Tramways, Limited, in regard to car licences; a copy of the Board of Trade returns of tramways and light railways just published.

"THE UNIVERSAL ELECTRICAL DIRECTORY" (J. A. BERLY'S), 1908, published by H. Alabaster, Gatehouse, and Co., Ludgate-hill, E.C. Prices post free in the United Kingdom are 14s., Colonies 15s., United States of America 18s., other countries 16s. (The "A" edition, started a few years ago for the convenience of home and Colonial firms, contains the British and Colonial and general sections only, price 4s. less in each case.) The 1908 edition consists of four sections: the British, with 14,790 names; Colonial and general, with 5,050 names; Continental, with 7,838 names; U.S.A., with 5,875 names—a total of 33,553 names. Among other useful information, lists of all electricity undertakings in the United Kingdom, British Colonies, and some other countries are given, showing the nature of the supply, system of distribution, capacity of plant, voltage, and chief engineer's name, and, in the case of alternating current, the phase and periodicity also appear.

"THOM'S DIRECTORY OF THE MANUFACTURERS AND SHIPPERS OF IRELAND, 1908." Dublin: Messrs. Sealy, Bryers, and Walker, 94 and 96, Middle Abbey-street. Price, 10s.

The *Bulletin* of the Imperial Institute. London: Eyre and Spottiswoode, Fleet-street. 1s. net.

FORTHCOMING EVENTS.

FRIDAY, FEB. 28.

Royal Society of Arts.—At 8 p.m., "The Removal of Dust and Fumes in Factories," by Dr. J. Scott Haldane.

Institution of Electrical Engineers (Manchester Local Section). At 6.30 p.m., annual dinner at the Midland Hotel.

SATURDAY, FEB. 29.

Institution of Electrical Engineers (Students' Section).—At 10 a.m., visit to Brimsdown power station.

MONDAY, MARCH 2.

Institute of Marine Engineers.—At 8 p.m., at the London Institution, Finsbury-circus, E.C., "The Organisation of the Staff in Engineering Works," by Mr. Matthew Lang.

TUESDAY, MARCH 3.

Institution of Civil Engineers.—At 8 p.m., discussion on paper "The New York Rapid-Transit Subway," by Mr. W. B. Parsons.

Civil and Mechanical Engineers' Society.—At 8 p.m., at Caxton Hall, "Notes on Engineering Works in Austria and Bosnia," by Mr. A. S. E Ackermann.

Institution of Electrical Engineers (Manchester Local Section). At 7.30 p.m., at the University, "Investigation on the Operation of Enclosed Fuses," by Prof. A. Schwartz and Mr. W. H. N. James.

THURSDAY, MARCH 5.

Institution of Electrical Engineers.—At 8 p.m., at Institution of Civil Engineers, Great George-street, "Fuse Phenomena" by Prof. A. Schwartz and Mr. W. H. N. James.

SATURDAY, MARCH 7.

Royal Institution.—At 3 p.m., "Electric Discharges through Gases," by Prof. J. J. Thomson. (Lecture I.)

Liverpool and District Electrical Association.—At 2.30 p.m., visit to the works of the British Insulated and Helsby Cables, Prescot.

P. and O. Batti-Wallahs' Society.—At 6.30 p.m., at the Holborn Restaurant, annual dinner.

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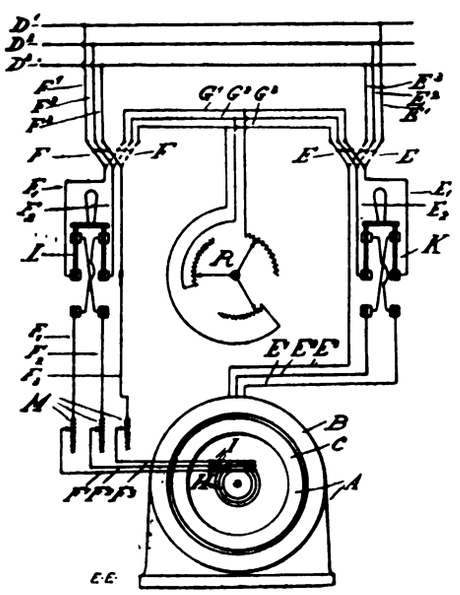
A NEW ALTERNATING-CURRENT MOTOR.

A patent has recently been issued to Carl Alfred Lohr, of Schenectady, N.Y., for the invention of an alternating-current motor of the class particularly of rotary-field motors in which alternating currents of different phases are used for generating the magnetic rotary field. The object of the invention is to provide a simple means for changing the speed of the motor and to do away with the changing of the number of poles or the use of different stators or rotors. The invention broadly consists of an alternating-current motor so arranged that its speed may be readily changed, and this will be easily understood from a reference to the accompanying illustrations.

The diagram given below indicates the electrical connections used for changing the speed of the motor. The alternating-current motor is represented by A, and B shows the stator and C the rotor. D^1, D^2, and D^3 are main conductors connected with a three-phase alternating-current source, and E^1, E^2, and E^3, when in contact with a double-throw, triple-pole switch, E, energise the stator. Three other supply conductors, F^1, F^2, and F^3, when in contact with the double-throw, triple-pole switch, F, serving to energise the rotor. Auxiliary conductors, G^1, G^2, and G^3, have interposed therein a regulating resistance, R, and are properly connected with the conductors G^1, G^2, and G^3, and thus connected with the switch E when thrown as shown in the full-drawn position, or connected with the switch F when thrown as shown in the dotted position of the switch.



The arrangement of this alternating-current motor differs from the usual construction in that both parts of the motor generate rotary fields when supplied from the alternating-current source. The speed of these rotary fields may be either the same or different. The speed may be different by the use of a different number of poles in the stator and rotor, or by connecting the stator and rotor each with a source of electricity, each having a different periodicity. Also the direction of rotation of the rotary fields in the stator and rotor may be the same or different. Two other cases also are possible—either to generate a rotary field in the stator and connect the rotor with the variable resistance, R, or connect the stator with the variable resistance, R, and connect the rotor with the current supply. When only the stator is connected with the line, and the switch F is thrown so as to make connection with the conductors G^1, G^2, and G^3, and thus connected with the variable resistance, R, the motor will run asynchronously with the speed of the stator field. When, however, only the rotor is connected with the line—that is, the switch, F, making connection with the conductors F^1, F^2, and F^3, and the switch E thrown so as to make connection with the conductors G^1, G^2, and G^3, and thus connected with the variable resistance, R—then the motor will run asynchronously with the speed of the rotor field. When both members, stator and rotor, are simultaneously connected with the line — that is, the switch E making connection with the conductors E^1, E^2, and E^3, and the switch F making connection with the conductors F^1, F^2, and F^3—and when the rotary fields are generated in opposite directions, having properly thrown the reversing switches, K and L, then the motor will run synchronously with a speed equal to the sum of the rotary field speed. When the rotary fields in stator and rotor are generated so as to rotate in the same direction, having properly thrown the reversing switches, K and L, then the motor will run synchronously with a speed equal to the difference of the rotary field speeds.—*Electrical Review* of New York.

BRUCE PEEBLES AND CO.

An extraordinary general meeting of the shareholders of Bruce Peebles and Co., Limited, was held at Edinburgh on Monday to consider a resolution for the voluntary winding up of the company. The chairman (Mr. W. Carmichael Peebles) presided over a large meeting.

The CHAIRMAN said the conditions with which the company had had to contend during the past year, culminating in the present crisis, might be summed up under the following heads: (1) the need of further working capital for the carrying on of the business, accompanied by the extreme stringency of the money market; (2) for the same reason the stoppage of practically all new contract work; (3) the very high prices of raw material; (4) the low price obtainable for the company's ordinary manufactures through undue competition. It had been found impossible to raise further money on a satisfactory basis owing to the condition of the money market. All new contract work had been delayed, whereas, had they been going on during the year as was fully anticipated, the company would now have been receiving the profits derivable from them. In nearly all cases prices of raw material had been on a considerably higher basis than the company was paying in 1906, and that was particularly the case with reference to copper. Whan the company was formed the prices obtainable for its ordinary manufactures were nearly double what they were to-day. There had been a constant decline in prices brought about, first, by foreign competition when they had dumping from abroad, and latterly by the continued competition of home firms. The company had some valuable specialities, the benefits from which had only recently begun to tell. The directors had from time to time taken every possible step to reduce costs of manufacture, and the result of last year's efforts in that direction had been of a satisfactory nature. With regard to the large Moscow tramway contract, for which the company was in treaty, an option had been obtained, and it was hoped it would be of benefit. Continuing, the chairman said he wished to impress upon the shareholders that the business connection and experience of the company was a valuable one, and that if they agreed to a scheme of reconstruction the company might emerge from the crisis stronger than ever. The combined holding of his family was £78,000 in shares. The joint liquidators would at once consider whether a scheme of reconstruction was feasible.

The resolution was carried.

The *Financial Times* stated on Wednesday morning that answers had been lodged in the Edinburgh Court of Session for Mr. C. J. Shields, a preference shareholder of Bruce Peebles and Co., Limited, objecting to the appointing of Mr. Andrew Wilson Tait, C.A., London, as official liquidator, on the grounds that he was not subject to the jurisdiction of the Court, that it was inexpedient that a director should be appointed liquidator, and that the expense attendant on the appointment of a London accountant was undesirable in the interests of economy.

CATALOGUES, LISTS, ETC.

Cryselco, Limited, Kempston Works, Bedford, have issued an illustrated card showing the advantages of Cryselco lamps. Mention is made of an 800-hour test recently made with a "Cryselco" and six lamps of other makes, and it is stated that the "Cryselco" gave 5,300 more candle-power hours at a cost of 11 units less than the best of the other six.

Messrs. Arthur Cort and Co., Bullace Works, 303½, Camberwell-road, London, S.E., have just issued their latest wholesale price-list of insulating hard or flexible vulcanised fibre; balata, guttapercha, and cotton belts; Chatterton compound, ebonite, vulcanite, etc. The dielectric strength of red vulcanised fibre is attested by the result of a test upon a sample made at the Westminster Electrical Testing Laboratories. The sample submitted was §in. thick. Besides testing the fibre as submitted, two samples approximately two-thirds and one-third of the thickness respectively were cut off and tested separately. It was found that a thickness of ·625in. broke down with 16,100 volts alternating, that a thickness of ·405in. broke down with 13,000 volts, and ·220in. with 7,900 volts. The substance was tested between two plates each of four square inches area, and the temperature of the surrounding air was 71deg. F. The material was not specially dried, but tested as received.

Messrs. Wm. McGeoch and Co., Limited, 28, West Campbell-street, Glasgow, have sent us three leaflets dealing with gas-tight switches and fuses, S.W.B. type main switches, and tubular switch fuses of the "M.G." type. The first-named have been specially designed for colliery work and for use in exposed positions. The S.D.B. switches are of the knife type.

From the Union Electric Company, Limited, Park-street, Southwark, London, S.E., we have received a little booklet dealing with the subject of factory lighting by means of arc

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lamps. The booklet has been specially prepared for circulation by contractors anxious to obtain electric lighting installations.

The Westminster Electrical Testing Laboratory, York-mansion, York-street, Westminster, S.W., has issued a booklet containing a scale of fees for testing lamps, instruments, etc.

The 1908 catalogue of lifting tackle issued by the Mork Patent Pulley Block Company, 42-44, Moor-lane, London, London, E.C., describes "Mork" and "Original" pulley blocks, electric travellers, wall crabs, etc. It also describes and illustrates the "Nonfrict" system of overhead runways and the "Mork" scaffold chains for builders.

Messrs. J. H. Holmes and Co., Portland-road, Newcastle-on-Tyne, have published a list of lighting and power installations which they have carried out for mining work. Installations have been carried out at the Sekondi Mines, West Africa, and at a number of mines in the North of England and elsewhere.

PERSONAL.

The Southend Town Council have increased the salary of Mr. Birkett, the electrical engineer, from £450 to £500 per annum.

Mr. J. Wilkinson, electrical engineer to the Hull Corporation, has had his salary increased from £400 to £500 per annum by four annual increments of £25.

Mr. E. W. Martin, of Stepney, has been appointed assistant distribution engineer in the electricity department of the metropolitan borough of Woolwich out of 43 applicants.

Dr. William Mansergh Varley, assistant professor of physics and electrical engineering at the Heriot Watt College, Edinburgh, has been appointed headmaster of the technical school at Devonport.

The Hull Corporation have increased the salary of their tramways manager, Mr. W. J. McCombe, from £450 to £500 per annum by two annual increments of £25 each, the increase to take effect from April 1.

The *London Gazette* announces that the partnership between Messrs. G. S. Aveyard and J. Hallsworth, carrying on business as electricians and engineers at 11, Ashton-road, Denton, near Manchester, under the title of the Denton Electrical Construction Co., has been dissolved by mutual consent.

The staff and employés of the Blackpool Corporation tramways have presented Mr. H. S. May, who for some years has been resident engineer of the department, with a gold watch, suitably inscribed, on the occasion of his leaving to fill an important position with the London County Council.

Mr. Thomas Taylor, chief superintendent of the Post Office telegraph department at Bristol, has been appointed postmaster of Colchester. Mr. Taylor entered the service of the old Magnetic Telegraph Co. in 1868, and was formerly postmaster of Goole and Ashton-under-Lyne.

A compliment well deserved was passed at the last meeting of the Acton Council. It was agreed to accord a very hearty vote of thanks to the electrical engineer (Mr. J. Martin Blair) and the committee responsible for the organisation of the recent electricity exhibition, which was such a great success.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Perth.—An explosion of gas occurred on the 22nd inst. at the Palace Restaurant, Perth.

St. Marylebone.—The Electricity Committee are recommending an extension of the electricity mains along Union-street from Cleveland-street.

Erith.—The Council have decided to supply electricity to the municipal cottages by ordinary carbon-filament lamps through prepayment meters.

Stretford.—Provision has been made by the Council for duplicating and extending the electricity mains. Land has also been secured upon which to extend the generating station.

Frome.—The Local Government Board will hold an inquiry on March 10 into the Council's application for sanction to a loan for the purposes of their electricity undertaking.

Ashton.—The Town Council have decided to install electric lamps in several roads throughout the borough in place of the antiquated method of gas lighting hitherto prevailing.

W. T. Henley's Telegraph Works Co.—The directors recommend a dividend on the ordinary shares of 15 per cent. less income tax, including the interim dividend of 5 per cent.

Wigan.—The Board of Guardians have decided to seek the relative merits of electricity and gas lighting in the new workhouse infirmary by inviting tenders from firms representing both industries.

Liquidation.—The *London Gazette* announces that the Accumulator and Motor Construction Co. has been wound up voluntarily, and Mr. Jesse Smith, 79, Queen-street, Cheapside, London, E.C., appointed liquidator.

Birmingham.—The electric supply department have decided to dispose of plant at their Dale End station. The detailed list of the apparatus may be obtained from the city electrical engineer. See advertisement.

Southampton.—The Electricity Committee are recommending the Council to authorise the electrical engineer to lay mains for electrically lighting the Terrace House Estate, Polygon, at a cost of £200, and cables as required.

Edinburgh.—The installation of the condensing plant at the M'Donald-road electric power station, Edinburgh, is practically completed and will soon be at work. There will shortly be erected two steam turbo-generators, each of 1,200 kw.

Woolwich.—The London County Council have agreed to advance £3,000 to the Borough Council to cover expenditure incurred and to be incurred in the purchase of electrical apparatus for letting on hire and for wiring consumers' premises on the hire-rental systems.

Brompton and Kensington Electricity Supply Co.—The directors of this company recommend a dividend of 11 per cent. per annum on the ordinary shares for the half-year, making 10 per cent. for the year, to place £4,000 to reserve, and allow £8,000 for depreciation, carrying forward £10,136.

Stoke-on-Trent.—The report of the electrical engineer shows that during the month of January 53,400 units were supplied, an increase on the corresponding period of last year of 90 per cent.; and that the number of consumers now on the books is 347, representing a total of 15,129 8-c.p. lamps for lighting and heating and 466½ h.p. in motors.

Merthyr.—The Town Council have passed a resolution that, having in view the abnormally high prices charged for public lighting at Merthyr Vale and Aberfan, the Council consider the advisability of approaching the Merthyr Electric Traction and Lighting Co. with a view of ascertaining their terms for the lighting of these districts by electricity.

Cape Town.—At a special meeting of the Town Council the report of a special committee on the reorganisation of the electric scheme was considered, and, after a lengthy discussion, was adopted. The report recommends the abandonment of the existing power station and the immediate construction of a new one. The estimated cost of the new scheme is £35,000.

Croydon.—A serious gas explosion occurred at 190, Brighton-road, Croydon, on Saturday evening. The occupier, Mr. J. T. Reeve, was cut in the head and face, and his son Percy, aged 19, was bruised about the head and back. The stairway leading from the first to the second floor was destroyed, and other parts of the house were damaged to the extent of £100.

Oldham.—At a meeting of the Oldham Electricity Committee it was reported that the units sold for lighting and power purposes during the past fortnight were 75,005, against 55,645 during the same period last year; for traction 154,886 units, against 146,364. There was an increase of 36 incandescent lamps and two motors, equivalent to 116 lamps of 8 c.p.

Stirling.—The report of the electrical engineer shows that for the four weeks ending Jan. 18 47,060 units were generated at the power station, as against 44,635 for the corresponding period of last year. The number of connections in equivalent 8-c.p. lamps was 23,953, as against 21,487 at the same date last year. The Town Council have agreed to transform the lighting of Gladstone-place from gas to electricity.

East Ham.—The erection of the new cooling towers at the electricity works has been completed. The Electricity Committee have adopted a pamphlet prepared by the engineer which is to be circulated in connection with the hire of arc lamps at an inclusive charge per quarter, together with a draft form of application and agreement to be entered into by consumers who wish to avail themselves of an installation under this system.

Macclesfield.—A petition signed by 2,034 users of gas has been forwarded to the Corporation. The petition is headed as follows: "We, the undersigned, wish to express our dissatisfaction with the inferior quality of gas supplied to this town; we contend that the present poor quality of gas is injurious to the eyes and health of many. We should be pleased if this matter, when brought before the Gas Committee, should be carefully considered, and steps taken for improving the quality of the gas."

Douglas.—At a meeting of the Town Council a special committee appointed to inquire into the advisability of providing an electric plant for the town asked for permission to engage an expert to advise them. The request was refused by 11 votes to 10, it being argued that the present means of lighting the streets and the tram systems were satisfactory, and that as the Corporation were already bound to a number of schemes involving large expenditure they could not at present undertake to provide an electrical undertaking.

County of London Electric Supply Co.—The directors have decided to recommend the payment of final dividends upon the preference shares of the company at the rate of 6 per cent. per annum for the half-year ended Dec. 31, 1907, less income tax, and on the ordinary shares of the company at the rate of 6 per cent. per annum, less income tax, for the half-year ended Dec. 31, 1907, making 5 per cent. for the year on the ordinary shares. The sum of £25,000 has been placed to reserve for depreciation, and £4,381 carried forward.

Electrical Development Co. of Ontario.—The Canadian Agency state in their weekly circular that negotiations are practically complete for transferring the control of the Electrical Development Co. to the Toronto Railway Co., or rather its subsidiary, the Toronto and York Radial Railway Co. It is proposed that the latter company will issue bonds to be guaranteed by the Toronto Railway Co., which will pay off the Electrical Development Co.'s floating debt and furnish a working capital. Common stock of the Electrical Development Co. will be transferred to the Toronto Railway Co. sufficient to assure it the control.

Yarmouth.—The decision of the Town Council to substitute electricity for the existing gas lamps at 54 points has upset the gas companies considerably. They now make certain suggestions as to

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alteration of prices. These have been met by an offer of the Electricity Committee to supply a better light at a more reasonable cost. The Council, in spite of the overtures from the companies, have decided to approve of the principle of gradual substitution of electricity for gas for lighting the public streets of the borough, and have requested the Electricity Committee to formulate a scheme and submit the same, together with a report from the borough accountant on the matter.

P. and O. Batti-Wallahs.—The third annual dinner of the P. and O. Batti-Wallahs' Society will take place on Saturday, March 7, at 7.30 p.m., at the Holborn Restaurant. At the annual general meeting recently held a number of new features were approved, the most important being that members are now being divided into three classes. This admits a new class, to be called associates, who will have all the advantages of full membership although they may not have been to sea in the P. and O. S. N. Co.'s services The balance-sheet show the finances of the society in very good state, the amount carried to this year being over full £11, and the membership had increased to nearly 100.

Lye.—On Monday a disastrous explosion by gas occurred in a cottage inhabited by a man named Moore and his family in Attwood-street, Lye. Early in the evening the lights of the house went out, and Mrs. Moore went to the gasmeter for the purpose of inserting a penny, by which means she hoped to procure more light. However, after she had done this no light was forthcoming, and her husband then went to the meter. It was then that there was a rush of gas into the room, and an explosion occurred. The roof of the cottage was blown off, and practically the whole of the furniture was wrecked. Moore himself miraculously escaped injury, and his wife only received a slight injury. It has since been ascertained that the main gas-pipe in the street had burst.

Baildon.—The Baildon District Council have considered a scheme for electric lighting in their district submitted by the Bradford Electrical Engineering Co. A representative attended the last meeting on behalf of the company, and laid before the Council a comprehensive lighting scheme, including the erection of a generating station. The members of the Council were favourably impressed with the scheme, which is to be further considered a month hence. Several members expressed the opinion that if a canvass of the district showed a fair number of applications for current for power purposes and inside lighting, it would be a serious question as to whether it would not be to the advantage of the district to carry out the scheme.

Southend.—At the last meeting of the Electricity Committee the electrical engineer reported that an accident had occurred to No. 1 engine, which had resulted in the temporary total disablement of this machine, and estimated that the cost of the repairs, which were now being executed, would amount to £35. The electrical engineer also reported that it would be necessary to expend the sum of £300 in addition to that already estimated by him in connection with the erection of a condenser at the electricity works, and it was resolved that application be made to the Local Government Board for a loan of this amount. The Local Government Board will hold an inquiry on March 5 into the application of the Corporation for sanction to borrow £26,690 for purposes of the electricity undertaking.

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: Commercial Cable Co.'s further issue of £82,917 sterling 500-year 4 per cent. debenture stock; Cordoba Central Buenos Ayres Extension Railway's further issue of £250,000 5 per cent. debentures of £100, Nos. 20,001 to 22,500; and Shawinigan Water and Power Co.'s further issue of £49,455 4½ per cent. perpetual consolidated mortgage debenture stock. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Great Western and Great Central Railways Joint Committee's scrip (fully and partly paid) for £2,500,000 3½ per cent. guaranteed stock; and Montreal Light, Heat, and Power Co.'s scrip (fully and partly paid) for 400,000dol. 4½ per cent. first mortgage bonds.

Wireless Telegraphy in Africa.—The council of the Liverpool Chamber of Commerce have adopted a resolution urging the Government to introduce wireless telegraphy installations in British possessions abroad. The President (Sir Alfred Jones) said it was hoped that the Colonial Office would establish the system in West Africa, but they had urged that it was not feasible. However, Signor Marconi had been consulted, and he expressed his confidence that there would not be the slightest difficulty in working it. In these circumstances it was hoped that the Government would take early action. Inquiries showed that the cost of laying a cable for Southern Nigeria and Lagos would be £20,000, and the cable companies wanted a guaranteed income of £4,000 a year before they would lay the cable. As against this the cost of installing wireless apparatus would be only about £2,000, the cost of working being the same.

West Ham.—The Council on Tuesday decided to apply to the Local Government Board for sanction for a loan of £51,600 for electricity purposes. The estimates of the electrical engineer set forth that a total of £71,925 capital would be wanted to meet the requirements of his department up to March 31, 1910. Of this total £36,630 was set down for generation purposes, £28,250 for distribution, and £7,045 to cover an excess on a previous loan. The Electricity Committee recommended that the Council get power to borrow the £71,925, but the Finance Committee, in view of the financial position, put forward a counter proposal that the loan be one for £51,600 only, that being the extent of the requirements to March 31, 1908. Alderman Littler, chairman of the Electricity Committee, said that the progress of the work of his department would certainly need the larger sum, but he added that he did not object to the proposal to make a second application, and the Finance Committee's proposal was adopted.

Rochdale.—On the 25th inst. Major J. Stewart, R.E., held a Local Government Board inquiry to consider the proposal of the Council to borrow £22,175 for purposes of electric lighting. It was pointed out to the inspector that recently there had been a large increase in the consumption of electricity, and more capital was required to meet the needs of the plant. During the last four years the consumption of electricity had increased from 1,600,534 units to 2,728,688 units, the largest increase being for purposes of traction. The capital expenditure in 1905 was £66,413, and in 1907 £81,807. The net profit last year was £1,135. 15s. 2d. Major Stewart said he noticed there were losses during the first three years the works were in operation, and the general manager, Mr. Atchison, informed him that altogether £5,543 had been taken from the rates for the purposes of meeting deficits, and the works had during the past four years repaid £5,350. Major Stewart said from what he knew of the beginning of the works that was a more satisfactory account than he expected to receive. There was no opposition.

Bedford.—Mystery surrounds the circumstances under which the town of Bedford was temporarily deprived of its gas supply on Friday night. At midnight the main tap at the works from which the town is supplied with gas was for some unexplained reason turned off, with the result that the whole place was immediately plunged in darkness. The resident engineer was quickly informed of what had happened, and he promptly turned the gas on again. The result was that in a large number of rooms, principally bedrooms, where gas had been left burning all night the gas began to escape. One of the chief sufferers was the Rev. Paull Wyatt, who happens to be chairman of the gas company. He was awakened in the night to find that he could scarcely breathe, and it was only with considerable difficulty that he managed to reach a window, which he opened. The company, it is said, have received a large number of similar complaints, but, so far as is known, fortunately no fatalities have resulted from the occurrence. The engineer's reason for turning on the gas again was that the company supplies gas to the railway signal boxes, and it was feared that some serious accidents might have been caused had he not acted as he did.

TRACTION.

Royton.—The Board of Trade have sanctioned the borrowing by the District Council of £5,372 for tramway extensions.

Southend.—The Town Council have decided to charge 1½d. per unit for power supplied to the light railways department.

Brighton.—The proposal to consult an expert traffic manager, with a view of improving the prospects of the Corporation tramways, has been abandoned for the present.

Woolwich.—The Borough Council have decided to ask the Greenwich Council to co-operate with them in an endeavour to get the London County Council to construct tramways from Beresford-square to Eltham.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Feb. 18, 1908, converted to gold, were £3,554; corresponding period 1907, £3,675; decrease, £121. Aggregate from Jan. 1, 1908, £25,520; aggregate from Jan. 1, 1907, £25,646; decrease, £66.

Brentford.—The District Council has decided to call on the tramway company to repave its track on the main road and replace all worn metals, as the Council is of opinion that much of the noise complained of is due to the defective state of the track. Failing compliance with the request, proceedings are to be taken under the Tramway Act of 1870.

Newcastle.—At the last meeting of the Tramways Committee it was stated that the receipts had dropped between £30 and £40 per day during the present week, and last week they dropped £100. It was decided to empower the chairman and vice-chairman of the committee and the manager of the tramway to make such arrangements as they might think advisable for curtailing the traffic.

Hull.—The Corporation Tramways Committee have agreed to make a contribution of £20,000 towards the reduction of the rates for the ensuing year. According to the balance-sheet, the Chairman states the estimated income to March 31 is £129,555, and the estimated expenses £100,158, a surplus of £29,397. After making the above grant at the request of the Finance Committee, he reckons they will have a balance of about £12,000.

Spain.—The *Gaceta* of Feb. 7 notifies that the Compañia del Ferro-carril de Sarriá á Barcelona have applied for a concession for an electric tramway in Barcelona, and that a period of one month from the date of publication has been appointed for the presentation of more favourable proposals. The *Gaceta* of Feb. 11 notifies the approval of the transfer of an electric tramway concession granted to the Seville Tramways Co. to the Compañia Sevillana de Electricidad.

Liversedge.—The District Council have decided to write to the Board of Trade "as to the impracticability and absurdity of the local tramway company's suggestion that the Council should take over a small incompleted portion of the light railway within the Council's district"; and a numerously signed ratepayers' petition has been acknowledged, in which the Council were asked to oppose to the utmost any attempt by the company to abandon the construction of such line.

Edinburgh.—A line of 50 cars, extending nearly the whole length of Princes-street, was to be observed on Saturday night shortly after 10 o'clock. The cause of the breakdown was the jamming of the points at the West-end, where the Lothian-road cars turn off. As this occurred at a period of the evening when the cars are usually well filled, some inconvenience was caused. A number of the passengers retained their seats until the obstruction was removed, the service being resumed after a lapse of about 20 minutes.

Belfast.—At the weekly meeting of the Electrical and Tramway Committee on the 24th inst., Sir James Henderson presiding, the manager, Mr. Andrew Nance, recommended the acquisition of three

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sets of Tierney's automatic point controllers at £80 each for experiments. If successful they will be applied to all the points, the total cost being about £3.500. The present system by which the points are moved by boys costs £1,750 per annum. The tenders for the supply of cables for the coming year were referred to a sub-committee for report.

Moscow.—A London syndicate, headed by Lord Stanley, has been formed to complete the construction of the electric tramways and railways in Moscow. The Municipality of that city undertook the work some years ago, but, after spending 17.000,000 roubles upon it further progress was so hampered by the action of the revolutionary agencies that the Municipality gave up the task and contracted for the remainder with a well-known Edinburgh firm, and the syndicate referred to having come to its aid, the operations are now expected to go forward without further delay.

Bahia Blanca and North-Western Railway.—An increase in the capital has been agreed to by the creation of £1,000,000 4½ per cent. guaranteed shares, to rank *parri passu* with the existing £1,250,000 4½ per cent. guaranteed shares, but the directors have no intention of making an immediate issue. Additional facilities are required owing to the increased area of land put under cultivation. The electrical installation to supply power for working the machinery on the company's mole at Puerto Galvan is nearing completion, and grain elevators have been built in order to deal with the shipment of grain in bulk.

Dundee.—Tramway traffic on the Maryfield and Baxter Park routes was interrupted for three-quarters of an hour on Saturday by a simple but alarming accident which occurred to the section box in King-street. The horse yoked to a lorry laden with flax, which was waiting at a warehouse in the thoroughfare, became restive and moved forward. A bale of flax collided with the section box and wrecked it. Some alarm was caused, but the occurrence was automatically signalled at the electric station at Dudhope-crescent-road, and the current for the section switched off. Fortunately no one was injured. A staff of workmen were soon on the spot, and were able to fix up the wires so that in three-quarters of an hour, as stated, traffic was resumed.

Aberdeen.—The Tramways Committee of Aberdeen Town Council have resolved to recommend that six additional cars be fitted with top covers at an estimated cost of £155 each, the cars to be ready before next winter. There are at present 35 covered cars, and the six additional will make 41. The contract for the supply of tramway tickets has been secured by J. R. Williams and Co., Liverpool, their offer being 1½d. per 1,000 for 17.000,000 tickets. The question of doubling the fare charged for cars running to and from Pittodrie Park on the occasion of football matches was raised by the Lord Provost, and the tramway manager was instructed to make inquiries as to the practice in other towns and to report. The reasons given for the proposed increased fares are that men have to be specially employed for the Pittodrie Park traffic, and that the cars have to wait at Pittodrie until the finish of the matches.

Tividale.—A serious tramway accident occurred on the 20th inst. at Tividale, on the Birmingham and Midland line, between Dudley and Oldbury, involving the loss of the life of the conductor and injuries more or less serious to 12 passengers. Whilst the car was crossing the points one of the wheels broke, causing the tram to capsize. The conductor, James McCabe, residing at Oldbury, who was at the time collecting fares from passengers on the top deck, fell underneath the overturned car, and when extricated was found to be dead. The driver had a miraculous escape from being killed. The majority of the passengers, who were hurled in all directions, were on the top deck, and sustained injuries necessitating the removal of nine to the local hospital. The traffic was suspended for several hours, and ultimately the car was drawn on the metals by three traction engines. At the place where the accident occurred the roadway is under repair.

Cardiff.—The Tramways Committee met on Tuesday last to consider the estimates for the coming year. The estimates for the tramway section were: traffic expenses, £32,244; general expenses, £8,356. 9s. 9d.; power expenses, £14,150; general repairs, £13,475; special items, £1,588. 17s.; loan charges, £45,166. 9s. 8d.; making a total of £114,970. 16s. 5d. The estimated income was: from fares, £112.500; sale of current to electric light department, £14,250; advertising, £2 000—total, £128,750, leaving a surplus of £13,779. 3s. 7d. The actual expenditure for the year ended March 31. 19 7, was £119.115, and the estimated expenditure for the year ending March 31, 1908, was £120,515. In respect of the electric lighting department the engineer estimated that the expenditure and loan charges would be £43,905. 9s. 8d., and he anticipated a net profit of £1,594. 10s. 4d. The estimates were approved. The electrical engineer laid before the committee a report concerning a recommendation that the present charge of 1d. per unit for energy supplied to the electric lighting department from the tramways power station should be reduced, as such a charge had become excessive during the past year as a result of the plant installed on account of electric lighting becoming remunerative in consequence of its being loaded up. The engineer observed in the report that the present station at Roath is becoming more and more a lighting station year by year, until such a time will arrive that the output for tramways will form a very small proportion of the total. He, therefore, recommended that the power station should be treated quite independently, and that each department should be charged with the actual number of units at the cost of productio , plus the proper proportion of loan charges and depreciation, based upon the actual amount of capital expended for tramways and lighting purposes respectively. By this means a fair charge would be made against each department. The recommendation was approved by the committee.

York.—Colonel Boughey on Tuesday presided over a sitting of the Light Railway Commissioners to hear the application of the York Corporation for a light railways order enabling them to install electric trams in the city under certain conditions. The York Corporation were represented by Mr. Tyldesley Jones, who in his statement on behalf of the Corporation observed that the area of the city was 3,682 acres, and, roughly speaking, the city was about three miles in breadth, as also from north to south, with a rateable area of £406.985. The population to be served numbered about 91.000, inclusive of the residents in the suburbs. After explaining the various routes proposed to be served by the suggested five lines, Mr. Jones said that such a railway was greatly needed in all the quarters to which it was proposed to extend the tramway. The two outside bodies interested—the Parish Council of Water Fulford and the Rural District Council of Escrick—had each passed a resolution supporting the scheme. The Corporation were unanimously in favour of the Corporation owning the tramways, but were not quite so unanimous as to whether the system should be worked by themselves or by a company. They were proceeding in the promotion of that light railways order upon the understanding that before the question was finally settled a poll of the ratepayers should be taken as to how the order should be carried out. The complete cost of the tramways on the surface-contact system was estimated at £128,000. Witnesses were then called in support of the application. The Lord Mayor (Alderman Sir Joseph S. Rymer) said there was a public necessity for an up-to-date light railway in the city. Alderman R. H. V. Wragge, chairman of the Corporation Tramways Committee, said the Corporation were not at present prepared to work the proposed tramways themselves. It was desired to take a poll as to whether (1) the Corporation should construct and work the system; (2) whether they should construct it and then lease the working; or (3) whether they should lease the whole undertaking to a company. Having been addressed at considerable length by the advocates of both parties, the Commissioners retired for private consideration of the matter, and, on returning, the chairman announced that the Commissioners thought they would grant the application.

Bury.—The tramways manager reported to the Tramways Committee at their last meeting that the increase in the receipts from April 1, 1907, to date was £6.146. 17s. 3d. Of this £4.558. 14s. 6d. were attributed to the extension of the Bolton-road section, leaving a net increase for the other sections of £1,588. 2s. 9d. After allowing for the increased receipts on the Bolton-road section, the average weekly increase on the Bury sections during the past four weeks was £23. 11s., as compared with a year ago. The receipts per car mile had been 10·86d., against 10·07d. a year ago. On the Radcliffe section, after allowing for the additional length in Black-lane, the average weekly increase during the past four weeks was £7. 11s. 2d. The car mile receipts had been 7·64d., against 7·35d. The gross receipts from April 1, 1907, to Jan. 12, 1908, were £45.911. 4s. 6½d.; previous year, £40,293. 0s. 11d. To Feb. 9, 1908, £49,771. 7s. 6d.; previous year, £43 624. 10s. 3d., being an increase for the 45 weeks of £6.146. 17s. 3d. The total receipts on the Bury sections to Feb. 9, 1908 (45 weeks), were £34,310. 4s. 4d.; previous year, £29,373. 15s. 7½d.—total increase, £4.936. 8s. 8½d.; average per week since April 1, £762. 9s.; last year, £550. 13s. 8d.; increase per week, £111. 15s. 4d. The average number of passengers carried per week has been as follows: ordinary, 98,731; previous year. 86.458; workpeople carried at single fare for double journey. 22,545; previous year, 17,391—totals 121,276, previous year 103,849. The total receipts on the Radcliffe sections to Feb. 9, 1908 (45 weeks), were £8,168. 13s. 6½d.; previous year, £7,227. 11s. 10d.; increase, £941. 1s. 8d.; average per week since April 1, £181. 10s. 6d.; previous year, £160. 2s. 1d.; increase per week, £21. 8s. 5d. The average number of passengers carried per week has been as follows: ordinary, 36,366; previous year, 30,529; workpeople carried at single fare for double journey, 11,657; previous year, 8,603—totals 48,023, previous year 39,132. The total receipts on the Heywood sections to Feb. 9 (45 weeks) were £6.609 18s. 3½d.; previous year, £6,366. 1s. 7d.; total increase, £243. 16s. 8½d.; average per week since April 1, £146. 17s. 9d.; previous year, £141. 9s 4d.; increase per week, £5 8s. 5d. The average number of passengers per week were: ordinary, current year, 19 597; previous year, 18,723; workpeople carried at single fare for double journey, current year, 6,742; previous year, 6,869—totals 26,339, 25,592.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Vich (Catalonia).—The Municipality invite tenders for electric lighting. Tenders by March 2.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Bremerhaven.—Tenders are invited by the Harbour Authorities for 27 electric cranes. Tenders by March 2.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for lead-covered cable. Tenders by April 20.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Bukharest.—The Municipality of Craiova invite tenders for the construction of tramways. Deposit, £200. Tenders by March 13.

Wigan.—The Board of Guardians invite tenders for the erection of an electrical installation at the new workhouse infirmary at Billinge.

Cassel.—The Prussian State Railways invite tenders for a three-ton travelling crane, together with electric motor. Tenders by March 27

Hackney.—The Borough Council invite tenders for the annual supply of arc lamp carbons. Tenders to the Town Clerk by March 12.

Madrid.—The Public Works Department invite tenders for the construction of an electric tramway in Barcelona. Tenders by March 7.

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Hornsey.—The Town Council invite tenders for meters and fuse boxes, cables, troughing, etc. Tenders to the Town Clerk by March 16.

Brazil.—The Government invite tenders for the installation of electric light and power supply in the city of Florianopolis. Tenders by March 5.

Oporto.—The Municipality invite tenders for the construction, maintenance, and working of tramways in Nova de Gaya. Tenders by March 11.

Madrid.—The Post and Telegraph Department invite tenders for laying, etc., telegraph cable between Chefarinas and Argelia. Tenders by March 30.

Radcliffe.—The Urban District Council invite tenders for low-tension three-core cable. Particulars from the Electrical Engineer. Tenders by Feb. 29.

Acton.—The Urban District Council invite tenders for meters, cables, steel tubing, etc. Particulars from the Electrical Engineer. Tenders by Feb. 29.

Heston and Isleworth.—The Urban District Council invite tenders for the annual supply of electrical stores and electric cables. Tenders by March 2.

Charleroi (Brussels).—Tenders are invited for the electric lighting of Charleroi. Particulars can be obtained at 58, Rue de Louvain. Tenders by March 9.

Dundee.—Tenders are invited by the Electricity Supply Committee for sub-station converters and apparatus, and switchboards. Tenders by March 2.

St. Pancras.—The Borough Council invite tenders for the supply of arc lamp carbons for 12 months. Tenders to the Town Clerk by March 23. See advertisement.

Fulham.—The Borough Council invite tenders for the annual supply of stores, including general and electrical stores. Tenders to the Town Clerk by March 11.

Hackney.—The Borough Council invite tenders for the supply of coal to the electricity works. Particulars from the Town Clerk, to whom tenders must be sent by March 12.

Spain.—Tenders are invited by the Corunna Harbour Board for three 3-ton electric cranes. Estimate, £4,618. Tenders to the Junta de Obras del Puerto de la Corunna by March 13

Handsworth.—The Urban District Council invite tenders for 315-kw. engine and dynamo and switchgear, and feed pump, economiser, and pipework. Tenders by March 4.

Birmingham.—Tenders are invited by the Electric Supply Committee for alterations and additions to existing offices and generating station, Dale-end, Birmingham. Tenders by March 3.

New South Wales.—Tenders are invited for 33 switchboards for private branch exchanges for common-battery working at the Postmaster-General's department. Tenders by March 4.

Bray (Ireland).—The Urban District Council invite tenders for the supply of coal for the electric light works. Tenders to Mr. P. MacDonnell, clerk, Town Hall, Bray, by 10 a.m. on March 3.

Gloucester.—The Electricity Supply Committee invite tenders for the supply of rough slack steam coal. Particulars from the City Electrical Engineer. Tenders to the Town Clerk by March 19.

Stoke-on-Trent.—The Electricity Committee invite tenders for one 300-kw. steam generator and surface-condensing plant and a water-tube boiler. Tenders to the Chairman by March 14. See advertisement.

Bury.—The Corporation invite tenders for the supply and erection of two 2,000-kw turbo-alternators, with exciters and condensers Tenders to the Town Clerk by March 16. See advertisement in last issue.

Finchley.—The Urban District Council invite tenders for the supply and erection of one 700-kw. high speed engine and dynamo combined. Tenders to Mr. E. H. Lister, clerk to the Council, by March 2.

Dundee.—The Tramways Committee invite tenders for the supply of stores for one year from May 16. Particulars from Mr. P. Fisher, the general tramway manager. Tenders to the Town Clerk by March 6.

Leicester.—Tenders are invited by the Tramways Committee for the supply of clothing for the employés. Tenders to the Chairman, Tramways Committee, 20 and 22, Humberstone-gate, Leicester, by March 14.

Middleton (Lancs.).—The Corporation invite tenders for the supply of coal for the electricity works. Particulars from the Borough Electrical Engineer. Tenders to the Chairman of the Electricity Committee by March 9.

Manchester.—Tenders are invited for the supply and erection of cooling towers at the generating station. Particulars from the Chief Electrical Engineer. Tenders to the Chairman of the Electricity Committee by March 10.

Beckenham.—The Urban District Council invite tenders for battery of accumulators, one reversible booster, milking booster, and switchgear, and automatic stokers with driving gear and accessories. Tenders to the Clerk by March 9.

Oldham.—Tenders are invited by the Tramways Committee for the supply of uniform clothing for the tramway employés during 12 months ending March 25, 1909. Tenders to the Chairman, Wallshaw Depôt, Oldham, by March 3.

Heywood.—Tenders are invited for plant required in connection with the electricity works extensions. Specifications, etc., from Mr. J. R. Salter, the consulting engineer, Atherton, Lancashire. Tenders to the Chairman of the Electricity Committee by March 16.

Edinburgh.—The Edinburgh District Board of Lunacy invite tenders for certain electro-medical appliances required in the hospital, Bangour Village Asylum. Particulars may be obtained on application to Mr. James Kyd, clerk, Castle-terrace, Edinburgh. Tenders by Feb. 29.

Birmingham.—The Electric Supply Committee invite tenders for extension to main flues, economisers, boiler and engine foundations, etc., at electric generating station, Summer-lane, Birmingham. Tenders to the Chairman of the Electric Supply Committee by March 3.

Ilford.—The Urban District Council invite tenders for the supply of stores to the electricity and tramway departments required during the year ending March 31, 1909. Particulars from Mr. A. H. Shaw, M.I.E.E., Electricity Works, Ley-street, Ilford, Essex. Tenders by March 10. See advertisement in last issue.

London, S.W.—The London County Council invite tenders for the manufacture, supply, and delivery of the points and crossings for the junctions, cross-overs, etc., required for the reconstruction, on the overhead trolley system of electric traction, of the existing tramways from Brixton-road to near Camberwell Green. Tenders by March 10.

Grimsby.—The Corporation invite tenders for the supply of: (Specification No. 56) consumers' electric supply meters (motor type); (60) house service and fuse boxes: (59) oil, engine-room stores, arc lamp carbons, globes, etc. Specifications from Mr. W. A. Vignoles, M.I.E.E., borough electrical engineer, Electricity Works, Grimsby. Tenders by March 4.

Melbourne (Australia).—The Postmaster-General invites tenders for the construction and laying complete of two submarine telegraph cables between the State of Victoria and the State of Tasmania. Tenders must be accompanied by a deposit of £1,000. Tenders to the Secretary, Postmaster-General's Department, 51, Spring-street, Melbourne, by April 14. See advertisement.

Wimbledon.—Tenders are invited for the annual supply of stores for the electricity department, including (1) engine-room stores; (2) joint boxes and jointing material; (3) transformers; (4) meters; (5) oils; (6) incandescent electric lamps, carbons, and accessories; (7) castings; (8) firebricks and fireclay. Particulars from the Chief Electrical Engineer. Tenders to the Town Clerk by Feb. 29.

Sydney (N.S.W.).—The Municipal Council invite tenders for the supply and delivery into their stores of maximum demand indicators of the thermal pattern. Specifications, etc., may be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W., on payment of a deposit of £1. 1s., which will be refunded on receipt of a *bona fide* tender. Tenders to Messrs. Preece and Cardew by March 5. See advertisement.

London, E.C.—Tenders are invited for the supply of (1) steel rails (50lb.) and fishplates, about 425 tons; (2) tiebars, gibs, and cotters, about 42 tons; (3) fishbolts and nuts and spikes, about 25 tons; (4) switches and crossings, 45 sets switches, 101 crossings, for the South Indian Railway Co. Specifications, etc., may be obtained at the Company's Offices. Tenders to the Chairman and Directors of the South Indian Railway Co., 55, Gracechurch-street, London, E.C., by March 3.

Wrexham.—The Town Council invite tenders for the supply of stores to the Electricity Department, including engine-room stores, tools and ironmongery, cables, cable-jointing requirements, double-pole service cut-outs, meters, incandescent lamps, arc lamp carbons, lubricating oils, coal, wood troughing etc., boiler scale solution, consumers' installation materials, special firebricks for Meldrum's refuse destructor. Particulars from the Borough Electrical Engineer, Willow-road. Tenders to Mr. Lawson Taylor, town clerk, by March 6.

RESULTS OF TENDERS.

Huddersfield.—The tender of Mr. John Senior for the supply of 4,000 tons of coal for the power station has been accepted.

Norwich.—The Town Council have accepted the tender of Messrs. Laurence and Scott, of Norwich, for an electric motor for the Roturbo pump at Trowse at £450.

Lochgelly.—The Lochgelly Coal and Iron Co. have placed an order with Messrs. Johnson and Phillips for the complete erection of a 3,000-volt overhead transmission line for their Lochgelly works.

London.—The London County Council have accepted the tender of Messrs. Johnson and Phillips for supplying and laying cables in connection with the extension of tramways in Seven Sisters and Caledonian roads.

Yarmouth.—The Town Council have accepted the tender of Messrs. Browett, Lindley, and Co., of Manchester, for a 580-h.p. engine coupled to a dynamo made by Messrs. Crompton and Co., for the sum of £1,681. 19s.

Southend.—The Corporation have accepted the tender of the Chloride and Electrical Storage Co. for the provision of a positive battery at a cost of £420 and for the maintenance thereof, upon payment of £37. 15s. yearly, for a period of 10 years.

Victoria.—The tender of G. Sweet, Carlton, has been accepted for the supply of 5,850 conduits of six ducts each and 3,750 conduits of four ducts each for £1,643. 18s., and that of W. McLean and Co., Melbourne, for 50 telephones (wall sets), at £3. 4s. 3d. each, £160. 12s. 6d.

New South Wales.—The Postmaster-General has accepted the tender of R. B. Hungerford, of Sydney, for five additional subscribers' sections and one junction-line section and extension in connection with new switchboard at the Central Telephone Exchange, Sydney, for the sum of £9,809.

Tasmania.—The tender of W. T. Henley's Telegraph Works Co., Melbourne, has been accepted for lead-covered cable, silk and cotton

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insulated, with 104 pairs of 12½lb. conductors, for £163, and that of the British Insulated and Helsby Cables, Melbourne, for hard-drawn copper wire, 70lb. to the mile, for £532.

London.—The Highways Committee of the London County Council recommend that the contract with the Electric Construction Co. for the manufacture, supply, and delivery of motor-generators, etc., entered into be extended so as to include the 150-kw. motor-generator for Hammersmith station, at a cost of £541. 10s.

Birmingham.—The Birmingham Tame and Rea Drainage Board have accepted the tender of Messrs. Johnson and Phillips for the complete erection and equipment of a 6,600-volt transmission line in connection with the new storm-water pumping plant which is being installed, the contract for which was placed with Messrs. Johnson and Phillips some months back.

London.—The Highways Committee of the London County Council have recommended that the contract with P. and W. Maclellan for the supply of flat-bottomed rails, etc., for car-sheds entered into be extended so as to include the supply of about 115 tons of two kinds of flat-bottomed rails required for the first portion of the central car-repair depôt in Woolwich-road, at a price of £7. 6s. 3d. a ton, together with bolts, fishplates, etc.

OPENINGS FOR CONTRACTORS.

ACCRINGTON—Public baths, James-street (£9,500), Town Council.

ABERDARE—County school, County Education Committee.

ABERDOVEY — Extensions to Trefeddian Hotel. Mr. D. Gillart, architect.

ALFORD — Dwelling-house at Montgarrie. Mr. W. Macdonald, architect.

ANNFIELD PLAIN—Forty houses, South Pontop, Messrs. Ritson and Sons; six houses, Catchgate, Mr. J. T. Castle; houses and shops, West-road, Mr. T. Parker.

ANNFIELD PLAIN—Forty-eight houses, Urban District Council.

ANTWERP — Warehouse for scenery at Flemish Lyric Theatre, Monsieur le Bourgmestre de la Ville, Hotel de Ville, Antwerp.

ARDSLEY—House, Woodkirk, Mr. Hudson; three houses, Lingwell-gate, Mr. W. J. Farrar.

ARMAGH—Conversion of Tontine buildings for town hall, Urban District Council.

ASHBY—Public offices, Urban District Council.

ASHBY — Two dwelling-houses and shop. Mr. W. H. Butterick, Scunthorpe, architect.

ASHINGTON—Houses, Industrial Co-operative Society.

ASHTON—Billiard hall, Old-street, Mr. T. Claverly; temporary church, Stockport-road, Wesleyan Trustees; alterations at electricity works, Town Council; houses, Mossley-road, Messrs. Schofield and Wrigley; six houses, Cooper-street, Mr. S. W. Farrer; halls, Oldfield and Williamson streets, Salvation Army.

ASHTON—Wesleyan chapel, Trustees.

ATHERTON—Cotton mill (£80,000), Ena Spinning Co.

AYLSHAM—Improvements to town hall (£1,400), Parish Council.

BALLYNAHINCH—Three houses, Church-street. Mr. B. Mooney.

BANNOCKBURN—Alterations and additions, houses, Old-road, Mr. D. Crokart.

BARNSTAPLE - Secondary school, County Council

BATTERSEA, S.W.—Schools, Christ Church parish, Mr. W. Hammond.

BATTERSEA, S.W.—Alterations, Bolingbroke Council School, London County Council.

BATTLE - Alterations and additions to infirmaries at the union workhouse, Board of Guardians.

BECCLES—Secondary school (£5,000), East Suffolk Education Committee.

BECKENHAM — Two houses, Cromwell-road, Mr. G. Weaver; two houses, Mackenzie-road, Mr. A. W. Keen; four houses, Croydon-road, Mr. H. Slade; cricket pavilion, Ibis Cricket Ground, Woodbastwick-road, Messrs. H. Copeland and Son.

BECKENHAM — Extensions to electricity works (£10,593), Urban District Council.

BEDLINGTON—Co-operative laundry, Managers.

BELFAST—Rebuilding licensed premises, Newtownards-road, Mr. J. King.

BELFAST—Manse at Upper Falls in connection with the Broadway Presbyterian Church. Messrs. Young and Mackenzie, architects.

BELPER—Homes in connection with workhouse, Cow-hill, Board of Guardians.

BERMONDSEY, S.E. — Alterations, Laxton-street Council School, London County Council.

BETHNAL GREEN, E.—Municipal offices, Borough Council.

BETHNAL GREEN, E.—Alterations and additions to Prichard's-road and Teasdale-street Schools, London County Council.

BINGLEY—Warehouse, Cottingley Mills, Woolcombers, Limited; houses, Ellen-street, Mr. J. Brown.

BIRKENHEAD—Branch library, Price-street, Town Council.

BIRMINGHAM—Alterations and additions to offices and generating station, Dale-end, Town Council.

BOLTON—Additions to mills, Fine Spinners' Association.

BOLTON — Installation of electricity at doubling mills, Messrs. Greenhalgh and Shaw; generating station, Bolton Iron and Steel Works, Messrs. Bessemer and Co.

BISHOPBRIGGS—Elementary school, Colston, Maryhill School Board.

BLACKPOOL—Two houses and shop, Hawes Side-lane, Mr. J. Boardman; three houses, Rosebury-avenue, Mr. J. J. G. Hall; three houses, Grosvenor-street and Charles-street, Messrs. Collins and Co.; 20 houses, Gloucester-avenue, Messrs. H. Rose and B. Smith; two houses, Newton-drive, Mr. Wm. Wild; six houses, Hawes Side-lane, Messrs. G. Whiteside and Sons; two houses, Palatine-road, Mrs. R Shaw; three houses, Lightbown-avenue, Mrs. A. E. Dent; hotel, Central-drive and Queen Victoria-street, Messrs. Magee, Marshall, and Co.; shop, Lytham-road, Mr. Wm. Hardwick.

BLAENAVON—Houses, Messrs. Teather and Wilson.

BLYTH—Presbyterian manse (£1,000), Mr. J. Goulding.

BOWBURN Rebuilding Hare and Greyhounds Inn, Messrs. J. Nimmo and Sons.

BOWHILL—Church (£11,000), Kirkcaldy Presbytery.

BRAMPTON—Alterations, elementary school, West Riding Education Committee.

BROMLEY—Houses, Park Farm-road, Messrs. Podger and Son; four houses, Burnt Ash-lane, Mr. E. Hinchcliffe.

BURGHEAD—Houses, Dunbar-street, Mr. J. Willett.

BURNHAM—Alterations to fire station, parish room, High-street, Urban District Council.

BURTON—Additions to infirmary (£1,040), Town Council.

BURY—Two 2,000-kw. turbo-alternators, etc., Corporation electricity works.

BURY—Extensions to Daisyfield Mill.

BUXTON — Extensions to electricity undertaking (£1,550), Urban District Council.

CAERAU—Additions to Caerau and Spelters Co-operative Society. Messrs. Evans and Jones, architects.

CAERGWRLE—Shop and house, Mr. J. Harris.

CAMBRIDGE—Engine-room, Homerton-street, Messrs. A. Negus and Son, 88, Regent-street; three houses, Mill-road, Messrs. J. R. Bennett and Sons, Gwydir-street; two houses, St. Philip's-road, Mr. E. Sizer, Belgrave-road; house and farm buildings, Madingley-road, Mr. W. Robinson, 13, Bene't-street; district nurses' home, Newmarket-road, Trustees of the District Nurses' Home; alterations, 44, St. Andrew's-street, Mr. A. A. Walker, 10, Emmanuel-street; telephone exchange, Alexandra-street and Falcon-yard, National Telephone Co., Victoria-embankment, E.C.; alteration, 9, Coronation-place, Miss Greene, Harston.

CANNOCK—Additions to workhouse, Board of Guardians.

CASTLE DONINGTON—Renovation of Church schools, elementary school, Education Committee.

CATFORD, S.E.—Eight houses, Perry-hill, Mr. Westworth.

CHADSMOOR—Higher schools (£3,220), Cannock Education Committee.

CHEADLE HULME—Elementary school (£9,315), Cheshire Education Committee.

CLECKHEATON—Secondary school (£2,500), Town Council.

CLITHEROE—Additions to fire station (£250), Town Council.

CLUNY—Additions, Cluny Castle, Mr. A Mackenzie.

COATBRIDGE—Higher-grade school, Albert-street (£3,000), Monkland School Board.

COLERAINE—Workmen's houses (£14,896), Urban District Council.

CORTON WOOD—Alterations, elementary school, West Riding Education Committee.

COSELEY - Alteration of elementary schools, Education Committee.

COSFORTH — Terrace of houses, 28 villas, Graham Park Estate Trustees.

COVENTRY—Elementary school, Broad-street, Corporation.

CRADLEY HEATH - Goods station (£20,000), Great Western Railway.

CRAMLINGTON—Mortuary chapel, Urban District Council.

CRANLEIGH—House and stabling, Mr. W. Buck.

CRESWELL - Wesleyan manse (£900), Local Trustees.

CREWE—Fitting and equipment of school, Earl-street, Education Committee.

CROYDON—Extensions, polytechnic (£5,000), Education Committee.

CWMAVON—Elementary school, Glamorgan County Council.

DARLINGTON—Rustic teahouse at the public park, Corporation.

DARTMOUTH—Post office, Messrs. Heydon and Ferris.

DEVIZES—Shops and houses, Sidmouth-street, St. Mary's Church Trustees; four houses, Mr. Ash.

DONCASTER — Hotel and shops on site of Ram Hotel, present Proprietor.

DOVER—Temporary school (£1,100), Education Committee.

DUDDO—Teacher's house, Berwick Education Committee.

DUMBARTON—Public library, Town Council.

DUNPHAIL—Two houses, Stationmaster, Dunphail Station.

EALING—Municipal tramways under consideration, Town Council

EASTBOURNE—Electricity undertaking (£7,000), Town Council.

ECCLES—Elementary school, Clarendon-road, Lancs. Education Committee.

EDENBRIDGE—Extension to Oddfellows' hall, Local Committee.

EDINBURGH—Classrooms, George Heriot's School Trust.

EDMONTON—Technical institute (£7,000), Middlesex County Council.

EDMONTON—Infirmary, Board of Guardians.

ELIE—Villas, Messrs. J. and T. W. Currie.

ELLAND—Four villas, Victoria-road, Mr. B. Sutcliffe.

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ENFIELD—Central library (£8,000), Urban District Council.
FARNWORTH—Extensions to Messrs. T. Barnes's weaving sheds.
FENTON—Town hall, etc. (£7,830), Town Council.
FINCHLEY—Extensions to the electricity plant, Urban District Council.
FOLESHILL—Four houses, Wootton-street, Bedworth, Mr. W. Shortridge; three houses, Courthouse-green, Mr. George Green; eight houses, Goodyer's-end, Messrs. Stevens and Russell; two houses, King-street, Bedworth, Mr. Birch; three houses, Little Heath, Mr. W. Prosser; 11 houses, William-street, Bedworth, Mr. Jacques.
FROME—Electricity undertaking, Town Council.
FULHAM, S.W.—Motor-omnibus garage, Farm-lane, London Road Car Co.
FULMER—Elementary school (£1,370), Bucks County Council.
FULWELL—Elementary school, Middlesex County Council.
GAYWOOD—Elementary school, Norfolk Education Committee.
GLASGOW—Public conveniences, Alexandra Park, Town Council.
GRANGE-OVER SANDS—Generating station, etc., at Westmorland Consumptive Sanatorium.
GRAVESEND—Extension of electricity mains (£7,075), Town Council.
GREAT HARWOOD—Storeroom, St. Hubert Mill.
GREAT YARMOUTH—Office buildings, Regent-street, Mr. R. S. Cockerill.
GREENOCK—Torpedo factory, Battery Park, Admiralty.
GUILDFORD—Extensions to workhouse, Board of Guardians.
HALIFAX—Boiler-house, mill, etc., Messrs. Medley, Hall, and Son; three shops, Rawson-street, Mr. T. Kershaw.
HALSTEAD—Elementary school, Governors Halstead Grammar School.
HAMPSTEAD, N.W.—Motor garage, Church-walk, Mr. J D. Hunter.
HAMPSTEAD, N.W.—Packing and receiving rooms, North-Western Fever Hospital, Metropolitan Asylums Board.
HANLEY—Office premises, Messrs. E. Jones.
HARROGATE—Bakehouse, Regent's-parade, Harrogate Co-operative Society.
HASLINGDEN—Offices at tramway depôt (£300), Town Council.
HASTINGS—Additions, Hill Crest, Priory-avenue, and alterations and additions, Waverley Hotel, Havelock-road—Mr. Hy. Ward, architect; alterations, Warrior-square Steam Laundry, Cross-street, additions, Carlton House, Fairlight-road—Mr. Alfred Dray, architect.
HEATH TOWN—Manual training centre (£450), Staffs Education Committee.
HEAVITREE—Parish church (£3,000), Churchwardens.
HEBDEN BRIDGE—Secondary school, West Riding Education Committee.
HELMSHORE—Elementary school, Haslingden Town Council.
HEOLYCYW—Mixed school to accommodate 200 scholars, public hall, reading-room, and library.
HERMITAGE—Alterations and extensions to Church schools ((£450).
HERTFORD—Alterations, Bayley Lodge, Messrs. Sworder and Longmore.
HEXHAM—Primitive Methodist chapel, Messrs. Cackett, Burns, and Dick.
HEYWOOD—Secondary school, Lancashire Education Committee.
HIRST—Houses, Ashington Industrial Co-operative Society.
HOLBORN, W.C.—Extension, Kingsley Hotel, Hart-street, Mr. C. F. Doll.
HOPKINSTOWN—Extensions, elementary school, Mr. D. M. Jones.
HOPKINSTOWN—Extensions to Council school, Pontypridd Education Committee.
HORTON—Elementary school, West Riding Education Committee.
HORSELL—Enlargement of parish church (£2,000).
HOVE—Furnishing and fitting public library (£1,737), Town Council.
HUCKNALL TORKARD—Public baths, Urban District Council.
HUDDERSFIELD—Two elementary schools, site of old Birkby Hospital, County Education Committee.
HULL—Alterations to public hall (£3,000), Town Council.
HUNSLET—Alterations at Hunslet and Holbeck Baths, Town Council.
ILFORD—Extension of parish church and erection of tower.
INVERONIC—Pavilion, Y.M.C.A. camping ground.
ISLINGTON, N.—Alterations, Grand Theatre, High street, Messrs. Matchem and Co.
KENDAL—Renovation and improvement, St. George's Catholic Church.
KENSINGTON, W.—Houses, Brompton-road, Mr. J. Wheeler.
KIDDERMINSTER—Foundry, Stourport-road, Mr. Bradley; boiler-house, Arch-hill, Messrs. Tomlinson and Adam; shop, Stourbridge-road, Mr. Walker.
KIDWELTY—Electricity installation, Urban District Council.
KINGSTON—Workhouse, Board of Guardians.
KNOWLE—Police and fire stations (£2,626), Bristol Corporation.
LANGLEY—Public library, Oldham Public Libraries Committee.
LEE—Eight houses, High-road, Messrs. Hatch and Hatch.
LEICESTER—Additions, branch library, Garendon-street (£203), Town Council.
LEWISHAM, S.E.—Temporary church, Longbridge-road, Churchwardens.
LEWISHAM, S.E.—Additions, Holy Cross Catholic Church, Sangley-road, Rev. E. Escarguel.
LIVERPOOL—Police and fire station (£4,000), City Council,
LLANDILO—Public hall, New-road, Urban District Council.
LLANFAIR-CAERINEON—Alterations to Sardis C.M. Chapel, Mr. E. Williams.
LLANFYNYDD—Rebuilding New Cross Inn, Mr. A. S. Williams.
LLANSTADWELL—Alterations and additions, National School, Mr. H. Thomas.
LONDON, W.—Alterations, Princess Hall, Christian-street, Mr. J. S. Heath.
LONDON, W.—Electrical installation connected with ventilation, Queen's Hall, Langham-place, Mr. E. W. Bowles.
LONGRIDGE—Extension to St. Wilfrid's Church (£3,000), Churchwardens.
LUDLOW—Alterations at Craven Arms Hotel, Mr. A. H. Ashdown.
LUTON—Elementary school, Beech-hill, Town Council.
MAESTEG—Offices, Messrs. North's Navigation Collieries.
MAESYCOED—Elementary school, Pontypridd Education Committee.
MANCHESTER—Extensive alterations and extensions to exchange (£500,000).
MANCHESTER—Alterations to Mauldreth-road Council school, Town Council; memorial school and parish hall, Princess-road, Alexandra Park.
MATLOCK BATH—Pavilion, Town Council.
MENSTON—House, Messrs Rogerson and Dawson.
MERTHYR—Free library, public baths, police court, and fire brigade station in Castlefields, Town Council.
MERTHYR—Thirty-one houses, Danyderi (£7,650), Merthyr Corporation.
MEXBOROUGH—Fire station and market (£1,570), Town Council.
MIDDLEWICH—Church and schools, Local Wesleyan Trustees.
MILLBROOK—Restoration, parish church of St. Nicholas.
MORECAMBE—Technical schools, Lancashire Education Committee.
MORLEY—Alterations and additions, Grove Mills, Messrs. D. Bradley, Limited.
MOSELEY—Restoration, parish church (£7,300).
NAVAN—Workmen's housing scheme, Rural District Council.
NEW HOLLAND—Elementary school, Sussex County Council.
NEW MONKLAND—Extensions to elementary schools (£420), Education Committee.
NORTHAM—Terrace of houses, Lewis-hill-gardens, Mr. Champion.
NORTHFLEET—Two houses, Downs-road, Mr. C. Bowles.
NORTH WITCHFORD—Alterations at workhouse, Guardians.
OLD DEER—Elementary school. Messrs. Sutherland and George, Aberdeen, architects.
OLDHAM—Music hall, Union-street, Local Syndicate.
OMAGH—Workmen's housing scheme (£35,103), Rural District Council.
OSSETT—Extensions to electric tramways (£22,806), Town Council.
OTFORD—Elementary schools (£3,790), Kent County Council.
OXTED—Elementary school, Sussex County Council.
PENYGRAIG—Alterations and additions to premises of Penygraig Industrial Co operative Society.
PENZANCE—Church house, St. John's Churchwardens.
POPLAR, E.—Dust destructor, Borough Council.
PORTSMOUTH—Extensions to infirmary (£1,600), Board of Guardians.
PRESTON—Public baths (£16,000), Town Council.
RAMSGATE—Post office, Commissioners of Public Works.
RENFREW—Police buildings, County Police Authority.
RIPON—Secondary school and technical institute, Town Council.
RISHTON—Fifteen houses and shops, Cliff-street West, Rishton Co-operative Society.
ROCHESTER—Extensions to tramway system (£11,000), Town Council.
ROMFORD—Elementary school, London-road, Essex County Council.
RUGBY—Enlargement of schools (£1,000), Town Council.
SADBERGE—Alterations and additions to elementary school, Darlington Education Committee.
ST. AUSTELL—Two houses, Hendra Downs, Mr. J. Mellow; Church schoolroom, Par Green, Governors; two houses, Mr. Bond; two houses, Highfield-avenue, Mr. Chas. Clemo.
ST. PANCRAS, N.W.—Alterations and additions, Council school, Aldenham-street, London County Council.
SALFORD—Additions to Ladywell Sanatorium (£5,361), Town Council.
SCORTON—Church and school, Trustees Wesleyan Church.
SCOTSTOUN—Elementary school, Victoria-drive, Renfrew School Board.
SCUNTHORPE—Church and schools, Frodingham-road (£5,000), Mr. H. Harper, Nottingham.
SEGHILL—Extensions to Boundary Inn, Messrs. Cackett, Burns, and Dick.
SENGHENYDD—Alterations to schools, Glamorgan County Council.
SHANKLIN—Kursaal, Town Council.
SHARDLOW—Laundry block at workhouse, Board of Guardians.
SHARLSTON—Alterations, elementary school, West Riding Education Committee.
SHOREDITCH, E.—Heating arrangements, etc., Standard Theatre, Messrs. F. Matchem and Co.
SILKSTONE—Alterations, elementary school, West Riding Education Committee.
SITTINGBOURNE—Elementary schools (£6,250), Kent County Council,

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SKIRCOAT GREEN—Two houses, Messrs. Jackson and Fox.
SLAITHWAITE—Two houses, Hill Top, Mr. A. Shaw.
SOUTHAMPTON—Sailors' home, Oxford-street.
SOUTHBANK—Unionist club premises (£2.000), Mr. F. Walshaw.
SOUTHEND—Electricity undertaking (£26,690), bandstand (£500), Town Council.
SOUTHEND—Six houses, Kingsway, Mr. J. Warren; shop, Sutton-road, Mr. A. H. Dunkley; house, Beach road, Mr. E. Woolhouse; four houses, Westcliff Park-drive, Mr. J. C. Flaxman; four houses, Lovelace-gardens, Messrs. Welbourne Bros.; additions, Winton Hall, Westcliff-avenue, Mr. A. W. Robertson; four houses South-avenue Westcliff, Mr. W. E. Davey; bungalow, Chadwick-road, Misses Freeman; house, Beach-road, Mr. W. Timms; house, Somerville-gardens, Mr. J. J. Blanch; four houses, Hainault-avenue, Mr. W. T. Wilson; additions, 11, Windsor-road, Mr. H. Cole; six houses, Elderton-road, Mr. W. J. Ardley; additions, Westcliff Hotel, Mr. W. J. Hockley; shop, Leigh-road, Mr. A. Greaves; additions to shop, Leigh-road, Mr. A. W. Robertson; two houses, Chalkwell-avenue, Mr. A. W. Robertson; house, Northview-drive, Mr. James Sears; showroom, Warrior-square, Mr. E. Mein; additions, Holmwood College, Mr. A. E. F. Francis; house and shop, Leigh road, Mr. A. E. Day; additions and alterations, Overcliff Hotel, Mr. W. J. Head; house, Glen-road, Mrs. Willett,
SOUTHFIELDS—Wesleyan church (£4,500), Local Trustees.
SOUTHFIELDS—Two houses, Balgernie-grove, Mr. R. Burr.
SOUTHWARK, S.E.—Factory, Redcross-street, Messrs. J. Spicer and Sons
STAFFORD—Nursing home, Infirmary Governors
STANLEY—Alterations, etc., Ledge-lane Provided Schools, Governors.
STIRLING—Additions, Causewayhead School, Logie School Board; municipal slaughter-houses, Town Council.
STIRLING—Motor garage, Barnton-street, Messrs. Henderson Bros.; motor garage, Port-street, Messrs. Menzies Bros.; villas, Bellfield-road, Mr. Owen.
STISTED—Public hall, Mr. J. N. Paxman.
STOCKTON—Motor garage, Bridge-road, Messrs. Mandall and Co.
STOKE MANDEVILLE—Alterations to Council schools, Bucks County Council.
STOKE-UNDER-HAM—Extensions to local Congregational church.
STOPSLEY—Elementary school (£1,012), Beds Education Committee.
STRATFORD-ON-AVON—Shop, Bridge-street; two houses, Evesham-road.
SUNDERLAND—Catholic school, Spring Garden-lane.
SUTTON COLDFIELD—Elementary school, Green-lanes, Education Committee.
TADCASTER—Alterations, elementary school, West Riding Education Committee.
THRAPSTON—Elementary school, Northamptonshire County Council.
TIBSHELF—Wesleyan chapel (£1,000), Trustees.
TIDWORTH—Concert hall (£4,000), War Office
TINSLEY—Alterations, elementary school, West Riding Education Committee.
TON PENTRE—Villa residence at Maindy. Mr. W. D. Morgan, architect.
TORQUAY—Pavilion (£1,000), Town Council.
TREHARRIS—Public library (£2,000), Merthyr Town Council.
TROON—Bank, Temple Hill, British Linen Banking Co.
WALLSEND—Twenty cottages, Wallsend Industrial Co-operative Society.
WALSALL—Alterations and additions, Elmore Green Council schools.
WALWORTH, S.E.—School for physically defective children, Beresford-street (£5,506), London County Council.
WANDSWORTH, S.W.—Houses, Melrose-road, Mr. E. A. Duff.
WARRINGTON—Paper mills, Messrs. J. Chadwick and Sons.
WARWICK—Two houses, Emscote-road, Messrs. Chaplin.
WESTCLIFFE—Congregational church (£15,000), Trustees.
WESTMINSTER, S.W.—Extensions to Stag Brewery, Pimlico, Messrs. Watney, Coombe, and Reid.
WEYMOUTH—Secondary school (£9,000), Education Committee.
WINCHESTER—Alterations to 30 houses, Winchester Cottage Improvements Society.
WINSCOMBE—Additions at Winscombe Woodborough Council school, Somerset Education Committee.
WOOLWICH—Six houses, Beech-hill-road, Mr. J. J. Bassett.
WORSBOROUGH—Two houses, Mount Vernon-road, Mr. A. Whitaker.
WORTLEY—School (£1,500), Wortley Bethel Congregational Church.
WRABNESS—Chapel, Manningtree, Wesleyan Trustees.
YARMOUTH—Three houses, Century-road, Mr. F. A. Osborne; iron shed, Southtown, Messrs. Crabtree and Co.; shop front, Salisbury-road, Mr. W. J. Thirkettle; additions, 36 and 37, Lowestoft-road, Gorleston, Mr. D. Spinney; fishing premises, South Denes, Mr. T. Jenkins; four houses, Mr. W. Nightingale; house, Hamilton-road, Mr. R. W. Barnes; four cottages, Kitchener-road, Mr. A. Trett; two cottages, Row 136, Mr. G. Brewster; alterations, 183, King-street, Mr. A. E. Kerridge; shed, Southtown, Messrs. Chateau and Co.
YIEWSLEY—Two houses, Otterfield-road, and four houses, Warwick-road, West Drayton, Mr. A. H. Winterburn; factory, Trout-lane, Messrs. Thomas and Thomas.
YORK—Elementary school, Sycamore-terrace, Town Council,

COMPANIES' MEETINGS AND REPORTS.

SCARBOROUGH ELECTRIC SUPPLY.

The annual general meeting of the Scarborough Electric Supply Co. was held on the 20th inst. Mr. G. Alderson Smith presided.

The CHAIRMAN moved the adoption of the report. He referred to the proposed refuse destructor, and stated that the Corporation had had two interviews with the directors and asked the latter to state a price per ton for the destruction of refuse. It was most difficult to arrive at a price, because in other towns it differed from 6d. to 3s. per ton. The directors asked 2s. 6d. per ton, which the Corporation thought was too high, but had never offered any alternative price. It seemed a pity that the Corporation should propose utilising land a mile further from the works, which would entail every cart going a mile further when they could have come to some arrangement with the Company. He moved that a dividend of 4 per cent. be paid, absorbing £3,990, that £750 be placed to the depreciation account, and that £248 be carried forward, against a dividend of 4½ per cent., absorbing £4,365, £500 placed to the depreciation account and £172 carried forward last year.

Mr. H. T. ELLIS, in seconding, said that Mr. Swinton, who was too ill to attend that meeting, was going to say something about the new electric lamps which he mentioned last year. These had been improved upon gradually, and it was as well that people should know what a great saving they obtained from using metal-filament lamps instead of carbon lamps, as they could get three times the amount of light with the same consumption of current. They looked upon such lamps as great competitors to the gas mantles, which had proved such a boon to gas companies.

The resolution was adopted.

YORKSHIRE ELECTRIC POWER.

The tenth half-yearly meeting of the shareholders of this Company was held last week, the chairman, Mr. A. G. Lupton, M.P., presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, stated that during the six months the sum of £3,746. 2s. 6d. had been expended on capital account, principally for mains laid in Farsley, Calverley, Horsforth, Ossett, Ravensthorpe, Liversedge, Thornhill, Hartshead, and Pudsey, and for service equipments required to supply consumers in those and other districts. Comparing the details of expenditure for this half-year with those of the preceding half-year, an increase in the cost of coal would be noticed. This was partly due to the fact that the sale of current had been greater than in the preceding half-year, but also in part to the abnormal rise in the price of coal. There was also an increase in the item of maintenance and repairs, etc., which was due to the cost of work done for consumers, and was met by the increase from £1,174 to £2,331 in the receipts on the credit side. The items under management and general expenses showed an increase of only £17. The revenue account showed receipts of £7,293, compared to £4,700 for the previous half-year (a 40 per cent. increase), and expenses £6,457, as against £5,103, resulting in a profit of £836, compared to a loss of £403—an actual improvement of £1,239. After payment of £975, the interest on the £40,000 mortgage, the net revenue account showed a loss of £139, as against a loss of £1,211 for the half-year ending June 30, 1907—a net improvement on the half-year's working of £1,072. At the meeting in February, 1907, he ventured to prophesy that the Company would be earning the whole of its costs by the end of the year, and it was satisfactory to find this prophecy had proved correct, and that the excellent service provided by the Company was rapidly winning the confidence of power users. Probably one of the most significant changes since then had taken place in regard to the textile industry. Four years ago the use of electricity for textile purposes was so small as to be practically negligible, but to-day there were districts where entire mills were run electrically. One very satisfactory feature was that nearly all the consumers had connected, or arranged to connect, more motors to the system than they originally agreed—the best evidence and proof of the value of the supply and its continued use. A determined effort was being made to attract new consumers into the district. The mains were laid in districts pre-eminently suitable for electric power users. Low rates, excellent canal and railway facilities, and the power company's supply offered every attraction. A serious difficulty that the Company had to contend with at the first was the hostility of local authorities in the district. This opposition to the Company's Act had resulted in a clause by which the Company could not supply in the district of a local authority who had taken out lighting orders, and before the Company first commenced its supply a large number of districts (24) were covered by local authorities who were not themselves in a position to give a supply, but were by this clause able to prevent the Company doing so without their consent. He was glad to say that this feeling of opposition had largely passed away. The revenue which the Company already derived from the supply of electricity to local authorities for them to distribute was growing fast. In the past the Company had had to spend considerable sums in protecting its area from attacks made by local authorities asking for powers which, whenever the question had come before committees of Parliament, had been refused. In the present parliamentary session there was only one Bill which the directors found it necessary to oppose. During the half-year under review agreements for 3,252 h.p. had been made, which was nearly four times the increase of the preceding six months. Terms had been arranged with the Brighouse Corporation by which they would close down their present generating station, and a considerable revenue might be hoped for from tramways in that borough, as well as from consumers on the route of mains to be laid.

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Mr. T. O. CALLENDER seconded the resolution, which was carried unanimously.

The shareholders gave their approval to a proposal of the directors that in future the report and accounts should only be issued annually.

NATIONAL TELEPHONE.

The forty-first ordinary general meeting of the National Telephone Co. was held on the 20th inst., Mr. George Franklin presiding.

In moving the adoption of the report, the CHAIRMAN stated that the income accrued in respect of the business of the half-year amounted to £1,387,189, as compared with £1,241,843, showing an increase of £145,346. The Post Office royalties had absorbed £132 621, or an increase of £14,121, and the working expenses amounted to £780 332, an increase of £69,840. The net result showed an increase of £61,385. Dealing with the figures for the completed year, the Chairman said that 1907 showed an increase in income over 1906 of £265,233. The Post Office royalties had advanced by £26,071 and the working expenses by £127,863. The net result was an increase of £111,299. In the distribution of the profits the Board had felt able to recommend 6 per cent. per annum on the deferred stock, after putting aside during the year £275,000 to reserve, which now amounted to £2,612 000. The Board hoped between now and the expiry of the Company's licence to make this reserve strong enough to protect the shareholders' capital from shrinkage as a result of any valuation which might then be placed on the plant. If in so doing they made excess provision, that excess would belong to the shareholders. With regard to the reserve fund, to the extent of £655,000 it was invested in freehold and leasehold properties, and the balance was invested in the Company's business. During the past year there had been added to the system 39,372 stations. A large number of these stations had been upon the measured rate. The development of the telephone enterprise had demonstrated the absolute unsoundness of the flat rate, that was to say, an annual charge for as many calls as the subscriber chose to send. The evils which had resulted from that method only revealed themselves by experience. These evils were overloaded lines, congestion of traffic, and engaged calls. The National Co. had many cases of flat-rate lines where subscribers were using their lines excessively. Indeed, to such an extent had this become the case that 24 per cent. of the calls were ineffective, and had become so by reason of what was known as the "engaged test." The constant ringing up of the exchange, besides finding more work for the operators, simply blocked the traffic, and made the last condition worse than the first. Nor was it prudent or wise on the part of a subscriber that he should have his line constantly engaged, as many of them were. To such an extent was that carried out that some subscribers thought nothing of sending 250 or 300 calls per day along a line, with the result that no other person could get into communication with them. The Board had felt bound to co-operate with the Postmaster-General in bringing into force throughout the provinces a measured-rate system The measured-rate system had been adopted as the result of careful study. The United States, Austria, Germany, and other countries, as well as Australia, had adopted it, abolishing the flat rate altogether.

Mr. S. H. SANDS seconded the motion, which was adopted.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

The tenth annual general meeting of shareholders in the Buenos Ayres and Belgrano Electric Tramways Co. was held on the 20th inst at Winchester House, Old Broad-street, E.C., Mr. J. B. Concanon, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report for the six months to June 30, 1907, stated that the actual net profits for the first six months of last year, after deducting the London office expenses, amounted to £32 668, and that they were considerably higher than they would have been had they had to make a provision for depreciation and renewals. It was not proposed to pay any dividend on the ordinary shares owing to the fact that before payment could be made an application to the courts for a reduction of capital would be necessary. He moved: "That a balance dividend on the 'A' and 'B' preference shares of 3s. per share, less income tax, be declared, making, with the interim dividend paid in October last, 6 per cent. per annum."

Mr. H. R. BEETON seconded the motion, which was agreed to unanimously.

An extraordinary general meeting was then held, at which the following resolution for the amendment of the articles of association was passed: "That the articles of association be amended by adding thereto the following new article: (82A) Upon the completion of any sale of the Company's undertaking, there may be paid to the directors as additional remuneration for their special services in negotiating and carrying into effect such sale, such sum as the Company in general meeting may determine. And the Company may in like manner authorise the directors, after completion of any such sale, to pay additional remuneration to any officers or servants of the Company."

NOTTING HILL ELECTRIC LIGHTING.

The ordinary general meeting of the Notting Hill Electric Lighting Co. was held on Tuesday, Sir William Crookes presiding.

The CHAIRMAN, in moving the adoption of the report, referred to the Company's progress to date, and stated that in 1907 the number of houses and lamps connected was 2,673 and 160.349 respectively, the revenue was £38,055, the profits were £19,007, while the dividend was 7 per cent. As regarded the future, everything pointed to increasing prosperity. A very important contract had been entered into by the Wood-lane works. It was in connection with the Franco-British Exhibition, which adjoined the Wood-lane Station, and they had come to an agreement with the Hammersmith Borough Council to assist the latter in supplying the electricity required, one of the conditions being that the Council would take not less than 1,000,000 units between April and November. This large increase in the output of the station should result in a very considerable reduction in the works costs during the summer.

Sir R. B. MARTIN seconded the motion, which was carried unanimously.

At a subsequent extraordinary general meeting a resolution was passed approving the Bill in Parliament to confer further powers on the Kensington and Knightsbridge, the Notting Hill, the St. James's and Pall Mall, the Westminster, and the Central Companies with respect to the supply of electrical energy.

SIMPLEX CONDUITS.

The second annual ordinary general meeting of the Simplex Conduits was held on the 21st inst. at the Company's offices, Garrison-lane, Birmingham. The chair was occupied by Mr. Henry Huggins (chairman), and the other directors present were Mr. F. Huggins and Mr. L. M. Waterhouse (managing director). The profits of the year, after providing for bad and doubtful debts, amount, with interest on investments and transfer fees, to £13 894. 8s. 11d., and after charging directors' fee, depreciation, and income tax, £2,340. 9s. 3d., and adding the amount brought forward from last year, £1,379. 13s. 7d., there remains for disposal £12,933. 13s. 3d. The Chairman congratulated the shareholders upon the result of the year, pointing out that after paying a dividend of 6 per cent. on the preference shares, amounting to £2,280, and 10 per cent. on the ordinary shares, absorbing £4,000, they had carried £4,000 to reserve and £2,653 forward to next year.

CHELSEA ELECTRICITY SUPPLY.

The report of the Chelsea Electricity Supply Co. for the year ended Dec. 31, 1907, states that the profit for the year amounts to £33,099, which with £1,092 brought forward and £451 balance of interest, makes a total of £34,642. The directors recommend that £11,619 be carried to credit of renewals and depreciation fund, £519 to credit of debenture stock premium redemption fund, that £802 be written off cost of extinction of founders' shares, and that a final dividend on the ordinary shares be paid at the rate of 5 per cent. per annum, making 4½ per cent. for the year, leaving £904 to be carried to the next account. The number of 8-c.p. lamp equivalents connected on Dec. 31, 1907, was 240,735, an addition of 7,430 during the year, and the total number of units sold was 3,548,628, being 240,914 more than the previous year. A Bill in Parliament is again being promoted to give London electrical supply companies powers of association, which, if granted, should effect economies in the cost of production, and enable them to deal satisfactorily with the question of bulk supply. The directors record with regret the death of their colleague, Mr. William Page. The vacancy has been filled, subject to the confirmation of the shareholders, by Mr. Henry Ramié Beeton, who has been chairman of the Brompton and Kensington Electricity Supply Co. from the commencement.

CHARING CROSS, WEST END, AND CITY ELECTRICITY SUPPLY.

The report of the Charing Cross, West-end, and City Electricity Supply Co. for the year 1907 states that the gross earnings of the West-end undertakings from sales of current, rents, etc., were £131,920. 13s. 5d., as compared with £126,145 in 1906, an increase of £5,775. The expenses, including depreciation, were £80,114 compared with £84,088, a decrease of £3,974, and the net earnings were £51,806 compared with £42 057, an increase of £9,749. After bringing in the balance of £4,574 from last year, and paying interest on the debenture stock, there is a balance on net revenue account of £42,023, out of which the dividend for the year on the preference shares and an interim dividend for the first half-year at the rate of 5 per cent. per annum on the ordinary shares have been paid, leaving a balance to be dealt with of £14,023. The directors propose a final dividend for the second half-year at the rate of 5 per cent. per annum, making 5 per cent. for the whole year, and to carry forward £4,023. The Company has now connected to its West-end mains the total equivalent of 538,964 8-c.p. (or 30-watt) lamps, which is an increase of 28,375 upon last year's figures. The total is made up as follows: 391,201 in lighting, 10,238 in heating, and 137,525 (5,501 h.p.—4,129 kw.) in motors. The gross earnings of the City undertaking from sales of currents, rents, etc., were £118,543, an increase of £13,041. The expenses were £63,748, an increase of £6,424, and the net earnings were £54,795, an increase of £6,617. The interest on debenture bonds (£460,000) has amounted to £22,875, the interest on loans (£155,704) to £7,258, and the dividend on the preference shares (£400,000) to £18 000. Deducting the deficiency on preference shares dividend, 1902-1905, £4,405, there is left a credit balance of £2,256 compared with the debit balance of £4,405 last year. The City undertaking has, therefore, been able out of its revenue for the year 1907 to pay the interest on its debenture bonds and dividend on its preference shares, to repay the balance of £4,405 to the West-end undertakings, and to carry forward £2,256 The Company has now connected to its City mains the total equivalent of 454,757 8 c p (or 30-watt) lamps, which is an increase of 42,073 upon last year's figures The total includes 287,787 in lighting, 26,770 in heating, and 140,200 (5 608 h p.—4,209 kw.) in motors. No progress was made in the last session of Parliament towards settling the question of the bulk supply of power in the metropolitan area. The question has again been carefully considered by the Board, in conjunction with the Boards of other electric lighting companies, and the directors are still of opinion that the most practical way of

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dealing with the question is to entrust the bulk supply to an undertaking composed either of all or some of the London electric supply companies. With this end in view a Bill is being promoted in the present session of Parliament to constitute a joint committee representing eight of the London electric supply companies. The chief object of this joint committee will be the rendering of mutual assistance and the giving of a supply of energy in bulk.

ASCOT DISTRICT GAS AND ELECTRICITY.

The report of the Ascot District Gas and Electricity Co. for the half-year ended Dec. 31 last states that there is a profit on the gas account of £2,225 and a loss of £14 on the electricity account. After providing for every charge against the half-year's working and interest on mortgage debenture stock there remains £2,711 at the credit of profit and loss account, out of which the directors recommend the payment of a dividend at the rate of 5½ per cent. per annum, that £183 be set aside as a reserve for renewal of plant, and that £780 be carried forward.

CROSSLEY BROS.

The report of Crossley Bros. for the year ended Dec. 31 last states that the amount at the disposal of the directors is £117,677, out of which a dividend has been paid on the preference shares at the rate of 5 per cent. per annum and a dividend on the ordinary shares at the rate of 10 per cent. per annum to June 30, 1907, amounting to £38,600, thus leaving £79,077 for present disposal. The directors propose a further dividend for the second half of the year at the rate of 12 per cent. per annum on the ordinary shares (making 11 per cent. for the year), leaving £34,773 to carry forward.

OXFORD ELECTRIC.

The report of the Oxford Electric Co. for the year ended Dec. 31, 1907, states that the revenue account shows a profit, including £895 brought forward, of £15,848. After providing £2,000 for debenture interest and writing off £2,329 on account of hire-purchase and college installations, the balance available for dividend is £11,519. The directors propose to pay a dividend at the rate of 7 per cent. per annum, free of income tax, on the ordinary share capital, whereof 2½ per cent. was paid in September last, and to carry to credit of reserve and renewal of plant account the sum of £2,500, leaving £977 to be carried forward.

LANCASHIRE UNITED TRAMWAYS.

The accounts of the Lancashire United Tramways for the year 1907 show a profit of £12,789, and after payment of the prior lien debenture stock interest, there is a balance of £289. This amount, together with the credit balance brought forward, has been written off the loss on the sale of motor omnibuses.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The report of the Telegraph Construction and Maintenance Co. for the year 1907 states that the accounts for the year 1907 show a net profit of £83,571 after charging the interest on the debentures. To this sum must be added £104,308 brought forward, making a total of £187,880. From this amount is deducted the interim dividend of 5 per cent. paid July 23, 1907, amounting to £22,410, leaving £165,470 to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 4s. per share, together with a bonus of 6s. per share, being at the rate of 12½ per cent., and making, with the amount already paid, a total dividend for the year of £2. 2s. per share, or 17½ per cent., free of income tax, leaving £109,445 to be carried forward.

NORTHAMPTON ELECTRIC LIGHT AND POWER.

The report of the Northampton Electric Light and Power Co. for the year ended Dec. 31 last states that the number of consumers has increased by 108. The output of units has been 837,161, an increase of 11½ per cent.; maximum load on plant, 645 kw. (10½ per cent. increase); load factor, 12 7. There has been a considerable increase in the cost of coal. There has been a substantial decrease in the cost per unit of current generated. The general outlook for the present year is very hopeful. The development of the business calls for a further increase in the generating plant, and this will necessitate additional capital outlay during the present year. The directors now propose to add £2,000 to the depreciation account, to write £100 off motors, and to apply the available balance—namely, £1,886—in payment of half-year's dividend at 5 per cent. on preference shares, £626, and half-year's dividend on the ordinary shares at 6 per cent. (making 5 per cent. for the year), £1,098, carrying forward £162.

NEW COMPANIES REGISTERED.

British Magneto Co.—Registered Feb. 13. Capital, £1,000 in £1 shares. Objects: to carry on the business of electricians, manufacturers of and agents for electrical apparatus for motorcars, etc.

British Metals Extraction Co.—Registered Feb. 18. Capital, £150,000 in £1 shares. Object: to acquire the Villiers Spelter Works and Swansea Chemical Works, Llansamlet. Registered office: Finsbury House, E.C.

Lea, Son, and Co., Limited.—Registered Jan. 21. Capital, £12,000 in £5 shares. Objects: to acquire the business of electrical and general engineers, metalworkers, dealers in scientific and electrical appliances, etc., carried on by J. A. Lea and J. F. Lea at Shrewsbury, Salop, as Lea, Son, and Co., and to carry on the same and the business of iron and brass founders, hardwaremen, etc. No initial public issue.

Liens Registered.

Coatbridge and Airdrie Electric Supply Co., Limited, London, E.C.—Charge Feb. 6, £3,500 on the undertaking and property, including the uncalled capital.

United Flexible Metallic Tubing Co., Limited, Westminster, S.W.—Lien Feb. 1, £200 5 per cent. debentures, part of £40,000. Amount previously issued, £23,100. No trustees. Secured on the general assets.

La Capital Traction and Electric Co. of Buenos Ayres, Limited, London, E.C.—Trust deed Nov. 19, 1907, supplemental to an unregistered trust deed dated Dec. 21. 1900, for increasing an issue of debentures from £600,000 to £800,000. Trustees: W. Trotter and R. Fleming. Secured on the undertaking and assets, including the uncalled capital, together with certain shares in the La Capital Tramways, La Capital Extension Tramways, and the Cordoba Light and Power Co. of Maine.

Delhi Electric Tramways and Lighting Co., Limited, London, E.C.—Particulars required by Sub-Section 4, Section 14, of the Companies Act, 1900, relating to a series of £50,000 5 per cent. first mortgage debentures. Trustees: R. C. Pearson and J. Greig. First specific mortgage on all the lands, properties, and rights, together with the benefit of the Delhi Municipality electric licence of 1905, and the benefit of the Delhi Municipality electric tramway order of 1906; also by a floating charge on the business, goodwill, and all the other assets.

LEGAL INTELLIGENCE.

TRUE AND THE VARIABLE ELECTRIC LAMP SYNDICATE v. THE BRYANT TRADING SYNDICATE.

In giving judgment on Saturday, Mr. Justice Swinfen Eady said the plaintiffs' claim was for infringement of two patents granted in 1901 to John Robert Quain, and now vested in the plaintiffs, or one of them. Both patents related to devices for obtaining different candle-power in the same incandescent lamp containing two filaments of different resistances by revolving the lamp within the holder. In the former patent, 15,689 of 1901, the patentee described a specially-designed holder adapted to fit the ordinary sockets in use. This was a ring or tube, the upper end of which was fitted with transverse pins, which fitted into the bayonet joints of the ordinary socket. The lower end of the ring or tube was divided into a considerable number of strips by vertical cuts or slits, the lower ends of which were opened out. A short distance above these lower ends there was formed an annular recess with a corresponding ring projecting outwards, and the cap of the lamp had a corresponding rib or ring projecting round it and fitting into the spring recess in the ring when the lamp was pushed up into its place. Thus the lamp could be freely turned round its vertical axis in the spring recess, and as different contacts were thus put in circuit either or both of the filaments were rendered incandescent. Thus revolving the lamp a short distance changed its candle-power. Although the patentee first described this specially-designed holder as an intermediate fitting between the ordinary socket and the lamp, he also pointed out that the special holder might be formed upon a permanent socket and as part of it, and without any intermediate fitting, and if the upper socket was so formed it would be adapted to receive his lamp with its projecting ring or rib. The third claiming clause claimed this modified form of the apparatus as a portion of the patented invention. But this form of the invention was practically identical with the apparatus described in the patent of Edison and Hill, 22,327 of 1905, which was a clear anticipation. In his opinion the first patent sued upon was invalid for want of novelty. The novelty in the second patent sued upon was to be found in the cap of the lamp. No special form of holder was required. The lamp was adapted for the bayonet socket holder in common use. The device, which enabled the filaments of different resistance in the same lamp to be used separately or together, consisted of a wire passing completely through a transverse opening in the upper part of the cap, its ends projecting sufficiently to engage in the notches of the bayonet socket. The opening on each side of the lamp through which the wire passed was elongated horizontally from the wire, or pivoted in the centre of its length to a vertical point in the centre of the cap. The wire could thus move freely backwards and forwards to the extent of the length of the slot in the cap, and either or both of the contact pieces connected with the filaments could thus be put in circuit. The advantages of this lamp were its extreme simplicity and its being adapted for nearly all fittings in common use. In his opinion the invention, although very simple, was extremely ingenious and meritorious. There was a problem to be solved requiring invention, and this the patentee had done. Until this invention there was not any invariable lamp on the market without a switch upon the lamp itself which was capable of being used in the ordinary fittings in common use, and unless some intermediate or adjusting piece was also employed. Many thousands of these lamps had already been sold. He had arrived at the conclusion that the invention was new, useful, and had not been anticipated. Hunter and Jack's patent, 3,426 of 1894, was quite different, and Edison and Matthew's, 7,530 of 1894, which was also relied on by the defendants, had nothing to do with the plaintiffs' invention. It was also contended that the plaintiffs' patent was invalid,

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as claim 2 was an independent claim to the user of a screw nut upon the end of a wire affixed to the holder to permit it to change its position, and that the use of such a nut for such a purpose was one of the oldest devices. In his opinion the patentee was merely describing a method of affixing the invention to the holder as an advantageous method of using it where special circumstances rendered it expedient—in case of vibration, for instance. The objection to the plaintiffs' second patent failed, and he decided in favour of its validity. There would be an injunction restraining any further infringement of the plaintiffs' second patent, the plaintiffs to have the costs of the action except so far as they were increased by the claim in respect of the first patent.

FERGUSON AND SONS v. PANDIANI.

In the Lord Mayor's Court last week Messrs. C J. Ferguson and Sons, electrical engineers. 54, Chiswell-street sued Mr. John Shirley Pandiani, agent, trading as the Electrical Industries, City-road, for £14. 12s. 11d. the price of a motor fan supplied.

The plaintiffs stated that they were instructed to procure an electric fan to ventilate the Cabin Restaurant, Moorgate-street. The box bladed alternating-current fan supplied by the defendant made a loud noise, and the occupiers of offices complained about it. For the defence it was argued that the galvanised shaft carried the sounds to the neighbouring offices. Evidence was called to show that the fan was not a suitable one for the work, and that any instrument of that description would make a noise. The jury stopped the case, and found a verdict for the defendant. Judgment was entered for the plaintiffs for 17s. 6d., an admitted amount, which had been paid into court, and for the defendant on a counterclaim.

THE OXFORD TRAMWAYS ARBITRATION.

In the High Court of Justice, King's Bench Division, last week, before the Lord Chief Justice, Mr. Justice A. T. Lawrence, and Mr. Justice Sutton, the special case submitted for the decision of the Divisional Court with reference to the Oxford tramways arbitration came on for hearing. The arbitration was opened in London in July last. The arbitrator for the company was Sir Albert Rollit, D.C.L., LL.D., while the arbitrator appointed by the Corporation was Mr. James Swinburne. The umpire was Sir Douglas Fox. The Divisional Court dismissed the contention of the Oxford Tramways Co. on the special case which had been stated without calling upon counsel for the Corporation.

PROVISIONAL PATENTS, 1908.

FEB. 14.

3321. Improvements in or relating to the trolley poles of electrically-driven tramcars and other vehicles. Walter Guy Whitfield, 50, Wellington-street, Leeds.

3347. Electrodynamic controller. Albert Fischer, Parliament-mansions, Victoria-street, London.

3369. Improvements in or relating to means for indicating or detecting the existence of high voltage to which a body may be electrically raised. William Mundell Thornton, Henry William Clothier, and A. Reyrolle and Co., Limited, 47, Lincoln's-inn-fields, London.

3388. Improvements in and relating to incandescent electric lamps. John White Howell, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Aug. 7, 1907, being date of application in United States.) (Complete specification.)

3391. Improvements in variable-speed dynamos. Henry Leitner, 4, South-street, Finsbury, London.

FEB. 15.

3447. Improvements in apparatus for the production and application of electrical oscillations. William John Rickets, 34, Church-lane, Charlton, Kent.

3464. Electric arc lamp. Lorens Sigfrid Andersson, 65, Chancery-lane, London. (Date applied for under Section 91 of the Act, Feb. 18, 1907, being date of application in Sweden.) (Complete specification.)

3465. Carbon-holder for electric arc lamps. Lorens Sigfrid Andersson, 65, Chancery-lane, London. (Date applied for under Section 91 of the Act, Feb. 18, 1907, being date of application in Sweden.) (Complete specification.)

3494. Improvements in electrical apparatus for igniting the charge in explosion motors, and for starting such motors. Pierre Marchal, 115, Cannon-street, London.

3505. Improved current collector for electrically-propelled vehicles. Gustav Mertens, 31, Bedford-street, Strand, London. (Date applied for under Section 91 of the Act, Feb. 16, 1907, being date of application in Germany.) (Complete specification.)

3507. Improved vacuum drying apparatus for electric cables. Emil Passburg, 31, Bedford-street, Strand, London. (Complete specification.)

FEB. 17.

3547. Improvements in automatic electrical thermostats for producing intermittent illumination and for like purposes. Thomas Alfred Mitchell, Broad Sanctuary-chambers, Westminster.

3539. Improvements in electric light and call apparatus. Charles Thorpe, 71, Cambridge-road, Kilburn, London.

3543. Improvement in bell and watch receivers in connection with telephone installations. Charles Kuhn, trading as F. C. Rein and Son, 108, Strand, London.

3556. Automatic telegraphic transmission instruments. John Gell, 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Aug. 12, 1907, being date of application in United States.) (Complete specification.)

3583. Improvements relating to radio-telephony. Georg Seibt 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 28, 1907, being date of application in Germany.) (Complete specification.)

3588. Improvements in and relating to telegraphs. Hans Knudsen, 12. Cyril-mansions, Battersea Park, London.

3592. Improvements in electric servo-motors. Alexandre Grammont and Joseph Louis Routin, 31, Bedford-street, Strand. London. (Date applied for under Section 91 of the Act, Feb. 21. 1907, being date of application in France.) (Complete specification.)

FEB 18.

3604. Improvements in trolley heads for electrically-driven vehicles. Frederick John Squire Hosken, 16, Blackburn-road, Darwen, Lancs.

3626. Improvements in and relating to rotary electric transformers and motor-generators. Crompton and Co., Limited, James Colquhoun Macfarlane, and Harry Burge, The Arc Works, Chelmsford.

3634. Improvements in electrically-driven elevating gear for barrel recoil ordnance. Fried. Krupp Akt.-Ges., 33, Chancery-lane, London. (Date applied for under Section 91 of the Act, May 16, 1907, being date of application in Germany.) (Complete specification.)

3646 Improved prepayment mechanism for electric and gas meters. James Anthony Robinson, 5, Richmond-road, Ealing, London.

3658. Improvements in secondary or storage batteries. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London.

3662. Improvements in electrical apparatus for the production of sound in air or water. Willie Dickson Kilroy, John Cuthbert Needham, and Evershed and Vignoles, Limited, 1, Queen Victoria-street, London.

3671. Improvements in and relating to electric batteries. Horace de Martis, 18, Southampton-buildings, London.

3689. Improved system of push-button apparatus for operating or controlling electric lifts. James Mair, 165, Queen Victoria-street, London. (Application for patent of addition to No. 5958/07.) (Complete specification.)

3700. Improvements in electric arc illuminating apparatus, more particularly for use in photography. Jean Schmidt, 31, Bedford-street, Strand, London. (Application for patent of addition to No. 9574/07.) (Complete specification.)

3701. Improvement in the method of transmitting graphic signs, photographs, and the like, by means of electric current. "Polyphos" Elektrizitäts-Ges. m. b. H., 31, Bedford-street, Strand, London. (Date applied for under Section 91 of the Act, Feb. 25, 1907, being date of application in Germany.) (Complete specification.)

FEB. 19.

3710. Electrical arrangement for starting the siphons of water-closet cisterns. Karel Johannes de Haas, 100, Wellington-street, Glasgow.

3715. Improvement in or applicable to electroliers. Richard Stuart Woods, 4, St. Ann's-square, Manchester.

3723. Improvements relating to electromagnetic brakes, clutches, and the like. David King Morris and George Anslow Lister, 18, Southampton buildings, London

3728. Improvements in and relating to apparatus for the telegraphic transmission of designs, portraits, and the like. Guillermo T. de Guillen Garcia, 23, City-road, Finsbury-square, London. (Complete specification.)

3753. Improvements in apparatus for opening and closing electric circuits at predetermined times. John Gunning, Birkbeck Bank-chambers, Southampton-buildings, London.

3764. Improvements in the method of operating electrical switches or the like. Ernest Luks, 55, Chancery-lane, London. (Complete specification.)

3770. Improvements relating to electrically-controlled pneumatic dispatch tubes, cash railways, and the like. Charles William Bluemel, Ernest Adolphus Bluemel, Frank Henry Bluemel, and Percy Richardson Shill, 11, Southampton-buildings, London. (Complete specification.)

3772. Improvements in and relating to electric ignition contact makers, distributors, and the like. Alexander Marshall Lodge, 18, Southampton-buildings, London.

3778. Improvements in and relating to electromagnets. Norman John Porter, 27, Chancery-lane, London.

3792. Improvements in apparatus for intensifying electric or sound waves. Johann Lagelbauer, 11, Southampton-buildings, London. (Complete specification.)

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FEB. 20.

3830. Improvements in the construction of electric condensers. Edouard Denieport, 100, Wellington-street, Glasgow. (Complete specification.)

3850. Conduit tramway continuous-current supplier. Edwin Godfrey Manning, 162A, Dalston-lane, London.

3860. Improvements in and relating to switches. Edward Charles Robert Marks. 18, Southampton-buildings, London. (Electrical Manufacturing Company, United States.) (Complete specification.)

3862. Improvements in and relating to the production of electrical energy and apparatus employed therein. William White Jacques, 55, Chancery-lane, London.

3894. Improvements in electric railway signalling system. Yorke Burgess, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on March 5.)

1907.

555. Electric switches. Clark and Vlasto.

634. Electric distribution systems. British Thomson-Houston Company and Wedmore.

634A. Electric switches. British Thomson-Houston Company and Wedmore. (Date applied for under Rule 13, Jan. 9, 1907.)

2926. Indicating and recording apparatus for electric pyrometers. Armour.

3025. Electric cut-outs. Hope.

3184. Method of and apparatus for treating textile fibres or materials by electrolysis in cleansing, extracting, carbonising, stripping, sterilising, and disinfecting same. Spivey.

3226. Electric heating apparatus. Holmes.

3305. Electrical brakes for hoisting apparatus, cranes, and the like. Reuter.

3543. Electric heating pads. Shellhamer. (Date applied for under International Convention, April 2, 1906.)

3740. Apparatus for controlling the supply of electrical energy from alternating-current electric generators or mains to alternating-current electric motors. Wood, McLeod, and Lancashire Dynamo and Motor Company.

3914. Electric furnaces. Reynolds.

4055. Safety plugs for electric conductor systems. Meyer.

4125. Wireless electric signalling. Cabot. (Date applied for under International Convention, March 10, 1906.)

4128. Wireless electric signalling systems. Cabot. (Date applied for under International Convention, March 10, 1906.)

4132. Systems of electrical distribution. Peck.

4134. Wireless electric signalling systems. Cabot. (Date applied for under International Convention, March 10, 1906.)

4833. Regulation of electric motor-generator sets. British Thomson-Houston Company and Garton.

5836. Alternating-current commutator motor. Franklin and Seyfert.

5952 Jointing, bonding, testing, and distributing boxes and sleeves for lead or other metallic covered wire and cable for electrical purposes. Hill.

7048. Magnetic wedges for dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

7432. Electric contact makers. Cooper.

8173. Inductor alternators. Milton. (Rights under Section 91, Patents, etc., Act, 1907, not granted.)

9172. Electric arc lamps. Ingram and Hunt.

9572. Manufacture of electric lamps having incandescing bodies of refractory elements. British Thomson-Houston Company. (General Electric Company.)

10861. Direct-current armatures with multiple-circuit multiple winding. Punga.

12374. Dynamo-electric generators of the inductor type. Lake. (Hallock.)

12973. Brake leverage systems. British Thomson-Houston Company. (General Electric Company.)

13983. Storage batteries. Little.

14752. Means for preventing inductive disturbances in telephone, telegraph, and other electrical circuits. Scott. (Date applied for under International Convention, July 9, 1906.)

14935. Distribution of electric currents in the three and more wire systems. Torda and Torda.

15810. Sectional induction coils. Pfanstiehl.

23416. Electrically-controlled pendulums. Féry. (Date applied for under International Convention, March 1, 1907.)

24751. Commutators for dynamo-electric machinery. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, Nov. 12, 1906.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price.
	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70 000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	½-⅝
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125 000	1 ..	23/32-27/32
—— Ordinary Nos. 1 125,000	1 ..	½-⅝
British Aluminium Co., Ordinary, 2 001 40 000	5 ..	3⅜-4
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4⅜ 5
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	5⅛ ⅜
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3⅜ 4⅛
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100 000	5 ..	6⅜-7⅛
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅛-6
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85 89
British Westinghouse Elec. and Manuf. 10 per cent. Pref., 275 001-475 000	3 ..	½-⅝
—— 4 per cent. Mortgage Debenture Stock	100 ..	43-48
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2 ..	0-¼
—— Non-Cum., 6 per cent., Pref.	2 ..	5/16-9/16
—— 4½ per cent 1st Debenture Stock	100 ..	79 82
—— 4½ per cent. 2nd Debenture Stock	100 ..	63-66
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	1 -12
—— 5 per cent. Pref.	5 ..	5⅜ 5⅞
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1⅛-2⅛
—— 5 per cent Debentures	100 ..	92-96
Dick Kerr and Co., Ordinary, 1 250 000	1 ..	1-1¼
—— 6 per cent. Cum. Pref., 1-300 000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock Red.	100 ..	99 102
Edison and Swan United, "A" Shares. 1-9 261	5 ..	¾-1
—— "A" Shares 01-017.139	5 ..	1½-2⅛
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112 100	2 ..	¼-½
—— 7 per cent. Cumulative Pref.	2 ..	1⅜-1⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	65-69
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock Red.	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅜-8½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	11½-1⅞
—— 4½ per cent. Preference	5 ..	5- ¼
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-1⅛
—— 4 per cent. Debentures	100 ..	99-101
National Electric Construction Co., 1-170,000	1 ..	⅛-⅜
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	33-35
—— 4 per cent. Bonds	100 ..	101-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9

Electric Lighting and Supply.—

Name.	Amount paid.	Last price
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10.000	5 ..	6⅛-6¼
Bournemouth and Poole, Ordinary	10 ..	10¼-11¼
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	10- 1 xd
—— 6 per cent. Cum. Second Pref., 15 001-22,500	10 ..	10-10⅜ xd
—— 4½ per cent. Debenture Stock, Red.	100 ..	100 03
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅜ 5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	96-98
Brompton and Kensington, Ordinary	5 ..	7½-8
—— 7 per cent. Preference	5 ..	7-⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6⅜ 7¼
—— Nos. 8 1,000-100 000	5 ..	5⅜ 6⅜ xd
Cambridge Electric Supply Company £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	98-102
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	97-.00
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	4⅜ 4⅞
—— 4½ per cent. Cum. Pref., 1-80 000	5 ..	4⅜-4⅝ xd
—— 4 per cent. Debenture Stock, Red.	100 ..	97 1 0
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4¼-4⅜
—— ditto (905) 40,001-80 000	5 ..	4⅜-4⅝
Chelsea Electricity Supply	5 ..	3⅝-4⅛
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	10-11
—— 6 per cent. Cumulative Pref.	10 ..	11⅛- ⅛
—— 5 per cent. Debenture Stock	100 ..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	99 102
City of Wellington Electric Light and Power Co., 6 per cent. Registered 1st Debs. Red., 1-1 630	£0 ..	50-53
Columbia Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50 000	5 ..	3-3⅜
—— 5 per cent. Preference, 1-50,000	5 ..	4⅜-4⅝
County of London Elec. Supply, Ordinary	10 ..	7⅛-8
—— 6 per cent. Cum. Pref.	10 ..	11-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	105-108
—— 4½ per cent. 2nd Debentures Prov. Certs.	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50 000	5 ..	⅛-¼
—— 6 per cent. Cum. Pref.	5 ..	3-1½
—— 4½ per cent. First Mort. Deb.	100 ..	76-80
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	— ..	75-78 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cum. Pf., 1-30,000	5 ..	2¼-2⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	92-95
Folkestone Electric Supply Ord., Nos. 1-10 000	5 ..	4⅜-4⅝
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	5-5⅛
—— 4½ per cent. First Deb. Stock Red.	100 ..	94-97
Hove Electric Lighting, Ord. 1-13 000	5 ..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	98-101
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red.	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150,000	1 ..	9/16 11/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10½

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4⅞-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	91-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.) all paid	100 ..	92-95
Metropolitan Ordinary, 100 001-100,000	5 ..	5½ 6¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	107 111
—— 4½ per cent. Cum. Pref.	5 ..	4⅞ 5⅛
—— 5½ per cent. Mortgage Debenture, Red	100 ..	£5 90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1933), C 1 1 000 ($100), D 1-5,000 ($500), M 1 4,400 ($1 000	— ..	76½-78½ p.c.
Mexican Light and Power Co. Capital Stock	$100 ..	49-51
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	83-85 p.c.
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	98 101
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	6½-6⅝
—— do., 57 010-75 000	5 ..	6½-6⅝
—— do., 75,001-87,500 (issued at £22 prem., 16s. paid	5 ..	6-6½
—— 5 per cent., Pref., 1-57,009	5 ..	5-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5 ..	5-5½
Notting Hill Electric Lighting	10 ..	11½-12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5 ..	5⅝ 6⅛
—— 4 per cent. Debenture Stock	100 ..	93-96
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1 ..	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red	100 ..	96 98
Rosario Electric Co. 6 per cent. Cum. Pref., 1-20 000	5 ..	4⅞ 5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15 000	5 ..	4⅞ 5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	102 1/4 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	½-1½
—— 4 per cent. Debenture Stock	100 ..	70-74
South London Ordinary	5 ..	2-3
South Metropolitan Electric Light and Power, Ord.	1 ..	½-⅝
—— 7 per cent. Cum. Pref.	1 ..	1⅛ 1⅜
—— 4½ per cent 1st Mort. Deb.	100 ..	101 104
St. James's and Pall Mall, Ordinary, 101-20,000	5 ..	7⅜ 8⅜
—— 7 per cent. Pref.	5 ..	6½-7½
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 8-30 007	5 ..	1½ 2½
—— 5 per cent. Cumulative Preference, 50 001-80,000	5 ..	2-2½
Westminster, Ordinary	5 ..	8-9
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 .	5-5½

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-200 007	5 ..	6-6½
—— 10 per cent. Non-Cum. 2nd Pref., 200,008-280,007 ..	5 ..	8½-8⅝
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	129-132
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	103-106
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1-10 000	10 ..	—
—— 5 per cent. Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-100,606	1 ..	⅝-¾
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1 ..	13/16-15/16
Birmingham and Midland Trams., 4½ p.c. 1st Deb. Stk., Red.	100 ..	97-99
Blackpool and Fleetwood Tramroad	10 ..	13⅜ 14⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10 ..	9¾-9⅞
—— 4½ per cent. Deb. Stock, Red.	100 ..	85-97
Brisbane Tramway Invest., Ord., 1-75,000	5	3 9/16-3 13/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅝ 4¾
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. ..	100 ..	97-101
British Columbia Electric Railway Co., Ord. Def.	100 ..	127-130
—— Ord. Pref.	100 ..	106 110
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	104 107
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	101-104
—— 4½ per cent. Vancouver Power Deb.	100 ..	100-105
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10 ..	1½ ⅝
—— 6 per cent. Cm. Pf. 30 001-60 000	10 ..	4⅝ 5⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	97-101
—— 4½ per cent 2nd Deb. Stock	100 ..	72-76
Bueno Ayres and Belgrano Trams.	5 ..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-4 000	5 ..	4⅜ 5⅛ x d
—— "B" 6 per cent. Cm. Pf., 1-27 500	5 ..	4⅜ 5⅛ xd
—— 5 per cent. Deb. Stock, Red.	100 ..	110 116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	95-99
Buenos Ayres Gd. Nor. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red. 1-2,275	100 ..	100-104
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	91 94 x d
Calcutta Tramways, Ord., Nos. 1-137 610	5 ..	6¾-7½
—— 5 per cent. Cum. Pref., Nos. 1-30 000	5 ..	5-5⅛
—— 4½ per cent. 1st Deb. Stock, Red	100 ..	101 105
Cape Electric Tramways, Nos. 1-480,000	1 ..	3 16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4⅜-4⅞
—— 4 per cent. 1st Mortgage Deb., 1-3 000 (1917)	100 ..	98-101
City of Buenos Ayres Trams. Co. (1 04), 1-243,000	5 ..	5 5/16-5 7/16
—— 4 per cent. Deb. Stock, Red. 1-85	100 ..	100-101
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	91-95
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	1-1¼
—— 6 per cent. Cum. Pref.	10 ..	12⅞-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60 000	10 ..	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12½-1⅞ xd
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk., Red.	100 ..	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1 000 ..	80 85
Imperial Tramways Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5 ..	⅝-1⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	91-94
—— £296 500 2nd Mort. Deb. Stock	— ..	—
—— £83, 30 Deferred Deb. Stock (all fully paid)	— .	—
Lisbon Electric Tramways Limited, Ord., Nos. 1-594,188	1 ..	⅝-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 ..	⅝-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red	100 ..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	81-85
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red. 1-[illegible],635	$1 000 ..	£6-90 xd
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21 635 and 23,436-25 000	5 ..	4½-5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	92-95
Metropolitan Elec. Trams., Defd., 1 000 001-1 314 016	1 ..	1/16-3/16
—— 5 per cent. Cum. Pref. 500,001-1,000 000	1	13/16-15/16 xd
—— 4½ per cent. Deb. Stock, Red.	100 ..	98-100
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	85-87 p.c.
Milwaukee Electric Rail. and Light. 5 per cent. 30-yr. Con. Mort. Bonds, 1926 1-5,500 and 7 001-8,000	$1 000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb. £01-2,000	100 ..	100-102 xd
New General Traction, 6 per cent. Cum. Pref., 1-10 000 and 34 001-74 000	5 ..	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅞-9
Perth Elec. Tramways (W.A.). 5 per cent. 1 Mrt. Deb. Stk.	100 ..	101-105
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	½-⅝
—— 5 per cent. Cum. Pref., 300 001-545 000	1 ..	½-⅝ xd
—— 4½ per cent. Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary 1-24 912	10 ..	4½-5
—— 6 per cent. Cum. Pref., 1-10 000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref., 1-30,000	5 ..	5 5½
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	96½-97½
Sao Paulo Tramway, Light, and Power Co.	$100 ..	121-125
—— 5 per cent. 1st Mort. Deb., Red. 1929 1-11,000	$500 ..	£6-98 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169 570, Prov. Certs.	1 ..	⅞ 1⅛
—— 4 per cent. Deb. Stock Red. 1 40	100 ..	78 82
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red. 1-1 600	100 ..	60-70
Yorkshire (West Riding) Elec. Tram Co. Ord., 70 001-110,000	5 ..	1-1½
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3⅛ 3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	64-67 xd
—— 4 per cent. Pref.	100 ..	82-84 xd
—— " " deferred	100 ..	44-47
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) ..	100 ..	101-103
City and South London, Consolidated Ordinary	100 ..	38-40
—— 4 per cent. Debenture Stock	100 ..	101-104
—— 5 per cent. Pref. Stock '91	100 ..	114-117 xd
—— " " " '96	100 ..	112 115 xd
—— " " " '01	100 ..	110 113 xd
—— " " " '05	100 ..	108-111 xd
Liverpool Overhead, 5 per cent. Pref.	10 ..	10-10½
—— Ordinary, 1-50 000	10 ..	3⅜-4⅜
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	42-45

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs. Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Coll. tr. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78 000	$1 000 ..	86-88
Anglo-American Telegraph Co. Ordinary	100 ..	55-58 xd
—— 6 per cent. Preferred Ordinary	100 ..	99-101 xd
—— Deferred Ordinary	100 ..	13½-14 xd
Anglo-Portuguese Telephone Co., 5 per cent 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co., 1-44 000	5 ..	7 7½
Commercial Cable Co., Ste., 500-year 4 p.c. Deb. Stk., Red.	100 ..	87-90
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10 ..	6¾ 7⅛
—— 10 per cent Preference, 1-6 000	10 ..	15½ 16½
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼ 3½
—— 10 per cent Cum. Preference	5 ..	8½ 9½
—— 4½ per cent Debs., 1 000	50 ..	99½-102½
Direct United States Cable Co.	20 ..	13⅛-14⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200 Red.	100 ..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	93 101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000 1913	25 ..	99-101
Eastern Extension Australasia and China, 1 300 000	10 ..	12⅞ 13⅛
—— 4 per cent. Mort. Deb. Stock Perp.	100 ..	99-102
Eastern Telegraph Co., Ordinary Stock	100 ..	13 -13⅝
—— 3½ per cent. Preference Stock	100 ..	84-87
—— 4 per cent. Mortgage Debenture Stock	100 ..	10 -103
Great Northern Telegraph Co. (of Copenhagen)	10 ..	32-34
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1 200, Red.	100 ..	99-101
Indo-European Telegraph Co.	£5 ..	5⅜-5⅞
Marconi's Wireless Telegraph Co., Nos. 25,128-84,190	1 ..	⅜-⅝
Monte Video Telephone Co., Ordinary 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	⅛-1
National Telephone, Preferred	100 ..	111-113
—— Deferred Stock	100 ..	111½-113½
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum., Second Pref.	10 ..	10½-12½
—— 5 per cent. Non Cum. Third Pref.	5	5 7/16-5 11/16
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-99
—— 4 per cent. Deb. Stock, Red.	100 ..	100⅜-102½
Oriental Telephone and Electric Company	1 ..	1¼ 1½
—— 6 per cent. Cum. Pref.	1 ..	1 3 32-1 7 32
Pacific and European Tel., 4 p.c. Guar. Debs. Red., 1-1 000	100 ..	98 101
United River Plate Tele. Co., Ordinary 1-100 000	5 ..	6½-7
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4¾-5⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10½
West Coast of America 1-30 000 and 53 001-53,008	2½ ..	1⅜-2
—— 4 p.c. Debs., 1-1 500 guar. by Western Telegraph ..	100 ..	98 101
West India and Panama Telegraph Co., Ordinary	10 ..	17/32-21/32
—— 6 per cent. Cum. 1st Preference	10 ..	8-8½
—— 6 per cent. Cum. 2nd Preference	10 ..	8-8½
—— 5 per cent. Debs., Red., 1-800	100 ..	100 103
Western Telegraph Co., 1-207,930	10 ..	13⅛-13⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	98½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Feb. 19	1,147	1,187	- 40	— h	27½	27½	May 31	72,605	17,676 000	1,529 682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 22	183	166	+ 16	—	8	8	,, 16	15,283	3,603,784	378,894	·97	9·28	1,917	5 35
Baker Street and Waterloo Ry.	,, 22	3 020	2,430	+ 590	+ 5,719	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 23	974	963	+ 11	+ 203	23 53	23·53	March 31	55,408	11,686,691	1.324,743	—	—	—	6·1
Birmingham Corporation	,, 15	6,258	5,360	+ 898	—	56½	54½	,, 31	18,557	5,252,098	215 345	·87	16·2	9,228	—
Blackburn Corporation	,, 19	9:5	868	+ 66	+ 3,508	23·80	23·80	,, 25	54,951	10,092,028	1,002 372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 20	351	344	+ 7	- 1,178	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3 09	12 803	—	7·795
Bolton Corporation	Feb. 23	2,097	1,912	+ 185	+ 6,589	42	42	March 31	111 294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 19	1,322	1,259	+ 63	+ 2 090	24¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 15	4,268	3 987	+ 281	+ 5,379	98	95	,, 31	232 427	46,728,977	5,167,261	1·195	10 79	2,421	—
Brighton Corporation	,, 23	668	650	+ 18	- 3,119	17·191	17·191	,, 31	50,652	10,769,310	1,798,505	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 21	4 530	4,635	- 105	—	51½	51½	,, 31	266,769	46,902,257	6.178,886	—	—	—	—
Burnley Corporation	,, 22	1,066	1,090	- 24	—	19¾	19¾	,, 31	62,699	11,967,4.8	1,205,830	1·31	12 48	5,825	8·21
Burton Corporation	,, 23	255	252	+ 3	- 642	9¼	8½	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	4·14
Cardiff Corporation	Jan. 11	1,894	1,918	- 24	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	Feb. 22	152	137	+ 15	+ 70	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 23	5,923	6,365	- 441	- 2 035	6	6	,, 31	349,298	43,057,897	1,279,698a	1·85	62·29a	55,357	5·22a
Charing X, Euston, & Hamp. Ry.	,, 22	3,065	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 21	3,216	3 002	+ 214	+ 2,419	9	6¼	h June 30	82,456	10.048,780	—	—	—	—	—
Colchester Corporation	,, 12	160	146	+ 14	—	8	8	*March 31	10,588	2.457,653	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 20	385	401	- 16	- 193	15½	15½	Dec 31	25,032	5.966 364	891.9 8	—	6·74	—	4·78
Croydon Corporation	,, 21	1,195	—	—	—	12 c	12 c	March 3	64,065	13,514,918	1,502.408	1 08	9·76	3, 25	6 67
Darwen Corporation	,, 21	223	226	- 1	- 40	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1,124	4¾	4¾	,, 31	12,468	3.178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Feb. 21	102	87	+ 15	+ 2·h	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 21	4 765	4,450	+ 315	+ 826	54½	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 19	1,038	1,015	+ 73	+ 2,090	22	22	May 18	57,672	15 554 906	1,162 792	·878	1·9	4,352	7·3
East Ham Corporation	,, 22	799	819	- 18	+ 469	14	14	March 31	47,140	15,049,240	1,062,151	·74	0 49	3 636	7 14
Glasgow Corporation	,, 22	16,331	16,029	+ 302	+18,561h	177½	169	May 31	387.381	224,063,068	20,350.367	·95	0·47	5,035	5 21
Gloucester Corporation	,, 19	212	223	- 11	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 22	5 210	3,890	+1,350	+13,706	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77 996	18,893,242	1,624 275	—	1·52	—	8·65
Huddersfield Corporation	,, 22	1,389	1,380	+ 9	+ 3 298	35½	35	,, 31	87,196	15 252,150	1.804,745	1 52	0 79	2,770	5·92
Hull Corporation	,, 22	2 364	2,259	+ 105	+ 6,507	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 15	351	407	- 56	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 19	122	127	- 5	+ 405	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 12	238	233	+ 5	—	7½	7½	May 15	13,702	4,640,618	466,919	6·2	7 55	1,723	4 85
Lancashire United Tramways	,, 19	1,153	1 032	+ 121	+ 669	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 15	6,075	5,960	+ 115	+12,764	96½	96½	March 31	327,794	73,024,853	7,358,185	1 06	10 69	3,352	5 58
Leicester Corporation	,, 22	2,047	2,001	+ 46	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 15	10,251	10,142	+ 109	- 972	104	104	Dec. 31	563.793	122,094,528	12,115.934	1·108	1 17	5,421	7·75
Liverpool Overhead Railway	,, 23	1,432	1,384	+ 48	+ 123h	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 8	29 670	25,360	+4,310	+227,133	98	98	March 31	1378,014	314,227 090	20,130 297	1·05	10 98	—	8·56
Lowestoft Corporation	Jan. 11	144	150	- 6	+ 101	3½	—	Sept. 30	11,039	2,622,922	343,190	1·03	7 9	2,156	6·39
Maidstone Corporation	Feb. 20	143	83	+ 60	—	3¼	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 2	13,828	12 959	+ 869	+ 43,664	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 22	8,771	8 018	+ 753	+ 1,179	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 23	14,855	14,789	+ 47	+ 408	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 22	120	124	- 4	- 22	2¾	2¾	March 31	7,709	2 035,300	203,203	·86	8 64	1,892	8 69
Newcastle-on-Tyne Corporation	,, 22	3,709	3,893	- 184	+ 985	59⅛	57½	,, 31	210.491	45,506,468	4,263,174	1·11	11·85	3,560	6·14
Newport (Mon.) Corporation	,, 15	565	570	- 5	+ 2.087	14½	14½	,, 31	32.421	7,760.403	772 753	1 03	10 01	1.525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35½	35½	,, 25	94,948	18,647,751	1,818,444	1·19	12·53	2,603	7·209
Portsmouth Corporation	Jan 18	1,470	1 416	+ 54	—	28½	28½	,, 31	98,911	20.668 825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,661	8,130 179	918 825	·96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	Feb. 17	4,303	4,131	+ 172	+ 6,612	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78c	4·78c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 23	5,103	5,269	- 165	+11 678	65¼	65¾	March 25	276,907	73 966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	,, 19	897	823	+ 74	+ 2,980	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 19	253	253	—	+ 168	9	9	,, 31	20,076	4,431,728	390,578	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248 656	—	9 464	—	4 849
Sunderland Corporation	,, 23	1,023	1,219	- 136	- 2,176	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	Feb. 20	201	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 15	712	708	+ 4	+ 691	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,965 296	429 785	—	10 724	1,989	6·95
West Ham Corporation	,, 20	2,018	2,179	- 91	+ 2,197	14·7	14 7	,, 31	142,881	35,602.836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 19	744	762	- 18	+ 540	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·035

* 1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE
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THE HOME OFFICE REGULATIONS.

The inquiry now being held before Mr. James Swinburne as to the draft regulations of the Home Office dealing with the generation, transformation, distribution, and use of electrical energy in premises under the Factory and Workshops Act, 1901, is being well attended. There were no less than one hundred and eighty-five objectors to these regulations, but a large number of these have united into different groups, so that it will not be necessary to hear one hundred and eighty-five representatives. The Incorporated Municipal Electrical Association thus represent nearly all the municipal objectors, the London companies have united, and there are other groups represented by counsel. We trust that this will lighten the heavy responsibility placed on Mr. Swinburne in making his report. The objections to these regulations, which have been most carefully drafted by Mr. Scott Ram, the electrical inspector to the Home Office, are being divided into two groups. Thus, on the first day attention was concentrated on general points affecting the whole question, while the details of the regulations are to be considered later. Of these general points, the question of the right of appeal is the most important. The Home Office acknowledge this by putting forward the following proposed addition to the regulations: "In case any difference of opinion shall arise between an inspector and an occupier under this regulation, the occupier shall be entitled to make a statement in writing for submission to the electrical inspector." This only gives an appeal from the Home Office inspector in any district to the head electrical inspector in London. If this appeal is not successful the case has to come before a magistrate which we think is not satisfactory. The magistrates are not, as a rule, qualified to give a decision on such technical points as would arise, and look to the Home Office to guide them in such matters. We think that the whole question of these regulations should be considered as to the effect they may have on industry generally. Electric lighting and the electrical driving of factories is now so general that the influence of the regulations ultimately passed, while principally affecting electrical engineers, will extend to all the industries of the United Kingdom. The rules are framed to prevent danger to operatives, and without any consideration of cost. In fact, Mr. J. H. Gray, in his opening speech for the Home Office, was pleased to note that very few objectors had introduced "this low ground of objection." If this argument is carried out to its logical conclusion, it may lead to an industry being extinguished rather than allow a few accidents to happen to the workers employed. There would then be no need for any rules at all. As an example, the electric driving of factories has been proved to be not only more economical than using one prime mover and countershafting, but also more safe. The risk of operatives being caught by belts and drawn into the shafting is reduced by electrical driving to a minimum. If, now, these new rules, with their automatic releases for the starting gear of three-phase motors and their means for quickly stopping the motor from "every place," so increase the cost of electrical driving as to make it less economical than a single prime mover, they will defeat their own object. The danger of any code like that before us being too rigidly interpreted is not found when a capable engineer like Mr. Scott Ram is in charge of the department. In course of time, however, the rules have to be applied by others who, while protecting the workers, also desire, like most Government servants, to protect themselves at the same time, and they find that this can be

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most quickly done in office hours by enforcing the strict letter of the law. This is why we strongly urge the right of appeal to an independent expert. We believe as strongly as the Home Office in the protection of the intelligent workman against accidents, but no regulations will prevent a fool hurting himself. In attempting to protect the fool (who, unfortunately, is too frequently with us) the cost of production may be raised to a point which renders business unprofitable. The workmen would then be quite safe, because there would be nothing for them to do in the factory so carefully equipped under the Home Office regulations. This is not the safety which we, as a nation, require.

OUR MENTOR.

We are not much concerned with the *Times* or its ways, but it is just a little indiscreet when it takes upon itself the position of grandmotherly adviser to the technical Press. Certainly, since the new era of management the *Times* does issue weekly supplements—spelled with an "a" rather than an "e" would better indicate their value—hence presumes it knows something of technical matters. It does—it half follows Brougham in giving us a little of everything, but not everything of one thing. Its attempt to appeal to everybody means that it appeals to nobody. In a grandmotherly fashion it has taken up electrical matters, dealing with these more lengthily than with any other branch of engineering; and probably when history comes to be written it will be found that an inadvertence of the *Times* did more harm to the constituting "of a strong majority resulting in an arrangement for mutual defence" than any other action in the history of the industry. The latest dogma of the *Times* is that "considerable dissatisfaction has been caused amongst the electrical manufacturing companies by the tone of recent comment in the technical Press on the present deplorable condition of the industry." What is the "tone," and is the whole or a small minority of the technical Press condemned? Is this dissatisfaction as to the "tone of comment" merely a political one of "tariff reform" *versus* "free trade," or is it that the technical Press have pointed out scores of times the danger of a continuous cutting of prices—a point that the *Times* seems just to have discovered, and so wants to make a record screech with its new discovery? Of course, the subject cannot be technical, as the *Times* does not deal with technics, yet "nothing," says the *Times*, "could be more mischievous than the habit of certain journals [what journals?] of asserting, or, at least, implying, the inferiority of foreign manufactures in certain departments" [again, what manufactures in what departments?]. Let us come to grips, sir. Technical journalists, as a body, do not assert and do not imply unless they know, and as it is their duty to compare they are justified to state the results of such comparison. As a matter of fact, it is very easy to show points in which British workmanship is supreme, and that the cheaper productions of foreign workmanship offered in competition are really dearer, though initially they cost less. It is just as easy to show wherein the foreign competitor reigns supreme; and we know of no technical journal that generalises habitually, as the *Times* asserts. Which are these condemned journals? We are prepared to take up the cudgel on behalf of the technical Press if no worthier volunteer steps forward, and we deny point blank the truth of the *Times*' accusation. The electrical industry owes its position very largely to experimental work carried on abroad, which, together with our own, has given results which again combined form the apparatus and systems in constant use. When we come to compare pieces of apparatus, many factors have to be taken into consideration besides costs. This is just what the technical Press does, and if it condemns, it condemns for valid reasons and not because the writers belong to this or that political faction.

THE NATIONAL PHYSICAL LABORATORY AND ITS FUNCTIONS.

There was issued this week the report by the committee appointed by the Treasury to inquire generally into the work now performed at the National Physical Laboratory. The circumstances which led up to the appointment of this committee of inquiry are too well known to need recalling here. Moreover, they are embodied in the report, a summary of which appears in another column. The terms of reference to the committee were to inquire into the character of the tests undertaken at the laboratory, the possibility of their interfering unduly with the business of other agencies, and the desirability of publishing the results of testing work. They were asked to report (*a*) "whether, having regard to the industrial interests of the country generally, and to those of private agencies, any change is desirable in the scope of the work of the laboratory"; and (*b*) "on what lines any further development of its business should proceed." The result of the committee's investigations has been awaited with much interest, not only by the private testing establishments and the analysts who are in the habit of adding engineering tests to chemical analysis, and who were beginning to look on the policy of the laboratory as a serious menace to their interests, but also by all classes of engineers, who look upon the laboratory as the proper institution to keep them abreast of physical research bearing on industrial problems, and to undertake the standardisation and verification of instruments. Now, in so far as a State-aided institution undertakes work—even if it be the testing of materials—which can be competently discharged by private bodies for lower fees than are charged by those bodies, there can be no question as to the legitimacy of any grievances that are raised, and it must be admitted that such a policy acts as a very real menace to private interests. But it is clear that if the testing of materials—or what has been commonly termed the commercial work—is withdrawn entirely from the sphere of the National Physical Laboratory, the staff of experimenters engaged there will be deprived of an important practical experience, and the advantage of the institution to the industry of the country will be considerably lessened. So that the committee had really to decide upon a matter which was not only fraught with very great delicacy, but which had an important bearing on both the scientific and industrial aspects of engineering. They have suggested an ingenious means for extrication from the difficulty in regard to clashing between public and private interests. After all, the question of how best to consult the reasonable interests of private testing establishments without impairing the utility of the laboratory is one rather of practice than of principle. The practice recommended is to distinguish "commercial testing" into (*a*) "contractual testing"—*i.e.*, the testing of materials to ascertain whether their quality and behaviour are in accordance with the requirements of contracts—and (*b*) "investigatory testing," which is in the nature of investigation for commercial purposes of various substances in which no question of contract arises. It is proposed that the laboratory should be debarred from the former (subject to certain reasonable exceptions), but in regard to the latter no restriction whatever is to be placed on the activity of the laboratory. There now arises the question of fees. It is intended to make the fees charged

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by the laboratory at least as high as those normally current for the testing of materials, and even higher than the normal for "reference testing." This, we think, is an adequate safeguard against injurious competition with private enterprise, and should dispose of the idea that it is the intention of the laboratory to undercut prices. There are many other points in the report, which are, however, dealt with in our summary elsewhere. We consider that on the whole a very fair and equitable policy is defined by the committee, and, although little or no alteration is recommended in the scope of the work of the National Physical Laboratory as defined by the committee of 1898, the modifications now suggested will lead to the clearing up of doubtful points of detail.

UNDERGROUND EXPRESS LINES.

A point which seems to gain comparatively little consideration from the proprietors and engineers of the underground and tube railways in London is the provision of facilities for the running of express trains over their lines. Such a proposal has at various times been mooted without anything having been made of it. Of course, it is well nigh impossible to have an express service on the same tracks as those used for ordinary local services, and the proposal would, of necessity, involve the provision of separate tracks for express trains. But when we come to consider what a great saving of time, as well as other advantages, such as a diminution in the service, would result from such an arrangement, it would seem to be well worthy of a trial. After all, this should not be so difficult a matter, for we believe there already exists in London, on the District Railway Company's system, a deep-level line upon which the experiment of an express service could be tried. The arrangement has already been tried with success on the New York Rapid-Transit Subway, and Mr. W. Barclay Parsons, in his paper on that interesting railway before the Institution of Civil Engineers, gave an account of the working of that arrangement. He said: "Stations for local tracks, except in a few instances where island platforms were more convenient, have platforms on the outside with short direct stairways leading to the pavement. There are for each platform usually two exit and two entrance stairs. The express trains are served by island platforms, one between each pair of tracks, connected with each other and with the street pavements by an overhead bridge. At such stations passengers can transfer freely and without extra charge from local to express trains and *vice versâ*. Such transferring is done to an unexpected extent, the local trains acting as gatherers and distributors for the express trains. The express trains are scheduled to make about thirty miles per hour, and the locals thirteen miles."

MEASUREMENT OF THE INDUCTANCE OF A CIRCUIT AT NORMAL CURRENT.

The well-known method of arriving at the inductance of a circuit by passing a sinusoidal alternating current through it and noting the volts, amperes, and ohmic resistance of circuit, leads to doubtful results when applied to a circuit which is only slightly inductive. The voltage measured is then so little in excess of the resistance drop, that the least inaccuracy in the measurements is greatly magnified in the inductance deduced. Mr. C. C. Chapin in the *Electrical World* describes a method by which this difficulty is avoided. The plan consists essentially of separating the counter E.M.F. of inductance from that of resistance, and measuring it alone. This is accomplished by the use of a differential galvanometer in which the counter E.M.F. of resistance of the test circuit is neutralised by that of another equal resistance placed in series. The scheme is shown in the diagram. The counter E.M.F. of resistance of the line under test is balanced by that of an accurately equal non-inductive resistance, R_h, placed in series with it, the connections to the galvanometer being such that the directions of the currents in the two coils are opposite. That this balance could be obtained may be readily seen by observing that the two portions of the circuit (the line and the rheostat) are in series, and that hence the currents in them must be in the same phase, and have the same instantaneous values, and give the same counter E.M.F. of resistance at all times. By impressing these two equal and synchronous potentials, due to resistance effects, on the two coils of the galvanometer in opposite directions, so that their magnetic fields oppose and neutralise, the resultant value of the counter E.M.F. of resistance acting upon the galvanometer needle will be zero, leaving the counter E.M.F. of inductance for measurement by itself.

The differential galvanometer used has a needle consisting of a bundle of fine iron wires suspended by a quartz fibre between the two halves of the coil, and with its axis set at an angle of 45deg. to the coil axis. The whole instrument is heavily shielded from external magnetic fields by soft-iron cylinders. The coil consisted of two similar parallel circuits of 56 ohms each. The sensitiveness is such that alternating E.M.F. of ·01 volt placed across the two coils in series (connected so as to help instead of oppose each other) gives a deflection of about 33mm., and this deflection is entirely independent of frequency within the commercial limits. For the purpose of adjusting the resistance of the carbon rheostat to exact equality with that of the line, a double-throw

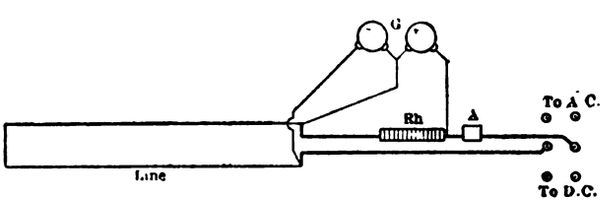

FIG. 1.

switch is inserted in the generator leads, as shown in Fig. 1, by means of which direct current may be used on the line. By adjusting the rheostat, R_h (Fig. 1), with direct current in the circuit until no deflection of the galvanometer is obtained, the resistance of the rheostat is made just equal to that of the line. A number of test results are given showing a close agreement with the calculated values.

THE WORKS OF THE REASON MANUFACTURING COMPANY, LIMITED.

It is quite in keeping with the spirit of change that Brighton, whose unique situation and health-giving properties led one writer to describe her nearly a century ago as "Proud as Phœnicia, Queen of Watering Places," should have developed from the mere fishing village, as shown in the old prints of the place, to the big modern city by the sea. But what may seem less congruous is that such a fashionable and opulent pleasure resort should become the headquarters of an important and prosperous manufacturing firm. Still, the memories of the Regency period have by no means faded before the development of industrial activity, nor is the literary halo that encircles the town likely to diminish in the face of commercial and industrial enterprise, although we do not imagine that when Horace Smith referred in his poem to the "bleak downs" of Brighton, he foresaw that almost at the foot of the said downs there would be placed the large works required by the Reason Manufacturing Company, Limited, for the manufacture of their various specialities.

We were afforded the privilege of being shown over these interesting works the other day, and of witnessing

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the manufacture of the Reason Company's meters, fuse boxes, arc lamps, etc., in their various stages. The buildings are comparatively new, having been completed in April, 1901, in which year they were occupied. They cover an area of 1½ acres, with a frontage of 408ft., and are built in the form of a quadrangle, the various sections being connected by bridges, which afford easy means of intercommunication. Before describing the equipment of the various shops and the manufacturing processes of the different specialities, it might be of interest to mention a few particulars concerning the history of the firm.

The first Reason Manufacturing Company was formed in 1891 to acquire the business of the late Mr. Henry Reason, who was the founder of the whole concern, and to whose foresight and energy the present company owes its standing among the electrical manufacturers of this country. The development of the undertaking under his management was extremely rapid, and various isolated premises had to be acquired to supplement the original workshops in the centre of the town. In 1900 the present works were constructed in order to centralise all these separate workshops in one building, and the present company was formed in the same year, with a capital of £70,000. Unfortunately, during that year Mr. Henry Reason met with a fatal accident in Australia. Since his death several changes have been made in the board of directors, which at present consist of Mr. William Reason (chairman), Mr. H. C. Hughes, Mr. W. Cowderoy, and Mr. Herbert Reason, the latter also being responsible for the management of the works and office and of the selling organisation. The secretary of the company is Mr. W. N. Scott.

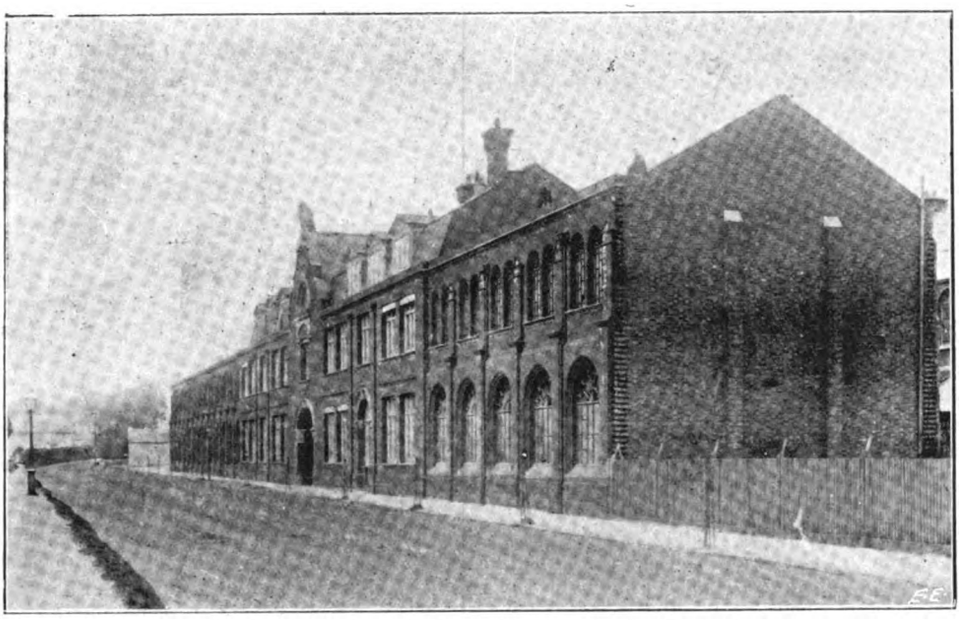

FIG. 1.—The Works of the Reason Manufacturing Co. (Frontage).

Coming now to the works themselves, the first part visited was the glass-blowers' shop, in which are made the glass tubes used in the electrolytic meters and demand indicators. The parts of the tubes are formed separately, then joined together by means of heating. When this is completed the tubes are annealed in a gas stove. The demand indicator tubes are then filled with sulphuric acid by means of heating a glass bulb in which the acid is placed. When one side of the tube is filled, the acid is drawn round to other parts of the tube by means of air suction. The tubes used for the electrolytic meter are carefully washed with caustic soda and other chemicals before they are filled with the solution, as the slightest impurity completely spoils the meter. The mercury in the electrolyte is in a "mercuric" or bi-valent condition, the reason being that mercurous solutions must all contain free acid, whereas a mercuric solution may be perfectly

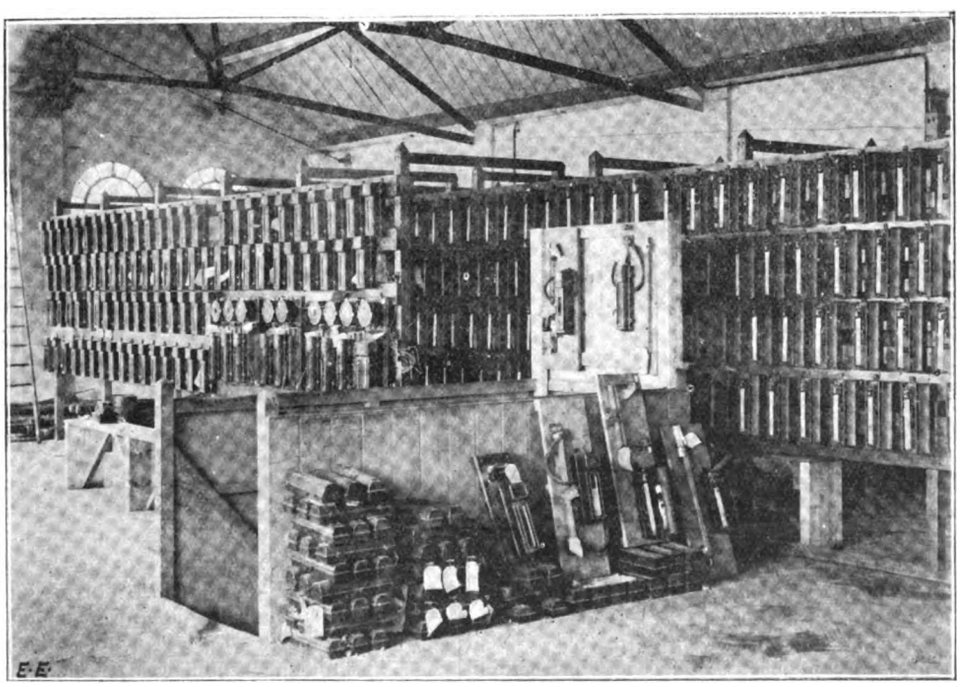

FIG. 2.—View of the Test-Room.

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neutral, and, therefore, without any conceivable action on the mercury or other materials present in the cell. The tubes are then fitted on a base and undergo a preliminary test before being fitted on to the shunts, after which they are assembled in another shop and fixed in their cases.

switchboards for testing the different capacities of demand indicators—ranging from 2½ amperes to 1,000 amperes—were erected by the Reason Company themselves. One consists of nine panels, each of which represents a different circuit, and is fitted with a voltmeter, ammeter, and quick-

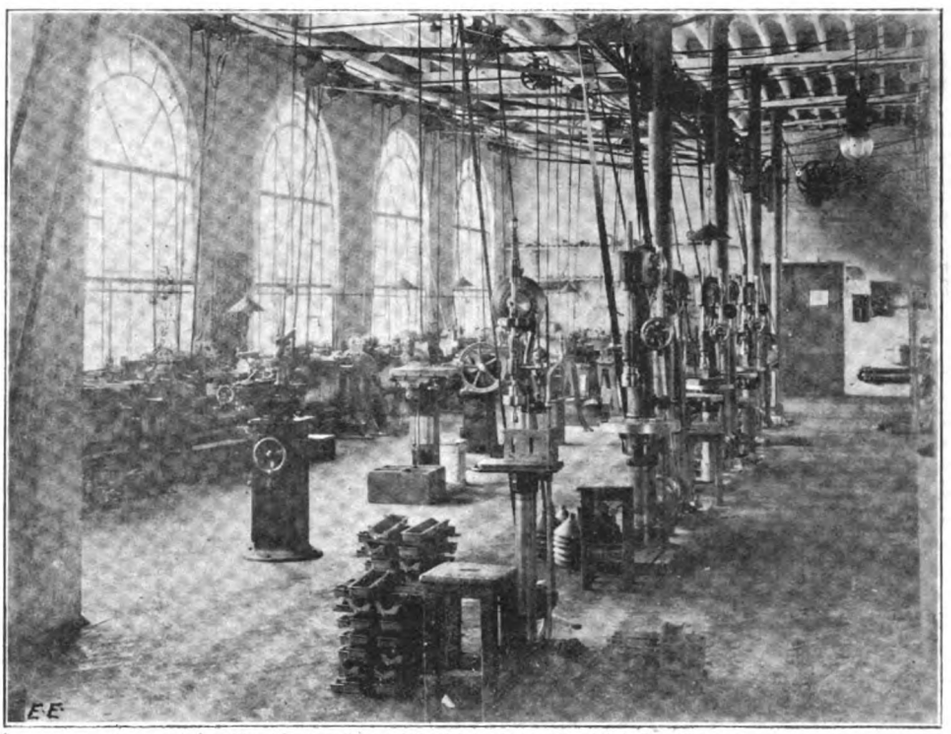

FIG. 3.—A portion of the Meter Department (Machine Shop).

The apparatus employed in the manufacture of these meters is of the simplest kind, as the essential processes call more for individual skill and attention than for elaborate and complicated tools. Both the electrolytic meters and the demand indicators undergo separate tests at various stages. Fig. 2 presents a view of the testroom

break switch. A separate switchboard is used for currents up to 1,000 amperes, and is specially designed for the convenient use of the Crompton potentiometer. Although the current used is obtained from the Corporation mains a battery of Tudor cells is used for testing, as it is possible to get a steadier current than that from the

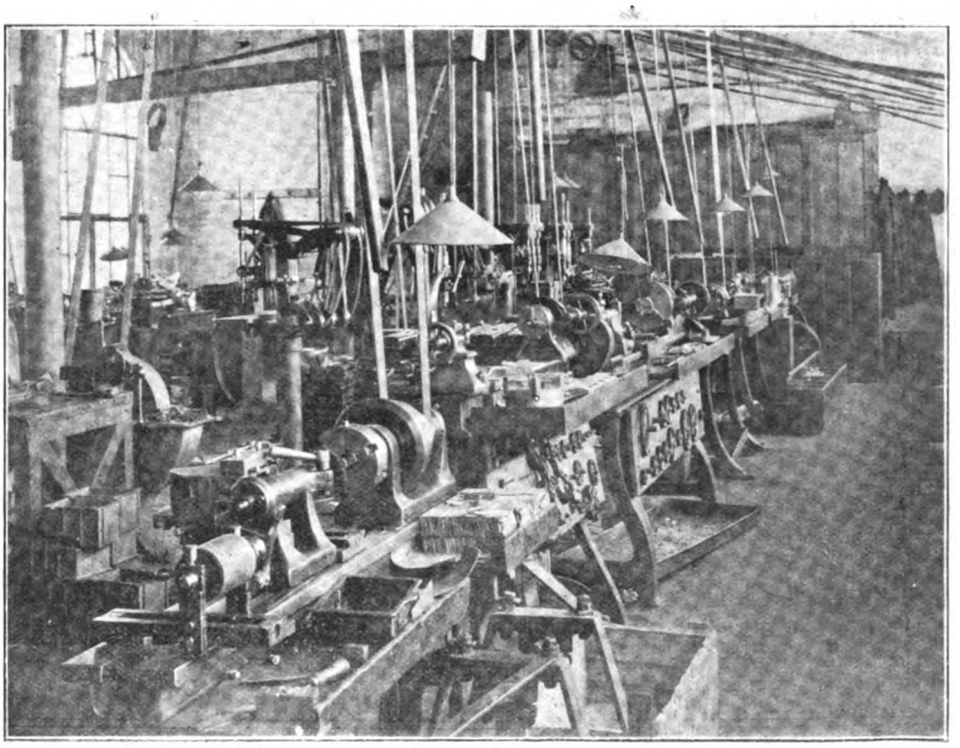

FIG. 4.—Machine Shop.

in which the complete instruments undergo their final test. It will be seen that the meters are fitted on racks and tested together. An electric current is passed through them, and the records are taken on strips of scaled paper placed underneath the reading-tubes. After records of all the necessary tests have been taken, the scale which is permanently fixed in the instrument is drawn. The

mains. These cells have been in use over five years, and have worked extremely well.

Fig. 3 shows portions of the meter department machine shop in which the parts of time switches and meters are made. There are in all in this shop 16 drilling machines and lathes of various sizes, and seven bench machines. These are driven by one 6-h.p., 1,300-r.p.m., 460-volt,

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5-ampere direct-current Bruce Peebles motor. The position of the motor is not shown in either of the illustrations, but we may say that it is fitted against the wall, thus economising in the way of floor space. It is connected by means of a belt to a pulley and shafting, the arrangement of which is to be seen in the illustrations. In the arc lamp department a 10-h.p. Bruce Peebles motor is used to run the machines and lathes employed in the manufacture of the solid parts of "flame" arc lamps, enclosed arc lamps for alternating and continuous currents, and miniature arc lamps. There are at present in hand many large orders for twin-carbon lamps, and for the miniature lamps there seems to be a very large demand. A shop is specially set apart in which the well-known fuse boxes and other accessories that are employed in connection with street-lighting are made. A big trade is done in fuse boxes, of which large stocks are always kept on hand. The cast-iron cases for all the manufactures are fitted up in one shop. In this shop there are several patent automatic screw-cutting lathes, the screwing, pointing, and cutting of the screws all being done in one operation. All the machine tools in the shop are driven by two motors, each 10 h.p., and belted through shafting, similar to those which are seen in the illustrations. All the brass castings required are made in a foundry. A fan in this foundry is driven by a small motor, which also drives an emery-wheel for grinding castings, etc.

The pattern shop does not call for much comment, but the wood-working shop is of interest, inasmuch as all the machinery is driven by an electric motor. Though the machines are comparatively small, and consist principally of three circular saws, one planing mill, and a few hand-feed drills, these consume a tremendous amount of current, the motor driving them being a 20-h.p., 750-r.p.m., direct-current Bruce Peebles machine. A few smaller machines in another shop are driven by the same motor. All the wooden parts, boards, etc., required for meters, fuse boxes, etc., are made in one of these shops, and finished off and polished in another. We might add that the office furniture was made in the company's own joiners' shops.

All the current required for power and lighting is taken direct from the Corporation mains, the batteries to which we have already referred being used for the purpose of steadying the current when required for testing purposes. The works, though they contain no machinery or tools of exceptional interest, are yet noteworthy for the completeness of their equipment. The various shops are spacious, light, and airy, and the articles are manufactured under the very best conditions.

The welfare of the workman is not neglected here, for we understand that there are various sports and athletic clubs for the employés, which are encouraged by the firm, who provide excellent facilities not only for the recreative needs of their men, but for their convenience at the works themselves. A large messroom has been provided where dinners are served at remarkably low prices.

We were pleased to notice that the various shops were in a very brisk state, thus showing that the business in hand is good. It is apparent, also, that a very fair street-lighting connection has been worked up. The company have agencies in London, Leeds, Newcastle, Glasgow, and Birmingham, as well as in Utrecht (Holland), Melbourne, and other places abroad.

We have to acknowledge our indebtedness to Mr. Herbert Reason and to Mr. Fowler, chief of the demand indicator department, for showing us round these interesting works.

THE CONDUIT SYSTEM OF ELECTRIC TRAMWAY CONSTRUCTION AND RECENT IMPROVEMENTS.*

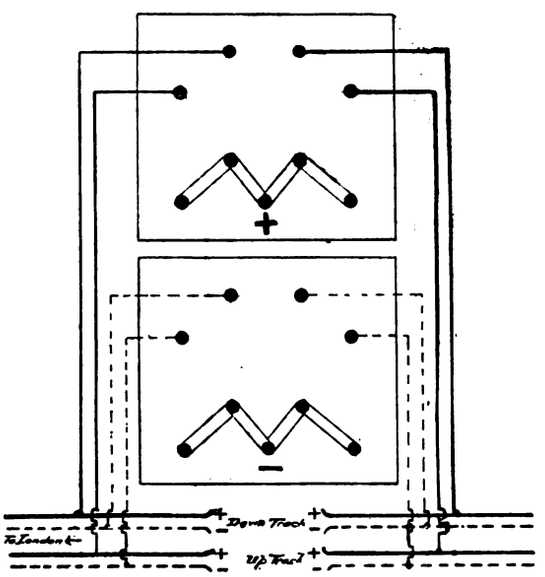
BY FITZ ROY ROOSE, A.M.I.MECH.E., A.M.I.E.E., F C S.
(L.C.C. ENGINEER'S DEPARTMENT).

(Concluded from page 264.)

SIDE-SLOT SYSTEM.

An alternative method of construction is in operation—viz., the side-slot system—of which only a very short length has been constructed in London. It has been in operation in Bournemouth since 1903, and, although slightly cheaper to construct, has not, in certain other respects, been entirely satisfactory. One of the slot rails forms the head of the running rail and the other forms the lip or cheek. The wear round curves with heavy traffic is found to increase the width of the slot to such an extent as to be rather dangerous to ordinary traffic, and for that reason

Fig. 21. Miniature Switch Board in Feeder Pillar.



the system may not be generally adopted in London where the traffic conditions are very severe, the length of line laid down being regarded as an experiment.

ELECTRICAL DISTRIBUTION.

Electrical energy for driving the cars of the London County Council tramways is generated at Greenwich, in a new station of a present capacity of some 20,000 h.p. It is generated at a pressure of 6,600 volts alternating current,

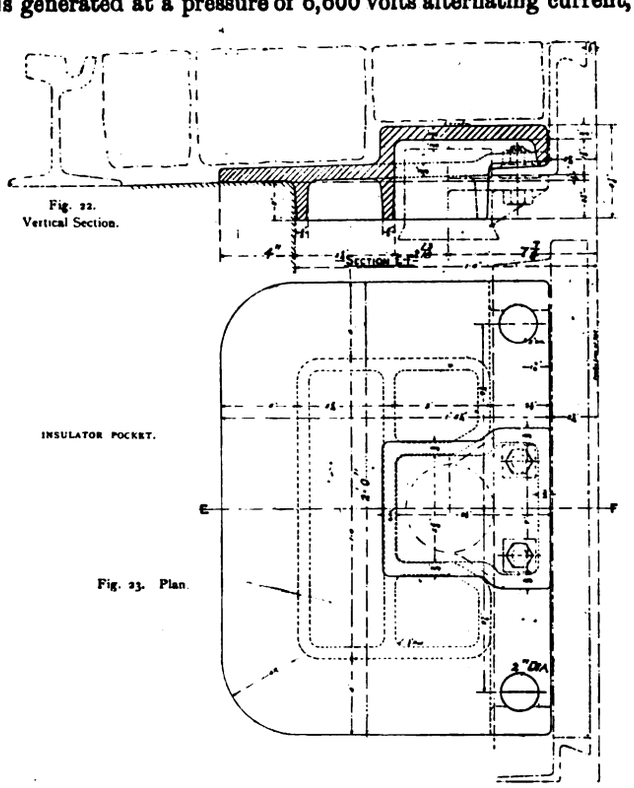


Fig. 22. Vertical Section.

Fig. 23. Plan.

and at that pressure is transmitted, by means of copper cables, to various sub-stations, each of which feeds a separate district. Power was originally obtained from various electric supply companies and from the Council's own or other companies' plant, but now the whole energy is derived from Greenwich, power being taken from one company only on occasions of overload. The second

* Paper read before the Junior Institution of Engineers.

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section of the Greenwich generating station is now under construction, and, when completed, about 50,000 h.p. will be available.

Sub-Station Conversion, etc.—The current, on being received at a sub-station, is converted from alternating to continuous

less liable to break down insulation and leak away, although, when testing the conductor bar work for insulation, etc., a pressure of 2,000 volts alternating is used as a precaution against weak points. The current, on being received from the central power station, is controlled by a switchboard

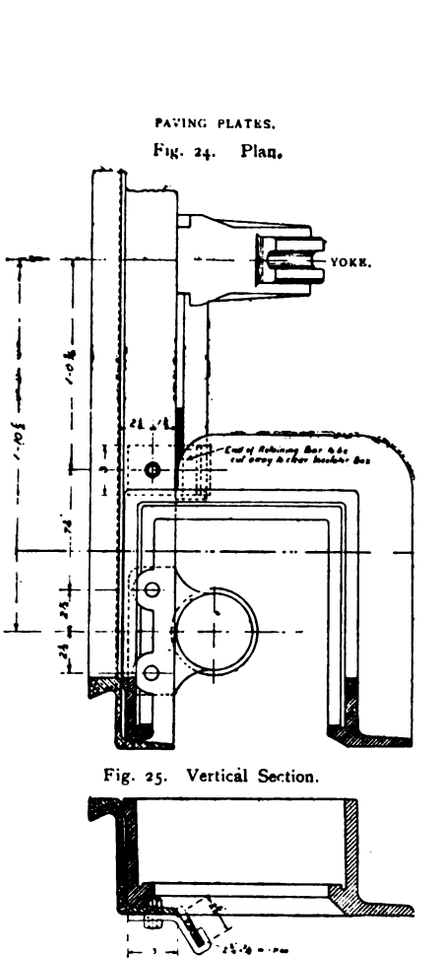

Fig. 24. Plan.

Fig. 25. Vertical Section.

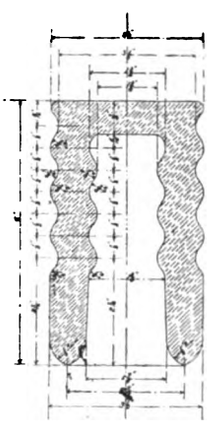

Fig. 26. Porcelain Cup.

INSULATOR.

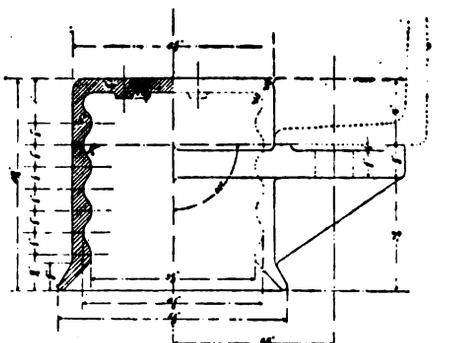

Fig. 27. Iron Hood.

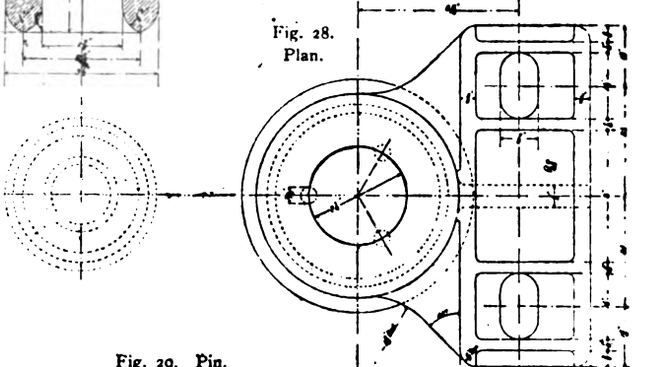

Fig. 28. Plan.

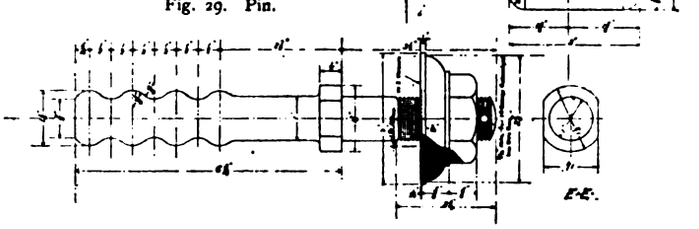

Fig. 29. Pin.

current at a pressure of 550 volts by motor-generators (synchronous and asynchronous), the motors of which are driven by the alternating current received from Greenwich, and in turn the motor-generators transmit the energy at

consisting mainly of three parts, each made up of a number of slate or marble panels. One part receives the high-tension current from Greenwich, and, through its necessary switches, meters, etc., passes it on to the

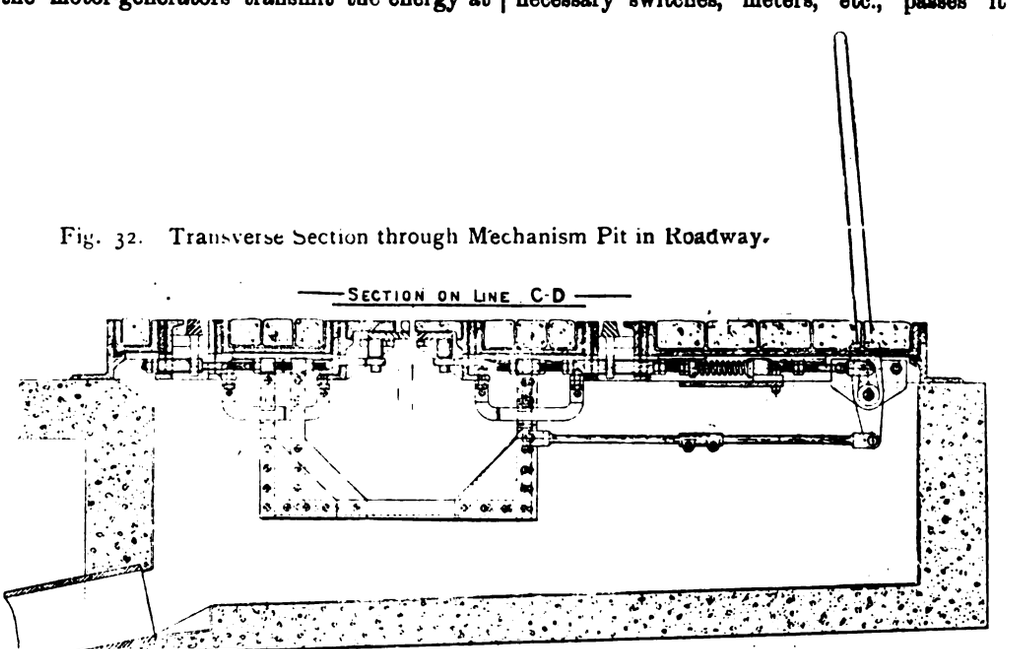

Fig. 32. Transverse Section through Mechanism Pit in Roadway.

continuous current to the different feeding points in each district, there being a feeding point to every half-mile section. Continuous current is used on the lines in preference to alternating, as, amongst other advantages, it is easier to control, and, being at a much lower pressure, is

motor-generator. Another part receives it from the generator, through switches, and transmits it through an automatic cut-out, ammeter, and voltmeter to two copper 'bus bars running the length of the switchboard. The third part consists of the feeder panels, which collect the current

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from the bars and distribute it through necessary meters and switches to the feeder cables, and these carry it to the feeding points.

Automatic Circuit Breaker.—Each feeder panel and dynamo panel has an automatic switch forming a circuit breaker, which performs a similar function to that of a safety valve on a steam-engine, its object being the safety of the dynamos, cables, switchgear, etc. For instance, should an excess of current pass through the cables from the dynamos, which might happen from an unduly heavy working load being suddenly thrown on the dynamos, or should a bad leak arise, which would also put a heavy load on the dynamos, if there were no circuit breaker, the cables, being insufficient to carry the load, might melt, the dynamo would spark and flash badly, which would damage the brush gear, etc., and in the event of a dead short-circuit might burn the armature of the dynamo right out and wreck the board. The object of an automatic circuit breaker is to open the circuit between the fault and source of supply, an operation which is effected by various contrivances, a satisfactory type being a magnetic blow-out. The switch maintains contact mechanically. The lever which holds the contacts together is kept up by means of a toggle, directly underneath which a magnetic coil is placed and connected in series with the main circuit.

Fig. 30. Longitudinal Sectional Elevation of Crossover

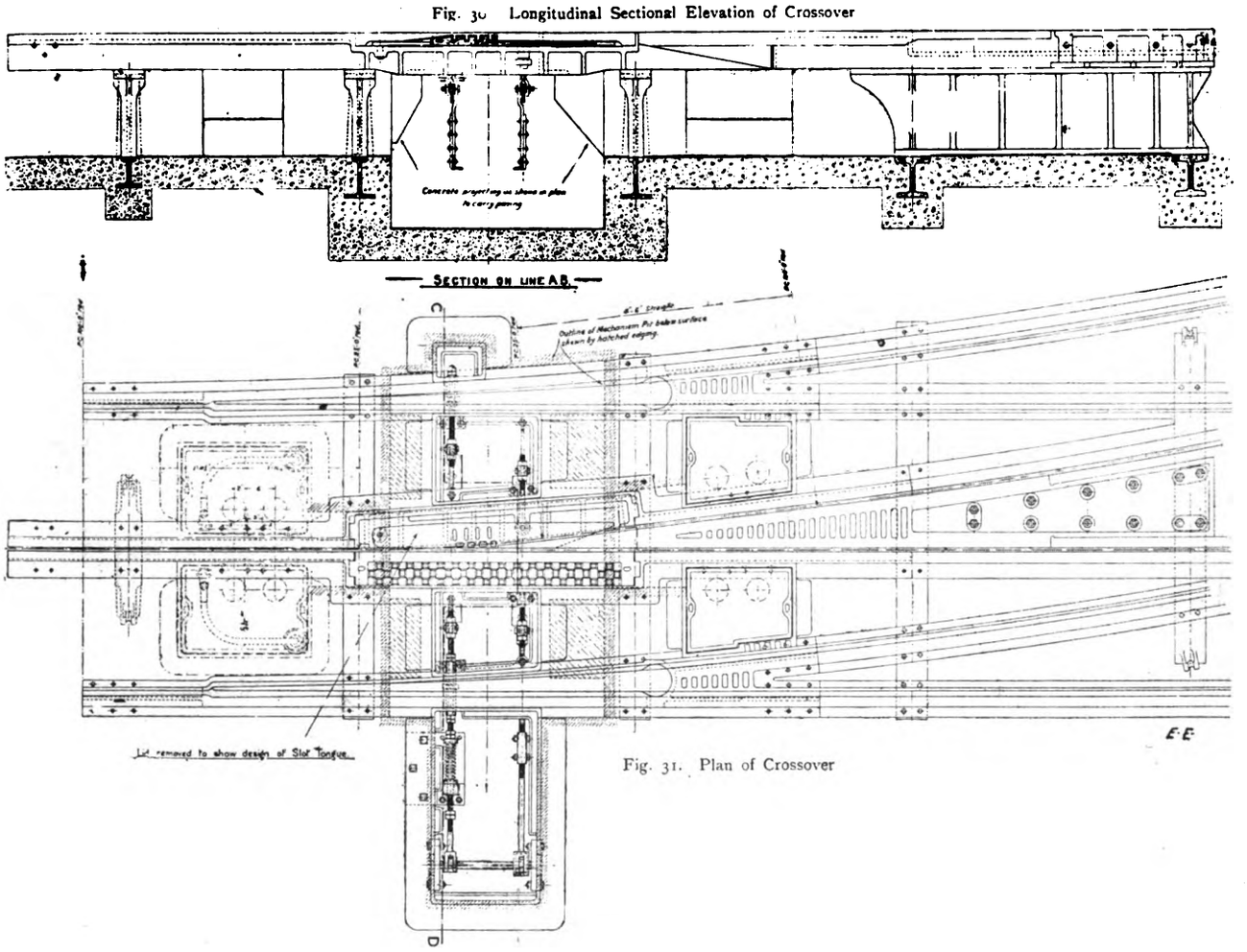


Fig. 31. Plan of Crossover

When the current is normal the magnetic coil is not strong enough to attract the solenoid core up and open the switch, but as the current rises on the main circuit, and thus through the coil, the weight of the core is overcome, and, being drawn up, trips the toggle. The switch opens, and the circuit is broken, and simultaneously the arc set up is destroyed by the magnetic flux. An electric alarm, which is usually attached, attracts the observation of the switchboard attendant.

Fig. 33.
Side Elevation.

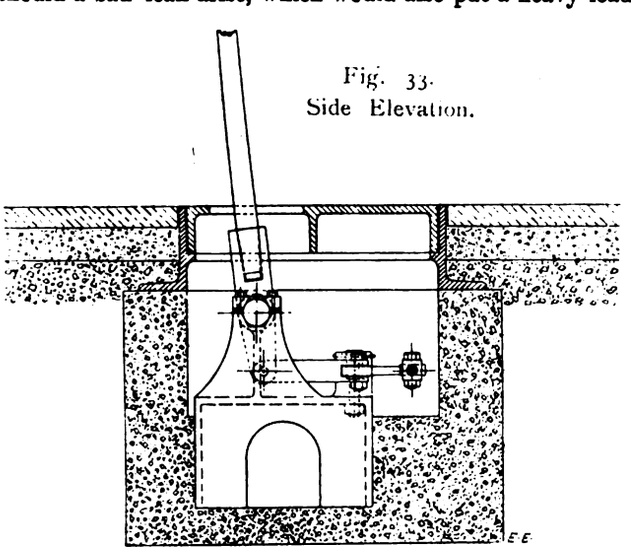
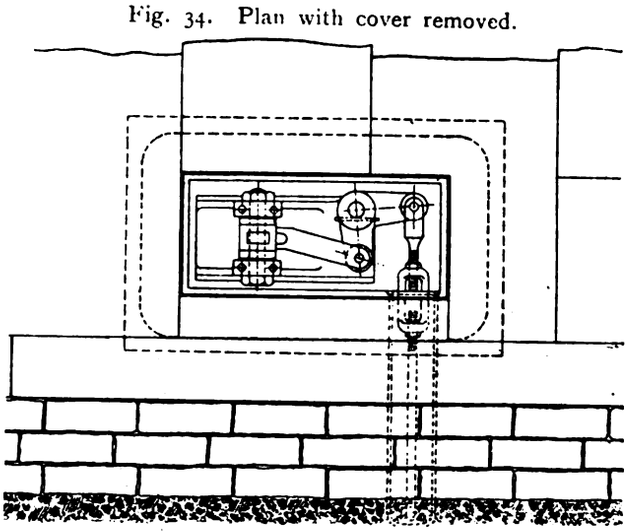


Fig. 34. Plan with cover removed.



Reversible Polarity.—A point of interest about the main low-tension switches on these feeder panels is that the polarity can be reversed on the feeders at will. This is done by having a double set of jaws, two at the top and

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two at the bottom; the blade of each switch being pivoted between the upper and lower jaws. The cables carrying the current from the 'bus bars to the feeder panels are

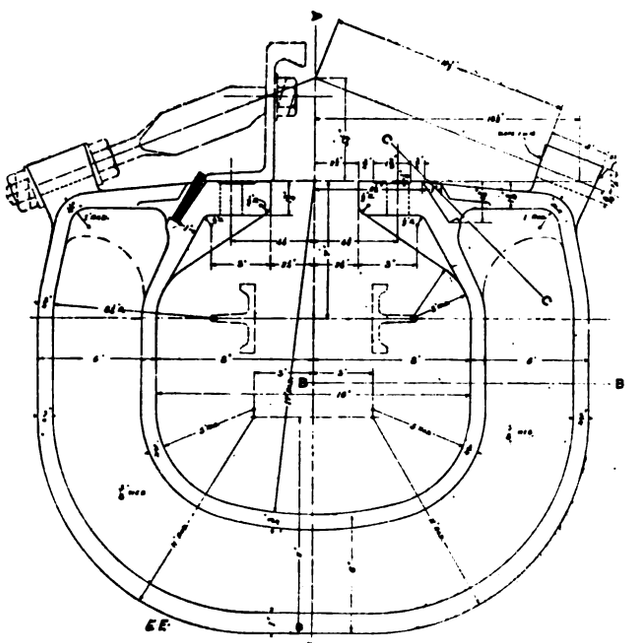
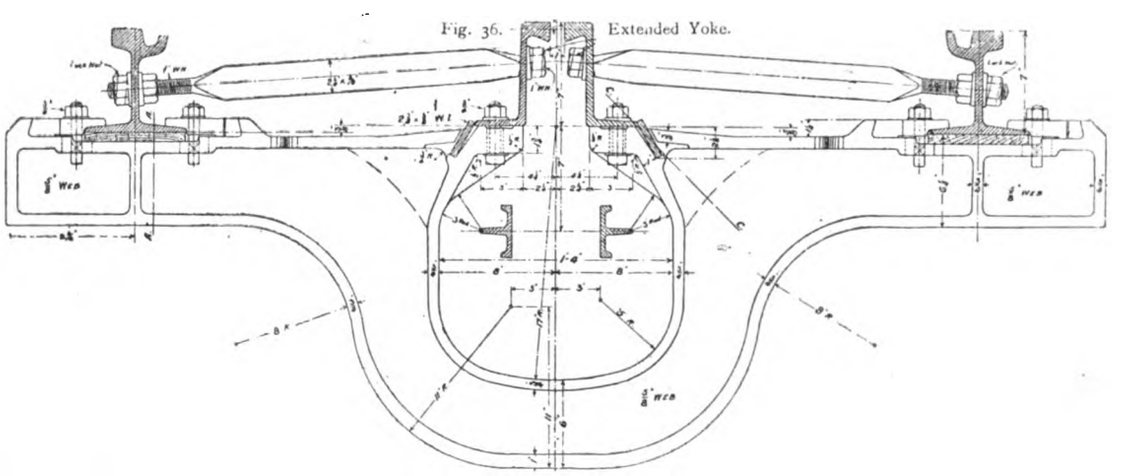


FIG. 35.

connected to these jaws. The normal position is to have the switch blades in the top contacts. This makes a given conductor bar in the conduit positive and the other negative.

Fig. 36. - Extended Yoke.



If an earth develops on the positive the switch blades are put into the bottom jaws. The connections are so arranged that this operation reverses the polarity of the conductor

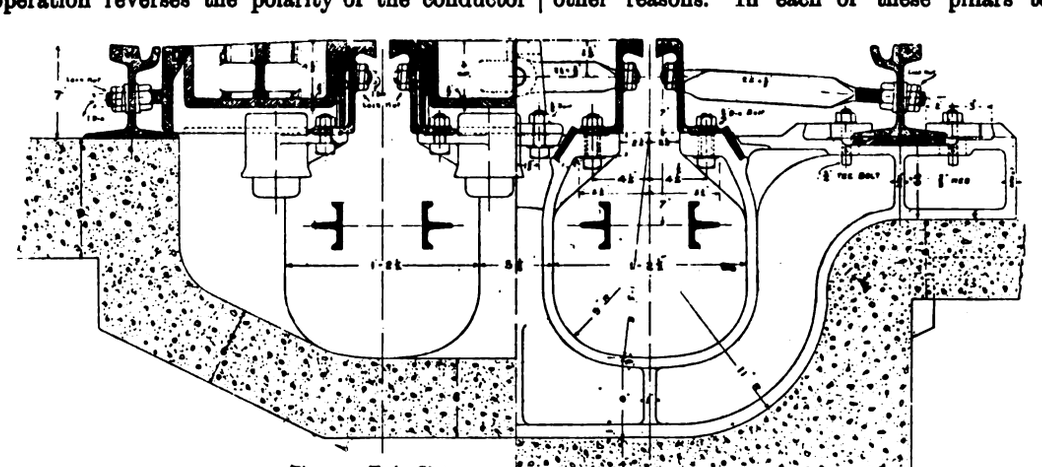


Fig. 37. Twin Slot.

bars in the conduit, thus putting the fault on the negative which is earthed in the sub-station. The fault is then corrected as soon as traffic permits.

Feeding.—The feeder cables on leaving the low-tension feeder panels are joined up to other lead-covered cables, which are drawn through earthenware pipes to the various feeding points every half-mile along the routes. Brick pits are built at intervals of about 100 yards for convenience of pulling these cables into the pipes, and for making the joints. The feeding points terminate in cast-iron feeder pillars erected on the footpaths. Each of these pillars, to which there is a door, back and front, contains a miniature switchboard (Fig. 21), consisting of two slate slabs, each of which has in front four switches, their jaws and blades being connected through holes in the slate to terminal studs at the back. The two feeder cables are drawn up into this pillar, the positive one being bolted on to the stud of the switch blades of the top or positive panel, and the negative connected to the stud of the switch blades on the bottom or negative panel, the four blades being connected to their feeder cable by copper strips. Four distributing cables are taken through earthenware pipes, one from each jaw of the four switches on the top panel through a cable pit (Figs. 19 and 20), to the positive conductor bars in the two tracks, each side of the break forming the section insulator, which has already been mentioned, and four distributing cables are taken, one from each of the four switches on the lower panel, to the negative conductor bars in the same way. It will now be seen that should it be necessary to cut off the current from any half-mile section, it can be done by drawing the switches in the pillars at either end of the section, thus isolating the line from the feeder cables. It is possible at the same time, should necessity arise, to cut out the feeders in each pillar by disconnecting the copper strips from them and bolting them together, and thus bridging the gaps at the section insulator, and making one feeder pillar feed two sections instead of one section, the intermediate pillar merely acting as a connecting link. This is done when any feeder has to be thrown dead, either for repairing faults or other reasons. In each of these pillars telephones are provided communicating with the sub-stations feeding each district. A special telephone has lately been added to all tramway termini which enables the inspectors and controllers to communicate with their head offices, and officials

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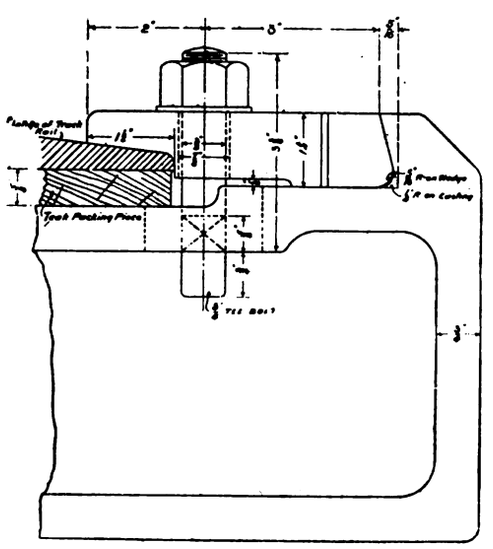
at the head offices can also communicate with the termini, a loud gong sounding in the pillar to attract the attention of the inspectors in charge.

Collection of Current.

Plough.—The current is transferred from the conductor bars to the motors on the cars by means of a collecting device called a plough (Figs 10—13), which is suspended on two horizontal bars or slides fixed to the car truck, and is free to traverse the entire width of the car. The plough consists of a main body of a rubber composite material, through which the two insulated leads pass, terminating in two rubbing surfaces, one on either side of the body, called shoes. These are made of cast iron, and are attached to the main body by means of springs and links, and the former, when fully expanded, leave the two surfaces 7in. to 7¼in. apart. When the plough hangs in position between the conductor bars, each spring has to be compressed half an inch, thus keeping the rubbing surfaces of the shoes pressing against the two conductor bars. The actual connection between the motor leads and the shoe is made by a small flexible conductor, which on occasion acts as a fuse. Current on reaching the car passes through automatic cut-outs to the controller on the driver's platform, whence it is transmitted through a series of resistances to the terminals of the motor, and which resistance the driver cuts out when starting up the car from rest.

Fig. 38. Elevation.



Insertion of Junctions, etc., during Reconstruction.

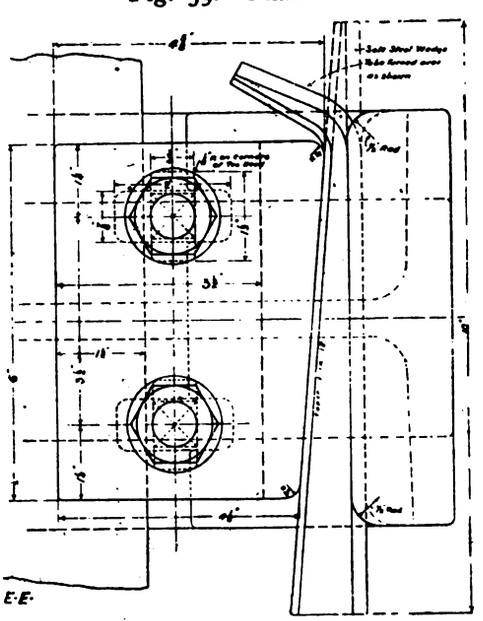
Having described the past and present methods of construction of the conduit system, some reference to the difficulties to be overcome during reconstruction when inserting junctions, etc., into existing electric conduit lines, carried out whilst the car service is maintained, may be of interest. Such work is accomplished in the following manner: The line is first thrown dead; the conductor bars are removed, and the old conduit and track foundations broken out, cars being run over the existing rails, which are packed up temporarily for the purpose. Traffic is suspended for a few hours during one night to enable the old ironwork to be replaced by new, which is packed up in the same manner, to allow the cars to run until it is possible to suspend traffic again for a short time, when the new conduit is formed and concrete foundations, etc., inserted. Traffic has once more to be suspended during the night in order that the conductor bars, jumpers, etc., can be replaced. The difficulties* of general construction work are greatly increased owing to the many obstructions which have to be encountered. Pipes, cables, etc., require to be diverted, on account of being laid at such shallow depth, before the conduit can be excavated or, as often happens, during its actual construction. Some of the most notable examples on the London lines occurred in Nine Elms-lane, where several large mains, including some 27in. and 36in. in diameter, had to be diverted, in addition to sundry small pipes throughout the whole length.

* The photographs exhibited illustrate some of the difficulties met with during the process of reconstruction.

Conclusion.

The conduit system of tramway construction has been greatly criticised, chiefly, however, on account of its greater cost of construction and maintenance compared with that of the overhead system, but very little has been proved against it as regards its general efficiency in operating. It has many points to recommend it, amongst others that it is much more sightly than the overhead system, there being no standards or overhead wires to disfigure the street, and when one considers the mass of such wires, etc., at an ordinary junction on the overhead system, one shudders to think what such crossings as the Elephant and Castle, St. George's-circus, or any similar district in London would be like with that system in vogue. It has a possible rival in surface-contact system. The London County Council are at present experimenting with a short length of the "G.B." (Griffiths-Bedell) system, but it yet remains to be seen if this, or any form of stud-contact system, will prove satisfactory under the conditions met with in London, although a few miles are being operated in the provinces.

Fig. 39. Plan.



The comparative average cost of the conduit, surface contact, and overhead systems is as follows, but it must, of course, be noted that in every system the cost of construction varies greatly, according to the nature of the obstructions and the extent of special work necessary:

	Per mile (single)
Conduit (including special work, pipe diversions, etc.) ...	£17,000
Surface contact ,, ,, ,, ,, ...	9,700
Overhead ,, ,, ,, ,, ...	9,200

The first installation of tramways on the conduit system in London was carried out with Sir Alexander Kennedy (past-president of the Institution of Civil Engineers) as consulting engineer; and since its completion the construction and conversion of the permanent way and roadway for the conduit system and street improvements connected therewith have been under the direction of the chief engineer to the London County Council, Mr. Maurice Fitzmaurice, C.M.G., M.I.C.E., M.A., etc., whilst the electrical equipment of power and sub-stations, together with feeding arrangements, have been supervised by the chief officer of tramways, Mr. A. L. C. Fell, M.I.E.E., the buildings of the central power station and sub-stations being designed by and built under the direction of the architect to the London County Council, Mr. W. E. Riley, M.I.C.E.

In conclusion, the author desires to thank those who have kindly assisted him by lending the lantern slides and the photographs used in connection with the illustration of his paper.

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ELECTRICITY IN FACTORIES AND WORKSHOPS.

Inquiry into Home Office Draft Regulations.

This inquiry was opened last Tuesday morning, when Mr. James Swinburne, who had been appointed commissioner for the purpose, commenced the sittings for the hearing of the objections against the draft regulations proposed by the Home Office for the generation, transformation, distribution, and use of electrical energy in premises under the Factory and Workshops Act, 1901. Our readers will be better able to follow the proceedings which took place at the inquiry with a copy of the draft regulations before them, and before giving a report we set out a copy of the draft as originally proposed:

Whereas the generation, transformation, distribution, and use of electrical energy in any factory or workshop, or any place to which the provisions of Section 79 of the Factory and Workshop Act, 1901, are applied by that Act, has been certified in pursuance of the said section to be dangerous: I hereby, in pursuance of the powers conferred upon me by that Act, make the following regulations, and direct that they shall apply in all places before mentioned. These regulations shall come into force on Jan. 1, 1908, except as regards such parts of electrical stations as were constructed before July 1, 1907, in respect of which they shall come into force on July 1, 1908.

Duties.

It shall be the duty of the occupier to comply with these regulations. And it shall be the duty of all agents, workmen, and persons employed to conduct their work in accordance with these regulations.

Definitions.

In these regulations:

Pressure means the difference of electrical potential between any two conductors, or between a conductor and earth, as read by a hot-wire or electrostatic voltmeter.

Low pressure means a pressure normally not exceeding 250 volts.

Medium pressure means a pressure normally above 250 volts, but not exceeding 650 volts.

High pressure means a pressure normally above 650 volts, but not exceeding 3,000 volts.

Extra-high pressure means a pressure normally exceeding 3,000 volts.

System means an electrical system in which all the conductors and apparatus are electrically connected to a common source of E.M.F.

Conductor means an electrical conductor arranged to be electrically connected to a system.

Apparatus means electrical apparatus, and includes all apparatus, machines, and fittings in which conductors are used, or of which they form a part.

Cable means a cable, wire, rod, strip, or other form of conductor used for conveying electrical energy.

Circuit means an electrical circuit forming a branch of a system.

Insulating stand means a floor, platform, stand, or mat
Insulating screen means a screen
Insulating boots means boots
Insulating gloves means gloves
} of such size, quality, and construction according to the circumstances of the use thereof, that a person is thereby adequately protected from danger.

Covered with insulating material means adequately covered with insulating material of such quality and thickness that there is no danger.

Bare means not covered with insulating material.

Live means electrically charged.

Dead means at, or about, zero potential, and disconnected from any live system.

Earthed means connected to the general mass of earth in such manner as will ensure at all times an immediate discharge of electrical energy without danger.

Sub-station means premises, or that part of any premises, in which electrical energy is transformed or converted, and which are large enough for a person to enter after the apparatus is in position.

Switchboard means a collection of conductors and apparatus for the purpose of controlling the current or pressure in any circuit or circuits.

Switchboard passageway means any passageway or compartment used in connection with a switchboard and large enough for a person to enter.

Authorised person means a person appointed by the occupier to carry out certain duties incidental to the generation, transformation, distribution, or use of electrical energy, and competent to carry out those duties.

Danger means danger of shock, burn, or of other injury to persons employed, or of fire, attendant upon the generation, transformation, distribution, or use of electrical energy.

Exemptions.

(*a*) Nothing in these regulations shall apply to any system the normal working pressure of which does not exceed 130 volts continuous or 65 volts alternating.

(*b*) Nothing in Regulations 7, 8, 9, and 10 shall apply in electrical stations to any circuit, conductor, or cable used for conveying electrical energy for public supply.

(*c*) Nothing in Regulation 12 shall apply to any motor of a motor-generator or to any motor forming a part of any electrical converter, regulator, or similar apparatus.

(*d*) If the occupier can show with regard to any requirement of these regulations that the special conditions in his premises are such as to prevent danger not less adequately than if the said requirement were observed, that requirement shall be deemed to be satisfied.

Regulations.

1. All apparatus and conductors shall be sufficient in size and power for the work they may be called upon to do, and so constructed, installed, protected, worked, and maintained as to prevent danger.

2. All cables shall be covered with insulating material, and further efficiently protected where necessary to prevent danger; or they shall be so placed and safeguarded as to prevent danger.

3. Every switch, circuit breaker, and isolating link shall be: (*a*) so constructed, placed, or protected as to prevent danger; (*b*) so constructed and adjusted as accurately to make and to maintain good contact; (*c*) provided with an efficient handle or other means of working, insulated from the system; (*d*) so constructed or arranged that it cannot accidentally fall or move into contact when left out of contact.

4. Every switch and circuit breaker shall be so constructed as to be incapable of remaining in partial contact, or of maintaining an arc on breaking circuit.

5. Every fuse, and automatic circuit breaker used instead thereof, shall be so constructed and arranged as effectively to interrupt the current before it so exceeds the working rate as to involve danger. It shall be of such construction, or be so guarded or placed, as to prevent danger from overheating, or from arcing or the scattering of hot metal or other substance when it comes into operation. Every fuse shall be of such construction, or be so protected by a switch, that the fusible metal may be readily renewed without danger.

6. Every electrical joint and connection shall be of proper construction as regards conductivity, insulation, mechanical strength, and protection.

7. Efficient means, suitably located, shall be provided for cutting off all pressure from every circuit.

8. Every circuit shall be efficiently protected from excess of current, and every circuit arranged to carry more than 750 watts shall be separately so protected.

9. Where one point of a system is connected to earth, no single-pole switch other than a link for testing purposes shall be placed in any cable connected thereto.

10. Where one of the main conductors of a system is uninsulated and bare, such as a bare return of a concentric system, no switch, fuse, or circuit breaker shall be placed in that conductor, or in any conductor connected thereto, and the said conductor shall be earthed.

11. Every motor, converter, and transformer shall be protected by a switch or switches, suitably placed, and so connected that all pressure may thereby be cut off therefrom and from any apparatus in connection therewith.

12. Every electrical motor shall be controlled by an efficient switch or switches for starting and stopping, so placed as to be easily worked by the person in charge of the motor. Every electrical motor rated at more than one-third of a horse-power shall be further protected by a release that will automatically break the circuit if the current is interrupted, unless the motor is incapable of re-starting automatically on the current being restored. In every place in which machinery is being driven by any electrical motor, there shall be means at hand for quickly stopping the motor.

13. Every flexible cable for portable apparatus shall be connected to the system either by efficient permanent joints or connections or by a properly constructed connector. Every portable apparatus and its flexible cable shall be independently controlled by a switch conveniently placed. Adequate precautions shall be taken against shock, due to leakage or other cause, in all places where the person handling the portable apparatus is not insulated from earth. In such places, and in any place where the pressure exceeds low pressure, the switch shall be so constructed as to break the circuit on each pole.

14. The general arrangement of switchboards shall, so far as reasonably practicable, be such that: (*a*) all parts which may have to be adjusted or handled are readily accessible; (*b*) the course of every cable may be readily traced; (*c*) conductors connected to different systems are kept apart and can be readily

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distinguished; (*d*) all bare conductors are so placed or protected as so prevent danger from accidental short-circuit.

15. Every switchboard having conductors normally so exposed that they may be touched shall be located in an area or areas set apart for the purposes thereof and suitably fenced or enclosed. No person except an authorised person, or a person acting under his immediate supervision, shall have access to any part of such area.

16. All apparatus appertaining to a switchboard and requiring handling shall so far as practicable be so placed or arranged as to be operated from the working platform of the switchboard, and all measuring instruments and indicators connected therewith shall so far as practicable be so placed as to be observed from the working platform. If such apparatus be worked or observed from any other place, adequate precautions shall be taken to prevent danger.

17. At the working platform of every switchboard and in every switchboard passageway, if there be bare conductors exposed, or arranged to be exposed when live so that they may be touched, there shall be a clear and unobstructed passage of ample width and height with a firm and even floor. For low pressure and medium pressure the clear height shall not be less than 7ft. and the clear width not less than 3ft., and for high pressure and extra-high pressure 8ft. and 4ft. respectively. Bare conductors shall not be exposed on both sides of a switchboard passageway unless either the clear width of the passage is double that otherwise required, or the conductors on one side are so guarded that they cannot be accidentally touched. Adequate means of access, free from danger, shall be provided for every switchboard passageway.

18. In every switchboard for high pressure or extra-high pressure: (*a*) Every conductor within reach from the working platform, or in any switchboard passageway, shall be so placed or protected as to prevent danger; (*b*) the metal cases of all instruments shall be either earthed or completely enclosed with insulating covers; (*c*) all metal switch-handles, and all metal rods connecting them with the switches, shall be earthed; (*d*) every switchboard in continuous use shall be so arranged that the conductors thereof can be made dead in sections, and no work shall be done at any section unless that section be (*a*) made dead, and (*b*) so separated, by permanent or removable divisions or screens, from all adjoining sections of which the conductors are live, that the work may be carried out without danger.

19. All fixed coils, conductors, or terminals of generators, motors, transformers, or other apparatus, at high pressure or extra-high pressure, and within reach from any position in which any person employed may require to be, shall be so protected as to prevent danger.

20. Where a high-pressure or extra-high pressure supply is transformed for use at a lower pressure, adequate means shall be provided to prevent the lower pressure system from being accidentally charged above its normal pressure by leakage or contact from the higher pressure system.

21. Adequate precautions shall be taken to prevent any metal other than the conductors from becoming electrically charged, and such metal shall be earthed where necessary to prevent danger.

22. Adequate means shall be provided and used for preventing any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

23. Where necessary to prevent danger, insulating stands or screens shall be provided and kept permanently in position, and shall be maintained in sound condition.

24. Portable insulating stands and screens, boots, and gloves shall be provided and used when necessary to prevent danger, and shall be periodically examined by an authorised person.

25. Adequate working space and means of access, free from danger, shall be provided for all apparatus that has to be worked or attended to by any person.

26. All those parts of premises in which apparatus is placed shall be adequately lighted to prevent danger.

27. All conductors and apparatus exposed to the weather, wet, corrosion, or to inflammable surroundings or explosive atmosphere, or used in any process or for any special purpose other than for lighting or power, shall be so constructed or protected, and such special precautions shall be taken, as may be necessary to prevent danger in view of that exposure or use.

28. Adequate periodical tests shall be made by an authorised person to ensure (*a*) that the insulation of all conductors and apparatus is duly maintained; (*b*) that no metal part of any apparatus, other than the conductors thereof, is electrically charged so that there is danger; and (*c*) that all earth connections are in order. Adequate periodical examinations shall also be made by an authorised person to detect any other defects from which danger may arise.

29. No person except an authorised person, or a person acting under his immediate supervision, shall undertake any work where technical knowledge or experience is required in order to avoid danger.

30. Instructions as to the treatment of persons suffering from electric shock shall be affixed in all premises where electrical energy is used, other than for incandescent lighting at low pressure, and in all premises in which electrical energy is generated or transformed.

31. Every sub-station shall be of ample dimensions and substantially constructed of fire-resisting material, and shall be so arranged that no person can obtain access thereto otherwise than by the proper entrance, or can interfere with the apparatus or conductors therein from outside; and shall be provided with efficient means of ventilation and be kept dry.

32. Every sub-station shall be under the control of an authorised person, and none but an authorised person or a person acting under his immediate supervision shall enter any part thereof where there may be danger.

33. Every underground sub-station shall be provided with adequate means of access by a door or trapdoor, with a staircase or ladder securely fixed and so placed that no switchboard or bare conductor shall be within reach of a person thereon: Provided, however, that the means of access shall be by a doorway and staircase if (*a*) any person is regularly employed therein, other than for inspection and cleaning; or if (*b*) there is moving machinery therein, other than ventilating fans; or if (*c*) there is extra-high pressure therein.

Mr. JAMES HUNTER GRAY, leading counsel for the Home Office, explained the procedure which it was proposed to adopt at the inquiry, and a discussion took place between the parties on this point. It was ultimately decided to deal first of all with the three or four main general questions, and after this had been disposed of, to consider means for dealing with the more detailed questions involved.

Lord ROBERT CECIL, K.C., M.P., who appeared for the London electric supply companies, suggested that if the Home Office decided in their favour on these main points it might lead to the retirement of many of the objectors, and thus considerably curtail the proceedings. The points upon which objections were raised were: (1) as to whether there should be a second separate authority; (2) the limitation of voltage; (3) the right of appeal; and (4) whether the regulations should be made retrospective.

After a little further discussion, Mr. SWINBURNE intimated his intention to divide the inquiry to a certain extent in two portions.

Mr. J. HUNTER GRAY thereupon opened the case for the Home Office. He first of all sketched the history of electric lighting in this country, with a view to showing its bearing upon the present inquiry. He thought that most of the objections were based upon a complete misapprehension. He read various sections of the Electric Lighting Acts of 1882 and 1888 to show that those Acts only applied to electric lighting stations, and pointed out that it consequently became the duty of another department of the State to make provision for the safeguarding of the lives of workmen in factories. The Factory Act of 1901 really brought electricity stations within those Acts, and it was under Section 79 of that Act that the present inquiry was being held. In 1904 the Secretary of State certified the use of electricity within his schedule of "dangerous trades," and in that year an attempt was made by the Home Office to put into operation a set of regulations for the control of the same. This proposal evoked much opposition, and it was, therefore, thought desirable to withdraw it until a complete code could be brought forward. Such a code, he said, was now before the Commissioner. The regulations now proposed had been prepared by Mr. Scott Ram, H.M. chief inspector under the Factory and Workshops Act, as the outcome of four years' continuous examination and investigation into all methods of electrical installation throughout the country. Counsel went on to show what practical objections seemed to his advisers justifiable. He said the Board of Trade regulations were directed to the safety of the public, and nothing else. The Home Office regulations, on the other hand, were directed, not to the safety of the public, but to that of the workmen, and, consequently, the rules must differ. He said that every attempt had been made to avoid the duality of control. Referring to the Board of Trade Regulations A (1) of those dated 1905, and relating to the wiring of occupiers' premises, he said these seemed to clash with some of the regulations now proposed by the Home Office. To avoid this the Board of Trade had decided to relinquish their

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control of pressure supply to consumers, and this was to come under the control of the Home Office, whose rules related to the same matter. The Home Office, in their turn, proposed to leave Sections 24 to 28 of their draft regulations to the Board of Trade. He said it would appear onerous to expect a consumer to be responsible for parts of his installation which he was not allowed to touch—*i.e.*, meters, cut-outs, etc.—and it was desirable that this should be given up so far as the Home Office was concerned and left to the Board of Trade. He had drafted certain alterations in some of the rules to make this change possible; the effect of which alterations would be that certain regulations would not affect a consumer's installation on the supply side of his terminals.

Counsel next dealt with the point as to whether the rules should be made retrospective. He admitted that it would be hard that rules which were intended for the future should make it impossible for existing works to carry on their operations, and he suggested that certain exemptions should be made to meet this difficulty. It was at one time proposed to frame a special rule to effect this purpose, but the exemption which was already in the regulations ought, in his opinion, to cover this case. He here stated that the object of the Home Office was to keep the rules in the shortest and simplest form, and he asked objectors to think twice before they suggested additional words or even rules. The Home Office would rather drop a particular rule than load it up with words.

Counsel now came to the third point—*i.e.*, the question of right of appeal. He admitted that the request for the right of some form of appeal was fair, but contended that under the proposed procedure such appeal would be always obtained in the best possible form. He explained that there were certain factory inspectors appointed over certain districts. The duty of these officials would be to inspect and find out whether the rules were being complied with or not, and to point out any breach in their observance. If the owner failed to make good that breach the inspector would send a report of the matter to the Home Office, and, unless the electrical inspector was otherwise satisfied, he would visit the place and examine into the complaint on the spot. He would then have an opportunity of hearing the occupier's case. That, he said, would answer the objection that the electrical inspector would not be able to personally investigate into complaints. But the Home Office would go even further, and give to the owner an opportunity of making a statement in writing to the Home Office, who would then have before it the separate statements of the owner and the factory inspector. It would then be able to examine the two sides of the case, and subsequently the electrical inspector would visit the premises as to which the complaint was made and investigate the matter on the spot. If, after all this, a prosecution were undertaken, the Home Office would be fighting, not for a matter of form, but for a substantial reason, and only real breaches of the rules would bring about prosecutions. He made it clear that if a factory inspector's report was opposed by a statement in writing by the owner, it would be compulsory for the electrical inspector to visit the works.

The next objection which counsel dealt with was that the regulation as to pressure should not be applied in cases where the voltage was below 250. He joined issue with those objectors who stated that the Board of Trade regarded 250 volts as perfectly safe. The Home Office in fixing 65 volts alternating and 130 volts continuous current did not in any way suggest to limit the use of electricity to these low voltages. He said, assuming 250 volts were safe for life, was it safe for any other injury, danger to limb or health? and he enumerated the kinds of danger which might be expected with even 100 volts alternating current. He did not think that any of the electrical gentlemen in that room would care to hold two live metal terminals, and he argued that not only was it impossible to hold 100 volts, but that for some it was even impossible to hold 25 volts. The force of counsel's remarks was that, while an instantaneous contact might not be necessarily dangerous or hurtful, the fact that it would occur to some people made it a serious matter. For example, a workman coming unexpectedly in contact with 25 volts might not thereby receive injury, but the shock might cause him to fall and lead to serious consequences. Again, a workman in putting in a fuse might have his face in the vicinity of that fuse. If the fuse blows the man gets a mass of molten metal in his face, which is burnt. These facts, he said, amply justified the Home Office regulations, and he hoped they had endeavoured to draft rules and to specify restrictions as to have duly in mind, not only the safety of workmen, but also that the electrical industry should not be unduly restricted by unnecessary regulations. It was because of this aim that many other regulations had been omitted which might otherwise have been introduced to bring the code in conformity with the Factory Acts. The question of expense was no answer in itself, and no objection raised on that ground alone would have any substance, if to prevent the loss of human life, that expense had to be incurred.

In summing up his remarks, counsel said: (*a*) an appeal of some kind should be given; (*b*) that the existing works were exempted by the fourth paragraph of the draft; (*c*) that the question of the regulation applying to certain voltages remained one on which the advisers to the Home Office did not propose to give way [Mr. Gray later stated that the Secretary of State might, however, make some concession]; and (*d*) that dual control would be very largely avoided.

Mr. Vesey Knox, K.C., and Lord Robert Cecil here called for a copy of the proposed amendments which the Home Office now offered, as they thought the proceedings might be curtailed thereby, but Mr. Gray declined to comply.

Mr. Scott Ram was then called to the witness desk, and gave evidence. The examination of this gentleman was mainly directed to the question of dual control. The Board of Trade, he said, was prepared to withdraw their Regulation A (1), which dealt with the wiring on consumers' premises, so far as factories and workshops were concerned. After pointing out where the rules of the two departments seemed to overlap, he submitted the following proposed amendment to exempt the particular portion of the owner's premises from the operation of these rules:

> "Nothing in these regulations shall apply on the premises of an occupier being a consumer of an authorised electricity supply undertaking to any service cables and apparatus on the supply side of occupier's terminals, and belonging to or under the control of the authorised undertaking."

This exemption, he said, would affect Rules 1, 2, 5, 6, 7, 8, 9, 10, 21, 25, 26, 27, and 28 of the present draft. With regard to the question of appeal, the modification which he suggested was as follows:

> "In case any difference of opinion shall arise between an inspector and an occupier under these regulations, the occupier shall be entitled to make a statement in writing for submission to the electrical inspector."

With regard to the question of the rules being retrospective, he said that the exemption (*d*) covered the existing works. He was not prepared, for his part, to accept anything higher than 65 volts alternating current and 130 direct current as the limiting pressures.

Lord Cecil hereupon took up the cross-examination of witness. In answer to questions, he agreed that it would not be a good plan to have two bodies controlling the use of electricity. Counsel directed his questions with a view to showing that the proposed Home Office regulations conflicted in certain respects with those of the Board of Trade. He elicited the admission that the Home Office inspector shall say whether there was danger in the apparatus or installation on any premises. Counsel pointed out that it would be a serious thing if the Board of Trade inspector took one view on a particular matter and the Home Office inspector took another, but Mr. Ram thought that such a contingency could scarcely arise with the withdrawal of A (1) of the Board of Trade regulations. Counsel hereupon drew the attention of witness to Regulation 21 of the Board of Trade, which stated that sub-stations shall be in the sole occupation and charge of the undertakers, and shall be erected above ground wherever possible, but where necessarily underground they shall be constructed in accordance with plans approved by the Board of Trade. Now, in the

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draft regulations, Rules 31, 32, and 33 give the Home Office very complete control over sub-stations. This, he said, was a case of duplication which Mr. Ram practically admitted, though, he said, the provisions had been discussed by the two departments and they need not overlap. Lord Cecil then dealt with the question of exemptions, and emphasised the fact that these exemptions were only partial; sub-stations were placed under both departments, whereas the service lines were exempted from the Home Office regulations. He asked why a distinction should be made between the two, and why an exemption should be made in the case of one and not in the other. The answer was that in the case of service lines the occupier could not be called on to do anything. As against the exemption proposed by Mr Ram, Lord Cecil submitted the insertion of some such exemption as follows:

> "Nothing in this regulation shall apply to any generating station, sub-station, conductors, cables, or apparatus of or belonging to any company, body, or authorised person by any special Act, licence, or provisional order to supply electrical energy for any public or private purpose and comply with the regulations made by the Board of Trade under such special Act, licence, or order for securing the safety of the public or to any system connected therewith and also complying with such regulations."

That, he said, would exempt everybody.

After the adjournment for lunch, Lord Robert Cecil cross-examined Mr. Ram further. He quoted from the Electric Lighting Clauses Act, Sections No. 10, 35, 36, and 69, to show that the Board of Trade carefully considered the details of the equipment of generating and sub-stations. Mr. Ram considered that even after the works had been constructed to the approval of the Board of Trade the Home Office should interfere if danger to the workman was found. He was then questioned as to the coal-mine regulations issued in 1905 by the Home Office, which provided under Rule 55 for arbitration before an independent expert if differences arose between the owners and inspectors. Mr. Ram considered that the present rules, dealing with so much more apparatus, should be interpreted by the Home Office. He did not think that the enforcement of the regulations would lead to the closing down of generating stations due to the fact that they had no power to purchase adjoining land compulsorily. He did not think the appeal to the inspector a farce, and there was the subsequent reference to the magistrates if the occupier did not carry out the alterations asked for.

Lord Robert Cecil then said that the clause the objectors were prepared to accept would provide for a competent and duly qualified independent person, not being an official, nominated by the Home Office on the application by either party. He then cross-questioned the witness at some length as to the voltage limits below which the regulations will not apply. Mr. Ram refused to accept the Board of Trade low-pressure limit of 250 volts either alternating or direct.

Mr. VESEY KNOX, representing the Newcastle-on-Tyne Supply Company, cross-examined the witness as to the staff at the Home Office capable of interpreting the rules. He said that he (Mr. Ram) was the only inspector at present called an electrical engineer, but that the district inspectors had all such matters under their charge. As regards Regulation 17, a large number of existing switchboards had not the space asked for. It did not follow that some alternative means other than rebuilding might not be approved by the Home Office for making these safe. He thought that it was quite right to leave the courts of summary jurisdiction to decide if the existing works came under the exemption. It was pointed out by the counsel that in the case of a high-tension transformer station on a manufacturer's works the sub-station and the factory would be under the Home Office regulations, but the low-pressure services connecting these two would come under the Board of Trade rules. In reply to a question, Mr. Ram said he had not estimated the cost of the changes required by the regulations. He was only concerned in the danger to workmen.

Mr. W. B. WOODHOUSE, of the Yorkshire Power Company, questioned the reason for the different limits of pressure for direct and alternating current at which the regulations came into force. He called Mr. Ram's attention to the fact that the Board of Trade regulations had gradually raised the limits of low and medium pressure. He asked why 250 volts should be allowed in houses as safe and not considered safe in factories.

Mr. SIDNEY MORSE obtained from Mr. Ram the statement that the regulations will not apply to street boxes or mains under the street. He also asked for a 250-volt limit, below which the regulations should not apply.

After a discussion as to procedure, the inquiry was adjourned until Wednesday.

When the inquiry was resumed on Wednesday morning, Mr. J. SWINBURNE stated that he had conferred with the Home Office on the question of procedure, and that the latter did not see its way to the publication of an interim report. Mr. Swinburne agreed that it would be inconvenient for him to issue such a report, because it would amount to this, that he would be asked to say whether there would be any overlapping of rules before he had heard the views of both sides. He agreed, therefore, that it would be better for him to make one complete report. He asked objectors to consolidate their objections with a view to shortening the length of the inquiry. But, he pointed out, it would be a mistake to rush through these rules, which were, after all, for the industry, and the question of expense of the inquiry should not weigh too much. A long legal discussion ensued upon the question of procedure.

Mr. RAM was then recalled, and was asked by Mr. Sydney Morse to give instances of accidents that had occurred in workshops from the use of portable lamps, but Mr. Ram had not the information at hand.

It having been arranged to go on with the consideration of the draft rules in their numerical order, Mr. J. Hunter Gray examined Mr. RAM, who explained each rule separately. Answering a question with regard to "definitions," he said that those in the draft rules were, as far as possible, in accordance with the general use of the terms. He had kept to the Board of Trade definitions as far as possible, but he pointed out that for the purpose of the present regulations the Board of Trade definitions could not be used in all cases.

Rule 17 was then dealt with. After reading it, Mr. Ram explained that the dimensions stated had been arrived at as the result of his having examined a large number of switchboards. The height of 7ft. was defined in order to allow a man to walk upright at the back of a switchboard. A width of 3ft. enabled a man to walk along and to do his work. He thought that to restrict these dimensions might be exceedingly dangerous. The larger dimensions allowed for extra high-pressure boards placed them out of the reach of an ordinary man. With regard to the second paragraph of the same rule—*i.e.*, relating to bare conductors in the switchboard passageway—he said the regulation was of importance if they were to have bare conductors on both sides of the passageway. A man might be doing something on one side and he might forget that there was live metal behind him, and it was, therefore, necessary to provide precautions against him touching the bare conductors.

Rule 12 was next dealt with. Mr. Ram explained the reason that had led him to draw up the rule in its original form. With regard to the rating of the motor to $\frac{1}{8}$ h.p. or more, which required additional apparatus, he explained that such a requirement was needed in order to meet a mechanical danger. For example, a motor might be driving a machine located on a different floor of the building. If the motor stopped and then went on again suddenly, persons in the vicinity of the machine in the other shop might receive injury. The automatic no-volt release proposed, however, would prevent this. In order to meet objections, however, he was prepared to insert after the word "restored" in the second paragraph of this rule the words, "or no danger is involved by the automatic restarting of the motor." It was not intended, he said, to enforce this rule where there was no danger. The third paragraph of this rule, relating to the stopping of the motor, was put in with a view to applying to places where one motor was driving machines on different floors, so that

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when an accident occurred from one machine the motor could be stopped. To make this rule more effective, he proposed to insert at the end of it the words, "or the machinery."

With regard to exemptions, as the result of objections it was proposed to bring Rules 7, 8, 9, 10, and 28 under Section (*b*). Objection was raised that the word "supply" might not include supply to tramways, so he proposed to add "supply or traction under licence or other statutory powers." Exemption (*c*) was intended to be applicable to existing and future works.

Mr. Ram then commenced to read out each of the rules and to make his comments upon them. Rule 1 was based upon and covered the same ground as 1 (*a*) of the Mines Special Rules, and was put in to cover various matters not separately covered by other rules, such as for the protection of resistance frames in factories, etc., to which this rule would apply.

Rule 2 was thought by many objectors to mean that all cables would have to be covered, but the rule did not prevent the use of bare wires under such circumstances. It required the wires to be properly cased in wood casing or metal tubing. The Institution of Electrical Engineers' rules provided for this, also as did the Board of Trade Regulations A (1), A (2), and B (1), which set up the same standard with alternative and A (1) and (C) 1, which provided that wires shall be enclosed in strong metal casing without alternative.

To meet the objections raised against Section C of Rule 3, he proposed to add after the word "system" the following words proposed by the Institution of Electrical Engineers, "and so arranged that the hand cannot touch live metal."

Rule 4 was then considered. After explaining why the rule appeared in its original form, Mr. Ram intimated his intention to substitute the following in its place so as to meet points raised by objectors: "Every switch and circuit breaker shall be so constructed that it cannot be inadvertently left in partial contact, and shall be so constructed that an arc cannot be inadvertently maintained."

Rules 5, 6, 7, 8, 9, 10, and 11 were next dealt with, Mr. Ram showing that in many cases they were based upon the Institution rules and in some upon the Board of Trade rules. With regard to Rule 11, so far as the motors were concerned the Board of Trade Regulation A (1) had been taken as a basis, as well as the Institution Rule 91 (*e*) and the Mines Rule 34. The object in framing it was that if a motor, or converter, or transformer had to have anything done to it, it should be dead. In order to meet a certain objection, he proposed to add the following words: "Provided, however, that where one point of a system is connected to earth there shall be no obligation to disconnect on that side of the system which is connected to earth."

As to Rule 13, the Institution recommended that the words "efficient permanent joints or connections" should be deleted, but he could not accept this, as there were cases where these were desirable—for instance, in tramway systems. In the second paragraph of that rule he proposed to substitute for the words "portable apparatus and its flexible cable" the following: "connector or group of connectors for circuits not exceeding 750 watts in the aggregate," and after the word "controlled" to add "on the live side."

To Rule 14 Mr. Ram proposed to add the word "well" after the word "kept" in Section C.

Rule 15 was proposed to be amended by the addition after the word "and" and before "suitably fenced" the words, "where necessary to that end."

As to Rule 18, in Section (*b*) he proposed to add after the word "instruments" the words "working at high pressure and extra-high pressure." Many objections had been raised against the paragraph (*c*), and he proposed to strike it out altogether, and to substitute the following: "All metal handles of high-pressure and extra high-pressure switches and, where necessary to prevent danger, all metal gear for working the switches shall be earthed."

After lunch, Dr. OLIVER, the author of a standard work on "Dangerous Trades," went into the witness box. Examined by Mr. J. H. Gray, Dr. Oliver said that there were three causes of death from electric shock. The first was terror, the next heart failure, and the third interference with the respiratory organs. He had found that the burns caused by electric contact healed badly and were disposed to slough. He considered that Regulation 30 was quite necessary, as it gave instructions as to the treatment of persons suffering from electric shock.

Cross-examined by Lord Robert Cecil, Dr. Oliver said that his experience of death from electric shock was confined to experiments on rabbits and dogs. The nature of the contact through which the shock was obtained had much to do with its danger, as had also the duration of the connection. He thought that 100 volts might be safely taken for one or two seconds; 50 volts would be safe if the contact did not last more than five seconds. It was, however, extremely difficult to give accurate times during which higher voltages could be stood without danger. He admitted that there had been considerable difficulty over electrocutions in the United States in spite of attempts to obtain good contact. He knew of no rules issued by the Home Office governing the use of gas as a motive power.

In reply to Mr. W. B. Woodhouse, he did not think that instructions posted up as required by Regulation 30 would increase the danger due to fear of electric shock. He thought that 250 volts alternating was equally dangerous as 500 volts direct current.

Mr. SCOTT RAM then resumed his explanation of the regulations commencing at No. 20. He adopted the modification of this rule as proposed by the Institution of Electrical Engineers. By this the expression "adequate means shall be provided," is changed to "suitable precautions shall be made to prevent the lower pressure system becoming accidentally charged," etc. In the next three rules no alterations were made. It was explained that under Rule 23 the expression "insulating stands and screens" must be taken to mean either or both, as in certain cases both were needed. Under Rule 24 Mr. Ram deprecated the use of gloves as a sole protection against shock. Under Rule 28 he explained the discrepancies between existing regulations, and considered that the Board of Trade Regulation A (6), which provides that the leakage shall not exceed one-thousandth of the maximum working current, was inadequate. To Rule 29 the following addition was suggested by Mr. Ram to define the authorised person: "When a contractor is employed and the danger to be avoided is under his control the contractor shall appoint the authorised person, but if the danger to be avoided is under the control of the occupier the occupier shall appoint the authorised person." As to Rule 30, he considered that the instructions as to the treatment of persons suffering from electric shock should be hung up near the factory regulations at the entrance to works. Rule 31, while insisting that sub-stations shall be kept dry, came under the general exemption (*d*). If it was impossible to keep the place dry, other adequate means must be employed. Rule 33 was altered to read: "A staircase or ladder securely fixed and so placed that no live part of any switchboard, or any bare conductor, shall be within reach of a person thereon."

It was then decided that Clause 17 should be discussed first, as a large number of objectors confined their objections principally to this clause. Mr. Vesey Knox cross-examined Mr. Ram on behalf of the Newcastle-on-Tyne Electricity Supply Company. Mr. Ram said he had examined the sub-stations of this company, but without consulting his notes could not say how many infringed Rule 17. A drawing of one of these sub-stations with deep brick partitions between each line of switchgear was shown to the witness and the commissioner. A cross-bar was also provided to prevent anyone accidentally stumbling against the high-voltage material. Mr. Ram would like to see the 2ft. passageway increased. The brick partitions projected 1ft. 6in. beyond the switchgear. He thought that expanded metal doors in front of the openings would make it more safe. He admitted the difficulty arising out of the second part of Rule 17, but exemption (*d*) enabled existing infringements to be met without reconstruction. If the Newcastle sub-station plan were submitted to him he should suggest three rails instead of one, and metal doors in front of each cell.

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In reply to Lord Robert Cecil, he admitted that he could not point out in his reports for electrical accidents for 1906 any sub-station accident due entirely to want of space in the passageway.

In reply to Mr. C. Fleetwood Pritchard, he admitted that there were many cases in which there was ample width, but did not comply in height. A plan of the Glasgow station switchboard was put in, in which there was switchgear on both sides of a broad passageway. He would require in this case more protection on one side or the other.

Mr. SYDNEY MORSE called the witness's attention to the fact that in the Home Office Regulations for Mines every rule included the qualification "as far as reasonably practical." He urged that similar qualifications should be put into the Rule 17, and that it should not be made retrospective.

The commencement of the proceedings on Thursday morning were delayed some time in consequence of a consultation which took place between counsel for the Home Office and various objectors with a view to a settlement of certain points, but Mr. Gray announced that in this he had not been successful, and that the inquiry would have to go on in the ordinary way. A discussion then took place on the drafting of exemption (*d*) so as to bring within it those railway companies who generate and use electricity for other purposes as well as for traction.

The cross-examination of Mr. RAM on Rule 17 was then resumed. Mr. Sillar asked why the passageway behind small boards should be 7ft. in height, and whether a board which had been in use some considerable time ought not to be exempted from the operation of Rule 17. He urged that in some cases there was perfect safety without the dimensions specified. In answer to Mr. Woodhouse, who asked whether, in the case of a consumer's premises in which the transformers and meters were on separate floors, the meters would come under the word "sub-station," Mr. Ram said they would. Mr. Woodhouse suggested some alteration in the dimensions of the switchboard passageway to meet the case of small switchboards, and Mr. Ram promised to consider the matter. A gentleman from Bristol asked for particulars as to accidents on which the regulations were based, but Mr. Gray interposed with the remark that the Home Office did not propose to rely on the frequency or the scarcity of accidents, and that to put in such a list would only prolong the inquiry without helping the commissioner. Mr. Ram was next asked to give the proportion of switchboard accidents dealt with by the officials of the Board of Trade under the Electric Lighting Acts, and by Home Office inspectors, but he had no recollection of any Board of Trade inquiry into a switchboard accident on factory premises.

Mr. GRAY thought it right that before re-examining Mr. Ram he should make a statement as to the dimensions of switchboard passageways which were enforced on the Continent. The French regulations (1907) for high pressure were: width, 1m.; height, 2m. Germany—width, 1m.; height, 2m.; but if the wall also had bare conductors the width was 2m. Switzerland—height, 2m. 20cm.; width for low pressure 80cm. and for high pressure 1m.; with conductors on the back wall the width was 1m. 20cm. for high pressure and 50cm. for low pressure. The Home Office advisers considered these dimensions too small. The limit for low-pressure voltage on the Continent was 600 volts for continuous current and 150 volts for alternating current.

Mr. RAM then explained on what particulars he had based his dimensions. In respect of the width of 4ft. for extra high pressure, he said he had been guided by the reports of the Dangerous Trades Committee; the other dimensions were formed from examples which he had seen. He was convinced, as a result of his experience, that for future works there should be uniformity of practice, and he was of opinion that the regulations would secure it.

(To be continued.)

Meadville (U.S.A.).—The City Council contemplate the building of a new municipal electric light plant at a cost of 25,000dol.

THE CASCADE CONVERTER.*

The cascade converter patented in 1902 by Messrs. La Cour and Bragstad has since then become widely recognised as a serious competitor of rotary converters and ordinary motor-generators for the conversion of alternating into direct currents. It has been employed in many installations both on the Continent and in this country, and use and experiment have fully justified the expectations formed of it. The machine consists of an alternating-current induction motor with "wound" rotor running with a large slip (usually 50 per cent.) and directly coupled mechanically to a direct-current dynamo—the characteristic difference from the ordinary induction motor-generator being that the rotor phases are connected directly, without the intervention of slip-rings, to a number of symmetrically spaced points on the direct-current armature winding. For convenience in starting, three of the rotor phases are usually brought out to three slip-rings to enable a starting resistance to be inserted and gradually cut out as the speed rises. The machine is usually started from the alternating side by switching the stator of the induction motor directly on to the supply volts. At starting the rotor phases are open-circuited at the neutral point, with the exception of the three phases which are connected to the slip-rings. These have a high starting resistance inserted between them. The machine then starts up, and when the normal speed is approached the direct-current generator, which is shunt or compound wound, excites itself. The "normal speed" is the speed at which the frequency of the rotor voltages is exactly equal to that of the voltages in the direct-current winding, and this equality occurs at half synchronous speed if, as is usually the case, the number of poles for which the induction motor is wound is the same as the number of poles in the direct-current generator. In any case the normal speed in revolutions per minute =

$$\frac{\text{Alternating-current supply frequency} \times 120}{\text{number of poles of the induction motor} + \text{number of poles of the direct-current generator.}}$$

When this speed is reached a considerable amount of the starting resistance will still be in circuit, since the slip is then 50 per cent. The next operation consists in synchronising the rotor volts with the direct-current armature volts by means of synchronising lamps, and then suddenly cutting out the remaining part of the starting resistance and short-circuiting the rest of the phases together at the neutral point by means of an external lever gear. The machine can also be started from the direct-current side, if desired.

The voltages induced per conductor in stator and rotor are in the ratio $\frac{\text{stator frequency}}{\text{rotor frequency}}$, and, since the true power ampere-turns are alike in both members, it follows that the powers taken up electrically by stator and rotor also bear the relation $\frac{\text{stator frequency}}{\text{rotor frequency}}$. The remaining fraction of the stator power is given off mechanically by the rotor to the spindle—*i.e.*, to the direct-current generator. The ratio $\frac{\text{electrical power from rotor}}{\text{mechanical power from rotor}}$ is a constant for a given machine, and is unity when the poles are equal. When the machine is running on open circuit, and neglecting the losses, the rotor takes up such a position that the voltages induced in it are exactly opposed in phase to the corresponding voltages in the direct-current armature. If the direct-current armature is now loaded up, the increased torque causes it to lag and enables more current to enter the stator windings from the alternating-current supply. At every load it is possible to vary the direct-current voltage by varying the direct-current field excitation. Thus, if this excitation is strengthened, the direct result is an increase in the direct-current volts, and at the same time an increased wattless current in the rotor circuits, lagging relatively to the direct-current armature voltage, and, therefore, tending to weaken the over-excited field. The net result is that for a given change in direct-current

* Abstract of an article by Herr A. Bloch in *Elektrotechnik und Maschinenbau.*

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voltage a greater change in excitation is necessary than would be the case if running as an ordinary direct-current generator.

Fig. 1 shows the dimensions and arrangement of a Kolben cascade converter for 370 kw., 375 r.p.m., for a three-phase input at 5,000 volts, 50 ~, and a direct-current output of 120 volts, 3,080 amperes. The induction motor and the direct-current generator are both eight-pole machines. The rotor has a 12-phase winding, and the direct-current armature is lap-wound with 12 equalising connections. Each of these equalising rings is connected to the end of one of the 12 rotor phases. Since the motions of the windings relatively to the fields is in

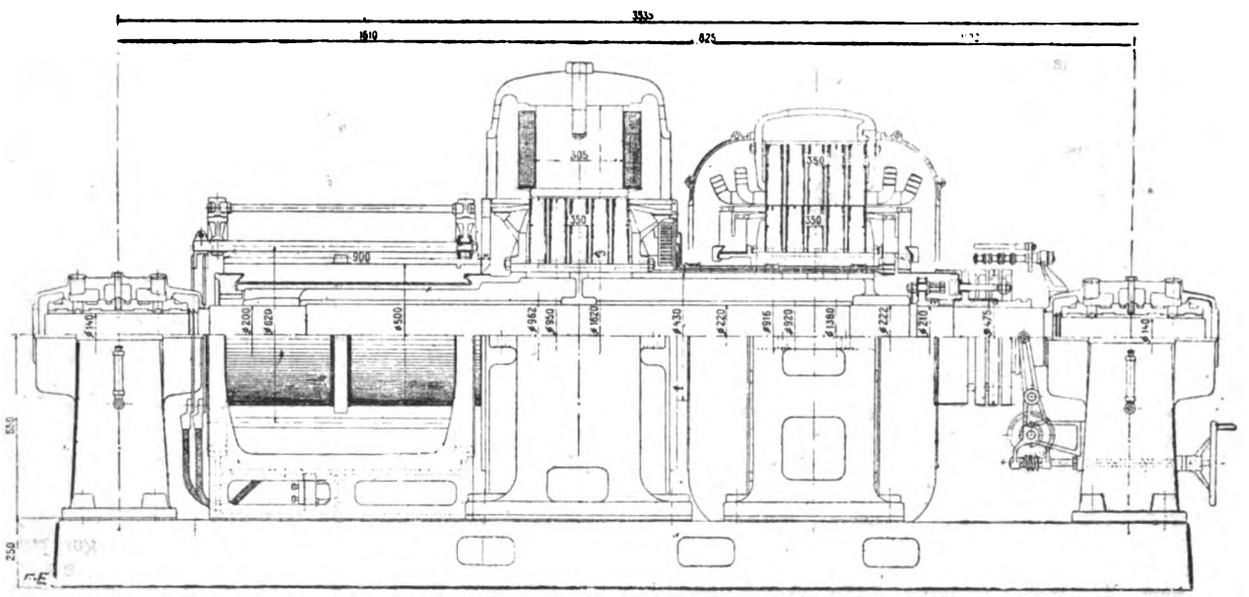

FIG. 1.

opposite directions on rotor and direct-current armature, the successive phases connected together must progress round in opposite directions on the two machines, and the correct connections are best determined by a preliminary run of the two armatures in opposite directions. In order to simplify the connection a central bearing is dispensed with. The rotor phase ends are all brought out at the slip-ring end of the machine, and the connections to the direct-current armature are carried back through the rotor spider. The connections are divided into two groups of six each. Each group is carried through a pair of the spider arms and contains the connection of six phases separated by 60deg., so that the sum of the instantaneous

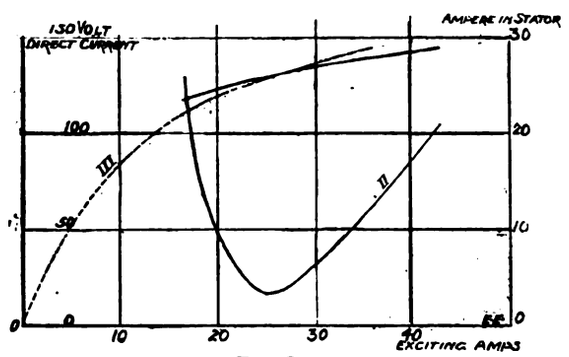

FIG. 2.

device are arranged. The latter consists of 12 bronze sockets attached to, but insulated from, a ring rigidly keyed to the spindle. A short-circuiting collar carrying 12 corresponding copper spring plugs can be moved axially along the spindle by means of worm gear. The rotor and the direct-current armature are mounted on a cast-iron bush common to both. The characteristic curves of this converter are given in Fig. 2. Curve I. shows the relation between direct-current voltage and excitation when working as a converter; Curve II. the stator current at 5,000 volts with varying excitation; Curve III. is the no-load currents in them is zero. Between the rotor and its end bearing the three slip-rings and the 12-pole short-circuiting of the latter. On the whole, the cascade converter is considerably smaller, cheaper, and more efficient than the corresponding motor-generator. A further advantage relatively to the asynchronous motor-generator is the fact that the power factor of the cascade converter is practically unity at all loads—in fact, it can be made to take leading currents by adjusting the direct-current field, if desired. The synchronous motor-generator shares this advantage, but, on the other hand, this type is difficult to start from the alternating side.

Comparing the cascade converter with the ordinary rotary converter next, it can be shown that the single-phase rotary converter armature is about 50 per cent. and the three-phase rotary 10 per cent. less effective than the direct-current armature of the corresponding cascade converter fitted with nine or twelve phase connections. The six-phase rotary, however, is about 30 per cent. more effective than the cascade converter, but this is partly counterbalanced by the six heavy collector rings required by the former. The cascade converter also has the great advantage, as regards commutation and over-all dimensions, that it requires only half as many poles as the rotary. The induction motor part of the cascade converter is replaced by static transformers in the case of the rotary, so that the total space occupied and the cost of the complete installation do not differ much in the two cases. The efficiencies are also nearly alike, whilst as regards liability to hunt and fall out of step the cascade converter is distinctly superior. The voltage regulation of a cascade converter can be carried through a considerable range without the aid of the choking coils which have to be inserted in the alternating-current supply lines of a rotary converter for this purpose.

THE HOPKINSON TEST APPLIED TO A SINGLE DYNAMO.

The Hopkinson or differential method of testing for efficiency and temperature rise is already very generally employed in the case of large machines, but the scope of

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the method is somewhat limited by the fact that two similar machines must be available, and that there are often difficulties in mechanically coupling the machines together. Herr A. Kolben points out in an article in *Elektrotechnik und Maschinenbau* that in the case of parallel-wound armatures without equalising connections the Hopkinson method can be applied to a single machine, provided the number of poles is divisible by four. The arrangement is shown in Fig. 1 for a four-pole Gramme

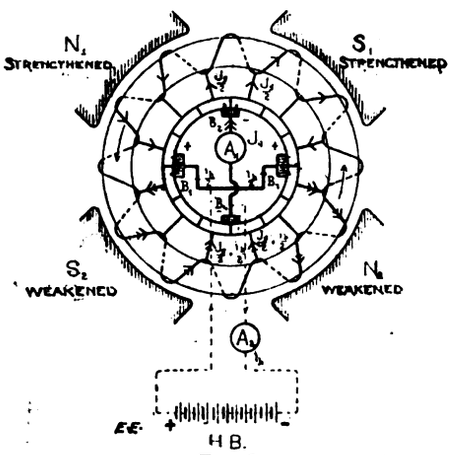

FIG. 1.

armature, and in Fig. 2 for a four-pole parallel-coupled drum armature. As soon as the circuit to the auxiliary supply (battery), H B, is closed through a starting resistance, the machine starts up as an ordinary motor. If the two upper poles, N_1 and S_1 (Fig. 1), are now excited more than the two lower ones, N_2 S_2, the upper part of the armature behaves as a generator winding, and only the lower part as a motor winding. The former develops a current, J_g, which can be measured by the ammeter A_1,

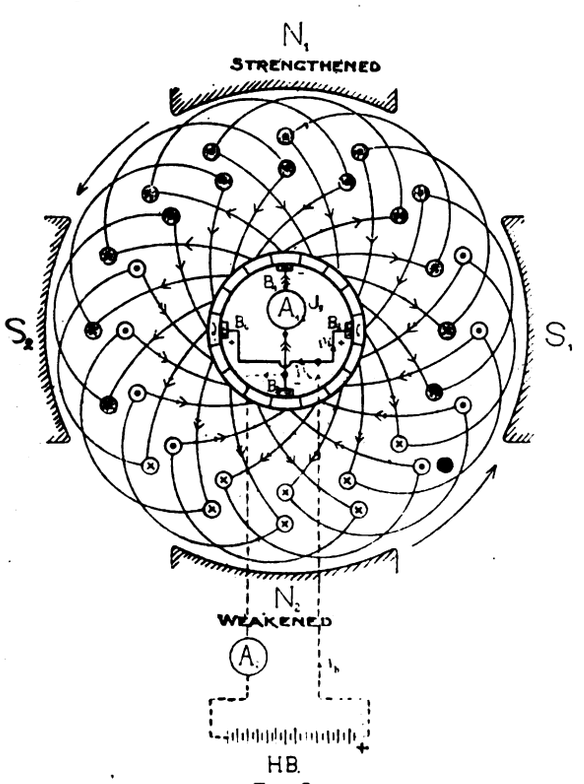

FIG. 2.

connected between the brushes B_2 B_4. The lower part of the winding receives the current J_g, plus the current i_h (representing the total armature losses) from the auxiliary source, H B. In the connection between the brushes B_1 and B_3 a current equal to half i_h flows. The value of i_h is measured directly in the ammeter A_2. The inequality in the excitation of the upper and lower poles is carried sufficiently far to make the current J_g equal to half the normal full-load current of the machine, and the machine is then running under practically normal full-load conditions In the case of the drum armature (Fig. 2), the conductors forming any one armature path lie under two neighbouring poles instead of under a single pole, as in the case of the ring armature. Instead of weakening one pair of poles and strengthening the other pair it is, therefore, necessary to weaken only one pole, N_2, and to strengthen the opposite pole, N_1, so as to obtain two equal voltage generator paths and two equal (but lower) voltage motor paths.

If the flux of N_2 is weakened as much as the flux of N_1 is strengthened, it is obvious that the fluxes of S_1 and S_2 will remain unchanged and equal. In Fig. 2 the conductors acting as the generator winding at the instant are shown shaded. It will be seen that three field circuits, each with its own regulating resistance, are required: (1) for those poles which remain unchanged, S_1 S_2; (2) for the strengthened poles, N_1; and (3) for the weakened poles, N_2.

An examination of Fig. 2 shows that no distortion occurs at poles S_1 S_2, because the motor and generator cross ampere-turns practically cancel out. Poles N_1 and N_2 have approximately the normal distorting ampere-turns. The effect of this distortion on the iron losses is, therefore, not quite the normal effect. Brushes B_1 and B_2 commutate approximately the normal current under normal conditions. At brushes B_3 and B_4 no actual commutation occurs, since the currents in the coil before and after passing these brushes are in the same direction. The losses under the brushes are, therefore, also somewhat different from the normal.

There is also the question of unbalanced magnetic pulls to be considered. Since a quite small difference in magnetic flux will suffice to pass the full-load current, the difference in pull is not very great, and if the stronger poles are arranged above and the weaker ones below the armature, the difference in pull will seldom more than compensate for the weight of the armature.

As regards commutation, the generator brushes operate under more satisfactory conditions than the motor ones because they work under the stronger field. When two separate machines are being tested, this difference can be rectified by independent shifting of the motor and generator brushes. This is not so easily accomplished with a single machine, as all the brushes are controlled by a single rocker. Good modern machines, however, will not spark on account of the slightly weakened field, and in any case the inequality between generator and motor brushes can be compensated for by giving all the brushes a slight backward shift.

SYNCHRONISATIONS.

Note.—The frequency of this epic is a bit disturbed owing to the fact that the engines couldn't be governed within 3 per cent.

Phase, phase, phase,
At a frequency, hundred and three.
Things I should not care to utter
The engineer says to me.

Lucky low-frequency man,
With a 'scope it must just be play.
And even at that his bloomers
Are saved by the swift relay.

Here fuses blow with a bang,
If the set doesn't pull in well.
Then cometh the chief with sarcastic tongue
And raiseth particularly unpleasant points of discussion.

Phase, phase, phase,
When the speed is exceedingly bad.
These flying shots at a winking lamp
Are driving me almost mad.

Ascot.—Since the opening of the electricity works in October last year consumers have been connected to the extent of 2,184 equivalent 8-c.p. lamps, and new applications for the current are continually being made. Cable is now being laid from Sunninghill Church corner right through Ascot High-street to the Royal Hotel, and from thence in all probability will be taken down the Windsor road.

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DIRECT-CURRENT TURBO-GENERATORS.

SIR,—We note that you publish in the current number of the *Electrical Engineer* an abstract of a paper with the above title recently read by Mr. Hoult at Manchester.

One of the illustrations to this paper (Fig. 7 on p. 300 of your current issue) consists of an unauthorised photograph of one of our turbo-dynamos, and we are, moreover, surprised to see the statement made by the author that this represents a Dick-Kerr turbo dynamo of 600 kw. This statement is strengthened by the fact that on the illustration itself, in the background, is a name-plate or shield bearing the name of the same manufacturer.

We desire to point out that the machine in question is undoubtedly of our manufacture, and, as far as we can tell, the illustration consists of an unauthorised photograph of the interior of a 600-kw. machine we supplied to Messrs. Willans and Robinson for the Blackpool Corporation last year.—Yours, etc.,

BROWN, BOVERI, AND CO., LIMITED.

London, March 2, 1908.

[The author described this machine as being made by Messrs. Brown, Boveri, and Co., and we regret that we are responsible for the statement that it was a Dick-Kerr machine. It was the name-plate which caused the mistake. On a further examination it will be seen that this name-plate is on a second machine seen through the bore of the Brown-Boveri turbo-generator.—ED., *E. E.*]

INTERNAL-COMBUSTION ENGINES AS APPLIED TO ELECTRIC GENERATION.

SIR,—I have read with interest your abstract of Mr. H. G. Biggs's paper delivered to the Northampton Institute Engineering Society, and as an old student would offer a point for the consideration of the author. The figures he quotes as representative of steam-engine economy—3lb. to 5lb. of coal per brake horse power hour—are clearly not indicative of the best practice, and the prime movers in question may only be considered as "good" steam-engines from the competitor's point of view. The figures he gives might border on an average value if all the steam-swallowing monstrosities in the kingdom—on which makers would be rather reluctant to display a name-plate—were taken into account. A recent test carried out by the Vulcan Boiler and General Insurance Company on an engine by Pollit and Wigzell gave a steam consumption of 12·48lb. per indicated horse-power hour, and an expenditure of coal 1·31lb. per indicated horse-power hour, and this with a mechanical efficiency of 75 per cent. (which is a low value) represents under 1¾lb. of coal per brake horse-power hour.

With this engine (a compound) no superheat was employed, the initial pressure was comparatively low, and the efficiency of combustion moderate, yet 11·9 i.h.p. for one hour were obtained per 1d. fuel cost!

With the advent of the piston drop-valve engine better efficiencies than this may be looked forward to, and, indeed, Messrs. Cole, Marchent, and Morley have already secured the remarkable steam consumption of 8·58lb. steam per indicated horse-power hour—this with a high degree of superheat. So that with a really efficiently fired furnace 1lb. of coal per indicated horse-power—or, perhaps, per brake horse-power—seems quite within the bounds of possibilities, and this with an average bituminous fuel at 10s. to 12s. per ton—not anthracite at anything from 15s. to 28s. per ton.

While not gainsaying the incumbrances of steam power plants, and admitting the excellencies of gas-engine producer units, in spite of some present imperfections, Mr. Biggs's comparison did not appear to me to be quite a judicious one.—Yours, etc.,

CHARLES J. KAVANAGH.

FORTHCOMING EVENTS.

FRIDAY, MARCH 6.

Northampton Institute Engineering Society.—At 5.45 p.m., "Some Points in connection with Water-Tube Boilers," by Mr. A. E. Palmer.

SATURDAY, MARCH 7.

Liverpool and District Electrical Association.—At 2.30 p.m. visit to the works of the British Insulated and Helsby Cables Prescot.

P. and O. Batti-Wallahs' Society.—At 6.30 p.m., at the Holborn Restaurant, annual dinner.

Royal Institution of Great Britain.—At 3 p.m., "Electric Discharges through Gases," by Prof. J. J. Thomson.

MONDAY, MARCH 9.

Institute of Marine Engineers.—"Artificial Illumination—Historical and Practical," by Mr. A. Battle.

Institution of Mechanical Engineers.—At 8 p.m., "Notes on Lubricants and Engine Lubrication," by Mr. R. C. C. Yates.

Royal Society of Arts.—At 8 p.m., "Fuel and its Future," by Prof. Vivian B. Lewes.

TUESDAY, MARCH 10.

Institution of Electrical Engineers (Manchester Local Section). At 7.30 p.m., at the University, "The Internal Structure of Metals," by Mr. W. Rosenheim.

Institution of Electrical Engineers (Manchester Students).—"Electrical Testing," by Mr. A. E. Jepson.

Liverpool and District Electrical Association.—At 8 p.m., "Static Transformers," by a member, and discussion on Mr. S. R. Gibbon's paper, "Storage Batteries as applied to Traction."

WEDNESDAY, MARCH 11.

Association of Engineers-in-Charge.—"Notes on Electric Lifts," by Mr. H. D. Wilkinson.

Institution of Electrical Engineers (Birmingham Local Section). At 7.30 p.m., "Artificial Load for Testing Electrical Generators," by Mr. R. K. Morcom and Mr. D. K. Morris.

Royal Meteorological Society.—At 7.30 p.m., "The Dawn of Meteorology," by Dr. G. Kellmann, of Berlin.

THURSDAY, MARCH 12.

Electrical Contractors' Association.—At 8 p.m., "The Comparison of Carbon and Metallic Filament Incandescent Lamps," by Mr. L. Gaster.

Institution of Electrical Engineers.—At 8 p.m., at the Institution of Civil Engineers, "America Revisited, 1907," by Sir W. H. Preece, K.C.B.

Rugby Engineering Society.—"The Systematic Design of a Line of Stationary Direct-Current Motors," by Messrs. H. O. Emrich and F. P. Whitaker.

FRIDAY, MARCH 13.

Junior Institution of Engineers.—At 8 p.m., "Automatic Fire Extinction as applied to Factories," by Mr. G. T. Bullock.

Physical Society.—At 8 p.m., meeting in the physics laboratory of the Royal College of Science.

Royal Institution of Great Britain.—At 9 p.m., "Transatlantic Wireless Telegraphy," by Mr. G. Marconi.

SATURDAY, MARCH 14.

Birmingham and District Electric Club.—At 7 p.m., discussion on the "Possibilities of Electrical Developments," to be opened by Mr. R. Borlase Mathews.

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REVIEWS.

Electricity in the House and Mensuration for Handicraftsmen. By PAUL N. HASLUCK. Cassell and Co., Limited. Price 1d.

These little booklets, which form part of a series of a similar character, deal with the elementary part of the work treated, and are both interesting and instructive to beginners.

MANCHESTER LOCAL SECTION DINNER.

The annual dinner held at the Midland Hotel, Manchester, under the chairmanship of Mr. A. B. Field, was a thorough success. The guests at the high-table included the Mayor of Salford, Dr. Glazebrook, Mr. S. Z. de Ferranti, Mr. Robert Hammond, Mr. J. Adamson, the President of the Manchester Association of Engineers, and many others. The speeches were interesting, and were mostly of the after-dinner order. Mr. J. Adamson, in proposing the toast of the Institution, advocated the formation of a central technical library in Manchester to which members of all the neighbouring institutions would have access. This might be contained in a building in which all the societies would hold their meetings. Dr. R. T. Glazebrook, in reply, made an eloquent and touching reference to the late Lord Kelvin. He spoke of the monument, which is to take the form of a marble statue, which the Institution hoped to erect with the co-operation of all electrical engineers. It was suggested by Mr. Haldane that he should make reference to the proposal to form a corps of electrical engineer volunteers in the Manchester district, which would resemble the corps now existing in London. Mr. Ferranti proposed the toast of the Local Section, to which the chairman replied. We were struck with the musical talent of the electrical engineers in Manchester, and the songs rendered by Mr. J. Gibson, Mr. T. S. Greenwood, Mr. P. C. Pope, and Mr. Mayhew's small talk added greatly to the enjoyment of a most pleasant evening.

A SINGLE-PHASE RAILWAY MOTOR.*

BY E. F. ALEXANDERSON

The motor discussed in this paper is neither a series nor a repulsion motor in the generally accepted sense, but embodies many of the best features of both, and is, therefore, given the name of a "series repulsion motor." The windings resemble those of a series motor, and the armature and stator are connected in series. A general diagram of the motor is shown in Fig. 1. In its performance it resembles the series motors with commutating poles, but several advantages are claimed. Instead of producing a commutating flux locally by coils on the stator, the conductors in the armature are located in such places where the desired flux will naturally exist. Thus the compensating winding of the series motor is replaced by an "inducing" winding with twice as many turns, and the energy is introduced either in the stator alone or in the stator and rotor together. The starting torque obtained is twice as high as in a corresponding series motor for the same commutation and the same supply of current. This double starting torque is obtained by winding the stator with twice as many turns as the armature. The motor starts as a repulsion motor with the armature short-circuited as shown in Fig 2. The current as it enters the stator has only half the strength of that in the rotor, owing to the ratio of stator to rotor turns. The short-circuiting switch of the rotor carries only half as much current as the rotor itself, because the current in the short-circuited connection is only the difference between the stator and the rotor current. The inducing winding, the field, and the armature are connected permanently in series, but with the connections shown the field is in series with the stator circuit at starting and with the rotor circuit when running. In starting, the rotor carries twice as much current as when running in order to give the same field strength—in this manner doubling the starting torque. The sparking at starting is quite insignificant up to a certain value of the voltage short-circuited by a brush, but beyond this point the commutation rapidly becomes bad. The critical value is about the same as that which gives a reasonably good commutation in running. The preferred method of control is one shown in Figs. 2 and 3. In starting, the armature is short-circuited and the full secondary voltage of the transformer is impressed upon the inducing and exciting windings.

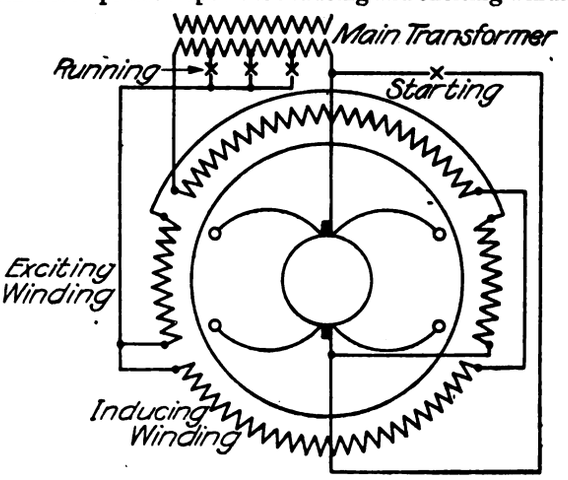

FIG. 1.

The current flowing through the stator continues through the armature. In the running connection part of the power is introduced in the stator and part in the rotor, and the field winding carries the same current as the armature—*i.e*, twice the stator current—thus giving a relatively greater field than in the starting condition, just as would be produced by a series-multiple connection of the field winding. Although the total potential impressed upon the stator and rotor is the same for starting and running, the result of changing the connection so as to transfer the energy input from the stator to the rotor has the effect of increasing the resulting voltage of the motor,

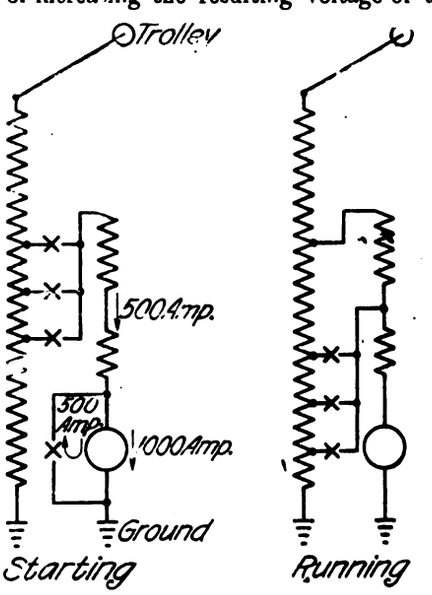

FIG. 2.

due to the ratio of transformation between stator and rotor. It is stated that the commutation of the machine at a frequency of 25 cycles is much better than that of a conductively compensated series motor at the same frequency, and even better than that of the latter motor at 15 cycles. This result is due largely to the use of the connections described above, although some improvement is attributed to the use of a fractional pitch winding on the armature. The introduction of the commutating flux tends to lower the power factor slightly, but the greater liberty in design that is gained in the new type allows the motor, as constructed for railway service, to possess practically the same power factor as does a conductively compensated series motor for the same duty.

* Abstract of a paper read in New York before the American Institute of Electrical Engineers.

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THE USE OF CONDENSERS ON HIGH-TENSION CIRCUITS.

In spite of the many ways in which condensers can be advantageously used in connection with high-tension circuits, they have hitherto been seldom employed, chiefly on account of insufficient reliability The causes of this unreliability are: (1) the low breakdown voltage of the dielectric employed; (2) bad contact between the conducting layers and the dielectric; (3) insufficient cooling; (4) the use of organic substances in the dielectric (such as paper, linen, etc.), as these suffer through gradual electrolysis of the impregnating fluids. Experiment has shown that when insulation of uniform thickness is used the breakdown almost invariably occurs at the edges of the conducting layers—the breakdown voltage here being often only one-fifth or one-sixth of the voltage withstood by the central part of the dielectric. It is for this same reason that any irregularity of contact between conductor and dielectric is objectionable, since the surrounding parts behave like the edge of a conducting plate.

The condensers made by the Allgemeine Gesellschaft für Elektricitäts Kondensatoren under Herr Moscieke's patents are specially designed to overcome the above difficulties and to form a robust piece of apparatus for ordinary industrial use. They consist of long glass tubes (Fig. 1) having a wall thickness at the open (upper) end some three or four times as great as that of the rest of the tube. The

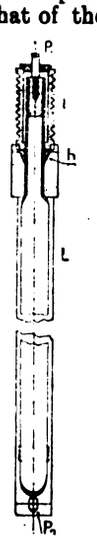

FIG. 1.

tube is coated chemically inside and out with an excessively thin skin of silver. This coating is then protected by a much thicker copper cover. The inside terminal, P_1, is protected by a high-tension insulator, I, cemented into the neck of the tube. The whole tube is fixed in an outer sheet-metal tube, L, which is in contact with the outer condenser coating by means of the second terminal, P_2. There is a watertight rubber joint, *h*, at the top of this outer tube. The outside of L is blackened, and the space below the condenser and L is filled with a non-freezing mixture of glycerine and water so as to dissipate the heat readily. A number of such units, each protected by its own fuse, are built up into batteries of condensers to suit any voltage and capacity desired. Each unit will stand 10,000 to 15,000 volts normally, being tested after completion up to 27,000 to 40,000 volts. For higher voltages a number of the condensers are connected in series, and batteries for upwards of 100,000 volts have been constructed in this way. Their efficiency is extremely high, reaching 99 5 per cent. usually.

The most important use for such condensers is in connection with the protection of transmission lines against atmospheric and resonance voltage rises. For this purpose, neglecting direct lightning strokes, protection is required against: (1) Static atmospheric charges due to contact with clouds, snow, or atmospheric dust, and which take the form of a unidirectional current to earth, often of large amount though of very short duration. (2) Inductive or influence effects due to atmospheric discharges in the neighbourhood of the line. These take the form of alternating currents of large amount and very high frequency (500,000 to 600,000 cycles per second). (3) Voltage rises in the line due to sudden changes of load, short-circuits, etc. These may have a frequency of several thousand cycles per second. Complete protection can, therefore, only be given by an apparatus which can carry either direct current or alternating current of very high frequency without offering a high resistance to earth as far as these discharges are concerned, whilst offering a very high resistance to the flow of the normal line currents to earth. None of the

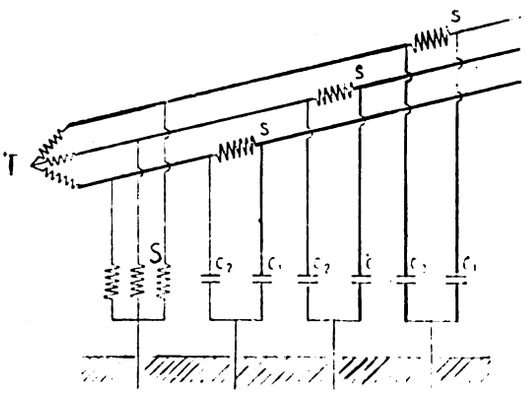

FIG. 2.

devices in use at present complies with all these conditions, whilst some of them—like the horn arresters and the roller arresters—are themselves the cause of high-voltage rises of the type described under (3) when they operate.

A condenser offers an ideal method of dealing with cases (2) and (3), for, as is well known, the current passed by a condenser increases not only in proportion to the volts, but also in proportion to the frequency. Thus a condenser which allows ·1 ampere to pass at the normal line voltage and 50 ~, will pass 1,000 amperes at 500,000 periods without any rise in voltage. In this way, if the generating station and the sub-stations are fitted with suitable condensers to deal with case (2), there will usually also be sufficient total capacity in the circuit to deal satisfactorily with voltage rises of type (3) in spite of their lower frequency. Case (1) is easily dealt with in another way. The lines have only to be connected to earth through choking coils of high inductance but low ohmic resistance. Such coils will offer a high impedance to the flow of the normal frequency line currents, but will offer practically no resistance to the flow of a direct current to earth of the type described under (1). The complete arrangement for the protection of a transformer or generator, T, is shown in Fig. 2. Here S is the low-resistance choking coil for dissipating direct-current discharges. High-frequency charges pass to earth through

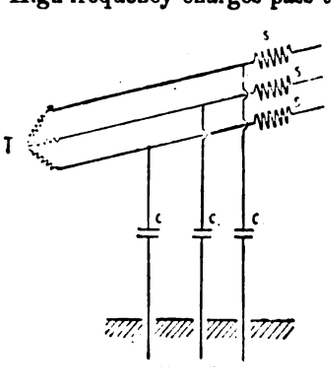

FIG. 3.

the condensers, C_1, as they are prevented from reaching the machine, T, by the iron choking coils, *s*. A small fraction of the charge, however, must flow through these choking coils before the necessary high back voltage is set up in them, and this fraction is carried to earth by the auxiliary condensers, C_2. A single low-resistance choking coil, S, will serve for a fair-sized transmission scheme of 10 to 15 miles Where the neutral point of the system is available, as in the case of star-connected three-phase machines, the coil, S, can be replaced by a low-resistance connection between the earth and the neutral point. Each station or sub-station should be provided with a set of condensers as shown, or, in the

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case of small schemes, the duplicate condensers may be omitted and the cheaper arrangement shown in Fig. 3 adopted

Condensers in parallel with the line have the further advantage of improving the power factor of the supply. Up to the present over-excited synchronous motors have been employed for this purpose in a few cases, but these are costly and may be advantageously replaced by condensers. Where the line voltage is less than about 13,000, it is advisable to employ transformers to raise the condenser voltage, because the condensers are most economical when designed for about 20,000 volts. Thus, suppose a 5,000-volt transmission scheme for 5,000 kw. has a power factor of ·85 ($\phi = 58$deg.), which is to be increased to unity by means of condensers:

Power to be dealt with by the condensers = 5,000 kw. $\times \sin \phi = 2{,}500$ kw.

2,500-kw. condenser battery at £1. 4s. a kilowatt...	£3,000
Transformers.....	1,200
Cost of installation	400
	£4,600

By the provision of this battery the output of the station is raised 15 per cent., or 750 kw., so that the cost per 1 kw. additional station output is

$$\frac{£4{,}600}{£750} = £6.\ 3s.$$

The presence of such a condenser has further advantages: (1) the regulation of the generator is considerably improved by the rise in power factor; (2) the higher harmonic components of the voltage and current curves are damped down, especially those of the highest frequency, which are

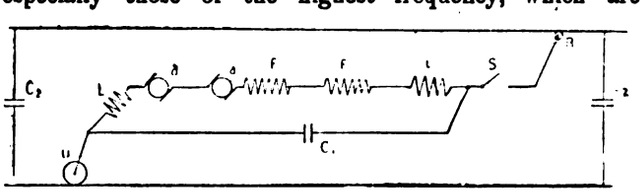

FIG. 4.

especially dangerous in view of possible resonance voltage rises in the line; (3) the resonance effects which sometimes result on the opening of a switch or circuit breaker are avoided, for these occurrences are due to rapid changes in the current of frequencies of probably 6,000 to 8,000 cycles per second, and at such frequencies the condensers can deal with 120 to 160 times their normal 50 ~ current.

Another use for condensers occurs in connection with direct-current traction motors. Whenever the trolley wheel leaves the line or the car wheels leave the rail momentarily a high-frequency current change occurs, and corresponding voltage rises up to 5,000 volts or so are liable to be set up. The arrangement shown in Fig. 4 forms a protection against this occurrence. R is the trolley wheel, S the controller, L L choking coils, F F field coils, *a a* motor armatures, and *u* the car wheels. C_1 is a condenser short-circuited across the motors, and C_2 C_2 are stationary condenser batteries connected between line and earth at intervals. With this arrangement all excessive voltage rises of high frequency are free to pass current to earth through the condensers without damaging the motors. *Elektrische Kraftbetriebe und Bahnen.*

SOME CHARACTERISTICS OF THE FLAMING ARC LAMP.

The exceptionally high efficiency of the flaming arc is due primarily to the phenomenon of luminescence. Light sources may be divided into two classes. The light rays of any source are either due to its high temperature, in which case the light rays are classed as temperature rays, or the temperature may be only secondary in importance, and the high efficiency of the illuminant is due to a property called luminescence by E Wiedeman and allactine by Warburg. All of the older types of artificial illuminants illuminate by virtue of their high temperature. Examples of these illuminants are the wax candle, petroleum, illuminating gas, acetylene gas, etc., all of which illuminate by virtue of the glowing carbon. Examples of illuminants which illuminate by virtue of their luminescence are the Geissler tubes, Tesla light, mercury-vapour lamp, etc.

The flaming arc illuminates by virtue of a combination of luminescence and high-temperature rays. The carbons are impregnated with strontium, barium, calcium, or similar chemicals, which are vaporised in the arc. While in the ordinary direct-current arc lamp the light due to the arc is approximately 5 per cent., that of the crater 85 per cent., and that of the negative carbon 10 per cent. of the total light, the light of the flaming arc lamp is due primarily to the luminescence of the arc proper. Also the light of the flaming arc is due to the fact that the energy of the rays of light is confined to but a small part of the spectrum.

The specific consumption or efficiency of a direct-current flaming arc lamp, according to Laporte ("Bulletin Soc. Intern Electr."), at a current strength of nine amperes varies with the E.M.F. of the arc—a variation of from 24 volts to 45 volts—and results in a variation of specific consumption or efficiency from 0·74 to 0·38 watt. According to the Physikalisch-Technische Reichsanstalt the specific consumption for direct current is 0·36 watt at 46 volts arc pressure to 0·48 watt at 36 volts. For alternating current the efficiency varies from 0·34 watt at 44 volts arc pressure to 0·59 at 48 volts. Generally speaking, the alternating-current and direct-current lamp efficiency is considered approximately equal. The above figures do not, of course, include the loss in the series resistance.—E. O. SCHWEITZER (*Western Electrician*).

A NEW HIGH-FREQUENCY SPARK-GAP.

The above is described by Herr J. Köhler in the *Elektrotechnischer Anzeiger*. It consists of two small spheres, *c d* (Fig. 1), about 2cm. diameter each, connected to the high-tension supply (influence machine or induction coil), J, and two larger spheres, *a b* (about 5cm. in diameter), between which the high-frequency discharge is obtained at *z*. Two small hydrogen flames, about 5·7mm. high, out of the glass nozzles, *h i*, are placed in the auxiliary gaps, *x y*. The hot gases of the flames act as conductors for the current, and

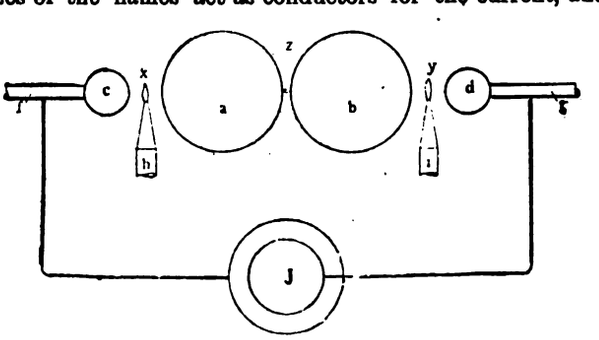

FIG. 1.

no sparks pass at *x* and *y*. A high-frequency spark, however, is found to pass at *z* when the influence machine is at work. If the machine is rotated slowly the sparks are intermittent, but if the speed is raised sufficiently a bright line of light results at *z*, and coherer and other experiments show that this is composed of high-frequency oscillations. How high the speed of the machine can be carried without interfering with the oscillations has not yet been decided, but it seems likely that the apparatus offers a new source of more or less undamped high-frequency oscillation.

HIGH-EFFICIENCY LAMPS IN BERLIN.

According to a recent visitor to Berlin, Germany, only flaming arc and high-efficiency incandescent lamps can be there seen in the business portions of the city, and that 90 per cent. of the outdoor lighting is now done with flaming arc lamps. Both tantalum and tungsten lamps are used, but the former are seen usually in old fixtures where the lamp cannot be placed vertically.

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NATIONAL PHYSICAL LABORATORY.

The report of the committee appointed by the Treasury to inquire generally into the work now performed at the National Physical Laboratory, together with a Treasury minute, dated Feb. 1, 1908, recording their lordships' approval of the recommendations contained in the report of the majority of the committee, has just been issued. The committee consisted of Mr. Gerald W. Balfour (chairman), Sir Andrew Noble, Sir J. Wolfe Barry, Mr. W. J. Crossley, M.P., and Mr. R. Chalmers, C.B.

A considerable amount of evidence was taken and a marked divergence of opinion was disclosed on two subsidiary points to which the committee's attention was specially directed by the Treasury minute — namely: (1) the possibility that the mechanical, physical, and chemical tests actually undertaken by the laboratory may interfere unduly with private enterprise; and (2) the desirability of publishing the results of all such testing work. The evidence received by the committee showed that private testing establishments, and also professional analysts who are in the habit of adding engineering tests to chemical analyses, were beginning to look on the policy they attributed to the laboratory as a serious menace to their interests. The committee are disposed to regard these fears as exaggerated, but they cannot regard them, in view of the diverse interpretation placed upon the report of 1898, and of the important additions recently made to the equipment of the laboratory, as unreasonable or wholly without foundation. Before stating their conclusions on this point, the committee distinguish "commercial testing" into "contractual" and "investigatory" testing — "contractual" testing being the ordinary testing of materials to ascertain whether their quality and behaviour are in accordance with the requirements of contracts; "investigatory" testing the investigation for commercial purposes of various substances in which no question of contract arises. They are of opinion that to place restrictions upon "investigatory" testing would be to hinder the advance of knowledge.

No restriction should apply to "reference" testing wherever, in cases of dispute, the parties concerned agree to refer their differences to the authoritative decision of the laboratory, or where the laboratory is called in by a court of law or of arbitration. In view of the character of the laboratory as a public institution, the committee think it ought to be free to accept any work which any Government department may desire to commit to it. In this category they include the work until lately carried out at Coopers Hill on behalf of the Indian Government. Reference testing, for the settlement of disputes, would not, in the opinion of the committee, involve any undue interference with the work of outside agencies; while as to Government work, it is improbable that much of this would in any circumstances find its way to private testing establishments. As an additional safeguard against injurious competition with private enterprise, they think, wherever the same tests of materials are carried out both by the laboratory and by outside agencies, care should be taken that the fees charged by the former should be at least as high as those normally current. In the case of reference testing, they think they should be distinctly higher.

On the question of the publication of all testing work conducted at the laboratory, the committee are of opinion that the executive committee of the laboratory should hold themselves somewhat freer than heretofore to exercise a discretion as to the withholding of results from publication, either wholly or in part, for a limited number of years, but they also think that in cases where publication is thus deferred, a considerably higher fee should be charged to the persons for whose immediate benefit the investigation is to be carried out. The committee further recommend that the sub-committees of the laboratory should be kept up to date and in close touch with the executive committee, and conclude: "Subject to these observations, we do not consider that any alteration is required in the scope of the work of the National Physical Laboratory as defined by the committee of 1898."

The report is signed by all the members of the committee, but Sir Andrew Noble and Sir J. Wolfe Barry add the following note: "We are of opinion that the restriction which we have recommended in respect of 'contractual testing' should come to an end after a definite time. A restrictive period of 10 years would, we think, adequately meet the case presented to us on behalf of private testing establishments, and would safeguard the interests of the public, which will be best served by leaving the authorities entrusted with the administration of the National Physical Laboratory completely free (as is the case in the national laboratories of Germany) to exercise their discretion in accepting or refusing any description of testing work."

The Treasury, in a minute dated Feb. 1, record their approval of the recommendations contained in the report of the majority of the committee. They learn that the president and council of the Royal Society accept in principle the recommendations contained in the report of the committee, and that the executive committee of the National Physical Laboratory have expressed their readiness to use their best endeavours to carry the recommendations into effect.

SOCIETIES AND INSTITUTIONS.

Royal Institution.

A general monthly meeting of the members of the Royal Institution was held on the 2nd inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. Colonel David Bruce, Miss Deane Butcher, Miss Cleghorn, Mrs. Dugald Clerk, Mr. V. Gordon, Mr. J. Hunter Gray, Miss Hassard, Mr. W. L. Preece, Dr. C. W. Saleeby, Dr. Hans Sauer, Mrs. Schilizzi, Miss Schilizzi, Mr. C. E. Wurtzburg, and Prof. H. A. Wilson, F.R.S., were elected members. The special thanks of the members were returned to Sir Andrew Noble, Bart., K.C.B., for his donation of £100 to the fund for the promotion of experimental research at low temperatures; to Mr. Shelford Bidwell for his donation of £5. 5s. to the general fund; to Mr. W. Hugh Spottiswoode for his present of a manuscript record containing the early laboratory experiments of the late John Peter Gassiot, F.R.S., who was formerly a manager and benefactor of the institution; and to Mrs. Kemp for her gift of a portrait of the late Sir Benjamin Baker, K.C.B., F.R.S., a vice-president of the Royal Institution.

Junior Institution of Engineers.

On Saturday, Feb. 22, a visit of great interest was paid to King's College, London, for an inspection of the experimental apparatus, etc., in the engineering laboratory, the Siemens electrical engineering laboratory, and the Wheatstone laboratory, through arrangements kindly made by Prof. D. S. Capper, M.A., M.I.C.E. (hon. member), Prof. H. Wilson, F.R.S., Prof. Ernest Wilson, M.I.E.E., and Prof. Waynforth. The apparatus includes various machines for testing materials and obtaining a thorough knowledge of their nature and properties. For thermodynamic work there are a 60-i.h.p. Marshall experimental compound engine, 20-kw. Belliss-Siemens direct-driven set, Parsons steam-turbine and direct-driven dynamo, Davey-Paxman and Babcock-Wilcox boilers, Dowson suction gas plant, Crossley high-speed gas-engine, condensing plant, various calorimeters, apparatus for flue and exhaust gas analysis, etc. Appliances are also provided for the determination of the cutting power of tools and efficiency of machine tools and belts and pulleys, and apparatus for determining the effect of blows on springs and the resisting power of asphalt. The Siemens laboratory is equipped with very complete and modern apparatus suitable for the practical instruction of students in every branch of electrical engineering. Direct current is obtained from the supply company's public mains, from a battery of Chloride cells, and from a Siemens 50-kw. generator of 500 to 550 volts. Alternating current is supplied from a Siemens 100-kw. eight-pole revolving-field type of alternator arranged to give one, two, or three phase currents at frequencies ranging from 50 to 25; also from two Siemens generators, each of 10 kw. output, with a special coupling which allows the phase displacement of the armatures to be altered. A complete tramcar equipment is provided, fitted with two 35-h.p. motors, with arrangements for testing draw-bar pulls, efficiencies, etc. In the Wheatstone laboratory were shown the dark room for optical experiments, workshops for repairs, the celebrated George III. and Wheatstone collections (which include the lodestone which belonged to Daniell and was used by Faraday in his classic experiments on the induction of currents), the coils of insulated copper strip used by Henry in his experiments, the rotating mirror which Wheatstone employed in his experiments on the velocity of electricity along wires, the original Wheatstone bridge and resistance boxes, and Clerk Maxwell's dynamical model to illustrate the induction of electric currents.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, March 14.

MONDAY, MARCH 9.—"A" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

TUESDAY, MARCH 10.—"B" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.
Recruiting night, 6.30 p.m.

WEDNESDAY, MARCH 11.—"A" badge examination, 6 p.m.

THURSDAY, MARCH 12.—"C" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

FRIDAY, MARCH 13.—"D" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

SATURDAY, MARCH 14.—Week-end run at Coalhouse for "A" Coy.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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PERSONAL.

The partnership between N. A. Thompson and J. G. Wilson, carrying on business as consulting electrical engineers at 22, North Bridge street, Edinburgh, has been dissolved by mutual consent by the retirement of Mr. Wilson. The business will continue to be carried on by Mr. Thompson on his own account and in his own name.

The *London Gazette* announces that the partnership between W. T. Garnett and R. R. Stell, carrying on business as electric cablemakers at Barkerend Mills, Bradford, under the title of W. T. Garnett's Cable Co., has been dissolved by mutual consent.

Mr. W. J. Bache, electrical engineer to the Cheltenham Town Council, has been granted an increase of salary of £50 per annum, making his salary £450.

According to the *London Gazette*, the partnership between C. H. Rosoman and S. Dicks, carrying on business as electrical engineers at Dacre House, Victoria-street, Westminster, has been dissolved by mutual consent.

We are informed that Mr. John Varley, 11, Stanley-gardens, London, W., has been appointed a director of the Callender's Cable and Construction Co. in succession to the late Sir D. Evans.

The Hampstead Borough Council have increased the salary of Mr. F. Northey from £110 to £125, and that of Mr. J. Goodchild from £112 to £118 per annum, both of whom hold positions under the mains superintendent. The salary of Mr. J. Barnes, the assistant shift engineer, has been increased from £78 to £85 per annum.

The Nottingham City Council have decided to increase the salary of Mr. J. Aldworth, the tramways manager, from £800 to £900 per annum.

The Dudley Town Council have appointed Mr. C. E. Savage as resident engineer at the electrical works at a salary of £225, rising to £250 per annum.

BUSINESS NOTES.

LIGHTING AND GENERAL.

River Plate Telephone Co.—The directors have declared an interim dividend of 3 per cent.

Caryle (Illinois).—The electric light plant is to be extended by the Municipality at an estimated outlay of 20,000dol.

Creston (Canada).—A company is being formed to develop electricity at the Goat River Canyon, 3½ miles from Creston.

San Luis (River Plate).—An electricity generating station in San Luis was inaugurated on Feb. 1, and gave general satisfaction.

Worcester.—The Electricity Committee of the City Council are about to install further plant at the electricity works at a cost of £539.

Chinley.—The Chinley Parish Council have communicated with the National Telephone Co. asking them to establish a call office at Chinley.

Stockton.—The Board of Trade have notified the Rural District Council that the rural district electric lighting order of 19 2 has been revoked.

Hull.—A gas explosion occurred at 13, Studley-street, Hull, on the 16th ult. through defective gas fittings. Some damage was done to the property.

Florencio Varela (South America).—The Municipal Council have decided to erect and equip a generating station for supplying the town with power and light.

Ogmore and Garw.—The Urban District Council have decided to ask the Ogmore Valley Electric Lighting Co. to light the streets until daylight up to March 15 next.

Hoddesdon.—The clerk to the Urban District Council has received £222 for the transfer of the Council's electric lighting order to the North Metropolitan Electric Light Co.

Haverhill (U.S.A.).—The Haverhill Electric Co. have decided to commence the work of placing the wires underground. The cost of the entire work is estimated at 200,000dol.

Mountain Ash.—The District Council having failed to obtain certain concessions sought for have decided to oppose the Bill of the Electric Distribution Co. now before Parliament.

Dover.—The Town Council have quoted certain prices for the supply of electricity to the Admiralty for lighting their property, and are about to spend £800 to provide for the requirements.

Rawtenstall.—The Corporation have received a request from the Haslingden Guardians to submit terms for the supply of electricity for power and light in connection with the infirmary and workhouse.

Rosario (River Plate).—The public electric lighting of Rosario for December cost 3,121dol. gold for 300 lamps. Private electric lighting was supplied to 3,219 subscribers at a cost of 10,770·50dol. gold.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the five weeks ended Jan. 31, 1908, were 401,412, compared with 366,569 units in the corresponding five weeks of 1907.

Abersychan.—The Board of Trade have revoked the Abersychan Electric Lighting Order, 1903, as confirmed by the Electric Lighting Orders Confirmation Act, 1903, as to the whole of the area of supply, as from Feb. 25, 1908.

Globe Telegraph and Trust Co.—The directors have declared a quarterly interim dividend of 3s. per share on the preference shares, less income tax, and of 2s. per share on the ordinary shares, income tax having already been deducted.

Glamorgan.—The County Council have agreed to support the Bridgend Urban District Council in their application for a provisional order to enable that Council to acquire the Bridgend generating station of the South Wales Electrical Power Distribution Co.

Cheltenham.—The monthly report of the Corporation's electrical engineer shows that there were 955 consumers, with the equivalent of 63,365 8-c.p. lamps connected to the private supply mains, the corresponding figures for last year being 910 and 60,591 respectively.

Belgium.—An electric recorder for registering the output of ore has been installed on the pithead of a Belgian lead mine. Each load of ore delivered at the top of the shaft actuates an electro-mechanism and marks a red line on a sheet of paper moved by a revolving barrel.

Henley.—The District Council have agreed to extend the electricity mains to a point opposite Reins Mill, provided suitable terms of supply can be arranged with the tenant, and that the sum of £350 be borrowed to cover an amount already expended on electric capital account.

Calcutta.—The Government have granted to the Calcutta Electric Supply Corporation a licence for the supply of energy for electric traction, and for the general supply of energy within the Dakhineswar magazine, the Government dockyard at Kidderpore, and other places in Calcutta.

Kensington.—The Borough Council have agreed to spend £72 on improving the lighting of the large town hall by the existing electroliers being fitted with Osram lamps, eight Osram lamps installed under the gallery, six Sunbeam lamps fitted in the ceiling, and two extra brackets of six lights each fixed over the platform.

Supply of Electric Power to London.—The Lord Chairman of Committees has given notice of his intention to move that the London and District Electricity Supply Bill, the London Electric Supply Bill, and the London (Westminster and Kensington) Electric Supply Bill be referred to a committee of both Houses of Parliament.

Merthyr.—At the last meeting of the Board of Guardians attention was called by the chairman to the large expenditure upon gas for the workhouse, it being stated that the cost now amounted to £100 per quarter. The Board decided to invite the electric lighting company to give an estimate of the cost of lighting the workhouse by electricity.

Bakewell.—Bakewell gas consumers were somewhat surprised at an early hour on Saturday morning last by the sudden extinction of their illumination. Investigation disclosed the cause to be an explosion at the gasworks, which are the property of the Urban Council. The whole of the plant in this building was considerably damaged, and the roof, windows, doors, etc., destroyed.

Brighouse.—The large gas-engine installed some 18 months ago at the generating station of the Brighouse Corporation electricity works suddenly collapsed on Tuesday night, and much damage was done to the engine. The piston rod and a portion of the cylinder were hurled a considerable distance, and it was fortunate that two workmen who were in the place at the time escaped without injury.

Alloa.—At the last meeting of the School Board a communication relative to the cost of laying the electric cable to the new school at the Grange was submitted from the town clerk on behalf of the Alloa Town Council. The letter bore out that the cost of laying cable would be £60 and the Town Council would be willing to proceed with the work provided the School Board undertook to pay half of the cost.

Sleaford.—A successful exhibition was held on Wednesday, Thursday, and Friday in last week at the Sleaford Fire Brigade station. The opening ceremony was performed by Councillor W. C. Bates, chairman of the Electric Lighting Committee. The exhibits were numerous and most interesting, and large numbers of interested spectators watched each evening the various appliances and machines.

Leek.—A Local Government Board inquiry has been held into the application of the Town Council for sanction to borrow £8,250 for purposes of the electricity undertaking. So bad is the escape of gas throughout the district that the attention of the Council has been called to the danger existing where gas-mains are laid in close proximity to electricity inspection chambers. An explosion occurred as a result last week.

Private Bills in Parliament.—In the House of Lords on the 3rd inst. the Interoceanic Railway of Mexico Bill, the Metropolitan Electric Tramways Bill, and the London (Westminster and Kensington) Electric Supply Companies' Bill were read a second time. In the House of Commons the Madras Railway Co. (Annuities) Bill was considered and ordered for third reading. The North-East London Railway Bill was read a second time.

Luxol Electric Signs.—We are informed by the Edison and Swan United Electric Light Co., of 36 and 37, Queen-street, London, E.C., that owing to the large demand for these well-known signs, resulting in decreased costs of manufacture, they are able to announce a reduction in price, not only of the completed signs, but also of the separate panel letters. Fulll particulars of the reductions can be obtained from the head office of the company or from any of their depôts.

Norwich.—The Guardians have discussed an offer of the Town Council to install and maintain electric light at the workhouse, and supply current for the sum of £350 per annum, including the maintenance and renewal of all lamps and other fittings, and giving the same amount of light as now obtained from gas. The Board as a result have decided that the workhouse should be lighted with electricity at the same cost as the use of gas at present involves.

Neston.—The Urban District Council have agreed to the erection of overhead telegraph wires throughout the district. The owners of the Hinderton estate have written the Council of their intention to provide an electric light supply by next Christmas, and have asked the Council if they would enter into an agreement to take electricity for a certain portion of the district. The Council, before definitely replying, have asked for the terms of the proposed agreement.

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Sunderland.—The fact that the Sunderland Corporation electricity undertaking lost £2,300 in connection with Messrs. Laing and Sons has led them to revise their system of collecting accounts. In future the condition of accounts will be reported at each meeting of the committee. It was reported to the committee on Saturday that no customer had been owing two accounts at the same time, and out of 1,300 accounts rendered there were only 30 owing for the quarter just due.

Ahmedabad (India)—Messrs. Crompton and Co have recently received an order from Messrs. Madhowlal, Ramchorelal, and Co., agents for the Ahmedabad Ginning and Manufacturing Co., Ahmedabad, for a 220-kw. continuous-current rope-driven dynamo 440 volts and two 150-b.h.p. motors of the same voltage. This plant is to be used to drive two lines of shafting in the new blowroom, which is situated in such a position that a direct drive from the main shafting is impossible.

Halifax.—The Halifax Tramways Electricity Committee have passed the following resolution: "That the town clerk be instructed to communicate with the Local Government Board protesting against the excision by the Board from sanctions for borrowing powers of wages of permanent workmen paid out of capital account, and that the electrical engineer be instructed to discharge in future permanent workmen when about to deal with work entailing capital expenditure, and then to re-engage such workmen as contractors."

Hanley.—Following closely on the Birmingham gasworks explosion on Sunday, Milton-street, Shelton, Hanley, was on Monday the scene of a similar accident, though happily attended by no loss of life. A main under the street became fractured, and a large volume of gas escaped, with the result that an explosion took place. The floors of two houses in the street were blown up, and plaster was stripped from the walls and ceilings, while one door was blown across the street and many windows were smashed. Several persons received injuries.

Llanelly.—At the last meeting of the Urban District Council the chairman stated that in accordance with a promise made at the previous meeting he had to inform the Press that the Council had decided to sell their electric light order. They were unanimous on the question, as that was their only chance of getting electric light for the town, and possibly traction as well. He was glad to see that the Llanelly and District Electric Light and Traction Co. were making such rapid progress in the laying down of the new tramway track.

Edinburgh.—An electrical engineer named Norman Nicolls met with a shocking death on the 27th ult. at Bruce Peebles' works, East Pilton, Edinburgh. Nicolls was engaged in the testing department of the works, and was examining the machinery when the accident occurred. He apparently touched a "live" part of the machinery, for his companions turned round to find him lying on the floor dead. An examination of the machinery showed 6,000 volts had passed through the body of Nicolls. The deceased was only 20 years of age.

Worksop.—At a meeting of the Lighting Committee of the Urban Council held on the 20th ult., the electrical engineer presented his monthly report. In it he suggested using 35 Nernst lamps to improve the street-lighting, these lamps to be substituted for the present bracket lamps on the arc columns. Correspondence with the manufacturers of the Nernst lamps was read, and estimates of the cost submitted to the committee. It was resolved not to make the alteration at present, but to obtain a further supply of two dozen prepayment meters.

Easington.—The Admiralty have decided to install a wireless telegraph station at Easington, near the Humber mouth. It will be under the control of a picked crew of coastguard signallers, all of whom will have passed through the special wireless telegraphy course. The station will be exclusively a naval one, and its functions will be to keep touch between the North Sea squadron and the authorities. The decision marks another step in the development of coast defence, and the selection of Easington, at the mouth of the Humber, is not without significance.

Birmingham.—A terrible explosion occurred at the Windsor-street gasworks at Birmingham on March 1. Three men were engaged in taking out a portion of a large main in the exhauster house when the explosion occurred. Two of the men were killed outright, and the other lies in a dangerous condition in the hospital. The roof of the exhauster house was blown off, and considerable damage was done to property in the vicinity of the works. As a further result of the explosion the buildings caught fire, and the fire brigade were engaged for two hours before the outbreak was subdued.

Warrenpoint.—A special meeting of Warrenpoint Urban Council was held on Tuesday to take into consideration the offer of the gas company to sell the works to the town. The meeting was held in private, but it is stated that there was considerable difference of opinion as to the advisability of purchasing the undertaking at the price asked, or, indeed, at any price. The question of electric lighting for Warrenpoint and district was under discussion, but it was eventually agreed not to come to any definite decision until the opinion of an expert had been obtained on the condition of the works.

Hornsey.—On the 28th ult. Mr. H. A. Reed M.I.C.E., an inspector of the Local Government Board, held an inquiry at the Hornsey municipal offices into applications made to the Board by the Hornsey Borough Council for sanction to borrow £10,000 for the extension of the municipal electric lighting undertaking. The local authority was represented by Alderman Wilson, chairman of the Electricity Committee; Mr. F. D. Askey, town clerk; Mr. E. J. Lovegrove, engineer and surveyor; Mr. Barrow Fish, accountant; and Mr. Norman Staniland, chief electrical engineer. The inspector intimated that he would report immediately to the Local Government Board.

Middlesbrough.—At the last meeting of the Corporation Electric Lighting Committee the engineer reported a reduction of the output and revenue during the past month as compared with the corresponding month of last year. This he accounted for partly by the rise in the price of coal, but chiefly through the shipyard strike and the stoppage of work. The output had only been 123 000 units as compared with 150,000 units, and the revenue had been £1,646 against £1,688. The estimated profit, exclusive of profit and redemption, had been £836, against £1.006. With regard to the output for the year, he thought they would just turn out more than in the previous year.

Dundalk Electric Lighting Scheme.—On Wednesday week the Dundalk Urban Council Bill in reference to the above scheme was before the Court of Referees at the House of Commons on the petition of the Property Owners' Association and others to be heard in opposition. The *locus standi* was opposed by the promoters. Mr. H. Lloyd K.C., supported the petition, and Mr. S. M'Carrey opposed on behalf of the Urban Council. After hearing Mr. R. Dickie, solicitor, Dundalk, who described the circumstances under which the Property Owners' Association resolved to oppose the Bill, the Court, without calling upon Mr. M'Carrey, decided that there was no legal proof of the existence of the association, and refused to grant the *locus standi* of the petitioners.

Aston.—The Electricity Committee have had under consideration the question of the scale of charges for current for lighting purposes, both in Aston and Erdington, and as the result they have approved an amended scale as follows: For consumption not exceeding 150 units, 3½d. per unit per quarter; 150 to 600 units, 3½d. per unit per quarter; 600 to 1,000 units, 3d. per unit per quarter; 1,000 to 1,500 units, 2½d. per unit per quarter, and over 1,500 units 2½d. per unit per quarter. The new scale of charges will come into operation as and from April 1. The number of units sold for the month of January is as follows: lighting, 91,243; power, 73,946; traction, 109,190—making a total of 274,379, being an increase over 1907 of 67,327 units.

Stock Exchange.—The Stock Exchange Committee has been asked to allow the Mexico Tramways Co.'s 200,000dol. additional general consolidated first mortgage 5 per cent. gold bonds of 500dol. each, Nos. B 13,201 to B 13,600, to be quoted in the official list. The Stock Exchange Committee has appointed special settling days as under: March 6, Sambas Rubber and Gutta Percha Co.'s 38,000 shares of £1 each, 15s. paid, Nos. 1 to 38,000; March 18, Beaufort Borneo Rubber Co.'s 60 000 shares of £1 each, 12s. 6d. paid, Nos. 1 to 60,000. The committee has also ordered Western Union Telegraph Co.'s 10,000,000dol. convertible 4 per cent. redeemable gold bonds, series A, for 1,000dol. each, Nos. 1 to 10,000 (1936) to be quoted in the official list.

Dunfermline.—Prof. Sir Alexander Kennedy, who was recently asked by the Council to obtain estimates as to whether the community would be better served by the Council erecting an electricity generating station for their own use, or whether it would be expedient to obtain a supply of current in bulk from the Fife Electric Power Co., has replied, stating, in view of the fact that he had already given his opinion, which the Council could not see their way to adopt, he did not intend to be at their service further. He accompanies his note with an account for 100 guineas for the report which he submitted. It may be remembered that at a recent meeting the Council discarded the professor's advice to sell their provisional order to the company. What the next development will be is a matter of uncertainty, but in all probability some other electrician of repute will be asked to furnish the estimates which Sir Alexander refused to give.

Wrexham.—At the last meeting of the Council Electricity Supply Committee the electrical engineer submitted the following statements: Connections and supply—used for tramways, 13,450 units; used for lighting, 52,336 units; new consumers connected, 3; total number of consumers, 274. The engineer submitted further correspondence with the Great Western Railway Co. in reference to the proposed terms for a supply of electricity to their Wrexham Station, and it was resolved that, in the event of the company agreeing to take a supply of electricity for the lighting of the station, the proposed terms be revised as follows—viz: for each unit up to 15,000 units per annum, 2½d.; for each unit over and above 15,000 units per annum, 2¼d., with a minimum annual charge of £90. The committee have decided to set aside a sum of £50 for advertising purposes during the ensuing financial year, on the suggestion of the electrical engineer.

Electric Installation on Upper Swat River.—An order has been placed by the India Office with Messrs. Crompton and Co. for an hydro-electric installation on the Upper Swat River. This installation is required in the first place to provide power for cutting through the Khar Tunnel and the Malakand Tunnel. The plant is to consist of two vertical shaft turbines of 120 h.p., each running at 375 r.p.m., and one similar turbine of 80 h.p. running at 428 r.p.m. The contract for turbines has been sublet to Messrs. James Gordon and Co., and they are to be suitable for an effective fall of 25ft. The electrical portion of the contract consists of two three-phase generators, having an output of 80 kw. at 50 cycles 2,200 volts, and one similar generator having an output of 53 kw. All generators will be of the vertical shaft pattern, direct connected to the water-turbine, having revolving fields, stationary armatures, and direct-connected exciters. A switchboard will also be supplied to control the three generators as well as a small 5-kw. station transformer.

Gunton.—A novel and very successful experiment has been carried out on Hubbard's Farm at Gunton, which is in the occupation (with other farms) of Mr. H. Rackham, C.C., of the Woodlands, Corton. Mr. Rackham is an enthusiastic machinery user, and he applies steam to all the processes of farm work where power is required. It was put to him that it would be more advantageous, so far as his Gunton farm was concerned, to lay down an electric motor or motors for threshing, grinding, milling, and the rest, especially as the cable passed the place. Thus it came about that on Wednesday week Mr. G. A. Bruce, the borough electrical engineer, with a view of demonstrating the

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superiority of electric power, ran a length of cable off the Yarmouth road main to Mr. Rackham's stackyard. Here a 30-h.p. Peebles motor was installed, which was coupled up to the threshing machine by belting and set to work. The motor went splendidly; there was not a hitch from start to finish, and the whole stack was threshed at the rate of 25 coombs per hour, as against the 20 coombs per hour at the most by steam-engine.

Morley.—At the last meeting of the Town Council considerable discussion took place on the minutes of the Electric Lighting Committee. The committee had considered plans and specifications submitted by the borough electrical engineer of plant for providing power for the proposed tramways, and it was recommended that the plans be approved, and that application be made to the Local Government Board for sanction to borrow the sum of £7,942 to carry out the work. It was further recommended that Mr. J. E. Ellis, the borough electrical engineer, carry out the scheme, and that he be paid 2½ per cent. commission on the expenditure not exceeding the above amount, and that his commission include superintendence, on behalf of the Corporation, of the construction of the tramways; that the salary of Mr. Ellis be advanced as from the date of the commencement of the tramways to £250; and that he be given an annual increment of £25 per year for the four subsequent years, making a salary at the end of the five years of £350. It was also recommended that application be made to the Local Government Board for sanction to borrow the sum of £5,000 for new electric cables. After discussion, the whole question was referred to the Council for further consideration in committee.

Eastbourne.—An inspector of the Local Government Board (Mr. H. Shelford Bidwell) held an inquiry at the town hall on the 28th ult. into an application by the Town Council for sanction to borrow £7,000 for purposes of the electricity undertaking. The borough accountant informed the inspector that the total capital expenditure on the electricity undertaking amounted to £181,951. 17s. 8d. He compared the charges for light now with those in 1900, when the Corporation took over the undertaking, and these showed reductions. The amount the Corporation had set aside from time to time to the sinking fund for the repayment of loans stood last March at £32,628. 19s. 4d., and there was a reserve depreciation fund of £8,809. 5s. 3d. The revenue accounts showed a working balance of £5,864. 12s., these three totals amounting to £47,302. 16s. 7d. The town clerk considered that these figures showed the undertaking to be very sound. Instead of it being a burden to the rates, a 1d. rate had been transferred to the relief of the rates out of the profits. The Corporation kept reducing the prices as the profits permitted. The present charge for electricity compared very favourably with the charge for gas, and there were constant demands for new services. It was stated that the number of consumers had increased from 600 to 1,400 since January, 1900. The inquiry then closed.

TRACTION.

Falkirk.—The Falkirk and District Tramway Co. intend equipping with covered tops a number of the cars running on the Falkirk electric tramway system.

Carrizal and Cerro Blanco Railway Co.—The company announce a dividend of 3 per cent. for the half-year ended Dec. 31, carrying forward 4,506dol.

Rochdale.—Last week's receipts on the Corporation tramways were £14 more than in the preceding week and £55 more than in the corresponding week of last year.

Madras Electric Tramways (1904).—The receipts for the fortnight ending Feb. 29, 1908, totalled Rs.16,303, being an increase of 9·8 over the corresponding period of 1907.

Brisbane Electric Tramways Investment Co.—Traffic receipts of the Brisbane tramways for the month ended Feb. 29, 1908, amounted to £13,390; corresponding month last year, £11,000 — increase, £2,390.

Barnes.—The Urban District Council have decided to oppose the West London, Barnes, and Richmond Tramways Bill, and have instructed their clerk to take the necessary steps in conjunction with the parliamentary agency.

Newport.—The total receipts of the Newport Corporation tramways for the week ending Feb. 29, 1908, were £566. 18s. 8½d., as against £564. 10s. for the corresponding week of last year. The number of passengers carried was 135,833.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending Feb. 25, 1908, were £3,645; corresponding period last year, £3,622—increase, £23. Aggregates from Jan. 1, 1908, £29,225; aggregates from Jan. 1, 1907, £29,268—decrease, £43.

Bradford.—The Tramways Committee of the Corporation have decided to receive a deputation from the drivers with respect to an alleged grievance under the speed regulations. Plans and estimates have been submitted of the proposed new offices and for contemplated alterations to the depôt at Bankfoot.

Halifax.—The Tramways Committee of the Corporation are recommending the adoption of the bell-punch system in place of the present method of collecting fares by boxes. They are also recommending the provision of overlapping stages, the relaying of considerable portions of the track, and the extensive purchase of new equipment.

Newcastle.—The traffic returns of the Corporation tramways for the week ending Feb. 29 show that passengers were carried to the number of 812,155, that the revenue reached £3 643, and the car average was 10·54, against the corresponding week last year, when there were 817,844 passengers and £3,851 in revenue, and a car average of 11·17. Receipts, it will be noticed, are £208 down.

Penarth.—At a meeting of the Penarth District Council a letter was received from the solicitors of the Penarth Tramway Syndicate (Messrs Vachell and Co., Cardiff) asking the Council's consent to the construction of a tramway to Penarth from Cardiff. The Council have asked the syndicate to accede to certain conditions which they stipulate, and upon a reply being received the matter will be further considered.

Croydon.—The Tramway Committee have had under consideration the memorial recently presented to the Council with reference to the proposed extension of the tramways through Morland-road, Woodside, and Portland-road, and have also considered a suggested alternative route. The committee have also received a report from the tramways manager with regard to the proposals, but have decided not to make any recommendation upon the subject until after the accounts for the present financial year have been made up for presentation to the Council.

Elland and Huddersfield Tramway.—There is a probability that the projected tramway connecting Elland, Rastrick, and Huddersfield by a system of electric cars is likely to be an accomplished fact in the near future. It is said that a number of local capitalists are interesting themselves in the scheme, and that in all probability in the immediate future an appeal will be made for local capital to be invested in the undertaking, which up to the present has been in the hands of London and other capitalists. Parliamentary sanction for the scheme has been obtained.

Camberwell.—The Borough Council have resolved to inform the London County Council that they adhered to their resolution of Jan. 30, in which they stated they were not prepared to consent to the overhead system of electric traction for the proposed line of tramway from the library in Lordship-lane, Dulwich, to Forest Hill, *via* London-road. The Council have also agreed to send a letter to the County Council requesting them to put in hand the widening of Lordship-lane from the public library to the fire station, and as far as possible give the work to the unemployed of Camberwell borough.

Lancaster.—At the meeting of the Tramways Committee of the Town Council the borough surveyor submitted a report on his inspection of the track, with sectional estimates for carrying out necessary repairs, amounting altogether to the sum of £1,130. The tramways engineer also reported that he estimated the cost of carrying out such repairs as may be necessary to the rails at the sum of £120. It was resolved that, subject to the approval of the Finance Committee, the whole of the repairs should be carried out in three sections, so that not more than one-third of the cost would be incurred each year, the amount to be paid out of revenue.

Bray and Enniskerry Tramways.—The project for the connecting of Bray and Enniskerry by an electric tramway, which has just been set in motion again, is an old project revived. Years ago the proposed route was surveyed for a light railway, but the venture did not come off. Now the affair has been advanced a step by a Greenwich firm seeking for an Order in Council to construct an electric tram track between the places mentioned, and also for the lighting of Enniskerry. The proposed line will start at Bray Station, and proceed *via* the Dargle-road to Enniskerry, which is an alternative to the original proposal of running the line along the bank of the Dargle River. The engineering portion of the work does not present many difficulties.

Erdington.—At the monthly meeting of the District Council the Tramways Committee, in their report, presented a statement—the first publicly made—of the working of the tramways from the date of their inauguration on April 22, 1907, to Jan. 31, 1908, a period of nine months and nine days. The number of passengers carried totalled 2,090,481, an average daily number of 7,335. Of the tickets sold 1,909,705 were single tickets and 180,776 returns, or workmen's tickets. Of the single tickets 1,394,393 were penny fares and 515,212 three-halfpenny ones, and of the workmen's tickets 128,454 were penny fares and 54,322 three-halfpenny ones. The receipts amounted to £9,970. 2s. 2d., an average daily amount of £35. The car mileage worked amounted to 224,092, and the receipts per car mile to 10·67d. As against the receipts, amounting to £9,970. 2s. 2d., the expenditure comprised the following items: To amount retained by the city Corporation to cover costs of traffic expenses, at 5d. per car mile, £4,658. 11s. 8l.; hire of regular cars, £419. 6s. 9d; hire of special cars, £50. 16s. 3d.; cost of current obtained from the Aston Manor Corporation, £1,669. 4s. 2d.; bank charges and principal and interest on loan, £1,701. 16s. 6d.; miscellaneous items, £51. 17s. 11d.; total, £8,561. 13s. 3d., which left a balance of £1,408. 8s. 11d. The statement did not include any provision for a reserve fund, which would be made at the end of the financial year. The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Dublin.—Tenders are invited for the supply of arc lamp carbons. Tenders by March 11.

Belfast.—The Tramways Committee invite tenders for electrical supplies. Tenders by March 16.

Burnley.—The Guardians invite tenders for electrical supplies for the ensuing year. Tenders by March 16.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for lead-covered cable. Tenders by April 20.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Rome.—Tenders are invited by the Italian Government Railways for the supply of corded copper cable. Tenders by March 9.

Bukharest.—The Municipality of Craiova invite tenders for the construction of tramways. Deposit, £200. Tenders by March 13.

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Cassel.—The Prussian State Railways invite tenders for a three-ton travelling crane, together with electric motor. Tenders by March 27

Hackney.—The Borough Council invite tenders for the annual supply of arc lamp carbons. Tenders to the Town Clerk by March 12.

Leith.—The Town Council invite tenders for the supply of summer uniforms to the tramway employée. Tenders to the Town Clerk by March 10.

West Ham.—The Corporation invite tenders for the supply of one 3,000-kw. two-phase turbo-generator. Tenders to the Town Clerk by March 12.

Hornsey.—The Town Council invite tenders for meters and fuse boxes, cables, troughing, etc. Tenders to the Town Clerk by March 16.

Adelaide.—The Postmaster-General invites tenders for one common-battery switchboard, subscribers' telephones, and protectors. Tenders by March 11.

Oporto.—The Municipality invite tenders for the construction, maintenance, and working of tramways in Nova de Gaya. Tenders by March 11.

Madrid.—The Post and Telegraph Department invite tenders for laying, etc., telegraph cable between Chefarinas and Argelia. Tenders by March 30.

Charleroi (Brussels).—Tenders are invited for the electric lighting of Charleroi. Particulars can be obtained at 58, Rue de Louvain. Tenders by March 9.

Wakefield.—The Corporation invite tenders for the supply of surface-condensing plant. Particulars from the City Electrical Engineer. Tenders by March 14.

Hackney.—The Borough Council invite tenders for the supply of coal to the electricity works. Particulars from the Town Clerk, to whom tenders must be sent by March 12.

St. Pancras.—The Borough Council invite tenders for the supply of arc lamp carbons for 12 months. Tenders to the Town Clerk by March 23. See advertisement in last issue.

Spain.—Tenders are invited by the Corunna Harbour Board for three 3-ton electric cranes. Estimate, £4,618. Tenders to the Junta de Obras del Puerto de la Corunna by March 13.

Manchester.—Tenders are invited by the Electricity Committee for the supply and erection of one 6,000-kw. turbo-alternator, with exciter and condensing plant. Tenders by March 25.

Gloucester.—The Electricity Supply Committee invite tenders for the supply of rough slack steam coal. Particulars from the City Electrical Engineer. Tenders to the Town Clerk by March 19.

Dewsbury.—The Electricity Committee invite tenders for the supply of a surface condenser and the erection of a cooling tower. Tenders to the Chairman of the Electricity Committee by March 30.

Madrid.—The Post and Telegraph Department invite tenders for the supply of cylinders for accumulators. Particulars from Direccion-General de Correos y Telegrafos, 10, Carretas. Tenders by March 21.

Bury.—The Corporation invite tenders for the supply and erection of two 2,000-kw turbo-alternators, with exciters and condensers Tenders to the Town Clerk by March 16. See advertisement in last issue.

Leicester.—Tenders are invited by the Tramways Committee for the supply of clothing for the employés. Tenders to the Chairman, Tramways Committee, 20 and 22, Humberstone-gate, Leicester, by March 14.

East Ham.—The Town Council invite tenders for the annual supply of stores for the electric lighting and tramways department. Particulars from Mr. C. E. Wilson, town clerk. Tenders by March 17.

Stoke-on-Trent.—The Electricity Committee invite tenders for one 300-kw. steam generator and surface-condensing plant and a water-tube boiler. Tenders to the Chairman by March 14. See advertisement in last issue.

Preston (Lancs.).—Tenders are invited for supply of electrical goods and supplies to the Lancashire County Asylum at Lancaster and Whittingham Asylum, Preston, for the year ending April 5, 1909. Tenders by March 19.

Middleton (Lancs.).—The Corporation invite tenders for the supply of coal for the electricity works. Particulars from the Borough Electrical Engineer. Tenders to the Chairman of the Electricity Committee by March 9.

Croydon.—The Electricity Department invite tenders for the supply of the following during year ending March 31, 1909: (*a*) coal; (*b*) meters; (*c*) house fuse and joint boxes. Tenders to Mr. F. C. Lloyd, town clerk, by March 16.

Manchester.—Tenders are invited for the supply and erection of cooling towers at the generating station. Particulars from the Chief Electrical Engineer. Tenders to the Chairman of the Electricity Committee by March 10.

Rawtenstall.—The Corporation invite tenders for the supply and laying of steel rails, points, crossings, and accessories for the permanent way of the tramways. Tenders to the Town Clerk by March 27. See advertisement.

Beckenham.—The Urban District Council invite tenders for battery of accumulators, one reversible booster, milking booster, and switch-gear, and automatic stokers with driving gear and accessories. Tenders to the Clerk by March 9.

Burnley.—The Tramways Committee invite tenders for the supply of sundry stores and raw material used in maintenance for year ending March 31, 1909. Tenders to the General Manager, Tramways Department, Queensgate, Burnley, by March 10.

Fulham.—The Borough Council invite tenders for the annual supply of stores, including general and electrical stores. Tenders to the Town Clerk by March 11.

Hastings.—The Corporation invite alternative tenders for supply of best Welsh smokeless coal for the electricity works (*a*) during six months from April 1, 1908, and (*b*) during 12 months from same date. Tenders to the Town Clerk by March 17.

Rawtenstall.—Tenders are invited by the Corporation for the supply and erection of one economiser (192 tubes), and the supply of direct and alternating current electricity meters. Tenders to the Town Clerk by March 23. See advertisement.

Stoke-on-Trent.—The Electricity Committee invite tenders for the supply of meters, house service cut-outs, and street-box fittings required during 12 months ending March 31, 1909. Tenders to the Chairman of the Electricity Committee by March 7.

London, S.W.—The London County Council invite tenders for the manufacture and supply of steel and cast-iron steam, exhaust, water, etc., piping, cast-iron water-tank, etc., to be erected at the Council's electricity generating station. Tenders by March 24.

Heywood.—Tenders are invited for plant required in connection with the electricity works extensions. Specifications, etc., from Mr. J. R. Salter, the consulting engineer, Atherton, Lancashire. Tenders to the Chairman of the Electricity Committee by March 16.

Aston Manor.—The Corporation invite tenders for the supply of one 300-kw. and two 400 kw. motor-generators, together with the necessary starting and field controlling gear. Tenders to the Chairman of the Electricity Committee by March 14. See advertisement.

Ilford.—The Urban District Council invite tenders for the supply of stores to the electricity and tramway departments required during the year ending March 31, 1909. Particulars from Mr. A. H. Shaw, M.I.E.E., Electricity Works, Ley-street, Ilford, Essex. Tenders by March 10.

Kettering.—The Urban District Council invite tenders for the annual supply of coal for the electricity works. Particulars from Mr. W. A. Walker, electrical engineer, Electricity Works, Kettering. Tenders to Mr. John Bond, clerk, Council Offices, Kettering, by March 11.

Edinburgh.—The Corporation invite tenders for the annual supplies commencing May 15, including electrical material for interior wiring, upholding house telephone and electric bell installations. Tenders to Mr. Thomas Hunter, town clerk, City Chambers, Edinburgh, by March 11.

Bristol.—The Docks Committee invite tenders for electric lighting of the second tobacco warehouse, Cumberland Basin, Bristol, and the maintenance of the work for 12 months after completion. Tenders to the Secretary of the Docks Committee, 19, Queen-square, Bristol, on March 20.

London.—The London County Council invites tenders for installations of electric lighting and fans at the Dawes-road Secondary School, Fulham, and the Hortensia-road Secondary School, Chelsea. Tenders to the Clerk of the London County Council by March 24. See advertisement.

Wigan.—The Guardians invite tenders for an electric lighting installation at the new workhouse infirmary at Billinge. Particulars from Messrs. Heaton, Ralph, and Heaton, architects, Victoria-buildings, King's-street, Wigan. Tenders to Mr. Henry Ackerley, clerk, 9, Victoria-buildings, King-street, Wigan, by March 25.

London, S.W.—The London County Council invite tenders for the manufacture, supply, and delivery of the points and crossings for the junctions, cross-overs, etc., required for the reconstruction, on the overhead trolley system of electric traction, of the existing tramways from Brixton-road to near Camberwell Green. Tenders by March 10.

Manchester.—Tenders are invited by the Tramways Committee for the supply of permanent-way points, tongues, and hardened steel centres. Specifications and forms of tender may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders to the Chairman of the Tramways Committee by March 9.

Colchester.—The Tramways Committee invite tenders for the supply of various materials required during year ending March 31, 1909, including castings, brake blocks, etc.; fittings for Dick-Kerr electric car, including bearings, controllers, trolley standards, trolley heads, etc.; overhead materials; rubber and fibre material. Tenders to the General Manager by March 11.

Melbourne (Australia).—The Postmaster-General invites tenders for the construction and laying complete of two submarine telegraph cables between the State of Victoria and the State of Tasmania. Tenders must be accompanied by a deposit of £1,000. Tenders to the Secretary, Postmaster-General's Department, 51, Spring-street, Melbourne, by April 14. See advertisement.

South Shields.—The Corporation invite tenders for the supply of engine-room stores (except lubricating oils), hardware, tools, carbons, lamps, etc., for their electricity works at West Holborn, for year ending March 31, 1909. Particulars from Mr. J. H. Cawthra, M.I.E.E., borough electrical engineer, West Holborn, South Shields. Tenders to the Town Clerk, Court Buildings, South Shields, by March 11.

Colchester.—The Electricity Supply Committee invite tenders for the supply of the following materials as may be required during year ending March 31, 1909—viz.: (1) ironmongery and tools; (2) oils; (3) oilman's sundries; (4) castings. Patterns and samples may be seen at the Electricity Works, Osborne-street. Tenders to the Chairman of the Electricity Supply Committee, 36, Osborne-street Colchester, by March 16.

London.—The London County Council invite tenders for the road-work and platelaying required for the reconstruction for electric

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traction, on the overhead trolley system, of the existing tramways from Brixton-road to a point near Camberwell Green, *via* Gresham-road and Coldharbour-lane, and for certain paving works of the street improvements in connection therewith. The total length of the above-mentioned lines is about 2½ miles single track. Tenders by March 24.

Bootle.—The Corporation invite tenders for the supply of the following stores and materials and the execution of repairs for one year, commencing on April 1: (1) V.B. wires and cables; (2) electric meters; (3) arc lamp carbons; (4) fuse boxes and terminals; (5) arc lamp globes; (6) oils; (7) compound and bitumen; (8) tiles; (9) street-lighting lanterns; (10) cast-iron lamp-posts and service boxes; (11) incandescent gas mantles. Particulars from the Borough Electrical Engineer. Tenders to the Town Clerk by March 14.

Erith.—Tenders are invited by the Urban District Council for the supply of stores under sections as follows for year ending March 31, 1909: (*a*) rags; (*b*) oils; (*c*) packings; (*d*) gauge glasses; (*e*) carbons; (*f*) meters; (*g*) lamps; (*h*) cables, joint-boxes, bitumen, insulating tapes, and compounds; (*i*) cut-outs. Specifications and forms of tender may be obtained at the Electricity Offices on payment of deposit by cheque of £1. 1s., such deposit to be returned upon receipt of a bona fide tender. Tenders by March 18.

RESULTS OF TENDERS.

Hull.—The Corporation Electric Lighting Committee have accepted the tender of the Lahmeyer Co., at £4,591, for three high-tension dynamos.

Frodingham.—The Frodingham Iron and Steel Co. have placed a repeat order with the Lancashire Dynamo and Motor Co. for the supply of a 500-kw. generator for direct coupling to a gas-engine.

Yarmouth.—The Board of Guardians have accepted the tender of Bowers and Barr, of Regent-street, for the maintenance of the telephones, fire alarms, and electric bells at the workhouse for three years at £21. 12s. 6d. per annum.

Wigan.—The Electric Light Committee have accepted the following tenders for the supply of stores: Universal Mill Furnishing Co., General Electric Co., and British Westinghouse Co., lamps; Thompson and Co., Park and Co., and Tickle Bros., iron and steel; G. Makinson, Kenyon, and Co. and I. Sandbach, engine-room stores; Roger Bolton and Son, Armorduct Manufacturing Co., T. J. S. Clephan, General Electric Co., and Electric Co., electrical accessories; W. T. Glover and Co., cables.

Dundee.—The Electricity Committee recommend the acceptance of offers for providing switchgear and transforming plant for the new electric station at Stannergate and at the sub-stations: British Thomson-Houston Co., Rugby, and British Westinghouse Electric and Manufacturing Co., Manchester. Offers for carbons were accepted as follows: Crompton and Co., Chelmsford, 12,000 pairs; Union Electric Co., London, 1,000; Oliver Arc Lamp Co., Woolwich, 12,000. The contract for oil was placed with A. Pringle and Co., Dundee.

Battersea.—The Electricity Committee have accepted the following tenders for the annual supply of stores to the electricity department: Carbons, Sloan Electrical Co., £292. 10s. 8d.; incandescent lamps, Edison and Swan and General Electric Co.; meters (ampere-hour), Ferranti Limited and (watt-hour), British Thomson-Houston Co.; bitumen, £7 per ton, Callender's Cable Co.; engine-room stores, W. H. Willcox and Co.; asbestos, K. Beldam; oils, Price's Candle Co.; ironmongery and tools, Pryke and Palmer; Welsh and bituminous coal, Foster and Co.

Croydon.—The County Council have accepted the tender of Babcock and Wilcox for a coal and ash conveyor for the electricity works for the sum of £1,154; that of the Weber Concrete Construction Co., of Queen Anne's-chambers, Westminster, for coal and ash bunkers, and the tender of the Electricity Department, at £205 7s., for builder's work in connection with same. The Council have also accepted the tender of Parsons, Fletcher, and Co., of Gravel-lane, Southwark, S.E., for the supply of cylinder and crank-chamber oils to the electricity works for the ensuing year; and the tender of the St. Pancras Ironworks Co., of Pancras-road, London, at £144, for switchboard flooring.

Hull.—The Education Committee have received the following tenders for the necessary electric light installation, fittings, and fans required at the Selby-street West School, now in course of erection:

W. L. Harrison, George-street (accepted)	£688	10	0
Haden and Son, Manchester	842	10	9
King and Co.	793	6	2
Mann, Egerton, and Co., Ipswich	865	18	6
J. H. Taylor and Co., Heckmondwike	799	0	0
W. Taylor and Co.	849	0	0
Wallis and Watson, Leeds	890	0	0
A. C. Dickens, Northampton	754	8	0
C. Pullan, Bradford	870	0	0
J. Scott, Beotle	1,000	0	0
A. Shaw	808	10	0
C. Wokes	897	0	0

OPENINGS FOR CONTRACTORS.

ABBEYLEIX—Housing scheme (£59,848), Rural District Council.

ABERDEEN — Electric lighting, slaughter-house, Hutcheon-street, Aberdeen Flesher Incorporation.

ABERYSTWYTH—Welsh national library, County Council.

ACCRINGTON—Extensions, Victoria Hospital, Trustees.

AMBLE—Dwelling-house, East Garth Field, Mr. Brown; dwelling-house, George-street, Mr. Burton.

AMBLESIDE—Secondary school (£3,500), Westmorland Education Committee.

ANTRIM—Housing scheme (£20,398), Rural District Council.

ARMAGH—Workmen's dwellings (£12,600), Urban District Council.

ARMONAY—Public abattoir (130,000fr.), Municipality.

ASHBY—Public offices, Bath-street, Guardians.

ASHFORD—Elementary school, Woodthorpe-road, Middlesex Education Committee.

ASHTON—Church, Ashton United Free Congregation.

AVELEY—Infants' elementary school (£1,748), Essex Education Committee.

AYR—Extension, Newtonhead School, Education Committee.

BAILDON—Electric lighting of district, Bradford Electrical Engineering Co.

BALLYCLARE—Manse, etc., Committee of Second Ballyeaston Presbyterian Church.

BALLYHONNON—Housing scheme (£11,810), Rural District Council.

BALLYWATER—Semi-detached pair of cottages. Mr. E. L. Woods, architect.

BARNARD CASTLE—Additions, The Starlings, Mr. R. T. Richardson; additions Teesdale Laundry, Thorntongate, Mr. G. S. Barrow.

BARNOLDSWICK—Six houses, Essie-street, Mr. W. J. Macdonald.

BARNSTAPLE—Residence in the Strand, Messrs. Ridge and Son; two houses, Portland-street, Messrs. Thorne, Squire, and Son.

BATLEY—Warehouse, Old Mill, Alderman J. W. Blackman.

BECKENHAM—Battery-house, electricity generating station, Churchfields, Urban District Council.

BEDFORD—Six houses, Short-street, Mr. Jeakings; house, The Embankment, Mr. E. Casbeard; three houses, Waldeck-avenue, Mr. K. Black; two houses, Bromham-road, Mr. S. Foster; three houses, Elstow-road, Messrs. Jacobs and Burton.

BELFAST—Manse at Upper Falls in connection with the Broadway Presbyterian Church; villa, Malone-avenue. Mr. T. Houston, architect.

BELLEEK—Housing scheme (£3,405), Rural District Council.

BERMONDSEY, S.E.—Parochial hall, Alfred-street, Messrs. E. Crosse and Co.

BERMONDSEY, S.E.—Temporary schools, Cow-lane, Fauston-place, and Rotherhithe-street, London County Council.

BIRKENHEAD—Twenty-three houses (£7,859), Town Council.

BIRMINGHAM—Extensions, Birmingham and Midland Eye Hospital, Governors.

BIRTLE EDGE—Children's homes, Bury Board of Guardians.

BLACKPOOL—Four houses, Cunliffe-road, Mr. J. Cunliffe; seven houses, Preston-road, Mr. J. Jackson.

BLACKPOOL—Two houses, Hornby-road, Mr. J. W. Riley; semi-detached villas, Peddar's-lane, Mr. Thomas Hill; two houses, Kent-road, Messrs. J. Parkinson and Sons; two houses, Hornby-road and Whitegate-drive, Mr. J. W. Lees; seven houses, Poplar-street, Mr. Thomas Blacoe; house and outbuildings, Lytham-road, Mr. W. Banks; four houses, Balla-grove, Mr. George Speight; two houses, Rosebury-avenue, Mr. J. G. Hall; house, Bryan-road, Mr. G. F. Clarke; bungalow, Mere-road, Mrs. Ratcliffe; four houses, Cunliffe-road, Mr. J. Cunliffe; seven houses off Preston-road, Mr. Jos. Jackson; alterations and additions to schools, Dickson-road, Wesleyan Church Trustees; alterations and additions, Church-street, Trustees of St. John's School; alterations and additions, Hornby-road, Exors. of the late Mr. Henry Fisher; alterations and additions, Springfield-road, Mr. Robert Ward; coach-house, Gorton-street, Mr. Arthur Wilson.

BLACKROCK—Housing scheme (£4,300), Urban District Council.

BLAENAVON—Residence, Blaenavon Co.

BLAENRHONDDA—Workmen's library and institute, Tydraw Colliery Workmen's Committee.

BOTWELL—Six houses, New-road, Hayes Development Co.

BRAMPTON—Extensions, Cortonwood School, West Riding Education Committee.

BRIGHTON—Students' college, Education Committee.

BRISTOL—Scheme for improving Y.M.C.A. buildings (£1,000).

BRISTOL—Electric lighting tobacco warehouse, Cumberland Basin, Bristol Docks Committee.

BROADSTAIRS—Church hall, Reading-street, St. Peter's Building Committee.

BROADWATER—Elementary school, Education Committee.

BRYMBO—Elementary school, Denbighshire Education Committee.

BRYNMAWR—Schoolroom, Trustees Calvary Baptist Church.

BURNHAM—Technical schools, Somerset County Council.

BURNLEY—Twenty-eight houses off Kirkstall-road. Mr. J. A Webster, architect.

BURTON LATIMER—Elementary school, Northamptonshire Education Committee.

BUXTON—Motor-house, Maison Rouge, The Park, Mr. Smallman; additions, house, Duke-street, Mr. Mortons; house, Temple-road, Mr. McDougall.

CAERAU—Additions to the Caerau and Spelters Co-operative Society.

CAMBORNE — Sunday schools (£2,000), Tuckingmill Wesleyan Methodists.

CAPE TOWN—Abandonment of the existing power station and construction of new one (£35,000), Town Council.

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CARDIFF—Vicar's residence. Mr. G. E. Halliday, architect.
CARNARVON—Higher-grade school, Governors.
CHARLEVILLE—Housing scheme (£24,415), Rural District Council.
CHATHAM—Public conveniences, etc., The Paddock, Military-road, Town Council.
CHELMORTON—Four houses. Messrs. Bryden and Walton, architects.
CHELMSFORD—Public convenience, Town Council.
CHELMSFORD—Additions and extension (£5,000), Essex Infirmary Committee.
CHINGFORD—Elementary school, New-road, Essex Education Committee.
CHWILOG—Elementary school, Carnarvonshire Education Committee.
CLAPHAM, S.W.—Houses, Lytham-road, Messrs. Dartnell and Banks.
CLECKHEATON—Secondary school, District Council.
COCKERMOUTH—Rebuilding St. Helens, Mr. H. J. Watson.
CRAMLINGTON—Elementary school, Northampton Education Committee.
CROYDON—Public conveniences, Thornton Heath, Town Council.
DAGNALL—Elementary school, Bucks Education Committee.
DANBURY—Residence, Southend Estate Co.; three houses, Mr. W. Baker; house at Galleywood, Mr. H. Rimmer.
DARWEN—Elementary school, Alfred-street, Education Committee.
DELVIN—Housing scheme (£58,480), Rural District Council.
DENTON—Elementary school, Kent Education Committee.
DEPTFORD, S.E.—Additions, New Cross Empire, Messrs. F. Matchem and Co.
DUBLIN—Residence, Drumclay, G.N. Railway Co.
DULWICH, S.E.—House, Woodwarde-road, Mr. W. J. Almond.
DUNDEE—Library, Dudhope, Free Libraries Committee.
DUNSTABLE—Three houses, Burr-street, Mr. A. W. Nash; house and shop, Peter-street, Mr. Holton; two houses, Union-street, Mr. Gange; additions, workshop, Burr-street, Mr. Dolman.
EAST GRINSTEAD—Board-room, lavatories, etc., Guardians.
EAST HAM—House, Romford-road, Mr. Farquhar; 12 houses, Kempton-road, Mr. C. Saxton; 47 houses, Randolph-road, Mr. Watson.
EAST HAM—Alterations, Sandringham-road Infants' School, Education Committee.
EASTLEIGH—Underground public convenience (£450), Urban District Council.
EAST LOOE—Public conveniences, Church End, Urban District Council.
EBBW VALE—Church and parish hall, Churchwardens.
ELGIN—Alterations to premises, High-street. Mr. J. Wittet, architect.
ELLON—Improvement, burgh schools (£975), Education Committee.
ENNISTYMON—Housing scheme (£26,478), Rural District Council.
FAILSWORTH—Public elementary school, Mather-street, to accommodate 700 scholars, Lancs. Education Committee.
FAIRHAVEN—Permanent church (£15,000), Wesleyans.
FARNWORTH—Rebuilding Bridgwater Inn, Messrs. Buckley.
FENCEHOUSES—House and shop, Morton-crescent, Mr. T. Langton; 28 houses, Fencehouses Station, Messrs. Sparrow and Lamb.
FENTON—Elementary school, town yard, fire station (£1,770), Urban District Council.
FLINT—Order for construction of light railway, Dyserth to Newmarket, confirmed.
GLENAGERY—Parochial hall for the Vestry of St. Paul's Church.
GLOUCESTER—Restoration works, Church of St. Mary de Crypt (£5,000).
GREAT HARWOOD—Council school, Education Committee.
GREAT TORRINGTON—Business premises, dwelling-house, and stable, Mr. J. Lile, South-street.
GREAT YARMOUTH—Office buildings, Regent-street. Mr. R. Scott Cockrill, architect.
GREENCROFT—Infants' school, Durham County Council.
GRIMSBY—Extension, Welhome Council School, Education Committee.
GRIMSBY—Church parlour, classrooms, etc. (£5,000), Trustees of Park-street U.M.F. Church.
HAKIN—Elementary school, Pembrokeshire Education Committee.
HALESOWEN—Elementary school, Worcestershire Education Committee.
HALIFAX—Shops, Rawson-street. Mr. T. Kershaw, architect.
HALSTEAD—Elementary school, Essex Education Committee.
HAMPTON—Additions and extensions, grammar school (£5,000), Middlesex Education Committee.
HAMPSTEAD, N.W. — Extensions, public library (£1,500), Town Council.
HAMPSTEAD, N.W.—Motor-house, Oak Hill Lodge, Hill-park, Mr. P. Morley Horder.
HANLEY—Office premises. Messrs. E. Jones and Jackson, architects.
HARRINGTON—Four houses and shop, Scaw-road, Mr. Harrison.
HARTLEPOOL—Primitive Methodist church and vestries, Central Estate. Mr. J. W. Phillipson, Newcastle-on-Tyne, architect.
HASLINGDEN—Extensions, secondary school, Borough Education Committee; infirmary, Board of Guardians.
HAYES—House and shop, Silverdale-road, Hayes Cycle Works; 10 houses, Blyth-road, Mr. H. Briant; additions, Hambrough Villa, Messrs. Thatcher and Co.; additions, house, Wood End Green, Mr. G. Salter; additions, Normanhurst, Mr. A. Clayton.
HARROGATE—House, kursaal, etc. (£3,965), Town Council.
HAYLE—Elementary school, Board of Education.
HELMSHORE—Council school, Haslingden Town Council.
HIGHAM FERRERS—Additional offices to Higham Ferrers School, Northampton Education Committee.
HIGHBRIDGE—Reconstruction of building for motor garage, Huntspill-road, Mr. W. W. Buncombe.
HINCKLEY—Church (£7,000), Churchwardens of Holy Trinity Church.
HODDESDON—Elementary school, Rye Park, Education Committee.
HODDESDON—Two houses, Whitley-road, Mr. W. Tilbury
HOLLINS—Mill, Executors of Mr. T. Greenwood; minister's house, Slack-lane Baptist Chapel Trustees.
HONLEY—Eight houses, stable, etc., Moor Bottom, Mr W. Brook; shop, Concord-street, Co-operative Society.
HOPKINSTOWN—Extension, infant school, Pontypridd Education Committee.
HORNE—Elementary school (£1,800), Surrey Education Committee.
HOUGHTON-LE-SPRING—House and shop, Hylton-street, Mr. J. H. Wood; house and shop, Grasswell, Mr. J. Dixon.
HOWDEN CLOUGH—Mission church and schools (£2,000).
HULL—Six houses, Kelvin-street, Mr. J. Ward; two houses, Park-grove, Mr. F. Allon; three houses, New-street, Messrs. Lison and Harris; 14 houses, Middleburg-street, Mr. A. Needler; 25 houses, Cranbrooke-street, Mr. H. Vokes; 25 houses, Holderness-avenue, Mr. J. T. Taylor; alterations to Trinity House, Trinity-square, Trustees; printing-room, Stoneferry, Messrs. Reckitt and Sons; showroom, Hull City Garage, Beverley-road; schoolroom, Beverley-road, Christian Science Association; additions, Shaw's Hull Malt Co., Wincolmlee.
HUNSLET MOOR—Elementary school (£14,000), Leeds Education Committee.
KEIGHLEY—Houses, Oakworth-road. Messrs. W. H. and A. S. Sugden, architects.
KENDAL—Rebuilding shop and dwelling-house, Wildman-street. Mr. S. Shaw, architect.
KILLARNEY—Alterations, St. Mary's Cathedral.
KILMACRENAN—Office buildings. Mr. J. M'Intyre, Letterkenny, architect.
KILMADOCK—Meeting hall, Kilmadock Established Church.
KINGUSSIE—Church (£3,000), Rev. Alex. Bain.
KINLOCHLEVEN—Factory (£100,000), British Aluminium Co.
KINLOUGH—Housing scheme (£7,201), Rural District Council.
KIRKBURTON—Elementary school, West Riding Education Committee.
KIRKBY-IN-ASHFIELD—Elementary school, Notts Education Committee.
LANCASTER—Additions to houses, Main-street, Mr. M. Aldren; four houses, Newsham-place, Mr. F. Hodkinson; four houses, Ulster-road, Mr. W. S. Higginson; eight houses, Coulston-road, Mr. S. Jackson.
LEADGATE—Alterations and additions to R.C. schools, Brooms, Rev. A. Magill, Durham.
LEATHERHEAD—Public mortuary, Urban District Council.
LEEDS—Extensions to restaurant, Kirkgate, Mr. F. Klostermann.
LETTERKENNY—Workmen's dwellings (£12,850), Rural District Council.
LEXDEN—Alterations to infirmary (£1,844), Board of Guardians.
LIMEHOUSE, E.—Shop, East India Dock-road, Mr. C. Dunch.
LIMERICK—Housing scheme (£62,145), No 1 Rural District Council.
LISKEARD—Alterations and additions to schoolroom in connection with the Baptist Church.
LLANWDA—Elementary school, Pembrokeshire Education Committee.
LLANFAIRFECHAN - Council school, Carnarvonshire Education Committee.
LLEYN—Chapel, Trustees, Independent Chapel, Hebron.
LONDON, N.W.—Workmen's dwellings, Prospect-terrace, Gray's-inn-road, St. Pancras Borough Council.
LONDON, W.—Work in connection with the Franco-British Exhibition, Director of Works.
LOWER WORTLEY—Additions, school, Leeds Education Committee.
MAINDY—Villa residence. Mr. W. D. Morgan, architect.
MALTON—Additional ward, Malton Cottage Hospital (£600).
MANCHESTER—Baths and wash-houses, Barnes Green (£38,400), Town Council.
MANCHESTER—Additions, Withington Workhouse, Guardians of Chorlton Union.
MARGATE—General Post Office, H.M. Commissioners of Public Works.
METHIL—Two houses off College-road, Mr. W. Foster; alterations to shop, Mr. J. Fisher.
MIDDLESBROUGH—Hippodrome, Wilson-street, Local Syndicate.
MIDDLETON—Spinning mill, Warwick Spinning Co.
MILFORD—Elementary school, Pembrokeshire Education Committee.
MOHILL—Housing scheme (£24,166), Rural District Council.
MOIRA—Workmen's dwellings (£12,317), Rural District Council.
MOLD—Four hundred houses, Bromfield Colliery Co.
MUSSELBURGH—Additions to Fisherow School, School Board.
MUSTONE—Mission church (£1,500), Trustees.
NEWARK—Joint isolation hospital, Urban District Council.
NEWBURY—Removing present town hall and building offices on the site (£1,500), Town Council.

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NEWCASTLE—Ten houses, Holme-avenue; eight houses, Rosewood-crescent; six houses, Briar Wood-crescent; two villas, Nun's Moor-road, near Fenham.

NEWCASTLE-ON-TYNE—Concert hall to accommodate 4,000, Town Hall Committee.

NEW PENSHAW—Alterations and improvements to school, Education Committee.

NORTHALLERTON—Hospital (£1,250), Rural District Council.

OLD DEER—Higher-grade school, School Board.

OLDHAM—Elementary schools, Education Committee.

PADIHAM—Council school (£8,750), Padiham Education Committee.

PENGE—Thirty-one houses, Kenilworth-road; five houses, Cleveland; conversion of houses into flats—Mr. A. W. Woolf; temporary church, Beckenham-road, Churchwardens.

PENMACHNO—Elementary school, Carnarvonshire Education Committee.

PENTRE ULHAF—Council school, Carnarvonshire Education Committee.

PERTH—City hall (£25,000), Town Council.

PINXTON—Two hundred houses, Pinxton Colliery Co.

PLAISTOW—Mission hall, Watson-street, Mr. R. Gordon.

PONTYPRIDD—New offices opposite workhouse, Guardians.

PRENTON—Congregational church, Storeton-road (£6,500).

PRESTON—Additions and alterations, Mauldeth-road municipal school, Withington, Manchester Education Committee.

PRESTONPANS—Public school, Education Committee.

PUDSEY—Secondary school (£10,000). Mr. Jowett Kendall, architect.

RADSTOCK—Extension to works, British Wagon Co.; enlargement of shop, Wells-road, Mr. W. F. Hobbs.

RAMSGATE—Secondary school, Ramsgate Education Committee.

RAMSGATE—Post office, Commissioners of H.M. Works.

RAVENSTHORPE—House and shop, Market-place, Mr. W. Blakeley; six houses, Huddersfield-road, Mr. J. Brooksbank.

RAYLEIGH—Elementary school, Education Committee.

RISHTON—Dwelling-houses, Cliffe-street, Rishton Industrial Co-operative Society.

ROCHDALE—Electric lighting (£22,175), Town Council.

ROCHESTER—Additions, police station, Corporation.

RODLEY—Additions, school, cookery-room, and handicraft workshop, Leeds Education Committee.

ROMSEY—Additions, parish church (£900), Churchwardens.

ROYTON—Vicarage, Heyside, Churchwardens.

ST. ALBANS—Elementary school, Beaconsfield-road, Herts Education Committee.

ST. ANNES—Public baths, South-drive (£12,000), Town Council.

SALFORD—Enlargement of Salford Royal Hospital (£50,000).

SANDAL—Two houses, Gordon-street, Mr. G. Ashton; alterations, house, Agbrigg-road, Mr. Cookson.

SANDIACRE—Eight villas, King Edward-street, Stapleford and Sandiacre Co-operative Society.

SHARLSTON—Enlargement, elementary school, West Riding Education Committee.

SILKSTONE—Elementary school, West Riding Education Committee.

SILKSWORTH—Six houses, Somerset-street, Mr. W. Welford; six houses, York-street, Messrs. J. and W Hodgson.

SILLOTH—Alteration, farm buildings, Dryholme. Mr. G. Armstrong, architect.

SIRHOWY—Alterations, Railway Hotel and dwelling-house, Hereford and Tredegar Brewery.

SKEWEN - Rebuilding Colliers' Arms. Mr. J. Cook Rees, architect.

SKIPTON—Restoration of parish church (£1,800), Churchwardens.

SOOTHILL—Alterations to houses, Soothill-lane, Mr. W. R. Spurr.

SOUTHAMPTON—Electrically lighting the Terrace House Estate, Polygon (£200), Electricity Committee.

STAFFORD—Enlargement of Council school, Corporation-street, Town Council.

STOCKTON—Motor garage, Bridge-road, Mr. W. E. Wardill; additions to theatre, Castlegate, Managers; two houses, Gray's-road, Mr. J. Jameson.

STOCKTON-ON-TEES—Extensions to lavatory accommodation, Ropner Convalescent Home. Mr. T. W. T. Richardson, architect.

STRANRAER—New high school, Board and High School Governors.

STRETFORD—Extension of generating station, duplicating and extending electricity mains, Urban District Council.

SUTTON—Elementary schools, St. Helens Town Council.

SUTTON BONNINGTON—Elementary school, Notts Education Committee.

SWANSCOMBE—Fire station, Church-road, Parish Council.

TADCASTER—Additions, elementary school, West Riding Education Committee.

TALKE—Elementary school (£4,600), Staffs Education Committee.

TARBERT—Church, United Free Methodists.

TEDDINGTON—Art school (£1,650), Middlesex Education Committee.

THRAPSTON—Elementary school, Northamptonshire County Education Committee.

THURLSTONE—Council offices (£1,000), Urban District Council.

TIVERTON—School (£6,000), Governors of the Tiverton Middle Schools.

TOLWORTH—Church hall (£1,000), Trustees.

TORQUAY—Municipal buildings, Castle-circus, Town Council.

TOTTENHAM—Alterations, Coleraine-park School, caretaker's house and school offices, Crowland-road, Education Committee.

TRURO—Showroom and offices, City Council.

TUNSTALL—Summer Bank schools (£9,893). Education Committee.

UXBRIDGE—Detached residence, Uxbridge Common, Mr. Wakefield; motor garage, New Windsor-street, Mr. T. S. Rose.

WALLSEND — Twenty cottages, Model Cottage Exhibition Estate, Wallsend Co-operative Society.

WEALDSTONE—Offices, depôt, mortuary, etc. (£1,400), Council.

WARMINSTER—House at Christchurch. Messrs. Long and Glass, architects.

WELSHPOOL—Four villas, Salop-road. Mr. R. W. Davies, architect.

WESTGATE-ON-SEA—Enlargement and improvement, St. Mildred's Hotel, Managers.

WEST HAM—One 3,000-kw. two-phase turbo-generator, Corporation.

WEST HAM—Electricity purposes (£51,600), Town Council.

WEST HAM—Alterations, Railway Tavern, Plaistow-road, Mr. Gladwell; mission hall, Norwich-road, Mr. R. Gordon.

WESTON-SUPER-MARE—Sunday schools in connection with proposed Primitive Methodist chapel, Brighton-road.

WHITEFIELD—Additions, Unsworth Church, Churchwardens.

WHITLEY BAY — Fire station, Whitley and Monkseaton Urban District Council.

WIGAN—Electrically lighting workhouse infirmary at Billinge, Board of Guardians.

WINCHESTER—Repairs to cottages, Winchester Cottage Improvement Society.

WINDERMERE—Public convenience (£500), Urban District Council.

WINDSOR—Additions to Rosemead, Old Windsor, Mr. Murray.

WOLVERHAMPTON—Secondary school, Education Committee.

WRABNESS—Restoration, parish church (£700), Churchwardens.

WREXHAM—Five villa residences, Beechley-road. Mr. F. A. Bevan, architect.

YARDLEY—Elementary school (£13,150), Worcestershire Education Committee.

YEOVIL—Station and buildings, L. and S.W.R. Co.

YORK—Alterations to premises, York Co-operative Society; additions to mission house, Nunnery-lane, Victoria Bar Chapel Trustees; alterations to house and shop, Kitchener-street, Mr. J. W. Cooper; four houses, Norfolk-street, Mr. G. Moss.

COMPANIES' MEETINGS AND REPORTS.

SOUTH METROPOLITAN ELECTRIC LIGHT AND POWER.

The ordinary general meeting of the South Metropolitan Electric Light and Power Co. was held on the 26th ult., Mr. Henry St. John Winkworth (chairman of the Company) presiding.

The CHAIRMAN, in moving the adoption of the report, said the lamp connections at the end of the year amounted to 160,380 8-c.p. equivalents, an increase of 15,668. The consumers connected at the end of the year numbered 3,383, and the net revenue increased from £24,118. 17s. 6d. to £27,067. 19s. 2d., an increase of about 12 per cent. for the year. This, with £7,103. 17s. 1d., the balance brought forward from last year, makes a total of £34,171. 16s. 3d. After deducting interest on debenture stock and interim dividend paid on the 7 per cent. cumulative preference shares, there remains a balance of £20,250. 6s., which the directors recommend be dealt with as follows: to payment of final dividend upon the 7 per cent. cumulative preference shares, £4,555. 18s. 7d.; to credit of depreciation account, £5,500 (as compared with £5,000 last year, and making the amount of this account £19,000); to payment of dividend upon the ordinary shares at the rate of 2½ per cent. per annum, £3,011. 14s. 3d., and that the balance of £7,182. 13s. 2d. be carried forward to next account. The units sold have increased from 2,381,788 in 1906 to 2,946,607 in 1907, an increase of over 20 per cent. more than one-half the increase being for power and the remainder for lighting. Seeing that the units sold increased more than 20 per cent. and that the net revenue only increased about 12 per cent, it shows that the consumers benefited during the year to a substantial extent by the reduction of the price. In this connection it may be interesting to mention that during the last four years the price per unit has shown a continuous reduction. The average price for the year 1904 was 4·04d. per unit; for 1905, 3·74d.; for 1906, 3·58d.; and for 1907, 3·23d. On the output for 1907 of 2,946,607 units, this represents a concession to consumers of about £10,000 as compared with the average price of 1904. Some inquiries have been made by shareholders as to the effect upon the business of the metallic-filament lamps, and he said that although the extension of their use may lead to a temporary loss of revenue from existing consumers, the directors feel that whatever benefits the consumer must ultimately benefit the Company. The reduction of the cost of the light makes the business more secure—it induces consumers to make a greater use of the supply, and it widens the area from which new business is obtainable. The capital expenditure during the year amounted to £42,281. 15s. 8d., and if deducting £5,500 placed to the credit of the depreciation account, the net addition to the capital account is £36,781, which includes about £20,000 in respect of the new power house. Part of the balance payable for the power-house has since been paid, and the remainder will become payable during the next few months. The

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increased earnings for the year amounted to £2,949, a little over 8 per cent. on the capital expenditure for the year. The power-house is now in full operation, and the anticipated economies are being realised.

Mr. HENRY W. BOWDEN seconded the motion, which was unanimously carried.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

The ordinary general meeting of the Kensington and Knightsbridge Electric Lighting Co. was held on the 27th ult., the chairman (Colonel R. E. Crompton) presiding.

In moving the adoption of the report, the CHAIRMAN dealt at length with the effect of the introduction of the metallic-filament lamps as against the ordinary carbon-filament lamps, and said the effect in regard to those people who had had the foresight to purchase this class of lamp was that they were able to obtain three times the amount of light which they previously had without any addition to the bills for current. For some time to come this might have an adverse effect on the consumption of electricity, but he said advisedly "for some time," because he felt that the saving would enhance the use of electricity as an illuminant, and the chances were that users would be more wasteful in the future than they had been in the past. Electric light was becoming more and more of a necessity and less of a luxury, and the companies should reap the advantage. He complained of the growth of rates and taxes, and said that if the sum which this Company had to pay of £6,500 per annum could only be reduced by one-third the directors would be able to pay a bonus of 2 per cent. upon the ordinary dividend. They had suffered in common with other electric lighting companies in regard to the increased cost of coal. In all the difficult circumstances of the past year he felt that the results presented would be regarded as satisfactory, for they were able to maintain the amount of dividend which they had paid to the ordinary shareholders for some years past—viz., at the rate of 10 per cent. per annum. He then dealt with the question of the bulk supply of electricity and the Bill which was jointly promoted by this and other West-end electric lighting companies in the present session of Parliament, and which would be of benefit to all concerned.

The report was adopted.

LONDON ELECTRIC SUPPLY.

The ordinary meeting of the London Electric Supply Corporation was held on the 27th ult.

Mr. ROBERT H. BENSON presided, and in moving the adoption of the report said there had been a decrease in the gross receipts of £6,500 and an increase of expenses of £3,700, so that they were only able to recommend a dividend of 2½ per cent. against 4 per cent. last year. There were a variety of causes which accounted for this, including the high price of coal and that the receipts from the London County Council had fallen off. They had not yet begun their supply of electricity to the London, Brighton, and South Coast Railway, but they would, they expected, supply them this year with current for the experimental running between London Bridge and Victoria. The outlook for 1908 was brighter, and they already saw increased net receipts in cash for the first quarter. The amount of units sold had increased in the first eight weeks of this year by over 20 per cent. When it was a question whether the dividend for 1907 should be 2 per cent. or 2½ per cent. the Board decided on the higher figure and a corresponding smaller addition to reserve. They did this partly because they expected 1908 would afford the opportunity of a considerable increase to their revenue and partly because for the three preceding years they had put exceptional sums to reserve, aggregating £65,000. The more power consumers they could get in the daytime the more continuously would their machinery be employed, and if only the London power producers as a whole were encouraged to associate and dovetail their customers, so as to have the minimum amount of idle machinery, the economy would be enormous. He then referred to the Company's Bill in Parliament.

Mr. R. STEWART BAIN seconded the motion, which was unanimously carried.

NORTHALLERTON ELECTRIC LIGHT.

The annual general meeting of the shareholders of the Northallerton Electric Light and Power Co. was held last week. In the absence of the chairman of the directors (Mr. John Hutton), Mr. C. E. L. Ringrose presided.

In the annual report it was stated that the accounts showed a net profit of £142. 0s. 7d., which, together with the balance brought from the last account, amounted to £214. 2s. 1d. The directors recommended that a dividend of £5 per cent. per annum, less income tax, should be paid on the preference and ordinary shares, absorbing £125. 19s. 3d., and that a sum of £70 should be written off for depreciation of buildings, machinery, and street and service mains, and that the balance of £18 2s. 10d. should be carried forward. The whole of the plant, machinery, etc., was in satisfactory working order, and had been maintained in a thorough state of repair out of revenue. The balance-sheet showed that the principal items under capital and liabilities were: share capital authorised—2 900 non-cumulative preference shares at £1 each, £2,900; 12,000 ordinary shares at 6s. each, £3,600; issued 1,151 non-cumulative preference shares of £1 each, £1,151; 4,561 ordinary shares at 6s. each, £1,368; mortgage debentures authorised, 500 at £10 each, £5,000; issued 470 debentures at £10 each, £4,700; less deposited to secure bank overdraft, £3,000; loan on mortgage of freehold property, £400; bankers (party secured), £3,742; profit for 1907, £142; and with other items, total, £8,940. Under the heading of property and assets the chief items were: capital expenditure—freehold land, buildings and machinery, street and service mains, as per last balance-sheet, £7,335 (less depreciation, £100), less sale of Robey engine and income from meters and motors, £7,817; stocks on hand, £322; debts due, £758; and other items, £8,940. On the profit and loss account the principal items were: expenditure—materials, wages, etc., £836; maintenance and repairs, £147. 19s. 10d.; salaries, printing, etc., £386. 7s.; balance carried down, £420. 1s. 11d.—total, £1,790. 17s. Receipts—charges for installations, current to private consumers and for street-lighting, £1,687. 16s., and rents amounted to £1,790. 17s., with balance brought down, £420. 1s. 11d.

The CHAIRMAN proposed the adoption of the report, which was seconded by Mr. LONG, and carried.

CROSSLEY BROS.

The eleventh annual meeting of the shareholders of Crossley Bros. was held at Openshaw, Manchester, on the 28th ult., Mr. W. J. Crossley, M.P., in the chair.

The CHAIRMAN, in moving the adoption of the report, said that although they had been successful in making the usual dividend, the year just closed had been a very trying one in many ways. There had been a considerable advance in the price of the raw materials, including copper and iron, but he was glad to say that the prospects for this year were very much brighter in that regard, for the prices were being lowered considerably. They had also to pay more for wages, a general advance in the engineering world having taken place. The lack of cash had also affected trade, but in their case the lack of cash was partly due to the extension of the works. They had just built and equipped one of the most modern works for the motorcar business, and next week the machinery in this important extension would be started. Not only had they fitted up the most modern machinery, but they had secured the services of experts in motorcar construction. Arrangements had also been made to build light delivery vans and other vehicles of that character. In addition to the gas-engine and motor works, they had within the last two or three years made another departure which had proved entirely successful. He referred to the gas-plant works. Their customers were now able to purchase cheap power for gas-engines. A large sum of money had been used for new patterns for the largest size gas-engines. The making of these patterns was extremely costly. It had been their practice not to consider the cost of such patterns as an asset, but to pay for them out of the general expenses account. There was a considerable number of the larger engines now in use. Some of them were about 600 h.p. or 700 h.p. They had recently put down a large gas-engine plant in Canada, and orders were in hand for large gas-engines for cotton mills. They had stocks of engines in nearly all parts of the world. It was mentioned that the reserve fund now stood at £100,000, and that the ordinary shareholders had received in dividend more than the amount of their share capital.

The motion was seconded by Mr. D. H. IRWIN, managing director, and carried.

LANCASHIRE UNITED TRAMWAYS.

The third ordinary general meeting of the above Company was held at 68, Dashwood House, London, E.C., on Friday, the 28th ult.

Mr. J. M. HENDERSON, M.P., occupied the chair, and, in proposing the adoption of the balance-sheet, referred to the fact that the receipts were adversely affected last year by reason of the very bad weather and the shutting down of the Liverpool and Prescot light railway for about five weeks in order to relay the track with granite in place of grit setts. The expenditure had also been increased owing to the increase in the price of coal, etc. On the other hand, he pointed out that the receipts per car mile were greater than in any previous year, and that this increase was being maintained up to date. He also referred to the successful institution of a cheap system of workmen's fares, which up to the present has proved satisfactory to the Company as well as advantageous to the workmen.

Mr. ALFRED ADAM seconded the resolution, which was carried unanimously.

METROPOLITAN ELECTRIC SUPPLY.

The report of the Metropolitan Electric Supply Co. for the year ended Dec. 31 last, to be submitted at the meeting on the 10th inst., states that the capital expenditure, which at the end of 1906 amounted to £1,802,383, has now reached a total of £1,840,876, being an increase during the year of £38,493. The gross revenue for the year amounted to £178,683, as compared with £175,635 in 1906, being an increase of £3,048. As the revenue for 1906 included £5,178 for the remainder of the St. Marylebone business transferred on March 31 in that year, the total increase of revenue in the Company's areas during the year 1907 was £8,226. The working expenses, which in 1906 were £82,938, amounted in 1907 to £83,333, being an increase of £395. The Bill which was promoted last session by the London County Council for a bulk supply in and around London was jointly opposed by all the London supply companies, and was thrown out by a Select Committee of the House of Commons. The Bill deposited jointly by these companies was withdrawn. In the present session of Parliament a Bill for bulk supply and other purposes has been deposited by certain persons seeking to be incorporated as the London and District Electricity Supply Co., against which this Company has petitioned. The Company has also joined with certain other of the London supply companies in promoting a Bill for establishing a Statutory Joint Committee to deal with the supply of electricity in London and surrounding districts. This Bill, which contains provisions for the guarantee by the promoting companies of the interest on the capital of the Joint Committee to be authorised under the Bill, will be submitted for the approval of the shareholders at an extraordinary general meeting to be held immediately after the general meeting. The balance at the credit of the revenue account, before providing

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for depreciation, is £95,349. The directors have set aside £20,000 as an addition to the depreciation and reserve fund, carrying to the credit of the net revenue account the sum of £75,349. This sum, with the balance brought forward from last account and other receipts, makes a total of £88 767. After deducting interest on debenture stocks and loans, dividend on preference shares, and other charges, there remains a balance of £44.878. To this the directors have added £21,000 from the undistributed balance of the St. Marylebone purchase money which was set aside towards the maintenance of dividends during the development of other business to replace the loss of St. Marylebone. This increases the balance at the credit of the net revenue account to £65,878. An interim dividend of 3s. per share (being at the rate of 6 per cent. per annum) on the ordinary share capital, amounting to £30,000, was paid on Aug. 6, and the directors recommend that a further dividend of 3s. 6d. per share on such shares, making a total distribution for the year of 6s. 6s. per share, or 6½ per cent. This will absorb a further sum of £35,000, and leave a balance of £878 to be carried forward.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

The report of the Brompton and Kensington Electricity Supply Co. for the year ended Dec. 31, 1907, to be presented at the meeting on the 10th inst., states that the revenue account shows a credit balance of £31,718, which, with £9,145 brought forward and £409 balance of interest received, makes a total of £41,273. After deducting £1,726 for interim dividend on the 7 per cent. cumulative preference shares and £6,779 interim dividend at the rate of 9 per cent. per annum for the half-year to June 30 on the ordinary shares, the directors recommend to carry £8,000 to credit of depreciation account and to pay a dividend on the ordinary shares for the half-year ended Dec. 31 at the rate of 11 per cent. per annum, making 10 per cent. for the year, to carry £4,000 to credit of reserve fund account and to appropriate £612 for directors' additional remuneration, leaving to be carried forward a balance of £10,136. The directors record with great regret the death of Mr. William Page, who served the Company as a director from its earliest years. Mr. Stanley Beeton has been appointed to fill the vacancy.

HOVE ELECTRIC LIGHTING.

The report of the Hove Electric Lighting Co. for 1907, to be presented at the meeting on the 12th inst., states that the result of the year's working is a net profit of £12,693, compared with £12,672 in 1906. Gross revenue shows an increase of £1,695, but working expenses increased by £1,676, due to the excess cost of coal and the additional outlay found necessary on repairs and maintenance. There was a balance brought forward to the present year of £525, which makes an available balance of £13,219. The directors now propose to place £4,000 to renewals and depreciation account, and to declare a final dividend at the rate of 9 per cent. per annum, making 8½ per cent. for the year, and to carry the balance, £780, forward. Expenditure on capital account during the year amounted to £2,893. With a view of replacing the capital expenditure taken from the reserve fund and investing this to provide for the future, 5,000 £5 preference shares were offered to the shareholders in November last and 2,559 shares were applied for and allotted. Investments on account of the reserve fund now amount to £11,481.

W. T. HENLEY'S TELEGRAPH WORKS.

The report of W. T. Henley's Telegraph Works Co. for the year 1907 states that during the past year a net profit has been made of £65,302. After payment of directors' and auditors' fees and debenture interest, and making allowance for depreciation of buildings, plant, machinery, etc., there remains £50,330, making, with £22,320 brought forward, a total of £72,650. The directors have transferred £10,000 to the reserve account, and recommend the payment of a dividend on the ordinary shares of 15 per cent. (less income tax), of which an interim dividend of 5 per cent. was paid on Sept. 2 last. These payments will, together with the preference dividend for the year, amount to £49,000, leaving £23.650 to be carried forward.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY.

The report of the Newcastle-upon-Tyne Electric Supply Co. for the year ended Dec. 31 last, to be presented at the meeting in Newcastle on the 10th inst., states that the total connections to the Company's system at the end of the year amounted to 92,764 h.p., which, compared with the previous year's figure of 70,000 h.p., show an increase of 22,764 h.p. The profit for the year, including £2,145 brought forward, amounts to £87,397. The directors recommend the payment of further dividends of 2½ per cent. on the amount called up on the preference shares and of 5½ per cent. on the amount called up on the ordinary shares, making the total dividends for the year 5 per cent. and 8 per cent. on the preference and ordinary shares respectively. They propose to transfer £5,000 to depreciation and to carry forward £2,024.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION.

The report of the County of Durham Electrical Power Distribution Co. for the year ended Dec. 31, 1907, to be presented at the meeting in Newcastle-upon-Tyne on the 10th inst., states that the profits of the year, together with £1,934 brought forward, amount to £24,946. The directors recommend the payment of a dividend at the rate of 2 per cent. per annum on the amount called up on the ordinary shares, to transfer to depreciation and reserve account the sum of £5,000 and to carry forward £382.

CITY OF CARLISLE ELECTRIC TRAMWAYS.

The report of the City of Carlisle Electric Tramways Co. for 1907 shows a surplus of £1,784, being a decrease of £117 as compared with the previous year; and the balance of profit and loss account, after providing for debenture stock interest and debenture stock trustees' remuneration, is £632, which the directors recommend shall be carried forward.

NEW COMPANIES REGISTERED.

Hanipha (Ceylon) Tea and Rubber Co., Limited.—Registered Feb. 17 by Norton Rose Barrington and Co., 57½, Old Broad-street, E.C. Capital, £50 000 in £1 shares. Objects: to adopt an agreement between G. W. Suhren, W. S. Taylor, and M. Bremer of the first part, the said W. S. Taylor of the second part, and the company of the third part, and to carry on in Ceylon and elsewhere the business of planters and cultivators of tea, coffee, and rubber and other produce.

West Canadian Deep Leads, Limited.—Registered Feb. 18 by Cave and Co., 20, Eastcheap, E.C. Capital, £75,000 in £1 shares. Objects: to acquire an option for the purchase of the Moxley Mining Lease, situate in Little Valley, Cariboo District, British Columbia, to adopt two agreements with L. A. Bonner and with the Electric Conversion Syndicate, to acquire any gold, copper, and other mines, mining rights, and properties of all kinds in British Columbia or elsewhere, and to carry on the business of gold and general miners, etc.

Liens Registered.

Longford Wire Co., Limited, Warrington.—Lien Feb. 19, £500 5 per cent. debentures, part of £45,000. Amount previously issued, £30,050.

Empire Electric Light and Power Co., Limited, London, E.C.—Discharge in full Feb. 21 of mortgage debentures dated Oct. 12, 1904, March 1, 1906, and June 27, 1906, for a total sum of £12,800.

Chesham Electric Light and Power Co., Limited.—Particulars of £10,000 debentures, created by resolution of Jan. 27, 1908, have been filed pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees.

Delhi Electric Tramways and Lighting Co., Limited.—Particulars of £50,000 5 per cent. debentures created by resolution of Jan. 3, 1908, and secured by a trust deed of even date (already registered), have been filed pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: Benefit of the Delhi Municipality Electric Licence, 1905, and of Delhi (Municipality) Electric Tramway Order, 1906, the company's interest in certain land in Delhi, the company's tramway line and appurtenances and its general assets and undertaking, exclusive of uncalled capital. Trustees: R. C. Pearman, 21, Old-buildings, Lincoln's-inn, W.C., and J. Greig, 18, Belsize Park-gardens, N.W.

La Capital Traction and Electric Co. (Buenos Ayres), Limited. A trust deed, dated Nov. 10, 1907 (supplemental to an unregistered trust deed, dated Dec. 21, 1900), for increasing an issue of debentures from £600,000 to £800,000, pursuant to resolutions of Aug. 8, 1906, and March 5, 1907, and substituting not less than 16,000 preferred and 18,000 ordinary shares of £5 each in the Buenos Ayres Grand National Tramways Co., for the shares, securities, and notes of the Cordoba Light and Power Co. of Maine, charged by the original trust deed, has been registered. Trustees: W. Trotter, Basildon House, Moorgate-street, E.C., and R. Fleming, 2, Princes-street, E.C.

LEGAL INTELLIGENCE.

MOTION BY METROPOLITAN ELECTRIC TRAMWAYS.

In the King's Bench Division on Friday, Feb. 28, before Mr. Justice Darling and Mr. Justice Phillimore, sitting as a Divisional Court, Mr. Page, K.C., moved on behalf of the Guardians of the Hendon Union for a rule *nisi* for a writ of prohibition calling upon the justices of Middlesex to abstain from hearing a rating appeal brought before their court by the Metropolitan Electric Tramways whilst certain members of the Middlesex County Council are upon the bench. Counsel explained that the Metropolitan Electric Tramways are the occupiers of the Middlesex County Council, the owners of certain tramways in the union of Hendon. An order for their construction was obtained on the joint application of the tramways company and the County Council, the latter providing the land and making street widenings, and the North Metropolitan Electric Tramway Co. the electrical fittings and tramcars. On Nov. 18, 1900, an agreement was entered into providing that in case an order was obtained—and it was, in fact, obtained early in the following year—the tramways should be leased to the tramway company until Aug. 6, 1925, at a fix rent, plus 45 per cent. of the net profits, these latter to be arrived at by deducting all expenses of running and management and rates. The tramway company have appealed against their assessment for rating in the Hendon Union, and the appeal in the ordinary course would come up for determination by the Middlesex County justices, but upon that bench, counsel said, there were various gentlemen who were also members of the Middlesex County Council, and he contended that it would be obviously improper for them, forming part of the corporate

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body which owned the tramways, and which must benefit if the tramway company obtained a reduction in their rateable value, to act as judges in the appeal. They would, in fact, be judging their own case. He submitted that these justices had a pecuniary interest in the appeal, and were, therefore, not competent to take part in its determination.

Their Lordships reserved their decision till Friday next, Mr. Justice DARLING observing that he believed there was some authority upon the matter in the records of the Court in cases which had not been reported. He was inclined to do absolutely nothing which could possibly infringe the most salutary rule that the administration of justice in the English courts should be above suspicion, and he was, therefore, by no means disposed to take any technical view as to the refusing of the rule. Possibly they might find reasons for coming to a decision one way or the other.

PROVISIONAL PATENTS, 1908.

FEB. 21.

3941. Combined high and low tension change-over switch Henry Arthur Hensley, 76, Marmion-road, Southsea, Hants.

3947. Improvements in the manufacture of mantle rings, burner nozzles, deflectors, resistances, and insulators or other like incombustible articles used in connection with gas and electric fittings. Alfred Austin Lines, 33, Chancery-lane, London. (Complete specification.)

3985. Improvements in and relating to electric ignition devices for internal-combustion engines. The British Thomson-Houston Company, Limited, and Bernard Hopps, 83, Cannon-street, London.

3986. Improvements in and relating to electrically-driven rolling mills. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Feb. 22, 1907, being date of application in Germany.) (Complete specification.)

FEB. 22.

3995. Improvements in or relating to electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

4002. Improvements in automatic targets whereby an indicator is shown, and electric or other bells are set ringing. William Hadley, 57, Spring-hill, Birmingham.

4030. Telegraph pole. Frederick H. Tidnam, 55, Chancery-lane, London. (Date applied for under Section 91 of the Act, July 9, 1907, being date of application in United States.) (Complete specification.)

4043. Improvements in or connected with disinfecting devices for telephones and like instruments. Arthur Davy, 77, Market-street, Bradford.

4052. Improvements in or relating to processes of melting in electric furnaces and their application to the extraction of metals. Henri Herrenschmidt, 111, Hatton-garden, London. (Application for patent of addition to No. 24517/07.) (Date applied for under Section 91 of the Act, Feb. 23, 1907, being date of application in France.) (Complete specification.)

4066 Improvements in connection with series-parallel electric circuits. William Herbert Exley and Henry Leitner, 4, South-street, Finsbury, London.

FEB. 24.

4082. Compound automatic electric fog signal. Leslie Edwin Taylor, 7, Main-street, Long Eaton, near Nottingham.

4087. Improvements in electric resistances. Walter Frederick Jones, 166, Wellington-road, Eccles.

4096. Method for electrically automatically switching on or off the supply mains transformers and the like. Ronald Lewis Randall, 302, Queen's-road, New Cross-gate, London.

4110. Improvements in and relating to electro-therapeutic methods and apparatus. Arthur Edmund Baines, Dashwood House, London.

4111. Improvements in or relating to recording arrangements or apparatus for use chiefly in connection with electrical measuring instruments. Siemens Bros. Dynamo Works, Limited, James Dalziel, Robert Brooks, and Charles Frewen Jenkin, 139, Queen Victoria-street, London. (Complete specification.)

4112. Improvements in or relating to section insulating arrangements used in the overhead construction of electric railways or tramways. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

4113. Improvements in electric polyphase induction machines. Wallace Fairweather, 65, Chancery-lane, London. (Allmänna Svenska Elektriska Aktiebolaget, Sweden.) (Complete specification.)

4137. Improved method of and apparatus for starting internal-combustion engines by electrical ignition. Robert Bosch, trading as the firm Robert Bosch, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Oct. 28, 1907, being date of application in France.) (Complete specification.)

4138. Improvements in or relating to apparatus for reading Morse and similar telegraph signals. Friedrich Edler von Kubin, 111, Hatton-garden, London.

4139 Improvements in lifting magnets for cranes. Arthur George Bloxham, Birkbeck Bank-chambers, Southampton-buildings, London. (Markische Maschinenbauanstalt Ludwig Stuckenholz A.-G., Germany.) (Complete specification.)

4161. Improvements in electro-capillary apparatus. Axel Orling, 22, Southampton-buildings, London.

4166 Improvements relating to electricity meters. Evan Evans. 31, Bedford street, Strand, London. (Complete specification.)

FEB 25.

4181. Electrically-propelled motorcar with single steering wheel. Carl Lassen, 322, High Holborn, London. (Date applied for under Section 91 of the Act, March 2, 1907, being date of application in Germany.) (Complete specification.)

4188. Coupling for electric wires or cables. William Prideaux Lakeman, Sunningdale, Avenue-road, Itchen, Southampton.

4191. Mechanical tilting sand-gear (improved) for electrical tramcars. James Riseley Flint, 24A, Ramsey road, West Hendon, London.

4193. Improvements in controllers for electric motors. Henry Lyon, 121, West George-street, Glasgow.

4212. Improvements in electric arc lamps. Henry Baggett, Norfolk House, Norfolk street, Strand, London.

4246. Improvements in or relating to telephone apparatus. Charles Franklin Bradburn, 60, Queen Victoria-street, London. (Complete specification.)

4257. Improvements in electrical ignition devices for internal-combustion engines. Robert Bosch, trading as the firm of Robert Bosch, Birkbeck Bank chambers, Southampton-buildings, London. (Application for patent of addition to No. 4137/08.) (Date applied for under Section 91 of the Act, Nov. 6, 1907, being date of application in France.) (Complete specification.)

4267. Improvements in and relating to electric motors. Alexander Lehmann, 27, Chancery-lane, London.

FEB. 26.

4292. Improvements relating to rectifiers for alternating electric currents. Samuel Wells Cuttriss, Prudential-buildings, Park-row, Leeds.

4297. Improvements in electric resistances. Walter Frederick Jones, 166, Wellington-road, Eccles.

4316. Improvements in and in connection with the trolley heads of electric tramcars and like vehicles. James Edward Slater, 3, Brown-street, Market-street, Manchester.

4318. Improved electric switch. John Macdonald, 100, Wellington-street, Glasgow.

4339. Improvements in magnetos for ignition purposes in explosion engines. Thomas Wardell, 65, Chancery-lane, London.

4348. Improvements relating to electric conductors for use in connection with installations of electric light. George Davis, Queen Anne's-chambers, Westminster. (Application for patent of addition to No. 12711/07.)

4349. Improvements in or relating to electric switches. Brian Harold Morphy, Queen Anne's-chambers, Westminster.

4350. Improvements in means for locking electric incandescent and like lamps in their holders. Brian Harold Morphy, Queen Anne's-chambers, Westminster.

4357. Improvements in or relating to magneto sparking plugs for internal-combustion engines. Arthur James Postans, Birkbeck Bank-chambers, Southampton-buildings, London.

4364. Improvements relating to the generation of electricity on railway trains, boats, and the like. Jon Hjaltalin Sveinbjornsson, 18, Southampton-buildings, London. (Complete specification.)

4368. Improvements in or relating to the electrical operation or control of railway points. William Robert Sykes, sen., 53, Chancery-lane, London. (Complete specification.)

4372. Improvements in or relating to the regulation of the pressure of electric machines. Felten und Guilleaume Lahmeyerwerke Akt.-Ges., 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, Feb. 27, 1907, being date of application in Germany.) (Complete specification.)

4391. Electric photophone for the production of photophonographs or use as a telephone transmitter, also means of reproducing sound from photographs thus obtained. Josiah Frederick Child, 258, Rosendale-road, Herne Hill, London.

FEB. 27.

4394 Revolving table made to carry any size printing frame for printing with the "electric arc." Edgar Watson Bowes, 16, Ethelden-road, Shepherd's Bush, London.

4410. Improvements in processes for producing metallic articles and combined metallic and non-metallic articles by electro-deposition and in the articles so produced. Frank Iorns Gibbs, 128, Colmore-row, Birmingham.

4429. Improved thermo-electric light controller. Harry Rivers Hannay, Worcester Court, Worcester Park, Surrey.

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4221. Improvements in and relating to the transmission of a series of electric impulses along land lines or cables. Axel Orling, 22, Southampton-buildings, London

4432. Improvements in or relating to single-phase commutator machines. Maschinenfabrik Oerlikon, 139, Queen Victoria-street, London. (Application for patent of addition to No. 28968/04.) (Date applied for under Section 91 of the Act, March 9, 1907, being date of application in Germany.) (Complete specification.)

4433. Improvements in or relating to the starting and working of three-phase motors from a single-phase supply. Siemens-Schuckertwerke G. m. b. H., 139, Queen Victoria-street, London. (Application for patent of addition to No. 1243/07.) (Date applied for under Section 91 of the Act, June 28, 1907, being date of application in Germany.) (Complete specification.)

4444. Improvements in connection with electrical radiators. Herbert John Dowsing, 115, Cannon-street, London. (Complete specification.)

4464. Improvements in the manufacture of coils of large section for electromagnetic apparatus. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

4472. Improvements in and relating to electric wall plugs. Tom Charles Schneidau, 19, Holborn-viaduct, London.

4475. Improvements in and relating to automatic electric circuit breakers. Hjalmar Rudman Schultz, 77, Chancery-lane, London.

4477. Improvements in and relating to electric switches. William Charles Dieppe and William Thomas Knorr, 88, Chancery-lane, London.

4479. Improvements in or relating to Rontgen tubes and the like. Adolph Friederich Lindemann and Frederick Alexander Lindemann, 111, Hatton-garden, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on March 12.)

1906.

28609. Electric arc lamps. Beck and Deutsche Beck-Bogenlampen Ges.

28601. Electric arc lamps with supported electrodes. Beck and Deutsche Beck-Bogenlampen Ges.

1907.

3783. Transmitting systems for wireless telegraphy. Levy.

3963. Electric batteries. Richmond.

4031. Alternate-current motors. Fynn.

4085. Electric alarm apparatus. Coleman.

4137. Wireless electric signalling systems. Cabot. (Date applied for under International Convention, March 10, 1906.)

4181. Method of preventing electrolysis. British Thomson-Houston Company. (General Electric Company.)

4211. Rotary electric transformers and motor-generators. Crompton and Co., Macfarlane, and Burge.

4593. Transmitting apparatus for wireless telegraphy. Marconi and Marconi's Wireless Telegraph Company.

4832. Voltaic cells. Christensen.

5100. Electric furnace for the continuous extraction of zinc from its ores. Côte and Pierron.

5506. Alternating-current dynamo-electric machines of the commutator type. Lamme. (Date applied for under International Convention, March 15, 1906.)

6239. Methods of and means for controlling electric currents. Walter.

7180. Electric resistances. British Thomson-Houston Company. (General Electric Company.)

8984. Electricity meter. Hookham and Holden.

9591. Means for guiding and supporting carbons or electrodes in pairs in arc lamps. Gross.

9923. Electric switching mechanism for sending a predetermined number of current impulses. Roberts.

13072. Electric controllers. White. (Date applied for under International Convention, June 6, 1906.)

13195. Signalling systems for railways and the like. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

16087. Telephone alarm with attuned call. Mackenzie. (Lorenz.)

16952. Electric welding or soldering. Kjellberg.

20201. Means for rotating or training searchlight projectors, and for like purposes. Siemens Bros. Dynamo Works, Limited, and Holmes.

20949. Control of electrically-propelled vehicles and other apparatus. Siemens Bros. Dynamo Works, Limited. (Siemens-Schuckertwerke Ges.)

24238. Contact breakers for electrical ignition in internal-combustion engines. Bosch. (Date applied for under International Convention, Jan. 2, 1907.)

24874. Electric conductors. Richardson.

25118. Alternating-current wattmeters of the thermal type. Arcioni.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price.
	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
—— Ord., 1,125 000	1 ..	⅛-¼
Aron Electricity Meter. 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	23/32-27/32
—— Ordinary, Nos. 1 125,000	1 ..	⅛-¼
British Aluminium Co., Ordinary, 2,001-40,000	5 ..	3¾-4¼
—— 7 per cent. Cum. Pref., 1-40,000	5 ..	4¾-5¼
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	5-5¼
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100-103
—— 5½ per cent Loch Leven Deb. (Reg.). Red., 1-3,000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5¼-6
—— 4½ per cent. Mortgage Debentures	100 ..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85 87 xd
British Westinghouse Elec. and Manuf. 10 per cent. Pref., 275,001-475,000	3 ..	½-⅞
—— 4 per cent. Mortgage Debenture Stock	100 ..	43-48
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-¼
—— Non. Cum., 6 per cent., Pref.	2 ..	5/16-9/16
—— 4½ per cent. 1st Debenture Stock	100 ..	77-80 xd
—— 4½ per cent. 2nd Debenture Stock	100 ..	63-66
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10¾-11¼
—— 5 per cent. Pref.	5 ..	5⅜-5¼
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3 ..	1¼-2⅛
—— 5 per cent. Debentures	100 ..	92-95
Dick, Kerr, and Co., Ordinary, 1.260 000	1 ..	1-1¼
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	99 102
Edison and Swan United, "A" Shares, 1-99 261	5 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	87-90
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112,100	2 ..	¼-½
—— 7 per cent. Cumulative Pref.	2 ..	1¼-1½
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	65-69
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅞-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	89-92
W. T. Henley's Telegraph Works, Ordinary	5 ..	11¾-12⅜
—— 4½ per cent. Preference	5 ..	4¾-5 xd
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15¼-16¼
—— 4 per cent. Debentures	100 ..	99-101
National Electric Construction Co., 1-170,000	1 ..	¼-½
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	33-35
—— 4 per cent. Bonds	100 ..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9

Electric Lighting and Supply.—

Name.	Amount paid.	Last price
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4¼-5 xd
Bournemouth and Poole, Ordinary	10 ..	10⅝-11⅜
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15 001-22,500	10 ..	10-10⅜
—— 4½ per cent. Debenture Stock, Red.	100 ..	100-103
Bromley (Kent) Electric Light and Power Co	5 ..	4⅜-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	96-98
Brompton and Kensington, Ordinary	5 ..	7⅜-8¼
—— 7 per cent. Preference	5 ..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6¼-7
—— Nos. 80,000-100,000	5 ..	5¾-6⅜ xd
Cambridge Electric Supply Company, £10 Ord.	8 ..	12¼-13¼
Canadian General Electric Co., Common Shares	$100 ..	97-101
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	4¼-4⅜
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	4¼-4⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	97-100
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	4¼-4⅜
—— ditto (1905) 40,001-80,000	5 ..	4¼-4⅜
Chelsea Electricity Supply	5 ..	3⅝-4¼
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	10-11
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12⅛
—— 5 per cent. Debenture Stock	100 ..	122-125
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	99-102
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,630	50 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3-3⅜
—— 5 per cent Preference, 1-50,000	5 ..	4⅜-4⅝
County of London Elec. Supply, Ordinary	10 ..	7⅜-8¼
—— 6 per cent. Cum Pref.	10 ..	11-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	105-108
—— 4½ per cent. 2nd Debentures Prov. Certs	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	¼-½
—— 6 per cent. Cum Pref.	5 ..	½-1⅛
—— 4½ per cent. First Mort. Deb.	100 ..	65-75
Electrical Development Co. of Ontario. 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15 750	—	72½-75½ p.c. xd
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-2⅜
—— 5 per cent Debenture Stock, Red.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	91-94
Folkestone Electric Supply, Ord., Nos. 1-10 000	5 ..	4⅜-5¼
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	5-5¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	98-101
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	⅛-¼
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¼-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5	1¼-1⅜
—— 6 per cent. Pref.	5	4⅝-5¼
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	92-95
Metropolitan Ordinary, 100,001-200,000	5	5-5½
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4⅞-5⅜
—— 3½ per cent. Mortgage Debenture, Red.	100	85 90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000	—	76-78 p.c.
Mexican Light and Power Co., Capital Stock	$100	50-52
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	83½-85½ p.c.
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6⅜-6⅝
—— do., 57,010-75,000	5	6⅜-6⅝
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5	5¼-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	5¼-5⅜
Notting Hill Electric Lighting	10	11-12 xd
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5⅜ 6⅛
—— 4 per cent. Debenture Stock	100	93-96
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	⅛-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red.	100	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	4⅜ 5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	4⅝-5⅜
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96-98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¼-1¼
—— 4 per cent. Debenture Stock	100	70-74
South London, Ordinary	5	2-3
South Metropolitan Electric Light and Power, Ord.	1	⅞-⅞ xd
—— 7 per cent. Cum Pref.	1	1⅛-1⅜ xd
—— 4½ per cent. 1st Mort. Deb.	100	101-104
St. James's and Pall Mall, Ordinary, 101-20,080	5	7½-8½ xd
—— 7 per cent. Pref.	5	6½-7 xd
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1½-2¼
—— 5 per cent. Cumulative Preference, 50,001-80,000	5	2-2½
Westminster, Ordinary	5	7⅜-8⅜ xd
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	5-5¼

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5	6-6¼
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	8¼-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	129-132
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	103-106
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent. Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	13/16-15/16
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100	93-96
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec. Supply and Trams. Co., 6 per cent. Cum. Pref.	10	9½-10¼
—— 4½ per cent. Deb. Stock, Red.	100	95-97
Brisbane Tramway Invest., Ord., 1-75,000	5	3 9/16-3 13/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅝-4⅞
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	97-101
British Columbia Electric Railway Co., Ord Def.	100	127-130
—— Ord. Pref.	100	106-110
—— 5 per cent. Cum. Perpetual Pref. Stock	100	104-107
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	101-104
—— 4½ per cent. Vancouver Power Deb.	100	100-103
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10	4½-5
—— 5 per cent. Perpetual Debenture Stock	100	97-101
—— 4½ per cent. 2nd Deb. Stock	100	72-76
Bueno Ayres and Belgrano Trams.	5	4⅜-4⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅝ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅝ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	95-93
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	100-104
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, Ord., Nos. 1-137,610	5	6¾-7¼
—— 5 per cent. Cum. Pref., Nos. 1-30,000	5	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	101-105
Cape Electric Tramways, Nos. 1-480,000	1	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4⅜-7¼
—— 4 per cent 1st Mortgage Deb., 1-3,000 (1917)	100	98-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5¼-5½ xd
—— 4 per cent. Deb. Stock, Red. 1965	100	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	91-95
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12¾-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12½-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	12⅝-13⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	80-85
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	⅞-1⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100	87-91
—— 6 per cent. "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296,500 2nd Mort. Deb. Stock	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	⅞-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	⅞-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red	100	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7-8
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	81-85

Name.	Amount paid.	Last price.
	£	£
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25 000	5	4½-5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	90-94
Metropolitan Elec Trams., Defd., 1,000,001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum. Pref., 500,001-1,000 000	1	13/16-15/16
—— 4½ per cent. Deb. Stock, Red.	100	98-100
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	82-84 p.c. xd
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10 000 and 34,001-74,000	5	¾-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅞-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1	¼-½
—— 5 per cent. Cum. Pref., 300,001-545 000	1	¼-½
—— 4½ per cent. Debenture Stock	100	95-96
Provincial Tramways Co., Ordinary, 1-24,912	10	4½-5
—— 6 per cent. Cum. Pref., 1-10,000	10	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref. 1-30,000	5	5-5½
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	96-98
Sao Paulo Tramway, Light, and Power Co.	$100	121-125
—— 5 per cent. 1st Mort. Deb., Red. 1929. 1-11,000	$500	95½-97½ p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅞-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100	78-82
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1 600	100	63-68
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,251	5	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100	64-67
—— 4 per cent. Pref.	100	82-84
—— " " deferred	100	44-47
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	100-103
City and South London, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	101-104
—— 5 per cent. Pref. Stock '91	100	114-117
—— " " " '96	100	112-115
—— " " " '01	100	110-113
—— " " " '03	100	108-111
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	40-44
—— Deposit Receipts	—	40-44

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1 000	86-88
Anglo-American Telegraph Co., Ordinary	100	54-57
—— 6 per cent. Preferred Ordinary	100	97-99
—— Deferred Ordinary	100	12½-13
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	98¼-101¼ xd
Chili Telephone Co., 1-44,000	5	7-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	87-90
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	6¾-7¼
—— 10 per cent Preference, 1-6,000	10	15⅞-16⅛
Direct Spanish Telegraph Co., Ordinary	5	3¼-3½
—— 10 per cent. Cum. Preference	5	8½-9½
—— 4½ per cent. Debs., 1-600	50	99½-102½
Direct United States Cable Co.	20	13⅜-14⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	99-101
Eastern Extension, Australasia and China, 1-300,000	10	12⅞-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100	99-102
Eastern Telegraph Co., Ordinary Stock	100	131-136
—— 3½ per cent. Preference Stock	100	83-86
—— 4 per cent. Mortgage Debenture Stock	100	100-103
Great Northern Telegraph Co. (of Copenhagen)	10	32-34
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	99-101
Indo-European Telegraph Co.	25	54-57
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1	⅜-⅝
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	⅛-1
National Telephone, Preferred	100	107½-109½ xd
—— Deferred Stock	100	108½-110½ xd
—— 6 per cent. Cum. First Pref.	10	10½-12½ xd
—— 6 per cent. Cum. Second Pref.	10	10½-12 xd
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝ xd
—— 3½ per cent. Deb. Stock, Red.	100	97-99
—— 4 per cent. Deb. Stock, Red.	100	100½-102¼
Oriental Telephone and Electric Company	1	1⅛-1¼
—— 6 per cent. Cum. Pref.	1	1 3/32-1 7/32
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5	6¼-7
—— 5 per cent. Cum. Pref., 1-40,000	5	4⅞-5¼
—— 4½ per cent. Debenture Stock, Red.	100	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-30 000 and 53 001-53,008	2½	1 7/16-1 11/16
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	98-101
West India and Panama Telegraph Co., Ordinary	10	17/32-21/32
—— 6 per cent. Cum. 1st Preference	10	8-8½
—— 6 per cent. Cum. 2nd Preference	10	8-8½
—— 5 per cent. Debs., Red., 1-800	100	100-103
Western Telegraph Co., 1-207,930	10	13¼-13⅜
—— 4 per cent. Debenture Stock, Red.	100	98¼-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d
Aberdeen Corporation	Feb. 26	1,161	1,113	+ 48	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 29	180	168	+ 11	—	8	8	,, 15	15,283	3,603,789	378,834	·97	9·28	1,917	5 35
Baker Street and Waterloo Ry.	,, 29	3 130	2,315	+ 815	+ 6,564	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Mar. 1	1 058	989	+ 69	+ 438	23·53	23·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	Feb. 22	6 277	5,290	+ 987	—	56½	56½	,, 31	18,557	5,352,098	215,345	·87	,6·2	9,228	—
Blackburn Corporation	,, 26	86	869	- 2	+ 3,547	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·2
Blackpool Corporation	,, 27	351	349	+ 2	- 1,187	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	Mar. 1	2,025	2,127	- 93	+ 6,489	42	42	March 31	111,294	23,410,690	2,411,969	1·14	·1·03	2,649	6·12
Bournemouth Corporation	Feb. 26	1,373	1,271	+ 102	+ 2,193	23¼	24½	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·23
Bradford Corporation	,, 22	4,061	3 993	+ 68	+ 5,427	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	Mar. 1	654	727	- 73	- 3,193	17·191	17·191	,, 31	50,652	10,759,310	1,798,905	1·09	10·49	2,844	7·4
Bristol Tramway Company	Feb. 28	4,505	4,591	- 86	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 29	1,114	1,085	+ 29	—	19¾	19¾	,, 31	62,699	11,967,458	1,205,830	1·31	12 48	5,825	8·21
Burton Corporation	Mar. 1	247	249	- 2	- 644	9[illegible]	8½	,, 31	15,576	3,383,527	421,317	·07	8·87	1,768	6·14
Cardiff Corporation	Jan. 11	1,894	1,918	- 24	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	Mar. 3	155	130	+ 25	+ 96	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	Feb. 23	6,132	6,286	- 154	- 2,230	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,367	5 22a
Charing X, Euston, & Hamp. Ry.	,, 29	3,180	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway.	Mar. 1	3,376	2 961	+ 415	+ 2,834	9	6¼	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	Feb. 26	160	151	+ 9	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 27	381	363	+ 13	- 185	15½	15½	Dec. 31	25,032	5,966 364	891,938	—	6·74	—	4 78
Croydon Corporation	,, 28	1,193	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502,408	1·08	9·76	3,125	6 67
Darwen Corporation	,, 28	221	231	+ 10	- 52	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1,124	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Feb. 28	91	96	+ 22	— h	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 28	4 618	4,336	+ 282	+ 1,183	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 26	1,043	972	+ 71	+ 2,161	22	22	May 15	57,672	15,554 905	1,162 792	·878	11·9	4,352	7 3
East Ham Corporation	,, 29	804	817	- 13	+ 456	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3 636	7 14
Glasgow Corporation	,, 29	16,134	16,660	- 526	+18,434h	177½	169	May 31	387,381	224,063,088	20,350,367	·95	10·47	5,035	5 21
Gloucester Corporation	,, 19	212	222	- 10	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 29	5,5.0	3,910	+1,600	—	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,996	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	,, 29	1,456	1,4 1	+ 45	+ 3 343	35½	35	,, 31	81,196	15 252,150	1,804,745	1·22	10·79	2,770	5 92
Hull Corporation	,, 29	2 431	2,284	+ 147	+ 6,651	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 15	351	407	- 56	—	10½	10½	,, 31	26,499	6,586,754	645,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 26	123	115	+ 8	+ 413	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 26	251	228	+ 23	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1,723	4 95
Lancashire United Tramways	,, 26	1,149	1 092	+ 57	+ 783	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	,, 22	5 931	5 879	+ 52	+12,763	96½	96½	March 31	327,794	73,024,853	7,358,185	1 06	10·69	3,352	5 58
Leicester Corporation	,, 29	2,094	2,018	+ 75	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 22	10,360	10,295	+ 75	+ 897	104	104	Dec. 31	563,793	122,094,528	12,115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	Mar. 1	1,355	1,409	- 53	+ 70h	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	Feb. 22	29 823	27,050	+2,772	+232,772	98	98	March 31	1378,014	314,227 090	30,130 297	1·05	10 98	—	8·56
Lowestoft Corporation	,, 29	139	130	+ 9	—	3½	—	Sept. 30	11,079	2,622,922	343,190	1·03	7 9	2,156	6·39
Maidstone Corporation	,, 27	140	83	+ 57	—	3¼	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 15	13,828	13,416	+ 412	+ 44,173	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 29	9,065	7,832	+1,233	+ 8,412	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Mar. 1	15,084	14 776	+ 308	+ 716	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	Feb. 29	121	120	+ 1	- 22	2¾	2¾	March 31	7,709	2,035,300	203,203	86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation.	,, 29	3,643	3,851	- 208	+ 778	59⅜	57¼	,, 31	210,491	45,506,468	4,263,174	1 11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 29	566	561	+ 2	+ 3 081	14½	14½	,, 31	32,421	7,760,403	772 753	1 03	0 01	1.525	6·87
Oldham Corporation	Dec. 8	1 805	1,744	+ 61	+ 4,550	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2 603	7·239
Portsmouth Corporation	Jan. 18	1,470	1,4'6	+ 54	—	28½	28½	,, 31	98,911	20,668.825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,651	8,130 179	918,825	9[illegible]	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20 9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1 12	10 45	2,691	7·38
Salford Corporation	Feb. 24	4,224	4,064	+ 160	+ 6,772	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	Mar. 1	5.123	5,309	- 186	+11,452	65¼	65¾	March 25	276,907	73,966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	Feb. 26	916	772	+ 143	+ 3,124	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 26	263	232	+ 31	+ 199	9	9	,, 31	20,076	4,431,728	390,538	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	Mar. 1	990	1,333	- 348	- 2,523	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6·37
Swindon Corporation	June 5	153	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	Feb. 27	203	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 29	732	722	+ 10	+ 725	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,965 296	429.785	—	10 724	1,989	6·95
West Ham Corporation	,, 27	2,124	2,066	+ 58	+ 2,255	14·7	14 7	,, 31	122,881	35,502,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 26	809	742	+ 67	+ 607	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·036

* 1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE

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All communications intended for the Editor should be addressed C. H. W BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

Replies for the "Technical Problems" Column should reach the Editor within ten days of the issue in which the problem appears. Many Engineers, both at home and abroad, make use of this section of "THE ELECTRICAL ENGINEER," *where difficulties are found in their work, to get help from fellow readers, and others are invited to do so.*

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THE LEEDS FINANCE COMMITTEE.

We have on three separate occasions within the past three months found it necessary to comment on municipal matters concerning Leeds. This week again an article will be found in our columns which we think deserves the careful consideration of those who have the stability of municipal enterprises at heart. In such matters the Leeds councillors, and especially the Finance Committee, seem to disregard entirely the experience attained in other cities, and to strike out on new lines which will quickly depreciate the credit of the town. While we believe that the independence of the Yorkshireman is a valuable asset which has made the industries of the Leeds district, we are sure that this independence is being applied in a wrong direction when it refuses to consider Corporation finances on similar lines to that found necessary in other places. The first false move was made last year, when the Finance Committee took the bulk of the tramway reserve fund and used it for the reduction of rates. This was so far acknowledged that in February last a committee was appointed to consider what amount of reserve fund should be provided in addition to the sinking funds for the tramway, gas, electricity, and water undertakings. This committee has yet to meet, and it will be probably some months before its report is brought before the Council. As we pointed out in our leader for Feb. 14, the value of this report when received will be seriously reduced because the Council deleted from the resolution the power to employ outside experts. Hence it will be an amateur effort, and from the construction of the committee it is only too likely to endorse the suicidal policy of the present Finance Committee. This policy is clearly shown by the article elsewhere in this issue which gives the report of last week's meeting of the Council. The chairman of the Finance Committee then attempted to rescind certain resolutions which allowed the electricity department to build up a reserve fund from which antiquation charges can be met. This attempt to secure the small reserve fund which the Electricity Committee have put by, and to use it for the relief of rates, was defeated only by a narrow majority. Even this shows that the councillors are beginning to realise the inherent weakness of the policy of the present Finance Committee, which, unfortunately, has secured the acquiescence of the Tramway Committee. These reserve funds have been built up because they will be needed, and it took three or four years for the tramway department to lay aside out of profits the money appropriated by the Finance Committee. Now that all additions to this reserve fund has been stopped, there will be financial crisis in three or four years, when the general renewal of the track will have to be commenced. Then sums between £100,000 and £200,000 will have to be raised each year for two or three years from the rates, and the slight decrease now obtained in the rates will have to be returned in a lump sum. We hope that whoever may be chairman of the Finance Committee during the next two or three years that Alderman Wilson will be chairman then, and have to acknowledge that his amateur corporation finance has not produced the results he expected. It would be wiser now to have outside expert advice and to see if the corporations of other cities have good reasons for their financial policy with respect to tramway and electricity reserve funds.

TELEPHONY.

We always welcome the communications of Mr. H. Laws Webb on this subject, even though such communications seem common pabulum sent broadcast to the Press, but we

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never forget that he is the expert advocate for a particular clientele; hence his statements have to be most carefully examined as being limited by the sphere of his client's interest. He is an adept in his particular line, as is his great opponent (Mr. A. R. Bennett). Probably the utterances of the two will lead those of a judicial frame of mind to a course somewhere between the extremes. Mr. Webb has favoured us with another letter touching the war of rates and other matters, but we venture to think he is less than usually lucky with his arguments; indeed, on several points he is far from correct. Why, in the name of all that is good, do controversialists see fit to gibe at business men? Does Mr. Webb really believe what he says about business men acting detrimentally to their own interests? Depend upon it, if a lost call meant lost business, the business man would soon find a remedy; but no woman ever gave an order for a dress elsewhere, or an engineer for a dynamo, because the reply to a telephone ring was "Engaged." Efficiency is one thing, and does not depend upon either a "flat" or a measured rate, nor does the reply, "Engaged." Mr. Webb is behind the scenes. Will he tell us exactly how the "measured rate" is determined, and why it is more advantageous, and to whom than the flat rate? We are somewhat surprised also to see his remarks anent large and small users. We always thought the latter obtained great advantages because of the former, whether the business was concerned with telephony or with baking or tailoring. Tell us what is *the* unit telephonically. Surely it is not an effective call. You might as well say the four-pound loaf was the unit in a bakery or a single paper or book in a publisher's office. We are all thirsting for information and cannot be satisfied. If a measured rate is going to cheapen telephony, show how, and the chambers of commerce will withdraw all opposition.

THE BRIGHTON CORPORATION CASE.

The decision of Mr. Justice Joyce in the case of Heath *v.* the Corporation of Brighton, in which the plaintiff sought to restrain the defendants from so using the machinery at their North-road electricity works as to cause a nuisance to worshippers in the church of which he was incumbent, was made known on Saturday last, and is reported in another column. The point at issue was one of importance to owners of electricity works, for if the plaintiff had succeeded in establishing his claim for an injunction, the effect would have been to place many such works at the mercy of a neighbouring objector who had reason to believe that his peace of mind was being disturbed by the proximity of such works, notwithstanding the fact that the machinery in them was designed in accordance with the best scientific knowledge and the most modern engineering practice to obviate nuisance as far as practicable. However, the judge found that the noise caused did not constitute a legal nuisance sufficient to support an action. The granting of an injunction would have been a serious matter in this case, for it would have interfered with the statutory powers given to the Corporation, who were but exercising such powers and performing their duties with relation to the public snpply of electricity in a reasonable and proper manner, and according to the best and most approved methods. It was admitted by overwhelming evidence that the machinery at North-road was of the most modern type, and was adequately housed in a building specially designed and suitable for the purpose. In most parts of the church it was impossible to hear any sound at all from the works, and in other parts the sound amounted at most to a faint hum or buzz which could only be detected in the absence of other sounds. The Rev. Mr. Heath is entitled to sympathy in that the inconvenience, trifling as it is, interferes with his preaching. But a matter of this sort must be looked at from a reasonable point of view. It is singular that only the incumbent should be annoyed by the humming sound. We hope it will not be suggested that the minds of the congregants were sailing on the balmy wing of Morpheus, and that the sound heard by the incumbent was inaudible to the congregation in consequence.

TO MANUFACTURERS, ETC.

We are glad to record the appointment of Mr. H. R. Forbes-Mackay as electrical engineer to the Municipal Council of Sydney, New South Wales. Mr. Mackay sails this month to take up his new appointment, and he desires us to say that he will be glad to receive at the Town Hall, Sydney, price lists, catalogues, or other information from manufacturers, etc., more particularly relating to metallic-filament, incandescent, and flame arc lamps, although information relating to all kinds of electrical apparatus will be welcomed.

ELECTRIC POWER IN DOCKS.*

BY C. E. TAYLOR, ASSOCIATE MEMBER.

During recent years the use of electricity for power purposes in docks has been greatly extended, and as the power companies, now feeling their way, develop their business, it is probable that a still greater extension will take place. Electricity offers many advantages over the hydraulic system (which has up to recent times held this field almost exclusively), especially in places where electric power can be obtained at a reasonable rate from an outside source, and the user has not to incur the heavy capital expenditure involved in the provision of a generating station for the exclusive supply to the dock premises above. It is generally admitted that where a reliable supply can be obtained from an outside source, as in the Tyne district, it is much more advantageous to take supply from that source than to generate for such loads as are obtained in docks where the total consumption is small and the maximum demand large. From the user's point of view the advantages are great. The installation cost for distribution is small compared with that for a hydraulic supply, and not so liable to failure, whilst the consumption is proportional to the work done. The efficiency of electric machinery is necessarily much higher than that of hydraulic plant for the same purpose, especially that of the older type, and the distribution is more flexible, and lends itself to alterations and additions as they become requisite much more readily than its competitor.

The uses to which electrical machinery has been put in dock workings are numerous and are continually extending. For the loading of general merchandise the high gantry crane is much used, for short-distance electric traction capstans are very much in evidence, and for coaling vessels electric cranes and hoists are used, the former where the better facilities afforded by jetties or staiths cannot be arranged. Electric power is used also for preventing the breakage of coal which takes place when run from considerable heights into the holds of vessels, and it has recently been used to obviate in a simple and inexpensive manner the necessity for alterations to existing staiths and jetties which the increasing size of ships employed in the coal trade would otherwise involve. In other cases it is found that, whilst not desirable to replace all hydraulic by electric plant, it was advisable to make a beginning on a settled policy. Such a case may be instanced as that at the North-Eastern Railway Company's dock—Tyne Dock—where the steam pumping plant, being old, is being replaced by electrically-driven pumps with the intention of gradually replacing the hydraulic cranes, etc., as necessity arises, by electric plant also.

* Paper read before the Institution of Electrical Engineers.

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Coal Conveyors.—The difficulty of loading bunker coals into vessels when light from the older jetties or staiths has led to the adoption of special apparatus capable of running the coals on the level or on an inclined plane. One form of this apparatus is shown in Fig. 1. Coal conveyors have recently been brought into use at the North-Eastern Railway's Company's dock at Tyne Dock. The arrangement consists essentially in making the spout into an endless belt conveyor, coals being shipped at low level, and run over the belt in the ordinary way. When shipped into vessels, level with the spout, or above it, the latter is adjusted as may be required, and the belt run by an electric motor, the coals being carried along until they reach the hatch, when they drop over into the hold. The belt spout can be adjusted to any angle, but the useful maximum is about 25deg., and at this angle some 500 tons can be shipped by each conveyor per hour. Some experiments have recently been made on these conveyors, and it was found that the average power working at full load on a slight inclination was 12 h.p., and the consumption during the test was seven units, with a total quantity of coal shipped equal to

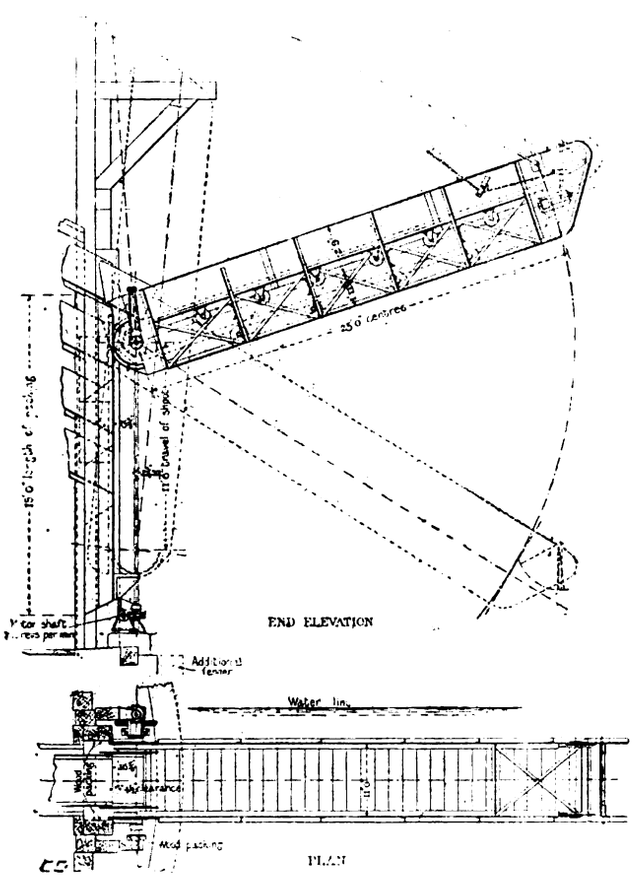

FIG. 1.—Motor-Driven Coal Conveyor. Tyne Dock

410 tons, giving an average per ton of 0·017 unit. Whilst the test was in operation some further experiments to show the power absorbed with various inclinations of the belt were made, with the curious result of a constant absorption of power for any inclination was obtained. Practically the power remained constant at 12 h.p., and it was found that the belt automatically regulated the quantity of coal carried according to the inclination. This was a result that had never been anticipated. A three-phase motor, capable of developing 16 b.h.p. at a speed of about 800 r.p.m, drives the spout by a suitable reduction gear at a velocity of 120ft. per minute. A margin between the average absorbed and the total power of which it is capable is allowed for cases where the belt is required to start with a considerable amount of coal upon it, or to take the load if coal is dumped upon it very freely, as often happens. The arrangement is extremely efficient for the purpose for which it is intended; no other motive power could have been used in this case, and the adoption of the system has obviated the necessity for reconstruction of the staiths for a very considerable time. In this way there has been a great saving on capital expenditure.

Anti-Coal-Breaker.—The more modern staiths for shipping coal at North Blyth have shown another defect which the use of electric power has done much to remedy. The staiths are very high, and coal has a long way to drop into the holds at low tide, with the result that much coal is broken, and its value is diminished thereby. The anti-coal-breaker arrangement consists essentially of a system of buckets balanced to run over the suspended shaft, the whole being suspended from the jib of an electric crane fixed on the upper part of the staith. Coal from the ordinary spout is run into the buckets on one side of the chain, and these are carried by gravity into the hold of the vessel, where they are emptied, and the buckets begin the return movement. The whole arrangement is clearly shown by Fig. 2. The jib crane is capable of carrying 8½ tons, and the lifting and slewing motors are 20 b h.p. and 8 b.h.p. respectively. The lifting speed is 25ft. per minute. As will be seen from Fig. 3, the speed of the bucket chain is capable of being regulated by an automatic centrifugal brake to a velocity of 120ft. per minute.

Coal Hoists.—In cases where the ground level is low coal hoists are used to a great extent, and also coaling jib cranes. With regard to coil hoists, this is a field in which hydraulic machinery has hitherto been universally adopted. The

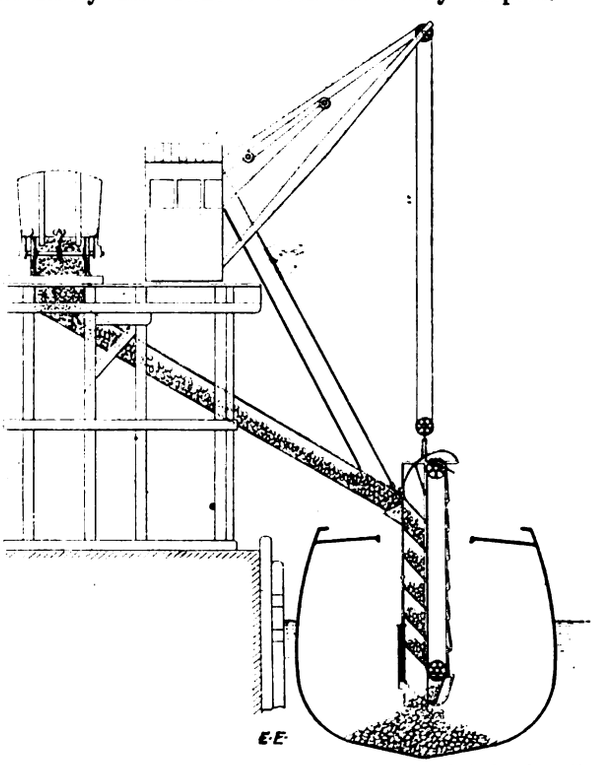

FIG 2.—Sectional View of Anti-Coalbreaker, showing Method of Operation.

wagons are raised by a hoist and tipped by means of another ram attached to the platform, the wagons being fitted with end doors; the wagon is then lowered again and the platform lowered to a high-level empty wagon road, where the wagon is run off and the platform lowered to the ground level for another full wagon. Electrically-driven coal hoists, which perform exactly the same operations, have recently been erected at Rothesay Dock, Clydebank, by the Clyde Navigation Trustees. In some cases coaling cranes are displacing hoists, or are being provided as additions. A typical example is the 25-ton crane installed on Humber Dock Quay, Hull. The lifting is done by two 50-b.h.p. motors, both coupled to the same shaft, and controlled by a series-parallel controller—the tipping motor is 50 b.h.p. and the slewing motor 20 h.p. Fig. 4 shows the arrangement of the ropes for lifting and tipping the wagons, the slack of the tipping rope is taken up by another barrel, which is geared to the lifting barrel, the rope being taken over a pulley which is fixed to two square thread screws. These screws are driven by the tipping motor and draw the pulley backwards and forwards, thus effecting the tipping motion. The radius of this crane is 31ft., the height of jib from road-level is 50ft., and the approximate amount of coal which can be shipped by this crane is 230 tons per hour.

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Wharf Cranes.—For loading and unloading material of a general kind and iron ore, etc., cranes of a high gantry type are in universal use. These cranes take up a minimum amount of space on the quay, and allow wagons, etc., to pass under them. In cases where a warehouse is built on the quay, a slight alteration is made by having one side of the gantry running on the quay wall, and the other running on a girder let into the building. This still enables wagons to pass under the cranes as before. Cranes of the high gantry type are in use at various docks, those at Middlesbrough and Hartlepool, on the North-Eastern Railway Company, being capable of lifting 10 tons and 3 tons at 150ft. per minute, 1½ tons at 250ft. per minute, and slewing at 400ft. per minute. The jib radius is 45ft., and the height of the jib top from the quay level is 60ft The hoisting gear is driven by a 50-h.p. motor at 300 r.p.m., and is geared direct to the barrel. On the motor shaft is fixed a band brake operated by a special electromagnet in series with the armature of the lifting motor. The two poles of the magnet are similar to a small two-pole dynamo with upright poles, and revolving between them is a solid steel armature, connected by a lever to the brake which is

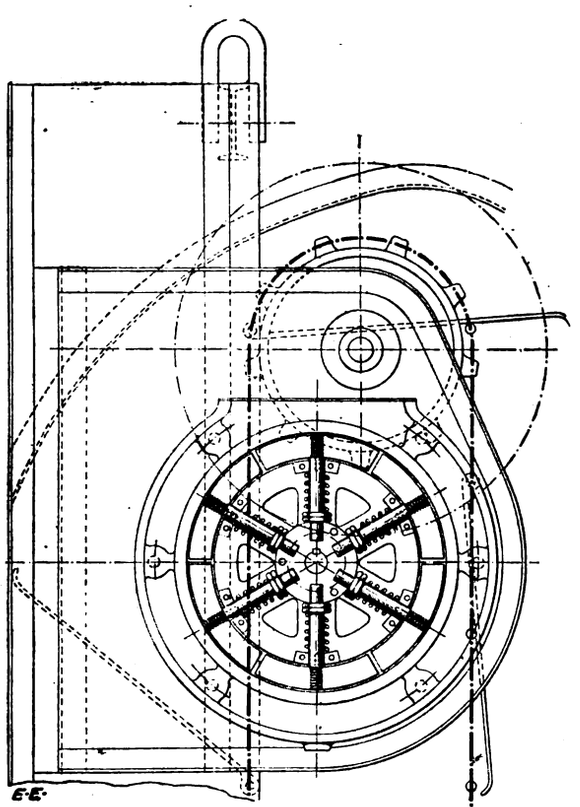

FIG. 3.—Centrifugal Friction Brake for Automatically Controlling Speed of Anti-Coalbreaker.

held on normally by weight. When the fields are excited and motor is started this armature turns through 90deg. and raises the weight, thus releasing the strap. The brake can also be operated by a lever near the controller, so that lowering can be carried out without the power being applied to release the brake. The slewing gear is driven by an 8-b.h.p. motor at 1,000 r.p.m., coupled to which is a worm driving a worm-wheel. This gears with a spur wheel on a vertical shaft, carrying the driving pinion which engages with a circular rack fixed on the top of the gantry. The motor is controlled by a foot brake on the motor spindle. The cranes revolve on 24 cast-steel rollers. A universal controller is used for both motors. The collector gear is fixed to a pillar in the centre and cables pass up the centre column and are attached to two rings mounted on ambroin, upon which are brushes fixed on porcelain insulators attached to the cabin floor, and from which wires pass to the controller. The cranes are moved along the quay wall by a 4-b.h.p. motor at 30ft. per minute, the gearing being arranged for hand working if necessary, each side being driven by means of a cross-shaft and bevel wheels. Current is taken from underground mains on the quay, which are connected at intervals of 50ft. to plug boxes. The crane plug is bell-shaped to prevent water entering the boxes whilst the cranes are in use, and can only be attached in one way, so that the correct motion is obtained The 10-ton cranes are of the same design as the three-ton cranes. The lifting motor is 60 b.h.p., and the revolving motor is 12 b.h.p. The lifting motor in single gear drives directly through a pinion on to the barrel, the ratio being 8 to 1, and a double part of rope is used. With single gear loads up to two tons are lifted, and double gear is provided for loads over

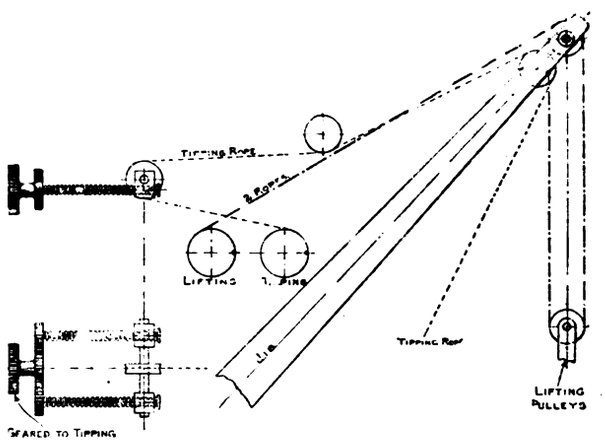

FIG. 4.—Diagram showing the Arrangement of Lifting and Tipping Ropes for 85-ton Electric Coaling Cranes

two and up to ten tons. It will be seen that in these cranes when lowering the motor is driven by the weight, but a new device is now in vogue on similar cranes, patented by Messrs. Stothert and Pitt. The lifting barrel is not keyed directly to the shaft, but runs loose on it, and is connected or disconnected by a friction clutch. The barrel shaft carries the main spur wheel rigidly keyed on to it, and this spur wheel gears directly by single reduction with the pinion attached to the armature spindle of the lifting motor. The hand lever actuating the lifting controller also actuates an electric solenoid which controls the lifting friction-coil clutch, the arrangement being such that on moving the lifting handle forward from the off position, current is switched on to the solenoid, the clutch is put into gear, and the lifting motor started simultaneously; after the clutch is in gear, a

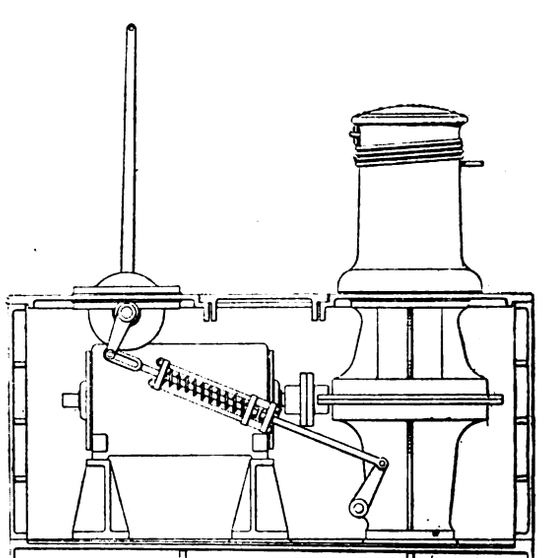

FIG. 5.—Type of Capstan with Fixed Rope and Loose Head.

further movement of the lever cuts out resistance and speeds up the motor. Provision is also made of a mechanical connection between the lifting controller handle and the coil friction clutch as an alternative to the electric solenoid. A large friction brake drum is keyed directly on to the lifting barrel, the brake strap being lined with willow blocks. The lifting controller does not reverse the motor, as the lowering is carried out independently by the loose drum The great advantage of this arrangement is the large increase in speed of working both in

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lifting and lowering, and also the reduced liability of accident to the motors, owing to the impossibility of suddenly stopping the armature. In cranes with the barrels always in gear with a reversible motor, care has to be taken to check the lifting motor when the hook is a sufficient distance from the jib head, so that the momentum of the revolving armature may be absorbed before the hook is overwound on the jib pulley, with the possible result that the jib itself is lifted and the tie-rods bent. With the system described above, lifting can be continued at full speed, and the load brought to rest instantly by pulling over the handle, the only revolving parts which have to be brought to rest being the barrel and brake drum, which have comparatively small inertia, and do not revolve at an excessive speed. The great gain in speed is in lowering, which can be performed at a vastly greater speed than is possible by a reversible motor, there being a perfectly free run out under the control of the foot brake, and, what is of equal importance, lowering can be commenced instantly without perceptible pause from lifting at full speed. The lifting armature can continue to revolve

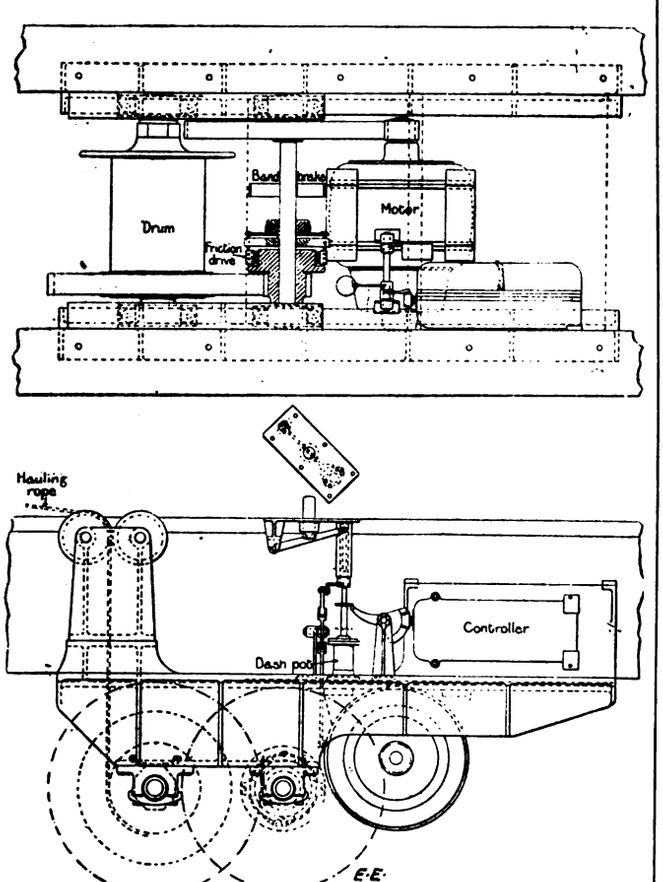

FIG 6.—Under Deck Type Capstan.

with slackening speed during the period of lowering, and then comes to rest quietly without shock. As a matter of practice, it is found that a load can be lowered 60ft. before the armature has ceased to revolve.

Capstans.—It is unnecessary to deal fully with capstans, as these are well known, but at Rothesay Dock a special capstan has been designed by Messrs. Baxter and Dixon, of the Clyde Navigation Trust, in which the principal feature is a fixed rope and loose head. A wire rope is permanently fixed to the capstan head, which is made to run loose on the spindle, but when required is connected to the spindle by a clutch sliding upon the upper end of the spindle inside the capstan head. The starting switch and clutch are controlled by a long lever, which in the backward position releases the head by throwing out the clutch, and in the other direction puts in the clutch and operates the starting switch. The man is thus free to work his starting switch in an upright position and see all that is going on, as against one foot and two hands. In places where a number of wagons have to be drawn up and used one at a time as in a coal hoist, this a very good arrangement, as there is a great saving in ropes and no wear on the capstan head. This type of capstan is shown by Fig. 5. The saving effected by electric capstans is sometimes very large, and in some cases where they have displaced steam-engines on staiths, which were previously necessary in order to run the wagons to the spouts through cross-over roads, etc. Electric capstans can be fitted in many cases where other forms could not be used. On the North-Eastern Railway Company's staiths at Dunston an under-deck type of capstan fixed entirely under the floor of the staiths is being experimented with. In this case the capstan is not furnished with the usual head, the rope being carried round a horizontal drum. This type of capstan is shown by Fig. 6. The motor is a 30-b.h.p. three-phase motor, running at 770 revolutions on a circuit of 440 volts 40 ~, and drives by means of a pinion a first shaft which has fixed upon it a friction drive for operating the barrel shaft. The barrel has on it a fixed rope which passes over the horizontal drums placed level with the floor of the staiths, so that the rope may work in either direction as required for hauling purposes. The method of working is such that, when the treadle is depressed, the stator is made alive, and the motor brought up to speed by cutting resistance out of rotor circuit; at the same time the band brake is released, the friction clutch engages with its drum, and the rope is wound round the barrel. When the treadle is released the clutch allows the rope barrel to stop immediately, and

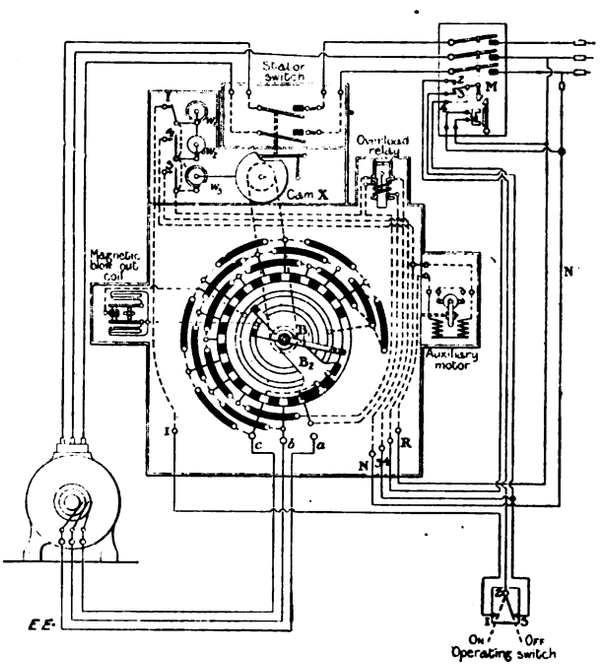

FIG. 7.—Automatic Three-Phase Starting Switch. Diagram of Connections.

the momentum of the motor is pulled up gradually by the band brake. This is a very essential point, as the wagons are drawn down a slight decline over the cross-over roads to the spouts, and each wagon must be stopped immediately over them; otherwise, if they run past, the whole train of wagons must be hauled back up the gradient. The motor is only operated in one direction, the drum running freely when slack rope is needed, which is drawn off by hand as required according to the number of wagons to be hauled.

Electric-Driven Hydraulic Pumping Plant.—Any new dock which may be built would probably be fitted with electric power throughout, as at Rothesay Dock, Fishguard, etc., but it cannot be expected that the hydraulic plant in use at an old dock should be pulled out and replaced by electrically-driven machinery until worn out. An improvement can, however, be made by installing electrically-driven hydraulic pumps supplied by power from a power company and working these automatically. This method does away with all boiler-house expenses, leaving practically only the engine-room staff to operate the pumps. A change of this kind is at present being made at Tyne Dock, where three engines and five boilers are being replaced by four electrically-driven pumps with three-phase motors of 132 b.h.p. each. These drive three-throw crank pumps through a flexible coupling. Each motor is provided

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with a three-phase automatic starting switch driven by a small motor $\frac{1}{12}$ h.p., which is connected between two of the phases and brought into action by a switch attached to the accumulator. Fig. 7 shows a full diagram of connections for this starting switch, the method of working being as follows: Each automatic switch is connected to the mains through a three-pole switch, M, which has a no-voltage release and is fixed on a separate switchboard. From this switch one main passes direct to the motor, whilst the other two pass through a magnetic blow-out switch fixed to the auto starter and operated by cam X. The circuit for working the auxiliary motor is coupled to two phases on the live side of switch M. Current passes along wire N, through overload relay, to cams marked W_1, W_2, W_3, which make and break contact with points 1, 4, and 3 as required. In starting, current passes down No. 1 to the operating switch on the accumulator, and as the accumulator is down passes to No. 2 on the switch, across to No. 4 on switch M, from this point to No. 4 on the starting switch through the auxiliary motor, and on to the other phase. The auxiliary motor now runs and drives the rotor switch, cam X, and cams W_1, W_2, W_3. This closes stator switch and No. 4 wire by cam W_2, No. 1 is then opened by cam W_1, the auxiliary motor continues to run through No. 4 wire contact until all resistance is cut out of rotor circuit, when cam W_2 opens contact No. 4 and puts in contact No. 3. This operation stops the auxiliary motor until the pump raises the accumulator sufficiently high to change over the operating switch to the off position, thus putting the auxiliary motor again into circuit and revolving the rotor switch to the off position, and opens the stator switch by cam X. On switch M is a contact No. 3, which is used, in case of failure of supply, to prevent damage when supply is resumed. When supply fails, switch M opens, putting contacts 3 and 4 in connection with each other. Thus, when the power is again put on, current can pass to the auxiliary motor by way of cam W_3, through 3 and 4 on switch M to auxiliary motor, revolving automatic switch to the off position immediately, and preventing switch M being closed with all resistance out. Between arms B_1 and B_2 is coupled an automatic magnetic blow-out coil which is opened and closed in conjunction with the automatic switch to prevent sparking on the rotor switch.

Other machinery at this power station comprises two centrifugal pumps driven by 8-b.h p. motors, which are operated by similar starting switches. These pumps are used for pumping the return water from a well at the lowest point of the dock up into tanks near the accumulators.

Discussion.

The discussion on this paper was taken jointly with that on "Electrical Power in Railway Goods Warehouses," by Mr. H. Henderson. The first speaker was

Mr. Roger T. Smith (Great Western Railway), who said that both the papers were of interest as showing the amount of electrical working of railway apparatus that was now being carried out by one railway company. He then proceeded to criticise the lifting speeds of the various cranes referred to in Mr. Henderson's paper. The underhung jib crane at New Bridge-street warehouse would lift one ton in less than five seconds, which appeared to him too fast. The motor would always be running on its resistance, and would never get on to its proper curve. He thought the speed should not exceed 50ft. in one minute, and that the motor should be reduced from 15 h.p. to 6 h.p. The travelling hoists lifted one ton in 28 seconds; this speed was too low, and it appeared to him that it would be an advantage if it had been about 250ft. per minute. Mr. Smith criticised the speeds of the jiggers at the same place, which, he thought, might have been greater. The underhung jib travelling type was an excellent arrangement. He had seen this apparatus at work in Newcastle, and so impressed was he by its success that his company (the Great Western Railway) proposed to adopt them. With regard to the design of the electric capstans, these pulled one ton at 250ft. per minute, and allowing about 85 per cent. efficiency of the gear, the brake horse-power would be about 20. The author stated in the paper that the brake horse-power of the motors was 26, and he (the speaker) wanted to know if the reason for having a greater capacity was due to the fact that the motor was not a compound motor. He then touched upon the question of sweating in a capstan, and stated that, as this was inevitable, all fine-wire coils should be done away with, and only a series motor employed. A treadle should only close a main by a spring or counter-weight. There must be a resistance in series with the motor, which, in his opinion, should be cut out independently, preferably electrically. A brake was also wanted to prevent the series motor running away when it was running light. He stated that the capstan head should be driven direct by worm gearing, and, if possible, the overload circuit breakers should be outside the box altogether. He said he would have an electric heater inside every capstan box with proper ventilation holes, and cage the whole of the inside to prevent sweating. Discussing now Mr. Taylor's paper, he said that the Tyne Dock coal conveyor described by the author was a striking testimony to the economy of conveying as against jib hoisting. The paper pointed out a great economy in capital cost of structures and working, and he thought that before long conveyors for shipping coal into vessels would be used to a very large extent. The enormous maximum power required for cranes was an important point if they had a generating station of their own at a dock, for the load factor of cranes was very bad. At Fishguard, during the past year, the annual load factor for both lighting and power was 9 per cent., and for 11 cranes 5·3 per cent.; a conveyor would probably have an annual load factor of 30 per cent. He wanted to know of what material the belt used in the conveyor was made—rubber or plates?

Mr. C. W. Neele (Great Central Railway) discussed Mr. Taylor's paper, and asked if there were any safety switches or circuit connections in the jib cranes to prevent over-winding. His company had installed cranes at their Liverpool warehouses having a clearance of 18ft., and had provided safety switches, but these had to be done away with, as they could not get the load over the side of the wagon. The goods department of the Great Central Railway had been working with speeds of over 100ft. on short lifts, and he had been specifying taper winding barrels in connection with some cranes they were about to install with a view to minimising danger from over-winding. He thought a more sensitive controller was wanted. Liquid controllers met the difficulties to a considerable extent, but they were not altogether satisfactory.

Mr. C. H. Bayley (South-Eastern and Chatham Railway) criticised the general design of capstans, which allowed very little room in them for carrying out repairs. The wires, switches, and controllers seemed to be so fragile, that with continued damp the insulation broke down. Another objection was the difficulty of keeping a foot on the pedal with a strong spring acting against it, and at the same time handling a rope. It was a mistake to put too high a speed upon a capstan.

Mr. Henderson, in reply, said he quite agreed that it was a mistake to make the speed of cranes too high. Apparently the traffic people of different railways thought that by this means time could be saved, but when the complete operations of the crane were taken into account the amount of time occupied in lifting was very small compared to the total time taken to handle the goods. His cranes were provided with over-running switches, which were gradually run out with a little worm at the end of the shaft. The action of the switch, however, depended upon the amount of the load, and he thought it better to get a good man to drive the crane and dispense with such a device. With regard to electric capstans, there again the speed was high, but a large percentage had to be allowed for slipping in the rope. Capstans were notorious for wearing out ropes, due to their high speeds. The best plan was to mount all switches outside in a small box, even if the cables were underground. The North-Eastern Railway had been troubled with the phenomenon of dampness inside the capstan boxes, but heaters were found to be too expensive, and had to be removed where tried. He thought that compound motors ought to be the best for capstan working. They did away with special machinery, like friction brakes, described in Mr. Taylor's paper.

Mr. Taylor stated that the belt conveyor described by him was composed of plates 4in. to 5in. broad, but the conveyors now being installed were made of a belt of canvas and rubber mixture. With iron plates it was possible to use the conveyor as an ordinary spout for gravitation.

DIRECT CURRENT SELECTED FOR RAILWAY OPERATION IN BELGIUM.

Mr. Frank J. Sprague, the well-known consulting engineer of New York, has just received confirmation by cable from Mr. Bertrand, administrator of traction and material for the Belgian State Railways, that after long investigation it has been decided to adopt direct current and the third rail for the initial electric railway equipment at the Parc de Laeken, near Brussels. This decision, made in opposition to the strong technical influence of near-by German engineers, and in face of the claim made for single-phase operation, is regarded as of more than ordinary importance.—*Western Electrician*.

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NOTES ON POWER FACTORS.

BY A. K.

We are taught in text-books, lectures, colleges, and technical schools that when the current lags behind the pressure in a circuit supplied with alternating current, there is a component of that current which is not productive of power, and this is known as the wattless component. This is true, of course, as far as it goes, but it is a somewhat incomplete statement of what is happening, as will be shown later.

It is often said that simple choking coils may be employed for the purposes for which in direct-current working resistances are used, but latterly electrical engineers have come to realise the disadvantages attendant upon the presence of a large amount of wattless current in a circuit. These disadvantages have been most apparent to those who are interested in the supply of electricity by alternating currents.

The subject is one, however, on which a certain amount of confusion exists, and it is often found that the knowledge possessed by such an engineer amounts only to a vague consciousness that if the power factor is low it is better to try to raise it. A low power factor signifies something which it is better to avoid, if possible, but a true notion of its cause, effects, and remedy is often notably lacking.

There must be wattless current in any alternating-current circuit which contains apparatus whose working depends upon the presence of a changing magnetic field. We cannot get rid of wattless current. It has a purpose to serve, and all we can do is to see that it fulfils that purpose with the least amount of disturbance to the system. The magnetisation of motors and transformers, of choking coils, and of arc lamps—all these things give rise to a lag between the pressure and the current.

The true watts in the circuit divided by the apparent watts—*i.e.*, the product of the volts and the amperes—gives the power factor. The losses in a wire carrying a current are proportional to the square of the current, and the power factor varies inversely as the current if the true watts remain the same. Therefore, if we call the losses l when the power factor is p, and L when it is P, and denote the current by C, we have

$$l \propto C^2.$$

$$p \propto \frac{1}{C}, \text{ or } C \propto \frac{1}{p}.$$

Whence

$$l \propto \frac{1}{p^2};$$

that is to say,

$$l : L = \frac{1}{p^2} : \frac{1}{P^2};$$

or, again,

$$\frac{l}{L} = \frac{P^2}{p^2}.$$

We thus see that the losses in the mains vary inversely as the square of the power factor.

The drop of potential in any line is proportional to the current, and, therefore, inversely proportional to the power factor. These considerations affect any conductor in which the current is flowing, whether that conductor be on the generator, or on the motor, or in the mains. Its effect upon the generator is not limited to causing increased copper loss. The wattless current flows in a contrary direction to the current in the field coil to which it is opposite. This necessitates an increase in the strength of the field, and demands more power from the prime mover. The copper losses are increased in the field as well as in the armature, and, therefore, the temperature rise is greater. The working capacity of the set is made smaller when the power factor is low.

A point which is not often considered is the effect upon switches and circuit-breaking devices. The arc formed on breaking an inductive circuit is very destructive, and, of course, the larger current tends to heat the contacts. If the wattless magnetising current can be supplied to the apparatus needing it from some point only a short distance away, the generators, switchboard apparatus, and feeders are freed from the obligation of carrying it, and its bad effects are confined to the distributors between the source and the apparatus. Several articles have appeared in the technical Press during the past year as to ways and means of effecting this object.

Static condensers, if they could be brought to be a commercial success, would be, of course, the ideal means of bringing up the power factor. It does not appeal to the practical mind of an engineer, however, to invite him to bring the two poles of his system within a fraction of an inch of each other with only some paraffin wax, or paper, or glass between them. Certainly it may be said, with some amount of truth, that such a course invites breakdown, but it should be remembered that the poles of the system are brought very close together across some rubber, or prepared paper, in every cable that is laid, so that one would think risk of failure could be to a large extent obviated by the use of a suitable circuit-breaking device. A more considerable objection is the great bulk of such apparatus. The use of very high pressures has been tried with some success on the Continent, step-up transformers being employed to energise the condensers, which are, of course, smaller in size for high pressures than for low. There is reason to hope that it may shortly be possible to point to static condensers in satisfactory operation on large systems in this country.

Synchronous motors, the fields of which are super-excited, may be, and are, employed for regulating the power factor of systems having an extensive business in power supply, and these are frequently called rotary condensers. This is not a good name, however, as although the effect on the system is the same—viz., the current is caused to be in advance of the E.M.F.—the mechanism of the action, if it may be so styled, is not at all similar. The increase in the field strength of the motor causes an increase in the back E.M.F., which changes the direction of the resultant E.M.F. which is operative in causing the current to flow in the armature; this current in the armature makes the same angle with the E.M.F. driving it, whether the field be strong or weak. The angle between the armature current and that in the circuit may be varied to any desired extent, so that if the machine's capacity is sufficiently great it may be made to supply all the wattless magnetising current, and thereby to relieve the generators. The working of a static condenser has been aptly compared to the resiliency of a spring, and its action does not depend at all on a magnetic field.

The subject of the distribution of alternate currents is one upon which volumes might be written. In the limits of a brief article it is only possible to touch lightly, and very much at random, on some of the more obvious points. Very likely it will be said that volumes already have been written on the subject, but here, as in too many other walks of life, theoretical men and practical men are as far apart as the poles—not of the system, but of the earth.

ENGINEERING NOMENCLATURE.

BY ROBERT H. SMITH.

There are at least three distinct divisions of this subject, whose great practical importance has led to its being much discussed recently. One division is that of algebraic symbolism. Another is uniformity of technical names to be used throughout the whole English-speaking world. A third is the provision of simple short names for the units of different kinds of mechanical and other quantities.

The recent discussions seem to have been wholly confined to the proposal to standardise algebraic nomenclature. Is strict compulsory standardisation in this realm either desirable or possible? Is W to indicate weight, or work, or watts, or wit, or wisdom, or weariness? Is F to denote force, or friction, or foolishness, or fancy? Is P to mean pressure or potential; D depth or diameter; S shear or surface; H height or heat? All these things come into engineering daily practice; all are influential; all have to be taken into account. The people who use such symbols are in greater number physicists and mathematicians who do not look to engineers for guidance and who will not submit to engineering authority. The most liberal-minded mathematicians are those who insist that in learning and

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teaching mathematics it is most important to cultivate the habit of applying the same ideas to various symbols; of not associating particular ideas with invariable letters. If the Standards Committee decreed that W must always mean Work and nothing else, this would not prevent any mechanical student from using W to mean Weight whenever he found it convenient to do so. It would be impossible to prevent him doing so, because it would be really undesirable that he should not do so.

But a general recommendation that quantities should be symbolised by the first letter of the common name for the quantity would be welcomed by all docile students of physics, mechanics, and engineering. In reading and understanding the general bearings of a formula, it helps very greatly that the letters should suggest the things without any appreciable strain on the faculty of conventional memorisation. It need hardly be noted that this custom is now very largely followed in books and in lectures, and is not in need of being decreed by any authority. There are, indeed, still some perverse teachers who refuse to take the trouble to comply with this useful custom, an example being found in a recently published treatise on hydraulics; but they are a rare species which is rapidly dying out.

Long ago Prof. Andrew Jamieson invented and introduced the very ingenious system of naming parts of apparatus, etc., by the first two letters in their names. This helped very greatly in diagram marking and in reducing to conciseness technical descriptions of machinery and plant. In formulæ of extremely simple character, there should be no objection to using this system In chemical formulæ combinations of two, three, or four letters are used without inconvenience. But chemical formulæ are, for the most part, simple summations. Engineering formulæ take forms so much more complicated that the use of such combinations would in most of them be intolerably clumsy.

It is, however, worth while to consider the numerical richness of the possible symbolic vocabulary constructed in this way. We have 26 letters, capitals and "lower case" or "small"; that is, 52 letters. Combined in pairs and taken singly as well, they would yield $52 \times 52 + 52 = 2{,}756$ symbols. If we had to deal with printed matter only, "italic" letters could be distinguished from "roman." and the number of possible pairs and singles would be increased to $104 \times 104 + 104 = 10{,}920$; but in writing it is inconvenient to make this distinction, while, in this matter, any standardisation must be equally applicable to written and printed matter. Probably the great majority of the 2,756 symbols would need to be very arbitrary and not in any way suggestive by the use of the initials of the names of the things symbolised. The numerical richness of such a vocabulary can be increased by the admission of Greek letters. Incorporating italics and 24 "small" Greek letters into the system, the numbers of pairs and singles rises to 16,512; or, omitting the italics, to 5,852.

It is, therefore, unnecessary to consider the numerical capabilities of a system of letter combinations of one, two, or three letters. The utility of memorising even a quarter of the above 16,512 would fall far below the mental cost of doing so. We need to use our brains otherwise than in practising mnemonics. One other consideration ought to be noted. Scientific study is now thoroughly international. Any standardisation of algebraic symbols would be very unfortunate if it were not international. But in Germany "heat units" are invariably indicated by W, the initial of "Wärme-einheiten," while H is used always in English for the same thing; in Germany F means surface or area (Fläche), while either S or A is used in English, and F is quite unsuggestive of area to the English mind. Who is to decide between rival international claims upon the letters?

The second division of this subject seems to form a more useful field for reform. We ought certainly in the beginning of this twentieth century either to abolish shop slang altogether or else to adopt a uniform slang to be used everywhere throughout the country. It is an undeniable nuisance that precisely the same thing should be called by half a dozen absolutely different names in different places; that a Scotchman should be unable to know what a Lancashire man is speaking about, and that neither should be intelligible to a Yorkshireman, and none of the three should understand a Londoner, although all four use precisely the same implements and are familiar with precisely the same details of plant, machinery, and buildings. These local slang terms had their origins in times when communications were difficult and when school boards did not teach the same language and workmen did not read the same books everywhere. Their still abiding existence is an anachronism which ought to disappear. In this matter some compulsory pressure put upon the compilers of technical books, who are sometimes more anxious to demonstrate their familiarity with technical details and customs than they are to prove their ability to improve these customs or even to understand and interpret their scientific import, would be very decidedly useful.

The third division of the reform of engineering nomenclature is, perhaps, that most nearly ripe for immediate action, if physicists and scientists were not really as conservative of their peculiarities as are slangy workmen. This is the adoption of simple names for the units of frequently used quantities, names which shall have general rational significations and not be restricted by reference to any one particular set of units—such as feet, pounds, minutes, or metres, kilogrammes, seconds. In reasoning about areas it is inconveniently irrelevant to speak of square feet, or square inches, or square centimetres; the generality of the reasoning is only indicated by speaking of "units of area." But we have no simple name for a "unit of area," nor for a "unit of length," or of energy, or of work, or of velocity, nor for a general "unit" of any of the quantities we are compelled to think continuously about. Our sentences in explaining any argument, or in deducing any useful result, about such things are made very unnecessarily long and clumsy, and not infrequently unavoidably obscure to the point of unpardonable ambiguity—pardonable only because the elements of our language are incapable of helping us out of the trouble—from the lack of such simple names.

Many years ago the present writer compiled a list of such proposed names as examples of the way in which they can be formed on a uniform system. The plan is to add "on" to the root of the common idea name. Thus, for instance, we have the following samples:

FOR ANY AND EVERY SYSTEM OF MEASUREMENT.

Name.	Short symbol	= Generic unit of
Linon	L	Length, distance.
Areon	A	Area, surface.
Cubon	C	Volume, Cubic Capacity.
Masson	M	Mass.
Denson	D	Density, mass per cubon.
Gravon	G	Specific Weight, weight per cubon.
Chronon	χ	Time.
Angon	An	Angle, difference of direction.
Roton	R	Angular Velocity, angons per chronon.
Velon	V	Linear Velocity, linons per chronon.
Celon	Ce	Linear Acceleration, linons per χ^2.
Ancelon	Anc	Angular Acceleration, angons per χ^2.
Momon	Mo	Momentum, mass × velocity.
Pellon	P	Mechanical Force of any kind—*e g*, contact Pressure, weight, magnetic attraction, etc
Presson	Pr	Intensity of Pressure, pressure per areon.
Tenson	Tr	Intensity of Tension, Tractive force per areon.
Sheron	Sh	Intensity of Shear stress, tangential force per areon.
Stregon	Sg	Intensity of Stress of any kind.
Strennon	Sn	Strain of any kind.
Prennon	Pn	Contraction, strain of compression.
Trennon	Tn	Extension, strain of elongation.
Shrennon	Shn	Twist, Shear strain.
Torson	T	Mechanical Torque, Force-Moment.
Ergon	E	Work done; also Energy of any kind.
Agon	Ag	Time-rate of doing Work, Ergons per chronon.
Thermon	Th	Temperature.

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Alton	Al	Potential of any kind.
Toraron	Ta	Surface Moment of Inertia.
Torcubon	Tc	Volumetric Moment of Inertia.
Tormasson	Tm	Mass Moment of Inertia.

An Agon is the general, or generic, unit of the kind called horse-power or kilowatt, whose dimensions are $M^1 L^2 T^{-3}$.

The difference between an "ergon" and an "erg" is that while an erg is a perfectly definite and particular quantity of energy with a definite numerical measure—namely, 1 in the C.G.S. set of measures—an ergon may be more or less energy according to the set of measures employed, but it necessarily and always has the numerical value 1. It means simply "unit of work" or "unit of energy" without qualification as to any particular system of units.

Such are a few examples of how convenient and easily understood unit names could be framed systematically from existing well-known word-roots. If we had a statement to make about velocity irrespective of the special units of measurement employed, we would speak of so many velons; perhaps 6 velons, perhaps v velons. If we wished to refer to a particular velocity measured in special units—say, feet and seconds—we would have the choice of saying 6 foot-seconds, as usual, which is, in this case, the least because the shortest expression, or else 6 ft.-sec.-velons. But in the whole rational development of kinematics and in all general reasoning on every kinematic subject, it is not only unnecessary but also very objectionable to refer to specific measurements of velocity in ft.-sec. or m.-min, because so doing suggests the untrue inference that the reasoning does not hold unless the specific measures referred to are employed. The objectionable nature, and the danger, of using such specific language in what is really general reasoning and deduction would be very greatly increased if we ever reached the otherwise desirable goal of the universal use of only one set of specific measures, such as the metric. It is only because all British scientific engineers habitually employ several systems of measurement that we, or most of us, are at present saved from this danger.

In speaking of a volume in special measure we might either call it 7cm.^{3}, as usual, or 7cm-cubons. But as the whole of rational geometry forms a series of reasonings and conclusions that are equally true in all systems, and even when we have no system, of measurement, it is most desirable that this science of geometry should have a unit nomenclature of simple short form and of universal applicability. Therefore, we need the words linon, areon, cubon for the geometrical units in place of the clumsy phrases "unit of length," "unit of area," "unit of volume." At present we cannot say what we mean in geometry without using these clumsy phrases

A force in specific measures may be called either 3lb.-weight, or else $3 \times 32{\cdot}2 = 96{\cdot}6$ft.-sec.-lb. pellons. But if no special measures need to be referred to, it would be simply called 3 pellons, or, perhaps, p pellons. And since the whole science of dynamics is not in the least degree dependent upon the use of one or other system of measures, it is most desirable that this science should have its own general unit nomenclature, pellon, presson, etc, stregon, ergon, agon, whereby it may be enabled to express both its basic and its resultant complex ideas clearly and concisely without being forced to introduce irrelevant ideas. Any reference to pounds or kilogrammes or seconds or minutes is totally irrelevant in the statement of a reasoned dynamic law.

The whole of scientific theory is built up on general bases without reference to special measures. Therefore the use of the above generic unit names would very greatly simplify an enormous mass of wordy teaching and investigation, making it more concise and less ambiguous.

The habit of such language would also help towards the development of truer conceptions of physical quantities. For example, it is only because of the absence of these names from common language that very few students of physics have any conception of a velocity except as a directed length divided by a time. But another conception of this relation is that a time is a length divided by a linear velocity, or, again, an angle divided by an angular velocity. Possibly, even probably, the latter conception is the truer and more basic: that is, that our real knowledge of time is derived from knowledge of difference of position and of velocity. Another possible view is that distance, time, and velocity are physical entities having each its own independent existence, and that perhaps the linear law of relation between them is a conventional law imposed on them only by our human intellects in order to make our science of kinematics a simple and easy one. But problems like these, or any broad unprejudiced questionings as to the real relations between physical quantities, cannot be studied, much less solved, when our physical language is so weak and meagre as to preclude almost their intelligible statement and certainly their clear and concise statement; when its elementary forms seem specially constructed for the purpose of fettering and riveting every student-intellect in one rigid framework of ideas of very probably conventional origin; and when its feeble prolixity renders all argument and reasoning on difficult matters so verbose and ambiguous that its almost inevitable fate is to be lost in fog and killed by self-contradiction.

HIGH-VOLTAGE INSULATOR MANUFACTURE.*

BY WALTER T. GODDARD.

Porcelain Insulators.

The transmission of power by means of electric currents of greater or less voltage began with the introduction of the electric telegraph, and almost the first problem encountered was line insulation. It is of interest in this discussion to note that the first insulators successfully used were of porcelain. From that time to the present the progress has been rapid, the voltage having risen from two or three volts of the telegraph to a present prospective line voltage of 150,000, and from the lowest to the highest it has always been recognised that best construction involved the use of porcelain insulators. Fig. 6 shows sectional drawing of a high-tension insulator made of several shells nested together and arranged to be fastened together by means of thin joints of Portland cement. This is the conventional design and is used for all voltages, though the size, number of shells, and shape may vary with the voltage. In general, American high-voltage insulators are now made of several shells nested together, while European manufacturers still persist in turning complicated shapes from solid masses of dry clay.

The manufacture of porcelain is one of the oldest arts, but only recently has it in any sense been placed upon a scientific basis; in fact, potteries for the production of electrical porcelain exclusively have not been in existence for more than 10 years, and during that time it has been necessary to develop an entirely new system of handling pottery products. Porcelain for electrical purposes is a mixture of ground flint or silicon dioxide and feldspar, or ($K_2OAl_2O_3SiO_2$) potassium aluminium silicate, raised to vitrifying temperature, that is, to a temperature sufficiently high to melt the feldspar and permit it to unite the particles of flint into perfectly homogeneous body of uniform electrical and mechanical strength. The production of electrical porcelain differs from the ordinary pottery product in that, in addition to presenting a symmetrical and flawless exterior, it must possess inherent electrical and mechanical strength.

Process.—Flint and feldspar occur in nature as rock, which is reduced at the mine by grinding to a degree of fineness comparable to that of flour, and of equal whiteness. The modern electrical porcelain potter mixes the proper proportions of flint and feldspar and again grinds the material in the presence of water, in order to obtain intimate mixture. The mixture, or, as it is dubbed in the factory, "clay," is separated from the excess water immediately after leaving the grinding mills by means of filter presses, and afterward brought to uniform plasticity by means of kneading machinery. The first step in the construction of an insulator is to build a model 16 per cent. larger than the required insulator, and from this model to

* Paper read before the Canadian Society of Civil Engineers.

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make moulds of plaster of Paris. Fig. 1 shows a plaster model of a 60,000-volt insulator top from which the mould in Fig. 2 was taken. Each shell of a multipart insulator is treated in this manner, the inside contour of the mould being that of the desired shell. Fig. 2 shows a conventional power-driven potter's wheel, upon the top of which is fixed the mould partly filled with clay. The whole device is rotated rapidly, and a forming tool, whose profile is that of the inside shape of the shell under consideration, is forced into the mass of clay. A few revolutions usually accomplish the desired end, and the mould with its wet and plastic clay is then placed in a hot room of approximately 130deg. F. Within an hour

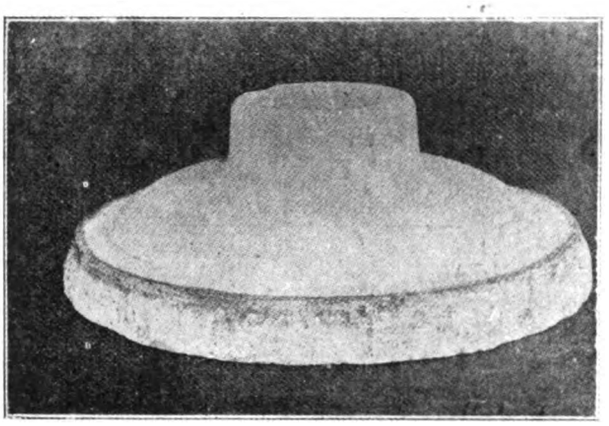

Fig. 1.

the warm air and plaster mould have absorbed a large proportion of the water in the clay, and the embryo insulator may be removed from its mould and the rough surface, which originally rested against the mould, scraped smooth. The shell, as it may now properly be designated, is set aside for a period of 10 days to two weeks in order that all water held by the clay be evaporated. If fired in this state the shell would come from the kiln hard, white, and quite rough, of good dielectric strength, but with a surface which would gather and hold dirt and soot, and, because of the extreme fineness of the irregularities, be practically beyond possibility of cleaning. For this reason, and no

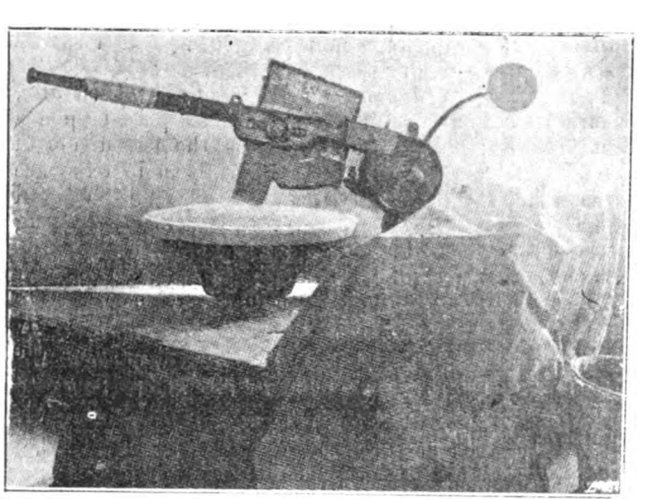

Fig. 2.

other, are the insulators covered with a glassy coating of extreme smoothness, capable of being washed by the gentlest rains. The glazing process is very simple. Immediately before being placed in the kiln the insulator shell, which in its dry state is about as strong as blackboard crayon, is dipped into a solution of clay and water and by virtue of its dryness absorbs a certain amount. On being heated the clay melts before the body vitrifies and so spreads very evenly over the entire surface. The presence of a small amount of iron in the clay is responsible for the brown colour so generally used in this country, although any colour can be obtained by the use of the proper materials in the glaze. The firing process is entirely a matter of temperature, and its complications are all practical ones, due to the large amount of material burned at one time and the difficulty of obtaining exact and uniform heat throughout the kiln.

Mechanical and Electrical Testing.—The mechanical properties of porcelain are so unvarying that a sample test has always been deemed sufficient. On the contrary, it is considered unsafe to permit any porcelain to go into service without testing each piece by means of a high-voltage transformer. As will be explained later, the higher-voltage insulators are made up of several shells each of which is subject to a high-voltage test of 50,000 to 60,000 volts. Fig. 3 shows the connections between the high-voltage transformer and insulator shells to be tested. Fig. 4 shows this method as practised. The table is insulated from the floor by means of porcelain cones in order that high voltage may be applied to the wire embedded in the table top and designed to make contact with the pans arranged for the reception of porcelain shells. The pans are filled with water, and so form one terminal of the high voltage. The other terminal is formed by water poured into the shell, attachment between it and the high-voltage overhead conductor being made by means of small chains. By some controlling device in the low-voltage side of the transformer, the voltage applied to the shells of porcelain is kept very near to arcing over, in most cases being about 55,000 volts. For ordinary commercial testing the spark-gap in air is usually employed when it is desired to ascertain the applied voltage. The number of failures is usually 2 or 3 per cent. of the number tested. When porcelain fails electrically the short powerful power arc through the very small puncture hole amounts to practically a short-circuit upon the testing transformer, and the excessive heat

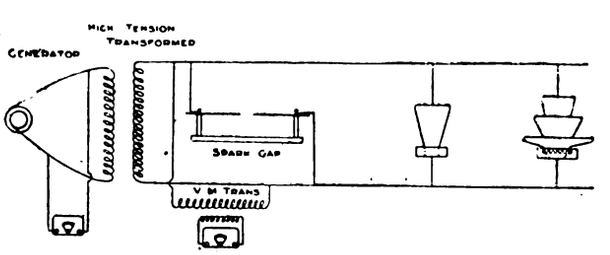

Fig. 3.

liberated in the porcelain often boils the water and destroys the shell. Once punctured the porcelain is ruined, and can by no method at present developed be recovered. The parts of multipart insulators are united by means of pure Portland cement mixed with water only. After the cement has obtained initial set the insulators are subjected to an assembled electrical test of double line potential for a period of time sufficient to remove all doubt as to the electrical strength of the insulators, usually from three to five minutes. To facilitate cementing and testing, racks, as shown in Fig. 5, are provided so that the operations may be performed with a minimum of handling. There is one very marked advantage in this manner of applying the assembled test voltage, and it is, that the voltage may be put on before the cement is dry enough to permit handling of insulators, so in case of failure by puncture of any shell it may be separated from the others without injury, a thing absolutely impossible once the cement becomes dry.

Design of High Voltage Insulators.—Insulators for the lower voltages call merely for the introduction of sufficient good material, between line and supporting structure, to prevent destructive leakage. For voltages up to 20,000 little or no difficulty is experienced in securing satisfactory insulation, but above that voltage it becomes not only necessary to have good material in plenty, but it must be properly distributed in order that the danger of puncture and severe leakage be reduced to a minimum. The manufacture of good porcelain from a mechanical standpoint forbids that it be made so vitreous as to resist a puncture test of 65,000 to 70,000 volts over $\frac{1}{4}$in. or $\frac{3}{8}$in. thickness. It is vain to attempt to gain greater dielectric strength by increasing thickness, since inherent cracks in thick pieces really reduce the effective electrical strength to that of $\frac{1}{2}$in. or $\frac{5}{8}$in. porcelain. Accordingly, it has come to be recognised as best practice to make no attempt to manufacture

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the higher-voltage insulators in a single piece, but rather to secure great electrical strength by multiplicity of parts. Though entirely possible to contruct 30,000-volt insulators of one piece and still safely apply a double potential test, years of experience have demonstrated that a multipart insulator is much less liable to fail entirely, when struck by stones or bullets, than are single-piece insulators, and so prevents complete shut-down of the transmission line. By far the larger proportion of shut-downs on the modern transmission line come from mischievously broken insulators. It is for this reason as well as for greater normal safety factor that engineers are selecting multipart insulators at higher cost, even for the lower voltages. In general, two-piece insulators are used for from 10,000 to 30,000 volts, three pieces for from 30,000 to 50,000, and four pieces for the 66,000 and 70,000 volt lines now in operation. Above 70,000 volts the underhung or suspended insulator works out most economically, and for entirely different reasons eight or ten shells of porcelain are introduced.

Considerations of puncture strength are the first concern of the designer. As before noted, good electrical and mechanical porcelain should be made of not more than $\frac{5}{8}$in. thickness with an ultimate electrical strength of not more than 70,000 volts. To gain greater electrical strength it is necessary to introduce other shells, which continue to add a proportional dielectric strength up to about 220,000 volts, at which point the curve gradually tends to become flat, and becomes very nearly so at 300,000 volts, so that it is apparently useless to utilise more than five shells unless some other condition is introduced. With this to start with, it is a very simple matter indeed to provide

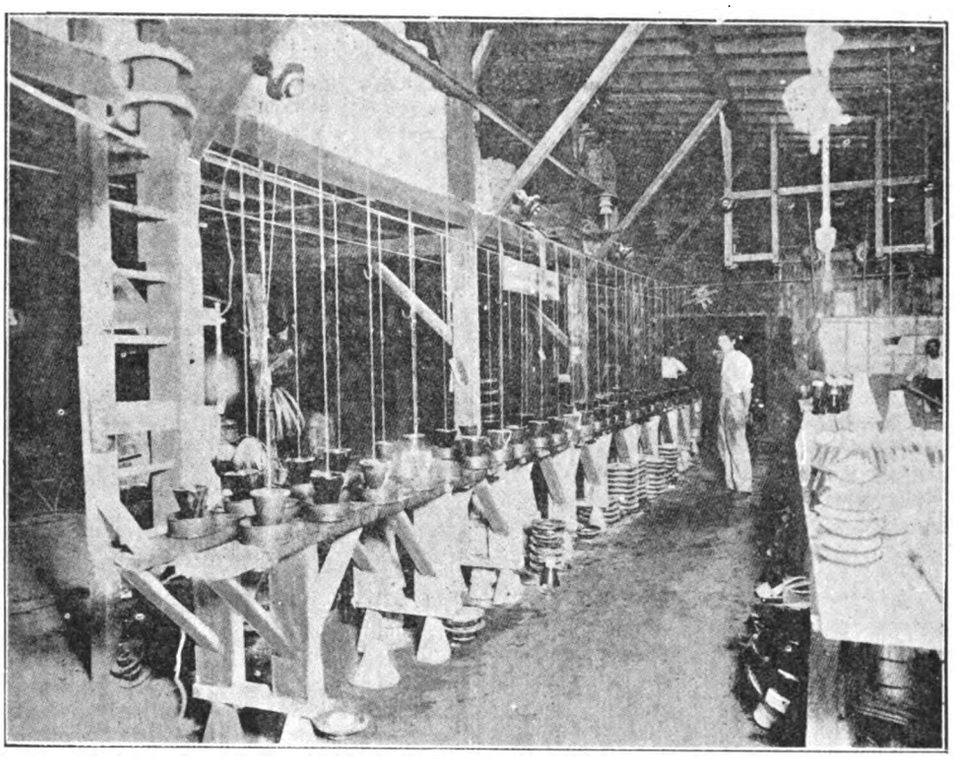

FIG. 4.

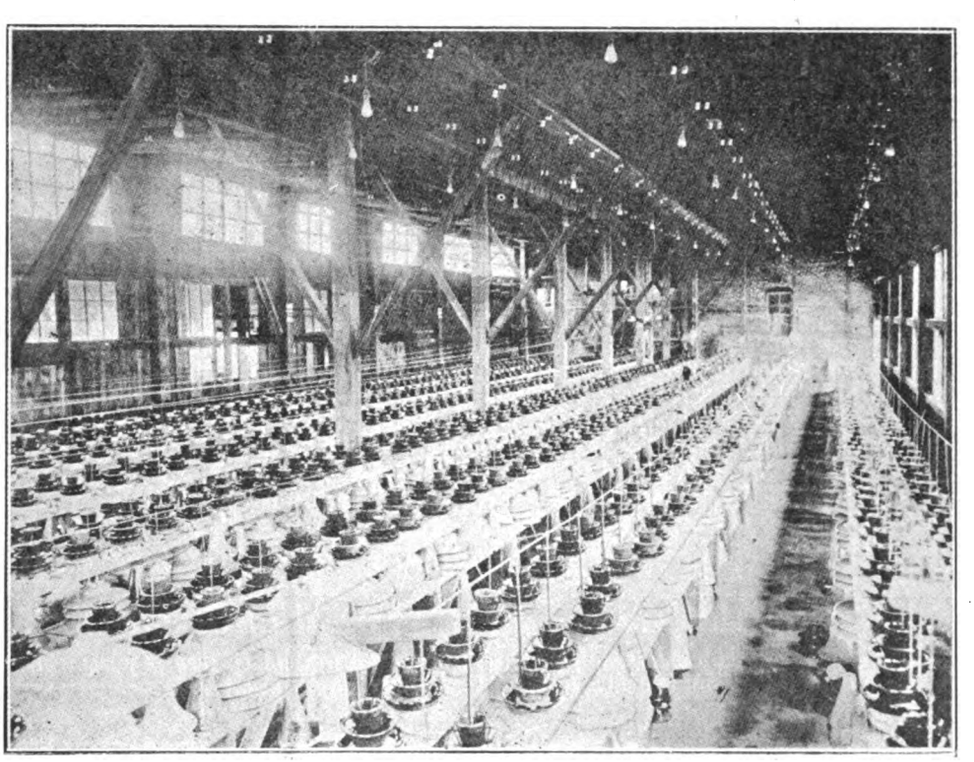

FIG. 5.

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economical insulators for any voltage up to the point where difficulty of manufacture begins to interfere with progress. The 10,000 and 20,000 volt insulators have little to do with puncture strength, provided, of course, that the porcelain is of good quality, and so the question reduces to an estimate of necessary leakage distance and carrying capacity when subjected to an artificial rain approximating the worst conditions to which the insulator will be subjected. This is not so simple as appears on the surface, for while an insulator may behave admirably under a downpour of unprecedented intensity, it is vain to expect Nature to limit herself to a vertical or what is technically known as a 45deg. rain, nor does she stop after five, ten, or fifteen

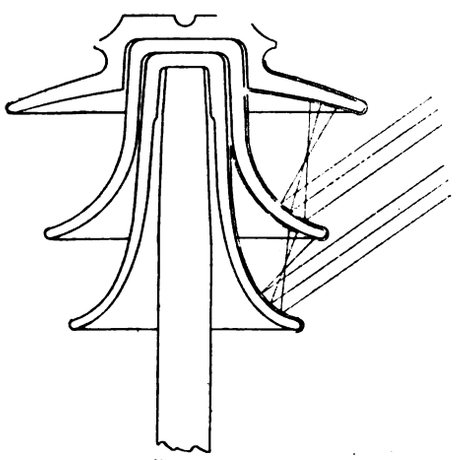

Fig. 6.

minutes, but is much more likely to accompany the downpour with sufficient wind to blow the rain very nearly horizontal, and to persist for any length of time. Under such conditions the insulator either meets its Waterloo or shows its mettle in the first 15 minutes, for at the end of that time all portions, except, possibly, the inside of the innermost shell, have become thoroughly wet and the surface leakage comes into play. As is well known, the persistence of any arc of definite length has to do with the voltage impressed and the current flowing, and the failure of an insulator is, of course, amenable to the laws which govern arcs. A designer should assume that his insulator will sometime become wet all over and should provide

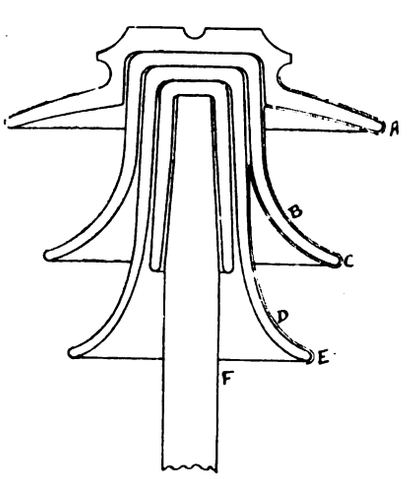

Fig. 7.

sufficient leakage resistance to prevent any considerable amount of current flowing, a small amount merely tending to dry off the insulator, whereas a large amount would quite likely start a disastrous arc under the shells and completely destroy them by its heat before extinguishing itself. Such an insulator represents very nearly the ideal, and it is regrettable that so few lines are equipped with insulators of so great a margin of safety. It must not be forgotten that only once or twice a year are insulators called upon to perform extreme duty—in fact, the insulators of most lines are for the greater part of the time working very inefficiently, probably at not over 20 per cent of their rated capacity.

The next best thing is to provide as much dry surface as possible under average storm conditions, and, to this end, it is of value to note the progressive wetting of an insulator under rain. It is customary to mount the insulator well above the cross-arm, so that all its shells are far removed from water spattering up from the arm. Assume an insulator of conventional design of three or four shells—the top becomes dripping wet at once, and the film of water held on the surface carries line potential to the outmost diameter. A certain amount of rain gets by the top and strikes upon the lower shells, part spattering upward and part downward, depending upon the angularity of precipitation. That portion which spatters upward soon wets the entire under surface of the shells above, and in this manner the potential is carried down to the lowest projecting shell. At this point the leakage path is broken, due to the fact that beneath the lowest shell there is no surface from which spattering may occur, and consequently it remains dry, but under this condition the central shell of the insulator is carrying the total strain both as to puncture strain and against flash over. Fig. 6 shows clearly the effect of spattering, the double line indicating the surfaces covered by a film of water, and thus carrying line potential down to the bottom of the lowest projecting shell. It may be further noted that between this double line, or line potential, and the pin there is but one effective shell which has been subjected to but 60,000-volt test, and lines of very moderate potentials have strains of this magnitude between line and earth. The shells must, of course, remain wet till the storm is over or some

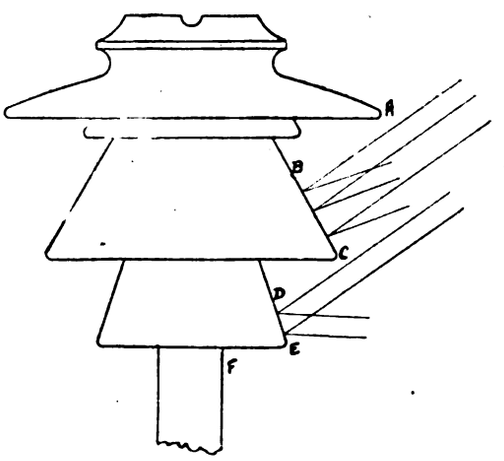

Fig. 8.

drying action is introduced. If the gap between the edge of the lowest shell and the pin is small enough a small arc will be established, thus completing the circuit and permitting a leakage current, formerly held in check by the dry inner surface of the shell, to flow, though limited in volume by the relatively high resistance of the pure water film covering the insulator. This leakage current heats and vaporises the water film, its first action naturally being where the current density is greatest at the neck of each shell, where, fortunately, the surface is not subject to the direct force of the rain. Since potential is in no way concerned with resistance, the thinnest and consequently highest resistance film of water is sufficient to inaugurate the drying process, so that an insulator in service cannot be caught unawares, and, if properly shaped, can care for itself.

From the foregoing it will be seen that the dielectric strength of the inner shell of any multipart insulator and the distance between its lowest edge and the supporting pin are of utmost importance, the remainder of the insulator serving as little more than a resistance in series or leakage distance to limit the amount of current which may flow when arcing takes place. To provide against the first requisite it is merely necessary to introduce a protected shell which cannot easily become wet. This is shown in Fig. 7, as is also the great distance between pin and edge of lowest shell. What has been said applies to insulators as it is necessary to build them to meet mechanical conditions imposed, and it is the mechanical characteristics, not the electrical, which influence their cost. Were it possible to make porcelain wire of great strength,

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an insulator of perfect certainty of action could be produced at minimum cost. An insulator should not be regarded as a barrier to current, but rather as a high-resistance path between line and earth, and its design should aim to serve this purpose. Referring again to Figs. 6 and 7, it will be seen that, as far as the ultimate strength of the insulator is concerned, the shape of the upper shells is of no moment, since they serve as series resistance only. There are reasons, however, why straight shells should be used and others equally good why curved shells should be introduced, but the adjustment between the desirable points of one and the desirable points of the other call for fine discrimination. Figs. 6 and 8 show straight and curved shell insulators subjected to a 45deg. storm which spatters most vigorously in the direction shown by the arrows. Of these two insulators the straight shell would probably keep dry the longest since a large portion of the falling water is deflected away. On the other hand, the distances A-B, C-D, and E-F are much greater on the curved shell type, permitting it to carry much greater potential previous to its becoming wet all over than could the insulator of the straight shells. The curved shells will thus be better able to take care of sudden potential rises when partly wet than will those of the straight shell form. However, this partly wet condition does not last long, as there is often abundant enough precipitation to entirely wet the shells, and it is only then that the insulator can be assumed to be operating under full load, a condition for which it should be designed. The foregoing applies equally well to low-voltage insulators, though up to 40,000 volts it is hardly necessary to provide protection for the innermost exposed shell, since its own strength is entirely ample.

(*To be continued.*)

ELECTRICITY IN FACTORIES AND WORKSHOPS.

Inquiry into Home Office Draft Regulations.

(*Continued from page 340.*)

After the adjournment Mr. C. P. SPARKS went into the witness box and stated that his principal objection to the regulations was their application to existing work In certain low-pressure stations he was responsible for it would be physically impossible to comply. The same applied to medium-pressure stations. Due to the fact that most of the older stations were for low pressure, there would be most difficulty with these. He proceeded to show plans of the Richmond station, where the space behind the switchboard varied between 2ft. and 2ft. 4in. There had been no accidents at this station, and in his opinion there was no material risk with competent men. It was quite impracticable to alter the arrangement without rebuilding the station and acquiring adjoining land. He did not consider he would be protected by the exemption clause, as the ordinary factory inspector would not take upon himself the risk of saying that the alternatives suggested were equally safe. Again, he did not think that the isolation of sections of switchboards asked for was possible on low-pressure boards. The risk in coal mines was much greater than in factories, as in mines one employé could risk the lives of all the others. He considered that the coal-mines' code of rules were satisfactory, and the qualification that they were to be applied "as far as practically possible" was reasonable. The mining inspectors were generally of a much higher class than factory inspectors.

Cross-examined by Mr. Gray, Mr. Sparks said that a competent inspector was more likely to secure safety without undue interference than an incompetent one. Mr. Trotter, of the Board of Trade, inspected his stations about twice a year. He agreed that for new work there was little objection to the proposed regulations, but there should be reference to an outside expert provided, and also a proper exemption clause. Three out of five of his stations would not comply with the rules Cross-examined as to the alternative means of protecting the Richmond switchboard, Mr. Sparks said he preferred bare conductors on porcelain insulators to any system insulating the 'bus bars. Screens would cut down the available space. He thought that the regulations showed that the danger due to the use of large currents had not been appreciated. This was much more difficult to guard against than danger due to high voltage. Re-examined, he said that he thought the inspector should tell you when you have broken the laws, and should not be looked upon to give advice as to what to do. The Board of Trade inspection was satisfactory. He did not think the Home Office should prepare a specification, and that the regulations should be made more general.

Mr. C. H. MERZ, examined by Mr. Vesey Knox, described the design of the sub-stations used on the Newcastle-on-Tyne supply system. They had 96 sub-stations, with 100,000 kw. of plant. A plan was shown of one of these in which the lines of switchgear were separated by brick partitions. The clear passageway was narrower than that asked for under the regulations. They had had no deaths from shock. He considered that the security of the supply must be considered as a factor in the case, and that an undue increase in the cost of the supply would seriously handicap the industries in the district. The Home Office regulation specifying only the clear space in front of a switchgear did not give safety. It was much more important to keep the panels separated in the way he had done. Again, there should be clear provision for showing a workman which panel he is working on. The single bar he had provided was much more safe on this than the three bars suggested by Mr. Ram. The iron guards suggested for isolating certain parts of the switchgear were not satisfactory, and were liable to cause accidents. They had put them in a few sub-stations and abandoned the use of them since. Cross-examined by Mr. Gray, Mr. Merz strongly objected to space dimensions being specified. They had in this way laid down a non-essential to safety. While he would trust Mr. Ram to accept alternative designs, he could not expect an ordinary inspector to do so.

Mr. W. W. LACKIE, of Glasgow, showed drawings of the Glasgow switchgear which did not comply with the regulations as to space. This switchgear was adopted as standard in 1893, and there had been no accidents from its use. He estimated that it would cost the Glasgow Corporation £120,000 to comply with the regulation in this respect.

The examination-in-chief of Mr. Lackie was continued by Mr. Pritchett on the resumption of the inquiry last Friday morning. Mr. Lackie declared that the passageways behind the switchboards in the sub-stations at Glasgow were perfectly safe against accident, although the dimensions did not comply with those specified in Rule 17. The position as regards a great many other stations was quite similar. He thought a difficulty would be overcome if the dimensions were struck out of Rule 17, and if a clause similar to Clauses 55 and 56 of the Coal Mines Regulation Act was adopted. Mr. Gray cross-examined him on the question of the safety of the passageway behind the switchboard at his station. Mr. Lackie admitted that the dimensions would not come up to those required by the rule, but contended that as the floor was of glass a man touching one of the 250-volt bare conductors would not get a shock. Asked whether in that case it would not come under the exemption, he said he did not think so, and he would have great difficulty in satisfying the inspector. Counsel suggested that all bare conductors should be either covered up or fenced, but witness thought this impracticable, though it would be possible to cover up each individual conductor with insulation and make the switchboard absolutely safe. As to covering the rheostats, he did not approve of this course, because arcing might take place without the operator knowing what was going on, and counsel submitted that that difficulty might be overcome by covering the apparatus with a glass plate. He admitted that it was possible to cover up all the bare conductors on the switchboard at the Glasgow stations and so reduce the number of places in which workmen run risk. In re-examination by Mr. Pritchett, he said that the alterations suggested by Mr. Gray, even assuming they were practicable, would not make for practical safety, and in some cases might increase the danger from fire. He objected to spending the additional large sums of money

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which the alterations would necessitate without any practical safeguards being secured. His station was under the provisions of Section 17 of the Factory and Workshops Act, and factory inspectors had visited the premises regularly, but none had ever suggested that there was any danger to life and limb in any of the works.

Mr. A. A. CAMPBELL SWINTON next gave evidence. He said he appeared in the interests of 42 generating stations (mostly of the small order) supplying power under provisional orders, and pointed out that the regulations, especially No. 17, would affect small concerns to a greater extent than they would large ones. The financial conditions of electricity undertakings in this country were by no means flourishing, and the structural and other alterations required by these regulations would entail a great deal of money, which it was at present difficult to obtain. As to the question of danger, it was impossible to make a thing absolutely safe, and in his view it was better to leave live parts bare so as to teach workmen to be careful. He thought the regulations were framed for the protection of the Home Office, so that if an accident occurred they could say they had done everything that was possible. He knew of many cases where the spaces defined would not be arrived at without the reconstruction of a whole building. Cross-examined, he had no objection to applying the dimensions to new works, but he considered them impracticable in the case of old works.

Mr. H. TALBOT, president of the Incorporated Municipal Electrical Association and chief electrical engineer at Nottingham, also gave evidence, in which he urged that the dimensions specified in the rule were unnecessary in the case of low-pressure stations, and that, if insisted upon at Nottingham, would require structural alterations.

Mr. W. B. WOODHOUSE also claimed that the arbitrary dimensions were objectionable, especially as regards switchgear. He referred to a multiple-control board where direct current and alternating current were worked in conjunction, and said that if the pressure of the alternating current was 100 volts, it would bring that board under Section 17. It was difficult to see how horizontal boards could be treated under this section.

With this evidence the consideration of Rule 17 was concluded, and Mr. RAM was recalled for cross-examination on Rule 12. In reply to Mr. Vesey Knox, K.C., he said he was informed that no-voltage release apparatus was made suitable for three-phase work, but he could not give particulars of any standardised article which would comply with the requirements of this regulation, and promised to supply these later. He knew of cases of accidents happening through the absence of such apparatus. He instanced that of a printing machine which failed through the fuses blowing in another room; the electrician replaced the fuses unknown to the man in charge of the machine who had forgotten to turn off a handle—consequently when the machine suddenly restarted the man was killed. If a no-voltage release had been employed, such as was required by this regulation, the handle would have been turned off automatically immediately the fuses blew. Mr. Knox contended that some consumers had from 250 to 300 three-phase motors in constant working without any accident, and under this section they were being made liable to criminal prosecution for not using an apparatus which Mr. Ram admitted he had never seen. Moreover, the cost of providing a no-voltage release for each motor would be prohibitive. Mr. Ram explained that one apparatus might work several motors. It would not be sufficient to employ only one release for a whole works where there were machines in different rooms, but one would suffice for a group of machines. In recommending its use, he was largely guided by the Institution Rule 91F, which provides that the starting gear of a continuous-current motor must consist of a regulating switch and a series resistance "fitted with a no-volt release." Counsel pointed out, however, that there was a permanent committee sitting which could easily alter this rule from time to time, whereas a factory regulation could not easily be altered. Mr. A. B. Caine (counsel for the London supply companies) pointed out that if the Institution regulation requires a release on every motor, this was really more than Mr. Ram was asking for. Mr. Ram agreed to amend the second paragraph, to make it clear that one release would be sufficient for a large number of motors in one room. Mr. Siemens asked with reference to the second paragraph who was to judge whether there was danger, and suggested that it would be better to add the words recommended by the Institution, "unless the motor is automatically prevented from starting."

Mr. Cozens-Hardy took up the cross-examination of witness after the luncheon interval. He asked what additional safety was introduced in the case of lifts by the use of a no-volt release. Most lifts were fitted with spring switches which automatically came off when the lift stopped working. He thought no additional safety would be secured by insisting upon the use of automatic apparatus in the case of a travelling crane; the no-volt release would always be some distance from the crane. He wanted to know in what way the apparatus would assist in a large factory with a motor in the basement working machines on the ground floor by means of rope control. Mr. W. B. Woodhouse urged in his cross-examination of Mr. Ram that the cost of fitting a no-volt release to every motor might increase the capital cost of electric driving in mills and factories, and so handicap electricity in competition with other forms of power for industrial purposes. He contended that the real protection against accidents from moving machinery was that people should be instructed not to touch the machine unless they had put the belt on the loose pulley, but Mr. Ram submitted that a no-volt release would be an additional safeguard. He pointed out, however, that if danger could be prevented by fencing, as was suggested by Mr. Woodhouse, there would be no need for using no-volt release apparatus. Mr. Sillar suggested that heavy cranes, capstans, and all classes of machinery which are continuously under the control of a man should be exempt from the requirement of this rule. A representative of the Birmingham Chamber of Commerce, speaking from the point of view of the manufacturer who had an installation to protect, contended that by adding to this installation a lot of automatic appliances the risk of that installation was considerably increased, but Mr. Ram pointed out that 75 per cent. of motors were already fitted with automatic devices.

This concluded the cross-examination of Mr. Ram, who was then briefly re-examined by Mr. Gray. He explained that the form of the third section of Rule 12 would be modified so as to read, "In every place in which machinery is being driven by an electrical motor there shall be means at hand for switching off the motor and stopping the machinery." With reference to the second paragraph of the rules, he could conceive no circumstances where this would not apply if there was one release for all the motors on an occupier's premises.

Mr. SWINBURNE here stated that the rule as it stood scarcely gave what the Home Office required, and he thought it might require redrafting.

Mr PATCHELL was next called on behalf of the Home Office, and expressed in a general way his views concerning the use of no-volt releases for alternating and continuous current motors. The apparatus was quite simple and reliable for continuous-current working, but for alternating currents more difficulty was encountered. He had used them for 200, 440, and 1,000 volts, but not for small motors. The expense was an important item, but could be met to some extent by grouping the motors under one piece of aparatus. He mentioned the names of makers of no-volt release apparatus for alternating-current motors.

Mr. C. H. MERZ was then called and examined by Mr. Vesey Knox. He said that he knew of from 3,000 to 4,000, and possibly 5,000, three-phase motors in use, not one of which was fitted with no-volt release apparatus He did not know of any motor in the world which was so fitted, nor did he know of any standardised article on the market for use with alternating-current motors. His supply was very seldom interrupted, and the tendency towards interruption of a public supply was nowadays diminishing. It would be absurd in his opinion to group motors on an alternating-current release in a factory or shipyard or colliery. The release would have to be fitted to the motor-generator, which would be undesirable. Its use would be an additional source of failure of electrical apparatus.

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There were even cases of continuous-current motors where this device was never applied, such as crane, winch, and other motors used in docks and elsewhere. In those places there was always a man in attendance who could break the circuit in the event of an interruption of the current supply. Mr. Gray, counsel for the Home Office, put the following question to Mr. Merz: Suppose a machine driven by a motor without an automatic release; the supply fails, and the man is in the meantime in some dangerous part of the machine. Suddenly the supply comes on, and the machine starts without any warning to the man. Would that be a desirable thing? he asked. Witness replied that if he were designing some work with machinery of such a complicated nature, he would use automatic release apparatus. He said, further, that shunt-wound motors and no-volt release were essential, but except in this the release was not necessary in other than exceptional cases. Counsel pointed out that installations in shipyards were grouped, and each circuit had a maximum cut-out or fuse, and asked why a no-volt release should not be used. Mr. Merz replied that such apparatus would be of no practical value in a shipyard, where some of the circuits were a mile or so long. He objected to this clause because it imposed upon 95 per cent. of the consumers the use of apparatus for which there was no necessity, while to about 5 per cent. a no-volt release would be of value. He considered it unnecessary to frame a rule for these exceptional cases, which were already covered. Moreover, he had never heard it suggested that such a device should be provided.

At this stage the inquiry was adjourned till Monday, March 16, at 10.30 a.m.

COST OF POWER PRODUCTION.

A well-informed paper on the "Cost of Power Production" was read at Glasgow before the Institute of Engineers and Shipbuilders in Scotland at a recent meeting by Mr. I. V. Robinson, Wh.Sc. The author dealt with the subject more particularly from the point of view of a comparison of the possibilities of water power and the gas-engine, with the latter fed from the waste gases of blast furnaces and coke ovens. The adoption of the gas-engine in this manner would render available about 1,500,000 h.p. in Great Britain. He compared the cost of power generated by gas and by water, as it appeared that in the generation of power in large quantities from coal, gas-engines would be almost exclusively used. Taking a power station designed for a continuous output of 20,000 b.h.p., he estimated the capital required, assuming (1) that waste gas from blast furnaces was available and (2) that gas producers and ammonia recovery plant had to be provided. With these capital costs he compared the costs of water-power stations of about the same output. As an up-to-date example of a water-power station he instanced the cost of equipping two stations on the River Aveto, in Italy. The total cost of these two stations was estimated at £640,000, or slightly over £14 per horse-power developed, including the cost of the transmission line, transformers, and distribution system. Another instance quoted showed the cost per horse-power as low as £8. 14s. Recent figures published by Prof. S. P. Thompson showed that the cost of water power at Notodden for the Birkeland and Eyde nitrogen-fixation process were ·025d. per unit, equivalent to 13s. 7d. per horse-power per year.

Gas-engines capable of developing 4,000 b.h.p. as a normal load had recently been set to work in America. The United States Steel Trust had recently placed an order for 36 engines, of 4,000 b.h.p. capacity each, of the four-cylinder, twin-tandem, double-acting type. The largest gas-engine working in Great Britain had a diameter of about 51½in. diameter, the stroke being about 55in. The latest practice was to have tandem double-acting cylinders even for driving blowing cylinders, as that reduced the maximum force exerted by each explosion. The tandem double-acting engine ran with sufficient regularity to drive 25-cycle alternators in parallel with a moderate flywheel capacity. The foundations required, however, were generally more expensive than in the case of a steam-turbine. The capital cost of a 20,000-b.h.p. gas-engine power station using blast-furnace gas was given in the following table:

		Cost per B.H.P. according this estimate.
Nine twin-tandem double-acting gas-engines to develop 2 500 b.h.p. at 94 revolutions	£112,500	£5 12 6
Nine 50-cycle 5,000-volt three-phase alternators for direct coupling to gas-engines	26,000	1 6 0
Centrifugal-type gas-cleaning plant	12,000	0 12 0
Switchboard, motor-generators, and connections to alternators	10,000	0 10 0
Engine-house, 470ft. by 80ft. steel structure, brick filled, with 20-ton crane	24,000	1 4 0
Foundations for gas-engines and engine-house, about 14.000 cubic yards	14,000	0 14 0
Cooling towers for jacket water, 300,000 gallons per hour	2,000	0 2 0
Water-pumps, air-compressor, and reservoir for starting gas-engine	1,500	0 1 6
Incidentals and supervision	11,000	0 11 0
	£213,000	£10 13 0

Using producer gas the station equipment would not be altered, except that a gas-producing and ammonia-recovering plant would be substituted for the gas-cleaning plant. This would bring the cost per brake horse-power up to £13. 16s., as compared with £10. 13s. for a blast-furnace gas station. The following table was given to show the working costs per brake horse-power per hour in the case of a works where steam plant had gradually been dispensed with in favour of gas-engines using blast-furnace and coke-oven gas:

Year.	Plant.	Units per annum.	Working costs per B.H.P. per hour.
1900-1	Steam only	1,789,781	·629d.
1901-2	Gas and steam	1,930,740	·554d.
1902-3	,,	2,007,290	·428d.
1903-4	,,	5,387,612	·212d.
1904-5	,,	9,999,216	·147d.
1905-6	,,	14,915,919	·116d.
1906-7	Gas only	24,000,000	·047d.

The output for 1906-7 of 24,000,000 units corresponded to a load factor of 50 per cent. calculated upon a full year of 8,760 hours. With a higher load factor the working costs per unit are decreased. M. Greiner gives the following figures based upon his experience:

Load factor.	Working costs per B.H.P. per hour.
25 per cent.	·0864d.
50 ,,	·0465d.
75 ,,	·0311d.
100 ,,	·0233d.

For a load factor of 95 per cent, which may be attained in electro-chemical or electro-metallurgical works, the total working cost per brake horse-power per hour would be about ·024d.

Having enumerated some of the disadvantages inseparable from a water supply, the author concluded as follows: "The gas engine using either blast-furnace or producer gas could be adopted with great advantage by public power supply companies and by municipalities where there is a good day load. Gas-engines should be installed of sufficient capacity to deal with the average day load, and steam plant kept to deal with the peak. With this arrangement the gas-engine plant would always be working with a high load factor, and would be able to generate power cheaper than an equivalent steam plant. This combination of steam and gas plant has several advantages, and is now receiving the careful consideration of many power supply companies.

A discussion followed, most of the remarks centring round the author's contentions with regard to the gas-engine. Mr. W. W. Lackie, dealing with the more purely electrical part of the paper, said the two methods described in the paper did not apply to a city supply except so far as it was referred to on the last page of the paper, and he would deal with the subject from a public supply company's point of view only. He would ask Mr. Robinson a question. On p. 20 he said the case stated by him was based on a 95 per cent. load factor. Was such a load factor possible in any ordinary industrial concern? As a rule, no manufacturing was carried on on Sundays, and there was a half holiday on Saturday afternoon, and generally about 14 days' holidays in the year. That in a works running 24 hours a day throughout the year at maximum load would give a load factor of 75 per cent. A dead steady load of maximum output even for that time would not be

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obtained. There were times of maximum and minimum demand which further reduced that 75 per cent., and in practice it was found that a night and day factory did not in itself have a greater power factor than 50 per cent. He felt that Mr. Robinson would have done better to work out his theoretical cost at a lower power factor than 50 per cent. From the figures given it seemed that the total annual bill for working cost in the instance given was the same in 1900, when 1,700,000 units were being sent out, as it was in 1907, when sending out 24,000,000. Also they saw from the table of works costs, varying with the load factors, that the works costs were inversely proportional to the load factor. That was to say, a load factor of 100 per cent. had half the works cost of a load factor of 50 per cent., and a load factor of 25 per cent. had a quarter the works costs of 100 per cent. load factor and half that of a 50 per cent. one. The other standing charges varied absolutely in the same way. That being so, all the figures given on p. 22 as the cost per brake horse-power per year on a 50 per cent. load factor would be practically doubled, and would give "the 15 years' life of the plant" at £5. 5s. per brake horse-power per year. Taking the supply of electrical energy in a city like Glasgow, where the load factor was only 15 or 16 per cent., even then these figures would require to be multiplied by 6·3, and it would be found that the cost would be £16. 6s. per brake horse-power per annum. It was no use telling a consumer that if he would only use the supply twice as long as he did his rate per unit will be reduced. His annual bill would be greater although his rate per unit was less. What was the average charge per horse-power per annum in Glasgow at the present time? Last year the demand was equal to 27,000 h.p. with a revenue of £224,000, or an average cost per horse-power per annum of £8, which compared favourably with the apparent cost of £16 for the gas-producer plant with the same load factor. At the same time they had quite a number of consumers whose rate per horse-power per annum was in the neighbourhood of £2. In Glasgow they now wanted units of 5,000 h.p. to 10,000 h.p., and no gas-engine of that size could be had, and if it could, the capital cost would be very much greater than the cost of a turbine of the same size. The capital charges amounted to 70 per cent. of the total cost of electrical energy, and, therefore, it behoved the supply authority to keep down the capital cost per kilowatt to the lowest figure. What was the record of gas-engine stations even of much smaller powers? In a town near Glasgow some 12 or 15 years ago gas-engines were installed, and they were replaced by steam plant within two years. A few years later a city in Ireland erected a gas-engine station, and that had to be abandoned at great expense to the ratepayers. Only last year a well-known Colonial city started up a very large gas-engine station, which had since been dispensed with in favour of steam plant. The gas-engine might come all right (some people said they were to get a gas-turbine), but the supply authority could not put aside the present demand and ask the consumers to wait. The corporation and the company alike must meet the obligations to which they were committed.

STORAGE BATTERIES AS APPLIED TO HEAVY TRACTION.*

BY S. R. GIBBON.

Storage batteries are often used without any means of regulation whatever—*i.e.*, simply as a floating battery, the battery freely charging or discharging according to the load fluctuations. The number of cells is so selected that when the direct-current generators or rotary converters, as the case may be, give approximately their average load, their E.M.F. will equal the line voltage. Thus, when the generators are loaded below the average the battery charges, and when loaded above the average discharges. It is essential that the generators have a falling characteristic. Even with such an arrangement the load on the generators is more constant than without batteries.

One of the chief objections to this system is that the efficiency of the whole plant is lowered by having to run the power station once in every two or three weeks at a higher voltage solely for the purpose of fully charging the batteries to prevent sulphating. It is more general to regulate the batteries by the installation of a booster in series with them, and, further, it is nowadays usual to make the booster reversible, in which case the battery can be discharged at pressures below the line voltage, the booster making the excess of line voltage over battery voltage, instead of only the excess of battery voltage over line. Taking 1·7 volts per cell minimum on discharge and 2·7 maximum on charge, with a non-reversible booster it would require 353 cells on a 600-volt system and 354 volts boost for charge. With a reversible booster under the same conditions, only 270 cells would be required and 130 volts boost for charge. There are two principal types of reversible booster employed—first, one in which the booster field is varied by the addition of compound windings, and, second, one in which the excitation of the booster field is regulated by suitable relays. This paper is based on the former type, and, further, the particular make known as the "Lancashire booster," a description of which has already appeared in the *Electrical Engineer*.

The salient points, however, are three coils on the booster field, A, B, and C. A is a shunt across the booster, which gives a boost that makes the algebraic sum of the booster and battery voltages at all times and in all conditions equal to the line. Coils B and C cause the battery to charge or discharge. B is connected across the mains, is reversible, and hand regulated. C is either in series with the booster if the battery is in an independent sub-station, or in series with the load on the generators if the battery is used in conjunction with a generating or rotary sub-station. The size of battery installed in a particular Lancashire and Yorkshire battery sub-station is 1,600 ampere-hour capacity—*i.e.*, traction rating—normal rate of charge or discharge, 800 amperes; maximum rate of discharge for one minute, 4,000 amperes; maximum rate of charge for 15 seconds, 1,600 amperes. With a reservoir capable of dealing with peak loads of this magnitude, it enables the whole plant to be run on fewer units; alleviates the severe mechanical strains thrown on the prime movers; particularly is this of importance with reciprocating engines. Further, reciprocating engines are not economical on overloads, nor Parsons turbines on light loads; therefore, a fairly constant load is of the utmost importance. It necessarily follows that the boiler-house will also derive benefit therefrom.

The ideal system so far as the load on the power-house is concerned is where the battery and booster are placed under the same roof as the rotaries. In this way the rotaries can be run at almost full load, which is their point of highest efficiency, and the power factor is greatly improved. To state a specific case, a rotary was supplying 300 amperes charge, when a demand came on the station calling forth instantly 1,900 amperes; 1,500 amperes were supplied by the battery and 400 amperes by the rotary, giving a ratio 2 to 9. On the Lancashire and Yorkshire four out of the five batteries are not installed at the rotary sub-stations, but at intermediate points. The location of batteries in these positions does not enable a constant load to be maintained at the rotary sub-stations, as peaks directly opposite them are not dealt with by the batteries at all. However, the ratio of maximum to minimum load at the power-house has been reduced from 7 to 1 to 2 to 1. In consequence of this particular location—*i.e.*, batteries between the rotary subs—the C^2R losses in the third rail and return have been halved, and this practically balances the losses in the battery, the net output from the sub-stations being the same whether the batteries are in use or not. The voltage at the points where the batteries are installed is greatly improved, being kept within 10 per cent. to 15 per cent. of rotary sub-station voltage. From this it follows that the train acceleration is better and timekeeping generally improved—points of vital importance. The engine hours may be reduced by getting the first train away in the morning and the last train home at night without the aid of the power station or subs. In starting up the sub-stations use may be made of the battery current to get the batteries into motion, which is a very great convenience, and rather more than would appear to be the case at first sight. As a stand-by in case of breakdown they are, perhaps, of most importance to the public, as they are not inconvenienced by being plunged into darkness, supposing the failure to occur at night.

* Abstract of paper read before the Liverpool and District Electrical Association, Feb. 25, 1908.

ALTERNATING-CURRENT RECTIFIERS.

Three patents have been granted to Mr. G. W. Pierce which described rectifiers for alternating current, making use of the

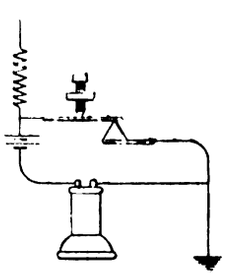

FIG. 1.

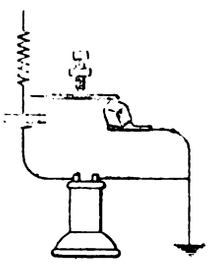

FIG. 2.

asymmetrical conductivity of various substances. In one patent which relates to the use of rectified alternating current with unidirectional ammeters, the inventor states his preference for carborundum as the asymmetrical conductor. In a second patent, which relates more particularly to detectors for use in wireless telegraphy, the substance employed as an asymmetrical

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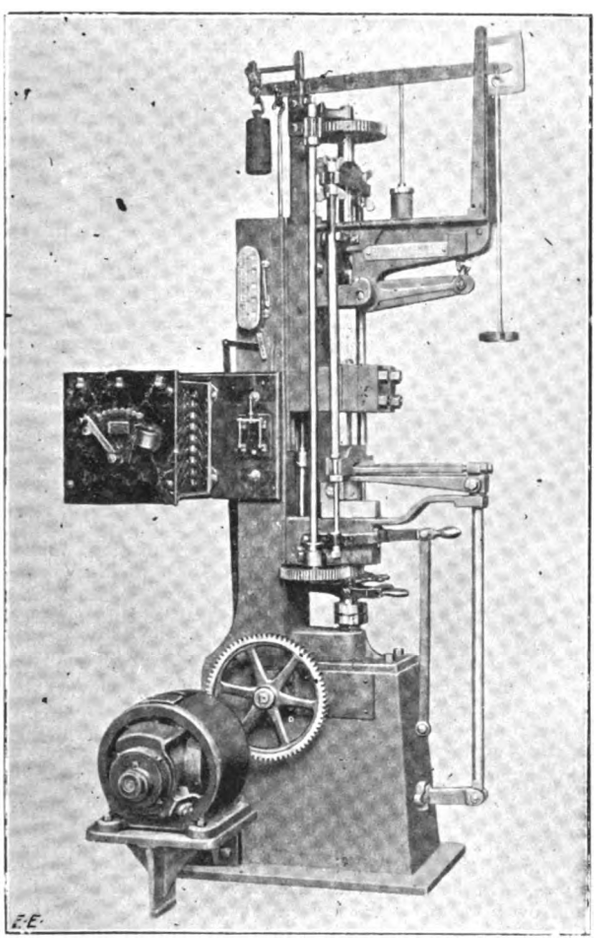
conductor is the oxide of titanium. The crystal is cut out on a plane substantially at right angles to its axis, and one of the electrodes is engaged with a point or corner of the crystal so that a small area of contact is secured. It is stated that when the substance is placed as shown in Fig. 1 it is highly sensitive as a detector of electromagnetic waves. In Fig. 2 a similar arrangement is indicated where telluride of silver is used as the asymmetrical conductor. The use of the latter substance for this purpose is covered by the third patent issued to Mr. Pierce.—*Electrical World.*

OLSEN'S NEW MOTOR-DRIVEN VIBRATORY TESTING MACHINE.

The illustration shows an Olsen new vibratory and endurance testing machine driven by a type "R" Westinghouse motor. The machine is designed for testing staybolt material under conditions exactly duplicating those met with in actual use. Staybolts as used in locomotives are subjected to severe strains due to vibrations and temperature effects, and thus a simple tensile test does not answer all the requirements. Early tests of this material vibrated the specimen in a to and fro motion

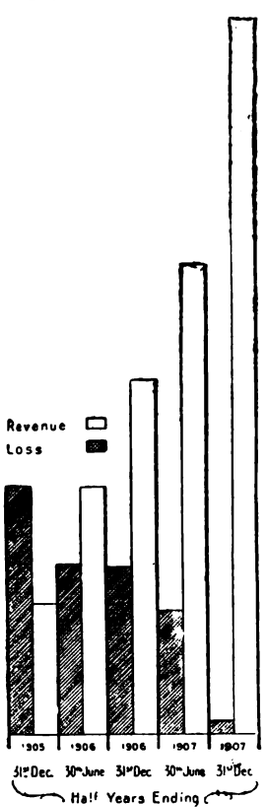


only, and the results thus obtained were not comprehensive enough to be reliable. The Olsen machine makes the test complete by subjecting the specimen to an oscillating vibratory motion while under a tensile load. It will test staybolts up to 1¼in. in diameter, and it grips the threaded bar so that no preparation of the test piece is necessary. The specimen is held firmly in the frame of the machine at one end, and the other end is clamped in a ball around which a bearing is rotated eccentrically to produce the desired strain. A total eccentricity of ⅜in. may be placed on specimen, as is indicated on a scale, while under a tensile load reaching 4,000lb. as a maximum. The revolutions or number of vibrations necessary to cause rupture are shown by a counter. Specimens of from 5in. to 8in. length from point of application of eccentricity to fixed supports may be tested.

In addition to this test for a staybolt, the illustration shows an attachment by which the ordinary pendulum motion may be transmitted to specimen when required. An attachment may also be obtained with this machine by which an initial fibre stress may be placed on specimen and thus vibrated, if preferable to subjecting specimen to a known eccentricity. The machine shown is exceedingly compact. Its direct connection to the Westinghouse motor affords a form of drive that is exactly suited to its requirements. The motor may be attached to a convenient lighting circuit and run day and night throughout the test without special attention. A comparison between power from a line shaft and individual electric motor drive demonstrates at once the superiority of the later in every point. The simplicity and reliability of the type "R" motor and its uniform performance adapt it especially for this class of work.

THE YORKSHIRE ELECTRIC POWER COMPANY.

The diagram below shows the comparative growth of revenue and decrease of loss which have occurred in the business of the Yorkshire Electric Power Company, Limited, during each of the past five half years. The revenue has made continued increases of a substantial nature, while the loss has now reached vanishing point. In the diagram the blank spaces represent revenue, while the shaded spaces represent loss. For the half-year ending Dec. 31, 1905, the revenue amounted to £1,297 and the loss to £2,407. The relative positions were transposed during the next half-year, when the revenue amounted to £2,475 and the loss to £1,684. This satisfactory development was continued in succeeding half-years, the revenue increasing in the latter half of 1906 to £3,523, and the loss declining to £1,664; in the first half of 1907 the revenue amounted to £4,700 and the loss to £1,211. For the half-year ending Dec. 31, 1907, after payment of mortgage interest (£975), the



net revenue account, amounting to £7,294, showed a loss of £139. These figures and the accompanying diagram clearly show the growth of revenue. A steadily increasing demand for energy and the reduction in the average cost of production which this must bring about, should assure the profitable and continuous growth of the company's business.

BURTON AS AN INDUSTRIAL CENTRE.

Burton is prominent in the public eye at present, especially as a centre of political disaffection. But it is prominent also, though in by no means so considerably marked a degree, as a centre which is being developed for industrial purposes. The Town Council have been very active of late in endeavouring to attract new industries to the town of Burton, and negotiations are at present proceeding with a number of firms. Now, the interesting point is how this activity affects the excellent electricity undertaking under the capable control of Mr. P. J. Pringle, the chief electrical engineer. In many of the cases the question of cheap electric power is one of the first requirements. With a view to the Council being able to supplement the already particularly good facilities they can offer in the way of cheap land, labour, fuel, etc., they have recently instructed the electrical engineer to prepare estimates as to the best means of extending the generating plant and mains so as to deal with the supply of electric power on as favourable terms as possible,

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INSTITUTION AND SOCIETY NOTES.

Institution of Electrical Engineers.

At a meeting of the Institution of Electrical Engineers on the 5th inst., the President (Colonel R. E. B. Crompton) announced that the first "Kelvin Lecture" would be delivered on Thursday, April 30, at 8 p.m., at the Institution of Civil Engineers, Great George-street, S.W., by Prof. Silvanus Thompson, who had chosen as the subject of his discourse, "Lord Kelvin." The following were elected at the same meeting:

Associate Members. — H. E. I. Bax, Eldon, Weybridge, Surrey; C. Bollam, Wareham, Dorsetshire; H. M. Cuff, Eastern Extension Telegraph Company, Singapore; F. J. Gerard, Telephone House, Victoria-embankment, E.C.; W. J. Gray, Telephone House, Victoria-embankment, E.C.; T. Hall, Electricity Works, Burton-on-Trent; T. H. Hurst, 35, Skerton-road, Old Trafford, Manchester; H. Lees, Corporation Electricity Works, Eastbourne; A. N. Rye, 1, East Stewartfield, Hawick; D. Sinclair, 461, Sauchiehall-street, Glasgow; Lieutenant E. J. Stevens, R.A., Ordnance College, Woolwich; H. E. Turner, 18, Spring-street, Hull; C. Wade, Garrison Side, Hull; J. M. Walshe, 51, Barker-street, Handsworth, Birmingham; A. E. Wilkins, 13, Belvidere-place, Dublin; J. W. F. Wyatt, 39, Queen's-road, Loughborough.

Students.—W. H. Apthorpe, 42, Coniston-road, Muswell Hill, N.; J. W. Arnott, Seacroft, The Cliffs, Gorleston-on-Sea; R. H. Barbour, Tiltwood, Crawley Down, Sussex; W. R. Brown, 66, Lordship-lane, Dulwich, S.E.; H. C. Chindian, 28, Montague-street, W.C.; N. J. Cook, Faraday House, Southampton-row, W.C.; H. C. Ellis, 12, South Brae-drive, Jordanhill, Glasgow; S. Fahmy, School of Engineering, Giza, Egypt; A. C. Fendick, 33, Beech Hill-road, Sheffield; J. Fleming, 46, Turkey-street, Keighley; W. S. Gould, City Engine Works, Eagle Wharf-road, N.; R. E. Grime, 6, Cornbrook-street, Old Trafford, Manchester; H. H. Hayhurst, Faraday House, Southampton-row, W.C.; G. S. Helme, Elsinore, Heaton Park, Manchester; J. A. Hogan, 77, Crowland-road, Stamford Hill, N.; W. Holt, 97, Frederick-road, Aston Manor, Birmingham; R. G. Isaacs, 595, Stretford-road, Old Trafford, Manchester; H. Jack, B.Sc., Muriel Cottage, Uddingston, N.B.; H. F. Jefferson, 140, Selhurst-road, South Norwood, S.E.; F. H. R. Lavender, Hughenden, Belvidere-road, Walsall; S. W. Ledbrook, 9, Swan-street, Warwick; D. C. McPherson, Electricity Works, Belhaven, Wishaw, N.B.; H. J. Magrath, 10, Dixon-road, New Cross, S.E.; G. V. Massey, Horndean, Terenure-park, Terenure, co. Dublin; G. T. Medforth, Elleslie House, Heworth-on-Tyne; W. A. Olds, Faraday House, Southampton-row, W.C.; C. Papageorge, 9 Havelock-street, Hillhead, Glasgow; W. H. Peberdy, Lansdowne House, Rugby; W. Pitt 143, Prescott-street, Birmingham; H. W. F. Pouter, 57, Queen Elizabeth's-walk, Stoke Newington, N.; J. L. Ridsdale, Kelfield Lodge, Streetly, Birmingham; A. T. Robertson, 61, Northumberland-road, Old Trafford, Manchester; C. I. Roddick, Faraday House, Southampton-row, W.C.; C. G. Saltren-Willett, Gilsten Rectory, Harlow, Essex; A. G. Savill, 31, Carnarvon-street, Hollinwood, Oldham; J. F. Shipley, 63, Shorrolds-road, Walham Green, S.W.; G. McK. S. Sichel, 87, Barrington-drive, Glasgow, W.; P. Smith, 12, Third-avenue, Hoe-street, Walthamstow, N.E.; S. Thompson, 52, Southgate-road, Canonbury, N.; A. D. Villares, 6, Tudor-road, Upper Norwood, S.E.; J. D. A. Vincent, 22, Crockerton-road, Upper Tooting, S.W.; A. Wadsworth, 59, Lynton-avenue, West Ealing, W.

Society of Arts.

The council will proceed to consider the award of the Albert medal of the Royal Society of Arts for 1908 early in May next, and they therefore invite members of the society to forward to the secretary, on or before Saturday, April 4, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting arts, manufactures, and commerce." Last year the distinguished recipient of the medal was the Earl of Cromer, while in 1906 the medal was awarded to Sir J. W. Swan "for the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing."

Association of Engineers-in-Charge.

Mr. H. D. Wilkinson read a paper on "Electric Lifts" on Wednesday evening. On Saturday, March 21, the members, accompanied by their ladies, will pay a visit to St. Paul's. The annual dinner will be held on Saturday, March 28. Sir Alex. Kennedy, his Honour Judge Rentoul, Messrs. T. Hurry Riches, E. B. Ellington, W. T. Hatch, J. W. Bradley, Prof. Adams, Mr. E. G. Rivers, and many other eminent gentlemen have already intimated their intention to be present.

Manchester Geological and Mining Society.

At a meeting held on Tuesday afternoon Mr. Geo. H. Winstanley read a paper entitled "Accidents in Winding, with special reference to Ropes, Safety Cages, and Controlling Devices for Colliery Winding Engines."

Junior Institution of Engineers.

At the last meeting of this institution, held at the Royal United Service Institution, Whitehall, the chairman, Mr. Frank R. Durham, presiding, a useful paper, entitled "Practical Notes on the Testing of Gas-Engines," was read by Mr. Gilbert Whalley, of Walton-on-the-Naze. The author, in his introductory remarks, referred to the increasing number of gas-engines which were being installed year after year, and cited the necessity for and objects of testing. He then dealt with the methods of carrying out tests, showing how to obtain expeditiously all the data required, including detailed measurements of cylinders, length of stroke, main and outer bearings, crank pin, and piston-pin bearing, etc. The mode of checking the settings and lifts of all valves, electric ignition settings, etc., was entered into, and the various systems of determining the brake horse-power by means of a dynamo, Prony brake, and rope brake were illustrated. Some interesting particulars with reference to the attachment of indicators and the computation of indicated horse-power from the cards were given, and reference was made to processes for the determination of fuel consumption when running on producer or town gas. The reduction of results to standard temperatures and pressures, water circulation details, preparation of report, including schedule of conditions, charts and diagrams to be submitted, formed concluding sections of the paper. In the discussion which followed, Messrs. W. A. Tookey, Stanley Hughes, Geo. Lygo, C. G. Evans, R. W. Brewer, W. H. Stevens, and R. H. Parsons took part, and the meeting closed with a vote of thanks to the author.

Siemens's Engineering Society.

We understand that an engineering society has just been started at Siemens Bros. Dynamo Works, Limited, Stafford, under the above name. The following papers have already been read before the society since its inauguration: presidential address by Mr. Lee Murray, on "Coal and its Application to the Production of Power Gas"; "The Siemens-Schuckertwerke Single-Phase Commutator Motor," by Mr. Schenkel; "Commutation Troubles: Their Cause and Cure," by Mr. S. P. Smith; "The Economical Life of an Electric Lamp," by Mr. H. G. Williams. On Tuesday, March 10, a lecture was given by Prof. Gisbert Kapp on "Electrification of Railways." All the papers read before the society, besides being published in the official magazine of Siemens's Institute, the *Electron*, are being published in pamphlet form for the convenience of the members. A conversazione held towards the end of April will conclude the present session. The hon. secretary is Mr. J. F. Crowley.

MOTOR TRANSPORT.

The second International Commercial Motor-Vehicle and Motor-Boat Exhibition will be opened at Olympia, Kensington, on Friday, March 27, by the Lord Mayor of London. The exhibition, which is organised by the Society of Motor Manufacturers and Traders, is under the patronage of the Prince of Wales, and will remain open till Saturday, April 4. The show is divided into three sections—viz., industrial vehicles, motor boats, and accessories—and the same plan as last year is adhered to, the industrial vehicles being staged in the great hall, motor boats in the annexe, and accessories, tyres, and wheels in the great gallery. In the vehicle section there will be many novelties which have never been previously exhibited, and are a distinct departure. Great improvements will be shown in motor omnibuses and motorcabs, whilst vans for tradesmen, with carrying capacities from 10 tons down to light carts to carry 10cwt., will show an immense advance. The exhibitors are from every part of the country and several from the Continent. The foreign contingent includes the Darracq-Serpollet, De Dion Bouton, Fiat, De Dietrich, and others. A notable feature will be the evidence of the great expansion of the tyre trade in the tyre and accessories section, which will also contain many interesting exhibits of carburettors suitable for the use of paraffin and low-grade oils for motor boats and heavy vehicles.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, March 21.

MONDAY, MARCH 16.—"A" Coy.—Infantry drill, 6 p.m.
Technical drill, 7 p.m.

TUESDAY, MARCH 17.—"B" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.
Recruiting night, 6 to 8 p.m.

WEDNESDAY, MARCH 18.—"A" badge examination, 6.30 p.m.

THURSDAY, MARCH 19.—"C" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

FRIDAY, MARCH 20.—"D" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TELEPHONE RATES.

An influential deputation representing the chambers of commerce and the municipalities waited upon the Postmaster-General at the House of Commons on Wednesday afternoon to discuss the question of service tariff of telephone charges. The Press was not allowed to be present at the meeting. We learn, however, that after a long discussion extending over three hours, the Postmaster-General (Mr. Sydney Buxton) promised to reconsider his present decision not to grant a flat-rate service. He is now prepared to grant a flat rate, and will submit proposals to the chambers of commerce as soon as possible.

FORTHCOMING EVENTS.

FRIDAY, MARCH 13.

Junior Institution of Engineers.—At 8 p.m., at the Royal United Service Institution, Whitehall, "Automatic Fire Extinction as applied to Factories," by Mr. G. T. Bullock.

Physical Society.—At 8 p.m., meeting in the physics laboratory of the Royal College of Science.

Royal Institution of Great Britain.—At 9 p.m., "Transatlantic Wireless Telegraphy," by Mr. G. Marconi.

SATURDAY, MARCH 14.

Birmingham and District Electric Club.—At 7 p.m., discussion on the "Possibilities of Electrical Developments," to be opened by Mr. R. Borlase Mathews.

Royal Institution.—At 3 p.m., "Electric Discharges through Gases," by Prof. J. J. Thomson.

Robertson's Social and Athletic Club.—At 7 p.m., fancy dress ball at Brook Green, Hammersmith.

THURSDAY, MARCH 19.

Institution of Electrical Engineers.—At 8 p.m., "New Alternate-Current Instruments," by Dr. W. E. Sumpner and Mr. J. W. Record.

Institution of Electrical Engineers (Leeds Local Section).—At 7.15, at the University, Leeds, "The Rules for the Electrical Installations of the German Union of Electrical Engineers," by Mr. W. P. Steinthal.

Royal Institution.—At 3 p.m., "Standardisation in its Various Aspects (1) Mechanical Engineering," Dr. R. T. Glazebrook.

SATURDAY, MARCH 21.

Royal Institution.—At 3 p.m., "Electric Discharges through Gases," by Prof. J. J. Thomson.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE FUTURE OF THE TELEPHONE SERVICE.

SIR,—There has recently been much discussion of "the telephone question" at chamber of commerce meetings and in the Press, but several of the most important points are lost sight of. Perhaps you will allow me space to state a few broad propositions based on long experience and observation of the working of the telephone service in America and in the principal countries of Europe.

The telephone service we shall have always with us. It is the quickest, the most direct, and the most perfect means of communication, and it is the cheapest. Since all business depends on communication, and communication is also largely required in social and domestic affairs, the telephone service is certain, if conducted on sound lines, to have an enormous development in this country. In spite of all the difficulties (for a clear view of these difficulties the student of the subject may read "Public Ownership and the Telephone in Great Britain," by Hugo R. Meyer; MacMillan and Co.), the telephone system of the country doubles itself about every six years. But I hope in my lifetime—and I am not so young as I should like to be—to see at least ten times as many telephones working in the United Kingdom as there are now. Such a development can only be brought about, however, by an enterprising administration, a highly efficient service, and a practical tariff.

The present quarrel of the chambers of commerce with the telephone administration is actuated solely by the large user of the telephone service fearing that he is about to lose a bargain which he thinks the flat rate for unlimited service gives him. This fear drives him to strange statements. The measured rate—payment for service in proportion to service rendered, a principle which is accepted in all other services and all other businesses—is described as "a tax on trade and commerce," and as likely to check the development of the telephone.

To describe a change in the method of charging for telephone service which offers low rates to the majority of users as a "tax on trade and commerce" is manifestly an exaggeration, for the amount spent on local telephone service in the average business establishment is a very small percentage of the total working expenses of that establishment. In the largest concerns, who are the chief opponents of the measured-rate principle, the cost of local telephone service is probably only a fraction of 1 per cent. of the total expenses. So much for the "tax on trade."

But the most vital point—and, strangely enough, it is one that is largely neglected by both parties to the discussion—is that the measured rate makes for efficiency of service, whereas the flat rate directly encourages the large users to spoil the service for themselves and for others. It is a most difficult thing to make the telephone subscriber realise that he is largely responsible for the general efficiency of the service. Over the actual manipulation of the telephone instrument, over the attention and efficiency with which inquiries and messages by telephone are received and dealt with, and over the facilities provided for handling the telephone traffic flowing in and out of his establishment the subscriber has full control. It should be clear to every telephone user that the quality of service other users get largely depends upon him. Yet what is one's daily experience? That the telephone is all too frequently left to the office boy or to other junior employés, who show a marked disinclination to handle the instrument and the service properly or to deal with inquiries and messages promptly and intelligently. Again, the largest concerns, the very establishments with which prompt communication is most in demand by the business community, are so continuously "engaged," owing to their telephone lines being constantly blocked with outward calls, that one is often obliged to abandon the attempt to communicate with them, after having spent much more time on several ineffective calls than one effective call promptly completed would have occupied. In all large towns there are subscribers who are "engaged" to attempted calls

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hundreds of times daily—to the exasperation of their correspondents and to the general detriment of the service; in many cases also the lost call must mean loss of business to the firm for which it was intended.

Now, what is really the prime requirement of the business man—the essence of "the telephone question" from a practical and commercial point of view? I say unhesitatingly it is efficient service—the maximum of effective calls, promptly and effectively dealt with at the incoming end. There is no difficulty to-day in equipping and organising a telephone service so that the average call shall be put through within 30 seconds. But it is essential for real efficiency that the subscriber on his part shall provide facilities for receiving the call and organised attention for handling it effectively. This the measured-rate tariff directly encourages him to do, whereas the flat-rate tariff operates in exactly the opposite way. Under flat rates the charge for extra lines is relatively high, so the subscriber refuses to take them. The measured-rate tariff makes low charges for lines and instruments, and low wholesale rates for calls. The large user is thus encouraged to provide, instead of one or two individual lines and telephones, a group of lines and telephones, made interchangeable by means of a switchboard. This arrangement, technically known as a "private branch exchange," is extremely flexible. It can be designed to fit any establishment. Every department has its telephone, and every call goes straight to its billet with the minimum of delay. As the lines are worked in a group, it is seldom that all are "engaged" simultaneously, and by watching the traffic the equipment can be so kept up to the requirements that the "engaged" call is eliminated. Thus, the big user gets a thoroughly effective service, which is what he needs far more acutely than an apparently cheap rate, for a rate which causes inefficient service is only apparently cheap. I venture to say that the large user has no real conception of what adequate telephone service means until he organises his telephone equipment on the "private branch exchange" basis.

What the measured-rate principle will do for the development of the telephone in Great Britain and for the efficiency of the service is amply demonstrated by results in America. Thirteen years ago there were in Greater New York about 18,000 telephones under flat rates, and development was almost stagnant. Measured rates were introduced, and the private branch exchange scheme was devised to provide adequate service for large users. To-day there are over 300,000 telephones in New York. A third of those are connected to private branch exchanges, and the ineffective call, which was formerly as great an evil in New York as it is in English cities to-day, has been nearly wiped out. The telephone in New York, besides being used in an efficient way by the large concern, has spread to all sorts of small establishments and to a very large proportion of private residences, for the measured-rate tariff makes equitable terms to all classes of telephone users.

Did the chambers of commerce but thoroughly study the subject, and realise that the measured-rate principle of telephone tariff makes both for general efficiency of service and for wide development of the telephone, they would undoubtedly petition the telephone authorities to abolish the flat rate forthwith, instead of arguing for its retention.—Yours, etc.,

HERBERT LAWS WEBB.

THE KAPP-HOPKINSON TEST ON ONE DIRECT-CURRENT MACHINE.

SIR,—With much interest I have read the abstract of Mr. A. Kolben's paper in the *Electrical Engineer* of March 6, 1908, published in *Elektrotechnik und Maschinenbau*, not only because I have been working on the same subject entirely independently of Mr. Kolben, but also because it appears to me that Mr. Kolben has overlooked some very important points. In strengthening pole N_1 (Fig. 2, p. 342) and weakening N_2 certainly an E.M.F. will be excited, and a circulating current will tend to flow from brush B_1 to brush B_2, dividing equally in the two armature halves. This circulating current flows down under N_1, up under N_2, and mixed up and down under S_1 and S_2. Consequently a strong armature reaction acts in the direction S_1 S_2, tending to weaken S_1 and to strengthen S_2 (and not, as Mr. Kolben maintains, that S_1 and S_2 remains unchanged). The armature revolves in this reaction field and excites in the same way an E.M.F. between the brushes B_2 and B_4, and the armature reaction of the current which tends to flow under this E.M.F. counteracts the distortion originally given to N_1 and N_2. For this reason it is not only impossible to obtain the full circulating current, but also a circulating current will flow as well from brushes B_1 B_3 as from B_2 B_4, so that the indications of ammeter A_1 represent by no means the only circulating current.

To obtain the full circulating current from B_1 to B_3, the poles S_1 and S_2 must be strengthened and weakened to exactly the same value as they are weakened and strengthened by the armature reaction. How this can be done in a very simple way I hope to show when I shall publish my research on this subject. I have adopted the above principle to test the efficiency of a lap-wound machine. There are, however, a few corrections to be made, as Mr. Kolben correctly remarks.

For the heat test, however, an easier method is possible, if a small auxiliary machine is available capable of carrying half the full-load current of the machine under test. The voltage of this machine applied to brushes B_1 and B_3 will force the circulating current to flow, N_1 and N_2 remain unaltered in strength, S_1 and S_2 are strengthened and weakened so as to exactly counterbalance the armature reaction. The volts increase between two auxiliary copper brushes in line with B_1 B_3 will give at once a measure of the armature resistance increase as time proceeds, and with the aid of the well-known formula (1): $R_T = R_0(1 + \alpha t)$, in which $\alpha = 0{\cdot}00428$ for $t = 0$, the temperature can be calculated without stopping the machine.

In case the armature is slightly out of centre, so that the voltage between B_1 B_3 is not zero, N_1 or N_2 have to be altered and this E.M.F. adjusted to zero. I tested in how far this test gives too small results. Owing to the fact that no distortion occurs under poles S_1 S_2, no circulating current flows through brushes B_2 and B_4. I tested the machine first in the well-known Kapp-Hopkinson test in which two similar machines are used, and also in above described way. The results differed about 6 per cent. Perhaps an error of this magnitude will seem unacceptable, but after considering that anyhow an error of the same value will occur through the fact that α in formula (1) is different for different copper, this method is quite adaptable.

I herewith have explained the principle on which the Kapp-Hopkinson test can be carried out on one direct-current machine. I intend to publish a full description of my research on this subject in a short time, but on seeing Mr. Kolben's article I thought it necessary to draw attention at once to points overlooked by him.—Yours, etc.,

DR. W. LULOFS.

Birmingham University, March 9, 1908.

DIRECT-CURRENT TURBO-GENERATORS.

SIR,—In your issue of the 6th inst. appears a letter from Messrs. Brown, Boveri, and Co., Limited, referring to the illustration of one of their machines in my paper on "Direct-Current Turbo-Generators," and which in your previous issue you have described as being of another make. I see from your footnote how the error arose, and am sorry that the interior of the magnet frame was not blocked out so as to make such a mistake impossible. I must express my surprise, however, that Messrs. Brown-Boveri should believe that in an Institution paper an author would show an illustration of one firm's machine and refer to it as that of another. It would have been at least fair and courteous to me if they had taken the trouble to see the original paper. I also absolutely refute their statement that the illustration consists of an "unauthorised" photograph. The original was received by me from the proper quarter with full permission to embody it in my paper.

I hope you will kindly give this letter equal prominence to that of Messrs. Brown, Boveri, and Co., Limited.—Yours, etc.,

WILFRED HOULT.

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LEEDS ELECTRICITY DEPARTMENT.

In December last we felt it necessary to write somewhat strongly our opinions as to the policy of the Leeds Corporation in dealing with its tramway and electricity supply undertakings. An examination of the tramway accounts shows that the reserve fund had been depleted by some £85,000 in order that a temporary reduction of the rates might be obtained. Not content with this, the Finance Committee, with Alderman Wilson as its leader, on Wednesday last made an attempt to secure a considerable proportion of the reserve fund of the electricity department. He moved that a resolution passed by the Council in March, 1906, adopting a report of the Electricity Committee on the electric light undertaking be rescinded so far as it related to the confirmation of the recommendations 2. 3, and 4 contained in the report. The recommendations referred to were as follows :

2. That the remainder of the cost rendered necessary by combining what are merely renewals with extensions be carried to an "extraordinary renewals account," and that the amount in the reserve or equalising fund, together with any surplus that would otherwise, according to the old method, be called "profits," be transferred to the credit of this "extraordinary renewals account," when the position of that account renders such transfer necessary.

3. That until such a provision is found to be unnecessary or excessive, any surplus, up to 3 per cent. on the entire capital, be placed to the reserve fund for renewals.

4. That no further sums should be applied to the relief of rates in any event until the renewals now contemplated are fully provided for, and the net liabilities on capital account are reduced to the average of other municipal electricity undertakings, after which the question may be reconsidered.

Immediately this resolution had been moved, Alderman KINDER asked that the consideration of the matter should be deferred until the committee appointed last December to consider the amalgamation of the tramway and electric supply undertakings had reported.

Alderman WILSON would not agree to this, and held that the recommendations he wished to rescind were *ultra vires*. There was in connection with the electricity department a sum of money which had been ascertained to be profits, but which had not been appropriated as required by the Consolidated Act of the city of Leeds. The Act, which applied to all trading committees, was quite clear. It prescribed various ways for appropriating profits. One was that such a sum as the Corporation might determine should be put into a reserve fund, which could be drawn upon for two purposes. One was to make good a loss in any one year, and the other to meet any extraordinary claim. Renewals had been held by the town clerks of other authorities not to be an extraordinary demand. In Leeds they had gone contrary to the Act, and the object of his resolution was to get the law carried out. He had no other object in view than to clear off some of those old matters.

Alderman EWING MATHIESON said that Alderman Wilson ought to have dealt with the report generally and the arguments which led the Council to accept it unanimously. They had to remember that the electricity undertaking had, owing to the circumstances of its purchase, an abnormal burden in its sinking fund and redemption charges. In the matter of cost of production, distribution, and management they stood in the first six of the big towns of the country, but notwithstanding that fact they were impeded at every step by the enormous sinking fund charges. They could not always meet the renewals in any one year out of that year's profits, particularly if, as sometimes occurred, they had to deal with contracts for machinery to the extent of £20,000 or £30,000. So far as cost of power was concerned, they had to bear in mind that the Leeds manufacturers were handicapped in their competition with Scotch manufacturers because their machinery was rated. Now in addition to that they found that manufacturers in neighbouring towns were able to get current cheaper. More than that, the Leeds current was higher than that of competing private companies on their borders, and they should not tempt the latter to try to get into Leeds. They had not tried yet with the arguments they were now in a position to advance. Alderman Wilson's course of action was doing more to postpone the advance of the electricity department than any course he could take. Alderman Mathieson went on to complain that the joint Tramways and Electricity Committee had not reported, as instructed, on the question of carrying out the duties, although the amalgamation was agreed to on the assumption that a report was to be presented at the February meeting of the Council. Further, the committee appointed to inquire into the question of renewals, etc., had not been got together.

Mr. R. ARMITAGE said the cost of power in Leeds would be kept high unless they could deal with the funds as other towns were dealing with them. Last year Liverpool put away £32,000 and Manchester £63,000 to a renewals fund after providing for sinking fund, and before letting anything go to the rates.

After a long debate the motion was rejected, so that the reserve fund is safe for the time. It is a curious coincidence that before the discussion a strong deputation of manufacturers in the city attended the Council to make representations with regard to the charges made by the Corporation for electric power. Mr. Hugh Lupton, who acted as spokesman, said they directly represented Messrs. Fairbairn, the Monk Bridge Steel and Iron Company, the Hunslet Engine Company, Messrs. Joshua Buckton and Co., Messrs. Whitley Partners, Messrs. Campbell and Hunter, Messrs. Joseph May and Sons, Messrs. Braime and Co., Messrs. Catton and Co., Bateman's Machine Tool Company, and Hathorn, Davey, and Co., Limited, together employing over 6,000 workmen. Indirectly they represented a very much larger number of firms. The firms directly represented all took power from the Corporation's station, and would take a great deal more of it if it could be had at commercial rates. They asked (1) that current should be supplied at a uniform scale to all users; (2) that the price should certainly not be more than in Bradford; (3) that current for lighting purposes should be supplied in liberal proportion to power users at power rates; (4) that a special meeting of the committee which has the matter in hand should be called at as early a date as convenient to consider the matter; (5) that any new scale should be submitted to and discussed with power users before being adopted. If, said Mr. Lupton, the Council would meet them on this matter, he had absolutely no doubt of a very large extension of the supply demanded.

POWER TRANSMISSION BY STEEL BAND.

For the purpose of replacing the ordinary belt and rope transmission, the Eloesser Kraftband-Gesellchaft, of Berlin, has recently brought out a form of thin steel band running either on ordinary bare pulleys or on pulleys faced with a special preparation. The following table gives particulars of some installations carried out, and shows that considerable saving in width of pulley results through the use of their steel band. Thus, in the first example, the width of an ordinary belt doing the same work would be about 24in. instead of only 4in. This reduction is especially advantageous in the case of overhung pulleys, as it not only reduces the length of shaft but also the leverage of the unbalanced belt pull. The steel band also enables very short drives to be used, and so reduces the floor space required in many cases.

Installation.	Pulley diameters.	Revolutions per minute.	Peripheral speed.	Breadth and thickness of steel band.
200-250-h.p. steam-engine driving a dynamo (L. Sudicatis, Berlin).....	144"/31"	150/685	5,300 f.p.m.	4" × ·02
125-h.p. gas-engine (Electric Block Station, Berlin).....	127"/36"	186/640	6,200 ,,	4" × ·02"
60-h.p. gas-engine (Electric Block Station, Berlin).....	110"/24"	180/840	5,200 ,,	$2\frac{9}{16}$" × ·012'
50-80-h.p. portable engine (Kopp and Co., Berlin).....	55"/47"	110/130	1,600 ,,	4" × ·024

The ends of the bands are joined by a special lock, having its inner surface rounded to the radius of the

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smaller pulley. The band does not stretch in use, so that the pulley distances can be fixed once for all at the start. This absence of stretch also reduces the apparent slip which occurs with ordinary belts, owing to the expansion of the belt whilst moving over the driven pulley and its compression whilst on the driving pulley. This slip is only about ·1 per cent. with the steel bands. Very high peripheral speeds are allowable with the new belts, and experiments have been carried out at speeds up to 12,000ft. per minute.—*Elektrotechnik und Maschinenbau.*

THE BRITISH ASSOCIATION.

Winnipeg Meeting.

The council of the British Association for the Advancement of Science has nominated Prof. J. J. Thomson, F.R.S., Cavendish professor of experimental physics in the University of Cambridge, to be president of the meeting of the association which is to be held at Winnipeg next year. The investigations carried on by Prof. Thomson in the Cavendish Laboratory, and by the distinguished men of science who first worked under him and received inspiration from his researches, laid the foundation for the new views held by chemists and physicists as to the electronic constitution of matter and the remarkable properties of radioactive substances. In 1894 Prof. Thomson was awarded one of the Royal medals of the Royal Society, and to this was added in 1902 the Hughes medal, in recognition of his contributions to the advancement of electrical science, especially in connection with the phenomena of electric discharge through rarefied gases. Two years ago he was the recipient of the Nobel prize for physics.

It is understood that provision will be made by the Canadian Government in the estimates for the coming financial year for a grant of 25,000dol. (£5,000) by the Dominion Parliament towards the expenses of the association's visit to Winnipeg. The city of Winnipeg itself proposes to make a grant of 5,000dol. (£1,000). The week of the meeting will probably be from Aug. 25 to Sept. 1, 1909.

AUSTRALIAN AFFAIRS.

A friend in Australia writes to us to say that there are at present on foot in the colony a considerable number of electrical schemes of some magnitude which only require some progressive or speculative individual to take some of them in hand to bring them to a head. Trade, he adds, is very good indeed, and he mentions the fact that he has had to increase his staff of 60 odd hands by eight during the past two months. Money, he says, is plentiful, and manufacturing is going ahead, especially in Victoria. This development does not manifest itself in electrical engineering alone, but is to be noted in every branch of manufacturing. There is at present being considered a scheme for providing Coburg with an electric tramway and lighting scheme. It is estimated that it will cost £25,000 to establish a plant for lighting all Coburg and part of Brunswick; for driving a tram service over the suggested mile and three-quarter route, and for providing six cars and six trailers, with an average speed of eight miles an hour and a maximum of twelve. The sum named will be sufficient to establish the service complete as a going concern. The matter is not being taken up by the Municipality, but by the Coburg Progress Association, which proposes to form a company to develop it.

Tenders are being invited by the Commonwealth Government for making and laying two cables between Victoria and Tasmania. It will be recalled that negotiations were opened up with the Eastern Extension Telegraph Company for the purchase of the cables now connecting Tasmania with the mainland, but they were discontinued. The Postal Administration desired an inspection of the cable in two places, but the company refused to lift it except at the expense of the Commonwealth Government, and with an indemnity in case of breakage. The Department decided to call for tenders for new cables. Tenderers are asked to supply 350 miles of main cable, 20 miles of intermediate cable, and 20 miles of shore end cable. The contractors are to lay the cables complete from the huts, which, subject to alteration, will be at Flinders, in Victoria, and Low Head, in Tasmania; and they are to provide accommodation for two officers of the Postal Department during the work of laying. The cables are to be maintained by the contractors in good order and condition for 31 days from the date when the final splice is made. Then they are to be tested, and if they conform to the specified electric conditions, delivery will be taken by the Department. Tenders close on April 14, and the first of the two cables is to be ready for use not later than March 1, 1909; the second to be completed a month later. A deposit of £1,000 is to accompany each tender. The existing licence of the Eastern Company expires early in 1909, and in the event of the Government arranging for new cables to be laid the present cables will be removed.

A local correspondent writes to us that, prior to leaving Australia, Mr. Merz, who was brought out by the Government to report on the proposed electrification of the Melbourne suburban railway system, expressed himself as highly impressed with the possibilities of Melbourne in that direction. He considers that Melbourne, with its immense seaside traffic, its residential suburbs stretching away in every direction, and numerous popular resorts within 20 miles of the city, offers an ideal opportunity for producing the best results from electric transit. He does not deem it necessary to proceed upon any merely experimental lines by recommending the construction of one electrical branch as a sample, and then to wait for results to encourage further enterprise. Mr. Merz deduces from the traffic returns, and the traffic which may be developed by a rapid and cheap electric system, that the whole of the suburban service may be converted to electricity in the full confidence that it will repay the investment. The report will be ready in about three months.

It is proposed to construct an electric railway from Victoria Park railway station, Collingwood, *viâ* Kew, to Doncaster. In explaining the scheme before the Railways Standing Committee, Mr. Kernot, the chief engineer for railway construction, stated that the length of the line, which was a single one, would be 8¼ miles, but with turn-outs the mileage would come to 8⅞ miles. The ruling gradient would be 1ft. in 14ft. The estimates of the cost of the line were as follows: earthworks, £3,602; bridges, £20,345; work at Victoria Park Station, £3,483; permanent way, £38,502; overhead construction, £9,192; car-sheds, £3,180; miscellaneous, £671 — total, £68,975. To that had to be added 10 per cent. for contingencies, £6,897; supervision, engineering, etc., £3,448—making a total of £77,320. The latter total did not include any expenditure for a power-house or for rolling stock. The estimate provide for a substantial tramway constructed in the same manner as that from St. Kilda to Brighton. If the suburban system of railways was electrified the passengers could be brought direct from Doncaster to Melbourne. As it was at present, Melbourne passengers would have to cross an overhead bridge at the Victoria Park Station. Asked how he would supply electric power, he said he thought it would be far better to look for power from a central generating station, assuming that the suburban lines were to be electrified. If the line was worked independently, it would be necessary to provide a small power-house and plant. He had looked into the matter of obtaining power from Dight's Falls, but thought that without storage the flow of water there would be insufficient to work the plant all the year round. About 350 h.p. was needed. He had looked up data as to the strength of the flow at the falls, and calculated that in drought periods there would not be sufficient force to develop 100 h.p.

ELECTRICAL BILLS IN PARLIAMENT.

Finchley Urban District Council Bill.

When the Finchley Urban District Council Bill was before the Court of Referees last week, application was made by the Barnet District Gas and Water Company, the Southgate and District Gas Company, and the North Middlesex Gas Company for a *locus* to be heard before the committee.

Objection was taken to Part 2 of the Bill, which deals with the electrical undertaking of the District Council, which seeks to extend the area of supply, to give discounts on electric lighting and power accounts, and to lay electric apparatus in streets or roads not dedicated to public use.

The gas companies based their claims for a *locus standi* on the grounds that they were ratepayers who would be injuriously affected by the proposals of the District Council, and that it was proposed to create new forms of competition with their statutory undertakings.

Mr. Vesey Knox, K.C., who appeared for the Finchley Urban District Council, did not deny that new competition would be set up by the extension of the Council's area of supply, but he submitted that it was not substantial enough in degree to warrant the petitioners having even a limited *locus*. The real object of the gas companies in seeking to be heard against the Bill was, he asserted, not the question of competition in the added area, which was trifling, but the desire to raise all sorts of matters in relation to the working of the Council's electrical undertaking.

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The COURT, at the close of the arguments, allowed a *locus* as against Clause 4 (extension of area of supply of electricity) to the Barnet and Southgate Gas Companies, but refused it in the case of the North Middlesex Gas Company, which has no power of supply in the proposed new area.

London Electric Supply.

The House of Lords have passed a resolution referring the London and District Electric Supply Bill, the London Electric Supply Bill, and the London (Westminster and Kensington) Electric Supply Companies' Bill to a joint committee of both Houses of Parliament. We understand that the Government is favourable to this course being adopted.

SOLID HELIUM.

The following telegram from Prof. Kamerlingh Onnes, of Leyden, was sent to Sir James Dewar on the 5th inst.: "Converted helium into solid. Last evaporating parts show considerable vapour pressures, as if liquid state is jumped over."

PUBLICATIONS RECEIVED.

The *Journal* of the Franklin Institute (Philadelphia).

Transactions of the North-East Coast Institution of Engineers and Shipbuilders, vol. xxiv., Part I. Newcastle-on-Tyne: Andrew Reid and Co., Limited.

Transactions of the Manchester Geological and Mining Society (part xi., vol. xxx). Published at Queen's-chambers, 5, John Dalton-street, Manchester.

"SPECIFICATIONS AND CONTRACTS," by Dr. J. A. L. Waddell and John C. Wait. New York: the "Engineering News" Publishing Company. Price, 4s. net.

"THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM," by J. H. Jeans, M.A., F.R.S. (Cambridge, at the University Press). Price, 15s. net.

"THE STEAM-TURBINE," by Robert M. Neilson. Fourth edition, enlarged and almost entirely rewritten. London: Longmans, Green, and Co., 39, Paternoster-row, E.C. Price, 15s. net.

The *Official Circular* of the Tramways and Light Railways Association for March contains several items of interest to members, and indicates the progress made by the various committees of the association now sitting. It is announced that an annual congress is to be held in various part of the country; the first one to be held in London in connection with the Franco-British Exhibition at Shepherd's Bush during the first week in July. An important decision is given in regard to Standing Orders affecting tramways, and a full report of the decision by the Court of Appeal in the case of Rhondda Tramways and Taff Vale Railway Company.

PERSONAL.

Mr. A. Gow, B.Sc., M.A., director of education, has been appointed secretary to the Imperial College of Science and Technology.

Mr. Ashton Bremner, borough electrical engineer, Burslem, Staffs, has been elected a member of the Institution of Electrical Engineers.

The Oldham Town Council have increased the salary of Mr. Lewis Slattery, the tramways manager, from £350 to £400 per annum, increasing by annual increments of £25 to £450.

Mr. F. Spencer, who recently retired from the managership of the Halifax Corporation tramways, has been presented with a handsome dinner service as a token of esteem from the tramway staff.

On the 6th inst. the eastern district staff of the National Telephone Co. held their second annual dinner and smoking concert at the Eastern Hotel, Limehouse. The function proved most enjoyable, and was a great success.

The *London Gazette* announces that the partnership between Messrs. A. H. Sowerbutts and F. Walker, carrying on business of electrical engineers as Sowerbutts and Rogers at 17, High-road, Kilburn, has been dissolved by mutual consent.

We regret to announce the death of Dr. Henry Clifton Sorby, the eminent scientist. Dr. Sorby rendered notable service to marine biology, metallurgy, and the science of agriculture, and was the author of several valuable scientific works.

We are informed that Mr. Cecil Hodges and Mr. H. Snowdon have disolved partnership. Mr. Hodges will continue the business of Cecil Hodges and Co. at Balfour House, Finsbury-pavement London, E.C. Mr. Snowdon will conduct his works and business independently at Millwall, and will trade under the name of the Millwall Electric Co.

Mr. J. Eaton-Shore has resigned his position as works manager for Messrs. Willans and Robinson, Rugby, in order to take up a similar post for Messrs. Siemens Bros., of Stafford. At a smoking concert last week he was presented with a silver loving-cup by the employés of Messrs. Willans and Robinson, together with an album containing nearly 800 signatures of subscribers to the testimonial.

The third annual dinner of the P. and O. Batti-Wallahs' Society was held on Saturday last at the Holborn Restaurant, and was well attended. The president, Mr. Walter Riggs, in replying to the toast of the president and committee, said he hoped that the new clause enabling electricians and electrical engineers who were not sea-going engineers, nor connected with the P. and O. Company, to join the society, would result in a large increase in membership. He announced that a branch was being formed in Birmingham.

We regret to learn of the death of Dr. W. E. Wilson, F.R.S., which took place at his residence, Duramona House, Street, co. Westmeath. Dr. Wilson has been well known for many years as a distinguished astronomer and physicist, and his investigations on the electric arc are well known to electricians. Among his numerous publications, many of which were contributed to and published in the *Philosophical Transactions and Proceedings* of the Royal Society and other learned bodies, were "On the Temperature of the Carbons of the Electric Arc," "On the Effect of Pressure of the Surrounding Gas on the Temperature of the Crater of an Electric Arc Light," "Radiation from a Perfect Radiator," etc.

APPOINTMENTS VACANT.

Switchboard Attendant, Electricity Works, Canterbury. Applications to the Engineer by March 20. See advertisement.

Premium Pupil.—Apply, Electricity Works, Canterbury. See advertisement.

Premium Pupil.—Apply, Borough Electrical Engineer, Burton-on-Trent.

Traffic Manager, Wigan Corporation Tramways. Salary, £200 per annum. Applications to Mr. H. Jevons, town clerk, by March 23. See advertisement.

LEGAL INTELLIGENCE.

HEATH v. BRIGHTON CORPORATION.

Mr. Justice Joyce delivered his reserved judgment in the case of Heath *v.* the Corporation of Brighton (reported in the *Electrical Engineer*, Feb. 7).

The plaintiffs sought to restrain the Brighton Corporation from carrying on an electrical transforming station at North-road, Brighton, so as to be a nuisance, alleging that the machinery caused a humming or buzzing noise which interfered with the conduct of service in their church, and was a nuisance to the worshippers. On behalf of the Corporation, it was contended that the noise had been reduced to a minimum, and that it could only be detected in the church by those who knew of its existence, or who purposely listened for it. The Corporation contended that they had exercised their statutory powers in a reasonable and proper manner.

HIS LORDSHIP, in giving judgment, said the plaintiffs were not entitled to more than the ordinary amount of quietude in the town, and had no special rights because of the purposes for which the church and its classrooms, etc., were used. He considered that annoyance might be caused to some persons who were more sensitive than others—such as persons who could not apply their minds to anything unless there was absolute silence—but it ought not to distract the attention of ordinary healthy persons, though several witnesses had asserted that the annoyance amounted to a serious nuisance. There might be a considerable annoyance, but not a legal nuisance. To grant an injunction in the case would be a very serious matter, and he thought, on the whole, that a sufficiently serious annoyance had not been shown to entitle the plaintiffs to an injunction. He must consequently dismiss the action. He suggested, however, that it would be quite right and proper that the Corporation should not insist on costs, provided the plaintiffs did not carry the case further.

MR. ASTBURY, K.C., on behalf of the Brighton Corporation, said the defendants would consider what his lordship had said with regard to costs.

BRITISH WESTINGHOUSE AND MANUFACTURING CO v. THE MERSEY RAILWAY CO.

The Master of the Rolls and Lord Justice Buckley on Saturday heard the appeal of the plaintiffs in the action of the British Westinghouse and Manufacturing Co. *v.* the Mersey Railway Co. from the refusal of Mr. Justice Eve to grant an injunction restraining the defendants from issuing the difference between £249,276 and £275,000 debenture stock at a higher rate of interest than 4 per cent., and from issuing the said difference or the difference between £620,000 and £703,000 debenture stock at any price lower than par without previous consent in writing of the plaintiffs, in breach of an agreement of July, 1901.

MR. MARTELLI, K.C., on behalf of appellants, said the question on the appeal was whether under the terms of a supplemental agreement the applicants had made such default as released the respondents from the provisions of Clause 4 of the original agreement. That was a works contract, under which the Westinghouse Co. agreed to electrify the undertaking of the Mersey Railway Co. The agreement recited that there was debenture stock to the amount of £249,276 issued by the company, and that the company were authorised to issue £275,000 new debenture stock, and that the Westinghouse Co. were to find the cash to redeem the original stock. The railway company were not to issue the difference between the two amounts at a higher price than 4 per cent. The price to be paid under the works contract was £620,000, and the total authorised issue of debenture stock was £703,750. If the Mersey Co. were to issue the

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unissued balance at a price lower than par, it would be impossible for the Westinghouse Co. to advantageously issue their stock except at the same price. Hence it was provided that the difference between the £620.000 and £703,000 should not be issued at a lower price than par. The Mersey Co. were to issue from time to time at the request of the contracting company debenture stock forming the contract price. There were quarrels between the railway company and the contractors, which were settled to some extent by a supplemental agreement of July, 1904, under which the contractors agreed, as and when required by the company on two months' notice in writing, to purchase from the company in each year between Jan. 1, 1905, and Jan. 1, 1909, so much of the company's new first debenture stock, but not exceeding £2,500 in any year, as the company should require them to purchase. And in case the contractor should at any time fail to purchase the stock when required, the company should stand released from Clause 4 of the works contract. The contractors had purchased the stock in 1905, 1906, and 1907. In November last the company gave notice that they required the stock for the present year purchased on Jan. 2. That was inconvenient to the contractors. Correspondence followed, and the contractors called on Jan. 8 and tendered the money, but were referred to the company's solicitors, and the company claimed that they were released from the obligations imposed by the original contract. Counsel now contended that the appellants had the whole of the year in which to pay, and that, assuming the exact time to be of the essence of the contract, the respondents had waived that, and could not come down on them at two hours' notice and require payment.

In the result their Lordships dismissed the appeal, holding that, in the circumstances, there was an obligation on the plaintiffs to purchase the £2,500 stock on Jan. 2, 1908, and that the defendant company were released from all their obligations under Clause 4 of the works contract.

GREENWOOD v. INGLETON ELECTRIC LIGHT CO.

In the Chancery Division on Saturday last, the case of Greenwood *v.* the Ingleton Electric Light Co., which was a motion for judgment in default of defence, came before Mr. Justice Neville.

The action was brought by the holder of all the debentures of the second series issued by the defendant company. The defendants were the company and three gentlemen who held all the debentures of the third, fourth, fifth and sixth series. The holders of the first series had not been added because the plaintiff did not seek to affect their rights in any way. The company was a public undertaking, but the power was given it under the Electric Lighting Acts and its memorandum of association to borrow money on the security of its undertaking. In 1901 the company issued to the plaintiff all the debentures of the second series and agreed to pay him in June, 1903, the principal sums and charge its undertaking with the payment. Plaintiff extended the time for payment until May 10, 1907, but the money was still owing with arrears of interest.

His Lordship made the usual order.

Counsel said that as it was a public undertaking he did not ask for foreclosure or sale, but merely for inquiries as to encumbrances, and that the further consideration should be adjourned to chambers. A receiver had already been appointed.

WARD v. WIGAN CORPORATION.

The hearing of a case in which Mrs. Mary Ward, on behalf of herself and her two infant children, sued the Wigan Corporation for damages for the death of her husband through a collision with one of the defendants' tramcars in Wigan was heard last week at the Liverpool Assizes. Mr. Ward was driving in his trap at the time. Negligence as to speed and bell ringing, etc., was alleged against the defendants, who replied by alleging contributory negligence, and the restiveness of the pony which Mr. Ward was driving. They also alleged that plaintiff had sustained no material damage, as the business could still be carried on in the plaintiff's interest. It had yielded the deceased about £300 a year for several years, and he had saved £4,000. The jury found for the plaintiff with £1,500 damages, apportioning £500 to the widow and £500 to each of the children.

"X" ELECTRIC ACCUMULATOR CO.

Mr. Justice Warrington, in the Chancery Division on Saturday, was asked, on the ground of urgency, to appoint a receiver and manager of the assets and undertaking of the "X" Electric Accumulator Co. His Lordship, upon the company appearing and consenting, appointed a receiver and manager, the managership not to extend beyond the second Saturday in the Trinity sittings.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN ELECTRIC SUPPLY.

The twenty-first ordinary general meeting was held on Tuesday, Mr. W. Harrison Cripps presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, March 6) stated that the capital expenditure now amounted to £1,840,876, being an increase during the past year of £38,493. This outlay compared favourably with the amounts spent in recent years. The large outlay generally represented the rebuilding of the Company's system after the loss of their St. Marylebone and Sardinia-street works, and he trusted that they had now entered on a quieter period, and that the expenditure of the past year might be taken as normal. The gross receipts on revenue account amounted to £178,683, being an increase of £3,047 for the year. This increase was somewhat less than the directors had expected, and they attributed the fact partly to the circumstance that the last quarter of the year was a poor one and partly to the increased use of metallic-filament lamps. Undoubtedly, the use of these lamps was immediately of some loss to the companies, but they did not believe that any permanent loss would come by supplying a three times better article for the same money. It would undoubtedly widely extend the area of business. The working expenses amounted in the past year to £83,333, or an increase of only £395, which was more than accounted for by the higher price of coal in 1907. Rents, rates, and taxes figured for a large sum—namely, £13,575—but this was only an increase of £200 on the previous year's amount. Companies had no voice whatever in the expenditure of the large sums provided by them; they were unable to express their views at the borough council meetings, and could only obtain a hearing through the costly procedure of the law courts. Their general progress had been satisfactory during the past year. As regarded the present year, during the first nine weeks of 1907 they added 14,000 lamps to their system, but during the corresponding period of this year the number added was 24,300. The balance to the credit of revenue, after paying all working expenses, amounted to £95,349. The directors proposed to set aside £20,000, as usual, to the reserve fund, which would then stand at £241,355; and the fund was not invested in the Company's business, but was in first-class securities outside. The net revenue then remaining of £75,349 was increased by the balance brought forward and other receipts to £88,767; and, after deducting the interest on debentures, loans, and preference shares, £44,878 remained. To this amount the directors had added £21,000 from the undistributed balance of the St. Marylebone purchase money, which, with the shareholders' sanction, was purposely set aside to meet their lean years, to meet the deficiency until the increase of business could be developed to replace the loss of St. Marylebone. An interim dividend of 3s. a share was paid last August, and the directors now recommended a further dividend of 3s. 6d. a share, making 6½ per cent. for the year, and leaving £878 to be carried forward.

Sir EYRE M. SHAW seconded the motion, which was carried unanimously, as was a motion approving the Bill promoted by the London electric supply companies.

BROMPTON AND KENSINGTON ELECTRICITY.

The twentieth ordinary general meeting of the shareholders of the Brompton and Kensington Electricity Supply Co. was held on Tuesday, Mr. H. R. Beeton, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said the net result of the year's working, in consequence of adverse conditions, showed only a small increase of £335. 9s. 4d., and the directors recommended the distribution of a dividend at the rate of 11 per cent. per annum on the ordinary shares, making 10 per cent. for the year, and the appropriation of the same amounts to depreciation and reserve, carrying forward a larger balance by nearly £1,000.

Mr. W. F. LEESE seconded the motion, which was adopted.

The CHAIRMAN afterwards moved a resolution approving the London Electricity Supply (Joint Committee) Bill. He said that it was not the existing companies, but the Acts of Parliament which were responsible for the limitations under which the supply of electrical energy was now furnished, and that if in the public interest it was now sought to obtain a supply free from the hindrances due to limited area and limited tenure it was the existing companies, who had risked their capital when the industry was in the experimental stage, who were entitled to be relieved from the existing disabilities. He added that the industrial demand for energy in London, which had been grossly overstated, had been fully and fairly met up to now, so that according to a recent census the existing companies were to-day supplying 46 per cent. of all the power in use. He was satisfied that any future demand should be as cheaply met by extending the existing undertakings as in any other way. The directors believed, therefore, that on grounds of expediency and of justice they had consulted the best interests of the Company in joining with other metropolitan companies in promoting the Bill which was the subject of this resolution, the effect of which would be to conserve the rights of the existing undertakings without disadvantage to the public. Whatever fate may be in store for the present Bills, he was hopeful that means would be found to satisfy the requirements of the public without introducing dishonest and wasteful competition. The terms upon which they had co-operated with the other companies were such that they were not to be called upon to supply current or guarantee capital, and their liability in the costs of the promotion was limited to £200.

Mr. STANLEY BEETON seconded the motion, which was agreed to.

COUNTY OF LONDON ELECTRIC SUPPLY.

The report of the County of London Electric Supply Co. for 1907, to be presented to the meeting on the 16th inst., states that the capital expended during the past year on account of the Company's London districts amounted to £57,669, and the sum of £19,678 has been deducted in respect of machinery displaced. The net total expenditure in respect of those districts up to Dec. 31 last amounted to £1,571,777. The balance brought forward from last account was £4,936. The balance in respect of 1907 is £104,153, making a total available surplus of £109,089. There has been carried to reserve for depreciation, repairs, renewals, etc., £23,000, and the directors now recommend a further dividend on the ordinary shares at the rate of 6 per cent. per annum, less income tax, making 5 per cent. for the year, leaving a balance of £4,381 to be carried forward. The profits derived from the Company's London stations for 1907 amounted to £118,200, against £105,300 for 1906. The total applications received

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at Dec. 31 last amounted to the equivalent of 1,001,171 30-watt lamps (30,035 kw.), being an increase of 106,040 lamps (3,181 kw.) for the year. Included in these figures are motors aggregating 14,851 h.p., being an increase of 2,166 h.p. for 1907. The total units sold were 13,970,179, as against 10,755,424 for the previous year, being an increase of 29·9 per cent. The funds required to meet the capital expenditure incidental to the increasing business of the Company have been provided by an issue of 6 per cent. preference shares at par to shareholders. The Bournemouth and Poole Electricity Supply Co. continues to show satisfactory progress. The directors have recommended a final dividend on the ordinary shares of that company at the rate of 9 per cent. for the six months ended Dec. 31 last, making 7 per cent. for the year. The business of the Coatbridge and Airdrie Electric Supply Co., formerly the Scottish House-to-House Electricity Co., shows substantial improvement. During the year additional applications for the equivalent of 28,999 30-watt lamps (870 kw.) have been received, including 907 h.p. in motors. The Bulk Supply Bill promoted in 1907 by the London electric supply companies, and referred to in the last report, was withdrawn. A limited liability company has been formed by eight of the London supply companies, and a Bill is being promoted by that company in the present session of Parliament. The directors have deemed it well to secure an interest in that company, and an extraordinary general meeting of the shareholders has been convened for the purpose of considering and, if thought fit, approving the proposed Bill. A supply is now available in Purley and Sanderstead under the Company's Croydon rural provisional order. The Royal assent has been obtained to the provisional order promoted by the Company in the last session of Parliament for the district of the Maldens and Coombe Urban District Council, which adjoins the Company's existing areas of supply.

W. T. GLOVER AND CO.

The report of W. T. Glover and Co. for 1907 shows a credit balance of £31,995. The sum of £11,044 was brought forward. From the total the debenture interests are provided, the sum of £4,000 is appropriated for the payment to trustees of second mortgage deferred stock, and £7,500 to first mortgage debenture redemption fund. A dividend is recommended for 3½ years on the preference shares (clearing off all arrears), and £5,576 is carried forward. The directors report a continued improvement in the financial position of the Company.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY.

The report of the North Metropolitan Electric Power Supply Co. for the year ended Dec. 31 last, to be submitted at the meeting on the 24th inst., states that the revenue for the year amounted to £59,373, and the expenditure to £36,252, leaving a balance of £23,120. After deducting £4,000, placed to the credit of the depreciation and renewals fund, there remains £19,120 to be carried to the net revenue account. This balance of £19,120, together with sundry receipts and the amount brought forward from the previous year, make up the sum of £20,505. After providing for debenture and loan interest and other charges shown in the account, there is a balance of £12,672. The directors recommend a dividend at the rate of 4 per cent. per annum, and that £386 be carried forward. The name of the depreciation and reserve fund formed out of the profits for the year ended Dec. 31, 1906, has been changed to "depreciation and renewals fund" to meet the requirements of the Board of Trade. The capital expenditure during the year amounted to £33,415, and has now reached a total of £433,820. During the year £3 per share was called up on 25,740 shares, making these shares fully paid, and a further 10,000 shares of £10 each have been issued, upon which £5 per share has been paid. The paid-up share capital to Dec. 31, 1907, was £350,020. £126,500 5 per cent. mortgage debentures were sold in July, 1907, being part of a total authorised amount not to exceed one-third of the share capital for the time being actually issued upon which one-half has been paid up. At Dec. 31 last £78,100 had been received in respect of such sales. The total number of units sold during the year amounted to 11,183,316, which, compared with the previous year's figure of 7,999,367, is an increase of 3,183,949 units (approximately 40 per cent.). An agreement having been entered into with the Corporation of the city of St. Albans for the incineration of the city's refuse, the erection of a generating station and refuse destructor is proceeding at St. Albans for this purpose, and also to enable the Company to give a supply of electrical energy in bulk under the St. Albans Electric Lighting Order, 1898. The Company has joined the British Electrical Federation, which has been formed by various electric traction and lighting companies for the purpose of co-operation and joint action in matters of common interest. The Company's investment in the North Metropolitan Electrical Power Distribution Co. has during the year been increased to £47,070, upon which a dividend of 2 per cent. will be received, calculated from the date of payment.

CITY OF LONDON ELECTRIC LIGHTING.

The report of the City of London Electric Lighting Co. for 1907, to be presented to the meeting on the 18th inst., states that the net expenditure on capital account as at Dec. 31, 1907, was £2,091,671, or a net addition to capital account during the year of £39,710. The directors have credited the first debenture stock premium redemption account with £1,310 from revenue for interest, raising the amount at credit of the redemption account at Dec. 31, 1907, to £55,921. They have also transferred the sums of £45,000 and £500 from net revenue account to reserve account. The balance at credit of reserve account at Dec. 31, 1907, stood at £221,206, in addition to which there were first debenture stock premium redemption fund, £55,921; standing reserve for doubtful debts, etc., £3,000; amount carried forward to 1908, £20,473; total reserves, £300,601. The total revenue for the year, including interest on investments and discounts, was £280,860, from which must be deducted the following items: expenses of generation and distribution, £66,560; repairs and maintenance of buildings, machinery, plant, mains, and other works, £10,264; rent, rates, taxes, management expenses, and special charges, £45,285; leaving £158,749, to which must be added the balance brought forward from 1906 (£20,621), making a total available revenue of £179,371. Of this sum interest on loan from bankers, consumers' deposits, etc., has absorbed £1,377, and interest on first and second debenture stocks for year £31,825. There has been transferred to reserve account £45,000, and to reserve for leasehold redemption £500. The directors now recommend a dividend on the ordinary shares of 12s. per share, being a distribution at the rate of 6 per cent. for the year. Of this sum 5s. per share was paid on account on July 17 last, leaving a balance of 7s. per share for present distribution, leaving to be carried forward £20,473.

CANADIAN GENERAL ELECTRIC.

The following telegram has been received from Toronto by the Canadian Bank of Commerce, London: "In view of present industrial conditions in the United States and Canada, the directors have considered it prudent in the meantime to reduce the dividend on the common stock to 7 per cent. per annum. Notice is hereby given that a quarterly dividend of 1¾ per cent. for the three months ending March 31, 1908, being at the rate of 7 per cent. per annum, has been declared on the common stock of the Company, and notice is also given that a half-yearly dividend of 3½ per cent. for the period ending March 31, 1908 being at the rate of 7 per cent., has been declared on the preference stock of the Company in accordance with the terms under which such stock was created and issued. The above dividends are payable on April 1, 1908."

HUELVA GAS AND ELECTRICITY.

The report of the Huelva Gas and Electricity Co. for the year ended Dec. 31, 1907, to be submitted at the meeting in Glasgow on the 17th inst., states that the net profit for the year amounts to £3,222, to which has been added £151 brought forward, making a total of £3,373. The directors recommend a dividend of 4 per cent. free of income tax; that the following amounts be written off: works, plants, etc., £200; electric light, £200; meters on hire, £216; artesian well, £13; and that £1,000 be carried to reserve account, leaving £743 to be carried forward subject to directors' and auditors' fees. The capital outlay during the year has amounted to £4,448.

NEW COMPANIES REGISTERED.

Munderi Rubber Syndicate, Limited.—Registered Feb. 11. Capital, £25,000 in £10 shares. Objects: to acquire any lands, properties, or estates in British India or elsewhere in the East; to adopt an agreement with F. W. F. Fletcher and Colonel J. P. C. Noville, and to carry on the business of cultivators, exporters, and importers of, agents for, and dealers in rubber, tea, and other produce, etc. Minimum cash subscription, all the shares offered to the public.

British and Foreign Rubber Corporation, Limited.—Registered Feb. 10. Capital, £22,500 in £1 shares (2,500 7 per cent. cumulative preference). Objects: to carry on the business of planters and manufacturers of and dealers in rubber and other gums, etc., and to acquire and turn to account concessions, grants, decrees, rights, powers, privileges or contracts in Brazil or elsewhere. No initial public issue. Registered office: 240-1, High Holborn, W.C.

Liens Registered.

Liverpool Electric Cable Co., Limited.—A memorandum of satisfaction to the extent of £500 of a debenture dated Dec. 9, 1904, securing not more than £6,000, has been filed.

Provincial Tramways Co., Limited.—A memorandum of satisfaction in full of debentures, created May 27, 1904, nominally securing £125,000, of which only £121,500 were issued, has been filed.

K Electric Accumulator Co, Limited, London.—A second debenture, dated Jan. 21, 1908, to secure £1,000, charged on the company's undertaking and property, present and future, has been registered. Holder: J. A. Bleackley, 34, Sloane-court, S.W.

Electrical Fittings Co., Limited, London.—A debenture, dated Jan. 31, 1908, to secure £6,000, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holders: Samuel Heath and Sons, Cobden Works, Leopold-street, Birmingham.

Coatbridge and Airdrie Electric Supply Co., Limited.—A charge dated Feb. 6, 1908, to secure £3,500, has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital, and the Coatbridge and Airdrie undertakings. Holders: County of London Electric Supply Co., Moorgate-court, E.C.

Electrolytic Alkali Co., Limited, Middlewich.—Issue on Jan. 27 of £350 4½ per cent. first mortgage debentures, part of series created July 9, 1904, to secure £50,000. Charged on the company's undertaking and property, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., 6, Castle street, Liverpool. Total amount previously issued of same series, £34,500.

Vera Cruz Electric Light, Power, and Traction, Limited.—A trust deed, dated Jan. 7, to secure £300,000 debentures, was registered on Feb. 17, 1908, pursuant to order of Court. Property charged: concessions, lands, and other immovable property in Mexico, and the

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company's other assets, present and future, including uncalled capital. Trustees: Sir Westman D. Pearson, Bart., M.P., 16, Carlton House-terrace, London, and Hon. A. W. C. O. Murray, M.P., Master of Elibank, Juniper Bank, Walkerburn.

South Metropolitan Electric Light and Power Co., Limited.—Issue on Jan. 17 of a £4,500 4½ per cent. debenture, part of series created July 3, 1900, and May 6, 1904, to secure not more than the amount of the share capital issued and paid up. Charged on the company's undertaking and property, present and future, including uncalled capital (if any). Trustees: H. R. Beeton, 18, Austin-friars, E.C., and W. R. Davies, 10, Moorgate-street, E.C. Total amount previously issued of same series, £251,468.

Vickers, Sons, and Maxim, Limited.—A trust deed, dated Feb. 11, 1908, to secure £1,000,000 third mortgage debentures, has been registered. Property charged: the company's undertaking, freeholds, leaseholds, and other property, present, and future, including uncalled capital, subject to £1,250,000 first and £1,000,000 second mortgage debentures (of which latter £843,000 are outstanding). Trustees: Hon. Algernon H. Mills, 67, Lombard-street, E.C., and Hon. Everard Baring, C.V.O., 8, Bishopsgate-street Within, E.C.

Barbados Light Railway, Limited.—Issue on Jan. 28 of £200 5 per cent. debentures, part of series created Oct. 16, 1907, to secure £10,000. Charged on freehold and leasehold lands and premises, fixed plant, machinery, immovable property, rights and interests in Barbados, and the company's undertaking and property, present and future, including uncalled capital. Trustees: J. P. Cave, Ditcham Park, Petersfield, Hants, and Colonel the Hon. E. A. Palk, Testwood House, Totton, Hants. Total amount previously issued of same series, £8,350.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Sale of Plant.—A useful switchboard is to be sold with accessories, particulars of which appear in our advertisement column.

Islington.—The London County Council have agreed to lend the Borough Council the sum of £6,935 for electric lighting purposes.

Leicester.—The profit of the Corporation electricity undertaking for the past year, after paying interest and sinking fund, is £4,617.

Lincoln.—The Electricity Committee have reported their ability to contribute £1,000 towards the relief of the rates levied by the City Council.

Beckenham.—The Urban District Council have decided to extend the cable 135 yards in order to supply Stanley-avenue. The outlay is estimated to be £50. 12s. 6d.

Dorking.—The Local Government Board will hold an inquiry on March 17 into the Council's application for sanction to borrow £11,600 for electric lighting purposes.

Edmonton (Canada).—A new power plant, consisting of a gas producer engine of 1,000 h.p. and a 2,300-volt generator, will be installed here on the site of the present power plant.

Woolwich.—The London County Council have agreed to lend the Woolwich Borough Council the sum of £3,000 for the purchase of electrical apparatus and wiring consumers' premises.

Birmingham.—By an explosion at the Corporation gasworks in Windsor-street on Sunday afternoon two men were literally blown to pieces and another was injured, though not seriously.

Direct Spanish Telegraph Co.—The directors have decided to pay a dividend at the rate of 4 per cent., free of income tax, on the ordinary shares for the half-year ended Dec. 31, 1907.

Norden.—At the last Urban District Council meeting strong complaints were made respecting the gas supply. The price demanded at the present time is no less than 3s. 9d. per 1,000 cubic feet.

Guildford.—The Guildford Electricity Supply Co. have been awarded a gold medal for their exhibit of lighting by electricity at the trades exhibition at Guildford Drill Hall last December.

Liverpool.—The chamber of commerce have resolved to request the Government to undertake short-distance wireless telegraphy experiments and the erection of stations at British possessions abroad.

Southend.—A sum of £26,690 is to be expended on new machinery and a condenser at the Corporation's electric power station. It is expected that this year's working will result in a profit of £2,000.

Wolverhampton.—The electricity department of the Corporation have, as a result of their operations during the past year, been able to make a contribution of 1d. in the £ towards the relief of the rates.

Merthyr.—A fire occurred on the 14th inst. in the power house of Hill's Plymouth Co., Clymmill Level. It originated from a fusion of some of the wires of the dynamo. The damage is estimated to amount to at least £200.

South Metropolitan Electric Light and Power Co.—The register of debenture stockholders will be closed from 18th to 31st inst. for preparation of warrants for interest at the rate of 4½ per cent. per annum for the half-year to April 1, 1908.

Alloa.—Upon the receipt of a complaint as to the poor lighting by gas at the infectious diseases hospital, the committee have given an instruction for the preparation of a scheme for the wiring and fitting of the building for the installation of electricity.

Llandilo.—At the last meeting of the Urban District Council it was reported that the total number of units consumed of the electric light for the past month was 2,741, against 2,418 in the corresponding month last year, showing an increase of 323 units.

British Insulated and Helsby Cables.—For the past half-year the directors recommend a dividend of 4 per cent. and a bonus of 2 per cent., making 10 per cent. for the year. The sum of £37,000 is placed to reserves and depreciation, and £28,000 carried forward.

Warrenpoint.—At the last meeting of the Urban Council the clerk stated that a representative of the firm of Wilson, Miller, and Pegg had called upon him with reference to the lighting of the town by electricity, and it was decided to invite him to the next meeting of the Council.

Victoria (B.C.).—According to the annual report of Mr. Matthew Hutchinson, superintendent of the city lighting department, several additions and changes will be found necessary for the city electric plant. He recommends the replacing of the older types of lamps and machinery before making further extensions.

Sandown.—The Council have decided to hold a ratepayers' meeting to consider the gas company's tender to light the town for £500. 7s. 6d. per annum, and the electric light company's at £540. At a similar meeting the electors decided to adopt the electric light, and the question of reverting to gas is to be left with them.

Johnstone.—The question of extending electric power and lighting to Johnstone is creating a good deal of interest in the town, and it is thought if no arrangement is come to between the Town Council and the Clyde Valley Electric Power Co., the advisability of approaching Paisley Town Council to supply electricity may be considered.

Release of Trustee.—The *London Gazette* announces that Mr. E. H. Hawkins, 4, Charterhouse-square, London, E.C., has been released from trusteeship in the estate of Mr. C. Vigant De Falke, lately carrying on business as electrical engineer under the title of the Electrical and General Contracting Co. at 17, Shaftesbury-avenue, London.

Leicester.—The past year's working of the Leicester municipal tramways has resulted in a net profit of £10,538. The number of passengers carried was 27,417,227, which is equivalent to each person in the city travelling 116 times on the cars. The miles covered by the trams were 3,334,924. No fatal accidents were recorded during the year.

Heanor.—A deputation from the local tradesmen's association attended the last meeting of the Urban District Council and asked the Council to consider the advisability of taking up the question of electric lighting in the parish. The Council appointed a sub-committee to obtain information to be placed before the Council in due course.

Farnham.—The Urban District Council have decided to allow the Farnham Electric Supply Co. to supply light by means of overhead wires on certain conditions, the principal of which are that a plan showing the positions of the standards should be submitted and approved by the Council, and that the generating station should be within the urban area.

Colchester.—At the meeting of the Corporation Electricity Committee the engineer reported that the output of electricity in units during December, 1907, was for lighting, 104,239, against 96,786 in 1906 and 83,383 in 1905; ditto traction, 49,545, against 42,435 in 1906 and 41,420 in 1905; used in generating station, 23,661, against 19 650 in 1906 and 9 088 in 1905.

Dundee.—According to a report by Mr. H. Richardson, electric engineer, the work of laying the extra high-tension mains from the station in Dudhope crescent-road through the central area of the city so Market-street has now been completed, while the cables from Market-street to the new generating station at Stannergate will be laid in the course of a day or two.

Sowerby Bridge.—At the meeting of the District Council the clerk, who had been deputed by the Electricity Committee to attend a conference at Whitehall with regard to the electric lighting order, reported that the Board could not consent to two years being allowed for the transfer of the powers to the Electrical Distribution Co. One year, or at the most 15 months, was the time allowed.

Melrose.—Strong complaints have been made at the Town Council concerning the poor results obtained from the use of incandescent mantles, the use of which has been introduced by the gas company in order to secure the best results from an obsolete lighting system. A portion of the town is illuminated by the electric lighting company, the operations of whom are rapidly superseding those of the gas company.

Birkenhead.—A gas explosion of a serious character took place in Oliver-street on Saturday evening, as a result of which a man named O'Brien received serious injuries. It seems that the injured man and his wife were moving into an empty house in Oliver-street when an escape of gas was detected, and whilst O'Brien was endeavouring to find it he was blown through the back parlour window to the bottom of the yard.

Wigan.—The units generated for lighting and power at the Corporation works during January last were 40,912, as against 51,199 in January, 1907. The highest daily output for traction was 2,260, as against 1,040 in January, 1907. The highest load on the station during the month was 468 kw., as against 392 kw. in January, 1907. Total units generated during the month were 88,102, as against 75,209 in January, 1907.

Shelton.—A gas explosion occurred on Monday last in Rectory-road through a defective main in the street which allowed the gas to escape into several houses. Two of these were damaged very considerably, and one of the inmates also sustained injury. It would appear that residents in their own houses are not safe from the continuance of an old custom which allows this dangerous agent to be distributed throughout the thoroughfares.

Edinburgh.—The Works Committee of the Edinburgh and Leith Corporations' Gas Commissioners have recommended an increase in the charge for lighting of streets and stairs in Edinburgh. The rates obtaining at the present time are 2s. 5d. per 1,000 cubic feet for the flat-flame lights in stairs and 2s. for the incandescent lights in the

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streets. The rates recommended for the ensuing year are 2s. 8d. for flat-flame burners and 2s. 6d. for incandescent lights.

Oldham.—At the fortnightly meeting of the Corporation Electricity Committee it was reported that the units sold during the fortnight ended Feb. 26 was: for lighting and power, 66,031, as compared with 50,156 during the corresponding period last year; for traction, 157,844, against 145,865—a total of 223,875, against 196,021. The number of lamps connected to date was 349 arc, 24,408 incandescent, 384 motors, etc., equivalent to 115,703 lamps of 8 c.p.

Sittingbourne.—No little consternation was caused by an explosion of gas which occurred in the refreshment bar on the down platform, Sittingbourne railway station, last Thursday week. All the glass windows were shattered and blown out on to the line, together with a quantity of eatables, glasses, and other articles. It was fortunate that few passengers were waiting for trains, otherwise the danger of using this obsolete production might have been more forcibly demonstrated.

Luton.—The electrical engineer reported to the last Council meeting that since Jan. 27 last 34,925 units had been generated, an equivalent of 387 8-c.p. lamps and one motor of 2 h.p. connected, making a total of 471 consumers, with 25,566 lamps and 222 motors of 1,368 h.p.; that the number of units generated showed an increase of 38 per cent. over the number generated during the corresponding period of last year; and that applications were in for over 1,800 additional lamps and 297 h.p. in motors.

Hounslow.—The clerk to the Heston and Isleworth District Council has issued a report on the three years' working of the local electric lighting undertaking. During the first two years a small profit was made, which reduced the loss on the three years' working to 11s. 10d. Comparing the undertaking with that of a company, the clerk states that under private management the business would have paid a dividend of 5 per cent. and placed a substantial sum to the depreciation account. A profit of 237 is estimated for the present year.

Poplar.—The cost of generating and distributing extensions proposed by the Poplar Borough Council for their electricity stations amounts to £27,000. The Electricity Committee are convinced of the absolute necessity for the contemplated extensions, and in order that plans may be prepared and a complete scheme, with the necessary actual estimates obtained and submitted for approval by the Council they have been authorised to obtain tenders from selected firms for the types of plant required, and report thereon to the Council.

Gillingham.—The borough electrical engineer reported to the Council that the equivalent of 45 8-c.p. lamps had been connected with the mains since the last meeting of the committee, making a total of 28,992 equivalent in 8-c.p. lamps, with 332 consumers connected, and that an application had been received for the equivalent of 34 8-c.p. lamps. A Local Government Board inquiry is to be held on March 17 into the application of the Council for sanction to the borrowing of £5,000 for the purpose of extending the electricity undertaking.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Montreal Street Railway Co.'s further issue of £460,000 4½ per cent. sterling debentures. The committee have also been asked to appoint a special settling day in Providence Tin Mines' 50,000 shares of 10s. each, fully paid, Nos. 1 to 2,007 and 152,008 to 200,000. The committee have further been asked to allow National Telephone Co.'s further issue of £383,575 deferred stock to be quoted in the official list.

Longton.—At the last meeting of the Town Council it was reported that the output of gas for six weeks ended Feb. 20 showed a decrease of 258,000 cubic feet compared with the corresponding period of the previous year, whilst the output of electricity during the month was 22,370 units, being an increase as compared with last year of 2,270 units. In view of the increasing tendency to disuse gas, the committee have decided that from the end of the current quarter the prices charged for gas for illuminating purposes (including public lighting) be reduced 2d. per 1,000 cubic feet.

Continental Telephones.—It is understood that the postal authorities have under consideration an important scheme of direct telephoning between England and the Continent, which would ensure an enormous additional convenience to subscribers. Experiments are being made through the cross-Channel cables by ringing up from subscribers in England direct to subscribers on the Continent. Although some difficulties occurred through inferior telephones being used by Continental subscribers, conversations were conducted with the greatest ease as far as the great towns in the South of France.

Fulham.—In January last the Borough Council authorised an expenditure of £400 for the erection of a sub-station in the Talgarth-road district, leaving the selection of the site to the discretion of the committee. Upon the recommendation of the borough electrical engineer the committee have acquiesced in the proposed erection of a suitable pavement transformer chamber in Talgarth-road, subject to the site being approved by the Council on the recommendation of the Works and Highways Committee. The total estimated cost of the amended scheme is £358, representing a saving of approximately £42 on the estimate passed by the Council.

Nuneaton.—At the monthly meeting of the Town Council a lengthy report was presented by the Highways Committee detailing negotiations which had taken place with the gas company on the subject of street-lighting, the gas company having given notice to charge 10s. per lamp more. The committee recommended that electric lamps be substituted, and the Electric Committee suggested that in the event of the above report being adopted application be made to borrow £6,000 for the purpose of electric extensions. Since the preparation of the report the gas company have become alarmed and are reopening negotiations, which are to be considered by the Council.

Newcastle.—At the annual meeting of the Newcastle Electric Supply Co. the shareholders agreed to a proposal to put down new works at Dunston. The Wallsend station can supply all Northumberland, Newcastle, and the lower reaches of the Tyne on the Durham side, but not conveniently the higher reaches and the interior of Durham. The directors have, therefore, leased 30 acres at Dunston, and intend at first to put down 30,000 h.p. To pay for this new station, which it is estimated would cost £250,000, and to pay off their loans, they propose to issue £500,000, being divided into 50,000 preference shares of £5 each and the same amount of ordinary shares.

Perth.—The Electricity Committee of the Town Council have had under consideration a letter from the general manager of each of the Caledonian Railway Co., the North British Railway Co, and the Highland Railway Co. stating that they had now had an opportunity of considering the proposal of the Town Council to increase the special rates for the supply of electric current for their hotel, yards, etc., and, without prejudice, they agreed for the current year to pay at the rate of 2¾d. per unit for the amount of energy taken by each of the companies, on the distinct understanding that the Council will reconsider the matter when fixing the rates for next year with the view of having the rate reduced.

Liverpool and District Electrical Association. — On the 7th inst. a large party of members and friends of the above association paid a visit to the works of the British Insulated and Helsby Cables at Prescot. On arrival at the works the party were met by a number of the members of the staff and split up into a number of small groups, when a tour of the large plant was made. Many of the machines were in motion, and the visitors were thus enabled to see the various process of cablemaking in operation. The copper-rolling department was an interesting sight, as was also the screw-making, wheel-cutting, switch, distributor-box, and numerous other departments, but the time at the disposal of the party would permit of only a hurried glance round.

Handsworth.—The Council Electricity Committee have had under consideration the question of the scale of charges for current for lighting purposes both in Aston and Erdington, and as the result they have approved an amended scale as follows: for consumption not exceeding 150 units per quarter, 3½d. per unit; for over 150 and not exceeding 600 units per quarter, 3¼d. per unit; for over 600 and not exceeding 1,000 units per quarter, 3d. per unit; for over 1,000 and not exceeding 1,500 units per quarter, 2¾d. per unit; for over 1,500 units per quarter, 2½d. per unit. The new scale of charges will come into operation as and from April 1, 1908. The number of units sold for the month of January was 274,379, being an increase of 67,327 on the corresponding period of last year.

Bangor.—It is clear that electricity is rapidly superseding gas by a perusal of the report submitted to the City Council, where the monthly gas statement was presented, showing that during the last four weeks 4,603,400ft. of gas had been made, being a decrease of 472,300 as compared with that period last year. The total amount of gas made up to date this year was 41,461,300, being a decrease as compared with the previous year of 547,400. With regard to the electricity works, 14 619 lamps had been connected up to Jan. 31 last. The total units sold during the last month was 16,891, as compared with 13,396 for the corresponding period last year, being an increase of 495. There was an increase of 6,765 units sold up to date this year as compared with that of the previous year.

Stepney.—The Council on Oct. 9, 1907, directed an application to be made to the Board of Trade for the Board's consent to the adoption of a 6,000-volt transmission from the proposed generating station at Blyth's Wharf. This application was duly made, and the Electricity Committee are now reporting that a communication has been received intimating that the Board of Trade approve of the system for the supply of electrical energy for the purposes of the orders obtained by the Council and their predecessors, subject to the regulations for securing the safety of the public and for ensuring a proper and sufficient supply of energy, and subject also to the Board's regulations with respect to supply at extra high pressure, and that the Board also approves of the connection by the undertakers (the Council) of certain parts of their electrical circuits with earth.

Camborne.—At the last meeting of the Urban District Council a letter was received from the Urban Electric Supply Co. offering to erect 50 lamps from the parish boundary to the tram terminus, Camborne, instead of the 30 gas lamps already fixed, and to guarantee that the light between the lamps should be three times as good as at present. They were also prepared to erect free from six to nine lamps for a month to show what they were prepared to do. The Town Lighting and Improvement Committee recommended that the new contract of the gas company be signed and sealed. A lively discussion ensued, but ultimately the friends of the gas company, discarding the obvious advantages of the offer from the electricity company, and without considering the light upon its merits, managed to get the Council to seal the gas contract.

Aberdeen.—A meeting of the Electricity Committee of the Aberdeen Town Council has been held for the purpose of considering what steps ought to be taken for the supply of electricity to the Deeside district direct from the Ferryhill electric station. In a report submitted by Mr. Bell, electrical engineer, two schemes were suggested. One was to cope with the immediate wants of the district by means of converting the present low-tension supply into a high-tension supply, and transmitting it to Cults, and there again transforming it to the required voltage. This scheme was estimated to cost £2,724. In view, however, of the increasing number of consumers in the Cults district, and the likelihood of extension having to be made to cope with the increasing demand in the west end in the city boundary, another scheme was proposed whereby three high-tension cables would be laid as far as the city boundary instead of only one. The cost was

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estimated at £6,600. The committee, after consideration, agreed to recommend the Council to adopt the larger scheme.

Ayr.—At the last meeting of the Town Council an exhaustive report was submitted by the electrical engineer relative to the extension of the buildings and generating machinery at the electricity works. The engineer pointed out that the Corporation were at a considerable disadvantage in having to work two systems of generating and distributing the electricity, the continuous-current and alternating-current systems, more especially with reference to the supply of motive power, but that it was doubtful if there would now be any saving in substituting continuous for alternating current. He outlined a scheme, to cost £22,800, to meet the requirements for the next eight years. The Lighting Committee recommended the Council to adopt an alternative scheme at a total estimated cost for six years of £15,050. They also recommended the Council to apply for additional borrowing powers to the extent of £30,000 to cover further extensions, and to ask the Board of Trade to extend the lighting area so as to include Prestwick and the Alloway district of the parish of Ayr to the River Doon. The proposals, however, were referred back to the committee.

Burslem.—The Electric Lighting Committee at the Town Council meeting reported that Mr. Hooper, an inspector of the Local Government Board, who had recently held a local inquiry at Hanley with respect to an application by the Town Council for sanction to a loan for the purposes of their electric lighting undertaking, had also visited the works at Burslem, and had told the engineer that, having regard to the probability of the scheme for the federation of the Potteries being carried through, it was advisable that no extensions should be made at Burslem which were not required for immediate necessities. The committee, however, adhered to their previous resolution requesting the Finance Committee to apply to the Local Government Board for sanction to borrow for the longest possible period £12,000 for the purposes of the electric lighting undertaking. The chairman, in proposing the confirmation of the Electric Lighting Committee's recommendation, said the electric lighting undertaking was succeeding beyond their expectations, and the proposed loan was absolutely necessary if they were to carry on the works efficiently and keep pace with their requirements. After lengthy discussion the recommendation of the Electric Lighting Committee was confirmed by the Council.

TRACTION.

Newcastle.—The Council have decided to apply to the Board of Trade for sanction to borrow £5,000 for the tramways in the Market-street extension.

Wolverhampton.—On the recommendation of the Tramways Committee, the Town Council have decided to purchase three additional double-deck tramcars at an estimated total cost of £2 000.

Builth.—Builth Wells Improvements Committee have decided to apply to the Great Western Railway Co. for a motor-omnibus service between Builth Wells and New Radnor during the summer months.

Derby.—The receipts of the Corporation tramways during the four weeks ended Feb. 22 amounted to £3,035. 15s. 5d., being an increase of £357. 11s. 2d. as compared with the corresponding period last year.

Kirkburton.—The Lepton Urban District Council have invited the Kirkburton Council to meet them to confer on the subject of the proposed extension of the Huddersfield tramways to Kirkburton. The meeting will take place on the 16th inst.

Reading.—The Town Council have given an approval to an elaborate scheme submitted to them by the Tramways Committee as to the payment of bonuses to and the gradation of conductors and motormen, with a view to encouraging traffic.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the eight days ending March 4, 1908, were £4 223; receipts for the seven days ending March 4, 1907, were £3,743—increase, £480. Aggregate from Jan. 1, 1908, £38,448; aggregate from Jan. 1, 1907, £33,011—increase, £437.

Liverpool.—A scheme of pensions for tramway employés has been adopted by a majority of the Liverpool City Council. The men are to contribute 2d. per week, and the Corporation the same amount, and the fund is to be augmented in some casual ways. It is expected £30,000 will be accumulated in 10 years.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board.—At the last meeting of the Board the commercial manager reported that the traffic receipts for the four weeks ended Feb. 15 amounted to £2,529. 4s. 0½d., and that the total receipts to that date from March 31 last were £35,512. 5s. 7½d.

Hebburn.—At a meeting of the District Council a letter was read from the Gateshead Tramway Co., stating they could not undertake the expenditure of extending the tramways in the district, but offering to work an extension for the Council if the authority laid the lines. A special meeting will be held to consider the proposals.

Perth.—During the month of February the number of passengers who travelled over the Corporation tramway system totalled 117,381, while the receipts amounted to £521. 3s. 5d., and the number of miles run was 16,928. Compared with last year there is a decrease in passengers of 466 and in mileage 625, and in receipts £14. 18s. 4½d.

Maidstone.—The Council have adopted the following amongst other by-laws recommended by the Light Railways Committee: "No person shall in any way wilfully impede or interfere with the traffic on the light railways within the borough, nor shall any driver or conductor needlessly cause interruption to the ordinary road traffic. Penalty for breaking a by-law, a fine not exceeding 40s."

Macclesfield.—The Tramways Sub-Committee of the Council have considered the Macclesfield and District Tramways (Abandonment) Bill, which has been introduced in the present session of Parliament, and have requested the Council's solicitors to examine the Bill, and to report whether the interests of the Council and their powers under the Macclesfield and District Tramways Act, 1906, are prejudicially affected by any of the provisions.

Dundee.—The subject of running motor 'buses along Clepington-road, Dundee, to join up the Maryfield and Fairmuir tramway routes was mentioned at a meeting of the Tramways Committee, and it was decided that the tramway manager should report on the matter. A remit was also made to the manager to report on a proposal to have a circular tramway route between Arbroath-road and Clepington-road *via* the Eastern Cemetery-road and Old Craigie-road.

Southwark Bridge.—The London County Council has addressed a letter to the City Corporation on the subject of the contemplated rebuilding of Southwark Bridge, the estimated outlay on which is over £500,000. The County Council ask that the Corporation will take into consideration the question of the extension of the tramways over the bridge simultaneously with its reconstruction, and suggest that the Highways Committee should confer with the Corporation on the subject.

Sheffield.—The grant of £22,000 in relief of the rates made by the Sheffield Tramway Committee has had the effect of reducing the district rate this half year by 3½d. in the £. It is worthy of note that since 1900 no less a sum than £125,694 has been applied from this source for the relief of the rates. From the profits on tramways also comes the cost of municipal music, provision of bands in the parks, concerts in public halls, etc., £1,000 a year for five years for Sheffield University, and a yearly grant to the School of Modern Languages.

Hampton.—A resolution is to be submitted at the next meeting of the District Council that the Council call upon the tramways company to carry out the widenings at High-street, Hampton Hill, in accordance with their agreements entered into with the Council, and dated June 9, 1903, and May 3, 1904, on or before June 10, 1908, and that if they fail to do so, the clerk be instructed to apply to the High Court for a mandatory injunction to compel the company to complete their contract with the Council, and for damages or such other proceedings as may be necessary with that object.

Swindon.—The ratepayers of Swindon have now practically paid all the compensation awards arising out of the disastrous tramway car accident which occurred in the town during the visit of the Bath and Western Counties Show on June 1, 1906. Already two special rates of 1s. and one of 6d. have been paid, and a further 1d., which is included in the ensuing half-year's rate, will clear the debt. It will be remembered that four persons were killed and some 50 or 60 injured, and the compensation claims amounted to over £25,000. This is 10s. per head of the population, but the Great Western Railway Co. pay 20 per cent. of the rates of the town.

Bath.—The Rural District Council have received a letter from the Bath Tramways Co. stating that they propose making an application to the Board of Trade for authority to increase their charges on the Weston route. They intend to ask permission to charge 1d. from the Great Western Railway Station to the Weston Hotel, and a further charge of ½d. to either Upper or Lower Weston. It is also proposed to charge 1d. from Weston to Marlborough-lane on the inward journey. The company stated that, subject to no objection being taken to the revision of fares on the Weston route, they would not take any steps to increase the fares on the Twerton route.

Bradford.—The Tramways Committee of the City Council have decided to recommend that the city surveyor be instructed to execute renewals of track as follows: Bridge-street, from Norfolk-street to Croft-street, £803; Croft-street, from Bridge-street to Nelson-street, £663; Morley-street, from Manchester-road to Laisteridge-lane, £3 451; Lidget Green, from Thornton-road to Norcroft-street, including doubling of track, £1,475; Westgate, from Godwin-street to City-road, £2,437; Manningham-lane, from the Yorkshire Penny Bank to Oak-lane, £5,645; Well-street, £978; Stanningley, from Woodhall-road to Gallway-lane, £4,430; extra cost for maintenance of services, £1,529—total, £21,411. The chairman and city surveyor have been requested to make inquiries and to report on a proposal that by way of experiment a length of track should be laid on wooden sleepers.

Wigan.—At a joint meeting of the Corporation Electric Light Committee and Tramways Committee it was decided that the Electric Light Committee should have the control of and be responsible for the efficient working of the electrical equipment, both underground and overhead; that the maintenance of such equipment be undertaken by the Electric Light Committee; and that the cost of such maintenance be charged to and paid for by the Tramways Committee. The chairman stated that it was the intention of the Tramways Committee to appoint a traffic manager for the tramways. It was resolved that Mr. James Slevin remain as electrical engineer and have charge of the maintenance of the electrical equipment of the tramways, both underground and overhead; that he have charge of the engineering shops, and of the cleaning and repairing staff at the central car-sheds; and that a portion of Mr. Slevin's salary be apportioned to the Tramways Committee.

West Ham.—The fourth anniversary of the inauguration of the West Ham Corporation tramways system was marked last week by a social at the public hall, Canning Town, under the auspices of the West Ham Corporation Tramways Social and Athletic Club. Mr. Blain (tramways manager), who was heartily received, said the traffic receipts to date were £109,000, and it was estimated that the total for the year—which ended in March—would be £119,000. The estimated gross receipts were £123,000, and the mileage was 2,750,000. Other figures given by Mr. Blain showed that the capital expenditure amounted to £500 000, and over £400,000 had been earned. After paying interest, etc., the net profit amounted to nearly £70,000, and no less than £30,000 had gone towards the relief of the rates. He added that he wished to thank the whole of the staff for their co-operation, for without this the work could not have been success-

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fully carried on. Referring to the bonus system, Mr. Blain said this was much appreciated, and £650 had been handed to the men, over 80 per cent. participating.

Swansea.—A comprehensive parcels delivery system that promises to be of great utility and benefit to Swansea traders and public generally is shortly to be inaugurated in connection with the Swansea Tramways and Mumbles Railway. Known as the Tramways Parcels Express, the scheme embraces the collection and delivery of parcels by means of special messengers in uniform, utilising the cars for transit; the frequent services of cars on all routes offering unequalled facilities for rapid collection and delivery. Including collection or delivery within half a mile of any part of the lines, the rates for packages are exceedingly low, being as follows: not exceeding 14lb., 2d.; 28lb., 3d; 42lb., 4d.; 56lb. 5d. Compared with the figures charged by rail or parcels post the saving is most noticeable. Agencies have been established at distances of about every half-mile on the tram routes, denoted by an enamelled sign. In addition, conductors have instructions to receive parcels at any of the recognised stopping places. The carriage can be either prepaid, or the charges collected from consignee. To places on the Mumbles Railway the same remarks apply, but the rates are: not exceeding 28lb., 3d.; 56lb., 5d. Special waterproof hampers and bags have been provided to ensure efficient protection from pilferage or damage by rain, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Belfast.—The Tramways Committee invite tenders for electrical supplies. Tenders by March 16.

Dresden.—The Municipality invite tenders for the supply of flame arc lamps. Tenders by March 16.

Valencia.—The Municipality invite tenders for the electric lighting of the town. Tenders by March 23.

Burnley.—The Guardians invite tenders for electrical supplies for the ensuing year. Tenders by March 16.

Danzig.—Tenders are invited by the Municipality for four electric travelling cranes. Tenders by March 24.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Brisbane.—Tenders are invited by the Deputy Postmaster-General for lead-covered cable. Tenders by April 20.

Aberdeen.—Tenders are invited for electric lighting the proposed new slaughter-house. Tenders by March 17.

Hackney.—Tenders are invited for the supply of lubricating oils for the electricity works. Tenders by March 26.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Paddington.—The Borough Council invite tenders for electric lamps and shades. Tenders to the Town Clerk by March 14.

Cassel.—The Prussian State Railways invite tenders for a three-ton travelling crane, together with electric motor. Tenders by March 27

Hornsey.—The Town Council invite tenders for meters and fuse boxes, cables, troughing, etc. Tenders to the Town Clerk by March 16.

Madrid.—The Post and Telegraph Department invite tenders for laying, etc., telegraph cable between Chefarinas and Argelia. Tenders by March 30.

Madrid.—The Post and Telegraph Department invite tenders for the construction and exploitation of the interurban telephone service. Tenders by April 2.

Madrid.—Tenders are invited by the Post and Telegraph Department for the installation and working of telephones in Valencia. Tenders by March 20.

Leeds.—Tenders are invited for the supply of steam coal for the power station. Particulars from Mr. H. Dickinson, engineer. Tenders by March 31.

Felixstowe.—The Urban District Council invite tenders for the supply of a storage battery and booster. Tenders to the clerk, Mr. F. B. Jennings, by March 25.

Bury.—The Corporation invite tenders for the supply and erection of two 2,000-kw turbo-alternators, with exciters and condensers Tenders to the Town Clerk by March 16

St. Marylebone.—Tenders are invited for the annual supply of stores for the electricity works. Particulars from Mr. F. A. Wilkinson, electrical engineer. Tenders by March 18.

St. Pancras.—The Borough Council invite tenders for the supply of arc lamp carbons for 12 months. Tenders to the Town Clerk by March 23. See advertisement in last issue.

Newcastle-under-Lyme.—Tenders are invited for the supply and laying of about 1,000 yards of mains. Particulars from the Borough Electrical Engineer. Tenders by March 21.

Manchester.—Tenders are invited by the Electricity Committee for the supply and erection of one 6,000-kw. turbo-alternator, with exciter and condensing plant. Tenders by March 25.

Gloucester.—The Electricity Supply Committee invite tenders for the supply of rough slack steam coal. Particulars from the City Electrical Engineer. Tenders to the Town Clerk by March 19.

Edinburgh.—Tenders are invited for the supply of stores to the electricity department for one year, commencing May 16. Tenders to Mr. F. A. Newington, engineer, by March 30. See advertisement.

Dewsbury.—The Electricity Committee invite tenders for the supply of a surface condenser and the erection of a cooling tower. Tenders to the Chairman of the Electricity Committee by March 30.

Madrid.—The Post and Telegraph Department invite tenders for the supply of cylinders for accumulators. Particulars from Direccion-General de Correos y Telegrafos, 10, Carretas. Tenders by March 21.

East Ham.—The Town Council invite tenders for the annual supply of stores for the electric lighting and tramways department. Particulars from Mr. C. E Wilson, town clerk. Tenders by March 17.

Madrid.—Tenders are invited by the Public Works Department for the construction and working of electric tramways. Particulars from the Direccion de obras publicas, Ministerio de Fomento. Tenders by March 22.

Huddersfield.—The Corporation invite tenders for the annual supply of single-phase alternating-current meters. Particulars from the Borough Electrical Engineer. Tenders by March 25. See advertisement.

Preston (Lancs.).—Tenders are invited for supply of electrical goods and supplies to the Lancashire County Asylum at Lancaster and Whittingham Asylum, Preston, for the year ending April 5, 1909. Tenders by March 19.

Aston Manor.—Tenders are invited for the supply and erection of steel coal bunkers. Particulars from the Borough Electrical Engineer. Tenders to the Chairman of the Electricity Committee, Council House, Aston Manor, by March 14.

Stockport.—Tenders are invited for the annual supply of stores for the electricity department. Particulars from the Borough Electrical Engineer, Millgate, Stockport. Tenders to the Chairman of the Electricity Committee by March 17.

Hastings.—The Corporation invite alternative tenders for supply of best Welsh smokeless coal for the electricity works (*a*) during six months from April 1, 1908, and (*b*) during 12 months from same date. Tenders to the Town Clerk by March 17.

Torquay.—The Electric Lighting Committee invite tenders for the supply of 1,500 to 2,500 tons of smokeless through steam coal. Specifications and form of tender may be obtained from Mr. Fredk. S. Hex, town clerk. Tenders by March 16.

Rawtenstall.—The Corporation invite tenders for the supply and laying of steel rails, points, crossings, and accessories for the permanent way of the tramways. Tenders to the Town Clerk by March 27. See advertisement in last issue.

Ipswich.—The Electric Supply and Tramways Departments require tenders for 12 months' supply of stores. Copy of specification and form of tender can be obtained from Mr. Frank Ayton, chief engineer and manager. Tenders by March 21.

Hull.—The Electric Lighting Committee invite tenders for the supply and laying of high and low tension mains, pilots and telephone wires, casings, boxes, etc, during period ending March 31, 1909. Tenders by March 26. See advertisement.

Bournemouth.—Tenders are invited for the supply of oils and greases and of brake blocks for 12 months for the Bournemouth Corporation Tramways. Particulars from Mr. C. Barber, engineer and traffic manager, Tramway Offices, Bournemouth.

London, S.W.—The London County Council invite tenders for the manufacture and supply of steel and cast-iron steam, exhaust, water, etc., piping, cast-iron water-tank, etc., to be erected at the Council's electricity generating station. Tenders by March 24.

Rawtenstall.—Tenders are invited by the Corporation for the supply and erection of one economiser (192 tubes), and the supply of direct and alternating current electricity meters. Tenders to the Town Clerk by March 23. See advertisement in last issue.

Heywood.—Tenders are invited for plant required in connection with the electricity works extensions. Specifications, etc., from Mr. J. R. Salter, the consulting engineer, Atherton, Lancashire. Tenders to the Chairman of the Electricity Committee by March 16.

Glasgow.—The Corporation invite tenders for the supply of large water-tube boilers, 1,000-kw. motor-generators and rotary converters, and sub-station extra high-tension and direct-current switchgear. Tenders to the Town Clerk by March 24. See advertisement.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for one 2,000-kw. turbine, the river pumps, and the feed pumps. Tenders are also invited for the supply of uniform clothing for the tramway employes.

Swindon.—The Corporation invite tenders for the annual supply of general stores for electricity and tramways departments and steam coal for electricity works. Particulars from the tramway manager, Mr. T. Medcalf, Electricity Works, Swindon. Tenders by March 21.

Aston Manor.—The Corporation invite tenders for the supply of one 300-kw. and two 400 kw. motor-generators, together with the necessary starting and field controlling gear. Tenders to the Chairman of the Electricity Committee by March 14. See advertisement in last issue.

Bristol.—The Docks Committee invite tenders for electric lighting of the second tobacco warehouse, Cumberland Basin, Bristol, and the maintenance of the work for 12 months after completion. Tenders to the Secretary of the Docks Committee, 19, Queen square, Bristol, on March 20.

Bolton.—Tenders are invited for the annual supply of stores to the Electricity Department, including lubricating oils, etc., joint boxes, service fuse boxes, etc., jointers' stores, mains sundries, etc., meters, motors and transformers, motor-starting switches. Tenders by March 26.

London.—The London County Council invites tenders for installations of electric lighting and fans at the Dawes-road Secondary School, Fulham, and the Hortensia-road Secondary School, Chelsea. Tenders to the Clerk of the London County Council by March 24. See advertisement in last issue.

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Croydon.—The Electricity Department invite tenders for the supply of the following during year ending March 31, 1909: (*a*) coal; (*b*) meters; (*c*) house fuse and joint boxes. Tenders to Mr. F. C. Lloyd, town clerk, by March 16.

Belfast.—Tenders are invited for the supply of about 100 tons of best rolled-steel girder tramway rails, with fishplates and bolts to suit. Particulars from the harbour engineer, Mr. W. Redfern Kelly, M.I.C.E. Tenders to Mr. W. A. Currie, secretary, Harbour Office, Belfast, by March 28.

Newcastle-on-Tyne.—Tenders are invited for (Contract No. 1) supply and delivery of 400 tons steel railway rails and fishplates; also (2) for the necessary points, crossings, and manganese rails for turnouts, for the Quayside improvement and extension. Tenders to the City Engineer by March 30.

Bristol.—The Electrical Committee invite tenders for the supply of unwashed small coal to (*a*) the electricity works, Avonbank, Feeder-road, and (*b*) the electricity works, Temple Back, for six or twelve months from March 26. Particulars from the City Electrical Engineer. Tenders by March 16.

Leeds.—The Corporation invite tenders for the annual supply of stores to the electricity department, including electric lamps, fittings, and the sundries; indiarubber-covered cables, mains, boxes, and fittings and jointing and insulating materials, etc. Particulars from Mr. Dickinson, engineer. Tenders by March 31.

Madrid.—The Post and Telegraph Department invite tenders for the construction and working of submarine telegraph cable from Cadiz to Teneriffe and Las Palmas, also for installation and exploitation of wireless telegraphy service. Particulars from Direccion-General de Correos y Telegrafos, 10, Carretas. Tenders by April 3.

Wigan.—The Guardians invite tenders for an electric lighting installation at the new workhouse infirmary at Billinge. Particulars from Messrs. Heaton, Ralph, and Heaton, architects, Victoria-buildings, King's-street, Wigan. Tenders to Mr. Henry Ackerley, clerk, 9, Victoria-buildings, King-street, Wigan, by March 25.

London, S.W.—The London County Council invite tenders for the manufacture, delivery, and laying of (*a*) about 32 miles of high-tension three-core lead-covered electric cables, etc.; and (*b*) about 50 miles of low-tension lead-covered electric cables, etc., and about 30 miles of telephone cables for the Council's tramways. Tenders by March 21.

Gillingham.—The Borough Council invite tenders for the supply and delivery for 12 months of the following materials for use in connection with their electricity department: (*a*) electricity meters, (*b*) lubricating oils. Particulars from the Borough Electrical Engineer, Generating Station, Gillingham-road. Tenders to Mr. F. C. Boucher, town clerk, by March 23.

Melbourne (Australia).—The Postmaster-General invites tenders for the construction and laying complete of two submarine telegraph cables between the State of Victoria and the State of Tasmania. Tenders must be accompanied by a deposit of £1,000. Tenders to the Secretary, Postmaster-General's Department, 51, Spring-street, Melbourne, by April 14. See advertisement in last issue.

Rio de Janeiro (Brazil).—Tenders are invited by the Reparticao da Carta Maritima do Brazil, 3 rua D. Manoel, Rio de Janeiro, for the construction of lighthouses on the coast of Brazil, and the supply and installation of lighting apparatus. Information may be obtained at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. Tenders by March 25.

Colchester.—The Electricity Supply Committee invite tenders for the supply of the following materials as may be required during year ending March 31, 1909—viz.: (1) ironmongery and tools; (2) oils; (3) oilman's sundries; (4) castings. Patterns and samples may be seen at the Electricity Works, Osborne-street. Tenders to the Chairman of the Electricity Supply Committee, 36, Osborne-street Colchester, by March 16.

London.—The London County Council invite tenders for the road-work and platelaying required for the reconstruction for electric traction, on the overhead trolley system, of the existing tramways from Brixton-road to a point near Camberwell Green, *via* Gresham-road and Coldharbour-lane, and for certain paving works of the street improvements in connection therewith. The total length of the above-mentioned lines is about 2½ miles single track. Tenders by March 24.

Erith.—Tenders are invited by the Urban District Council for the supply of stores under sections as follows for year ending March 31, 1909: (*a*) rags; (*b*) oils; (*c*) packings; (*d*) gauge glasses; (*e*) carbons; (*f*) meters; (*g*) lamps; (*h*) cables, joint-boxes, bitumen, insulating tapes, and compounds; (*i*) cut-outs. Specifications and forms of tender may be obtained at the Electricity Offices on payment of deposit by cheque of £1. 1s., such deposit to be returned upon receipt of a bona fide tender. Tenders by March 18.

Christiania.—The Commercial Intelligence Branch of the Board of Trade have been informed by his Majesty's Consul at Christiania that the Director of the Kongsberg Silver Mines has issued a call for tenders for an electric power station to be erected at the said mines. Tenders, marked "Kraftoverforingsanlaeg," are to be delivered to Kongsberg Solvverks Direktorkontor by 1 p.m. on March 21. Copies of the specifications and conditions may be inspected by British firms on application at the Commercial Intelligence Branch of the Board of Trade.

RESULTS OF TENDERS.

Norwich.—The tender of Laurence, Scott, and Co., Gothic Works, Norwich, has been accepted for the supply of an electric motor and other apparatus for £450.

Rawtenstall.—The District Council have placed a contract with the D.P. Battery Co. for the supply and erection of a D.P. traction storage battery and booster.

Worcester.—The Council have accepted the tender of Messrs. Baker, Scarborough, for a 23,500lb. vapour separator, at £118. 10s., for the Hylton-road electric station.

Grange-over-Sands (Lancs.).—The tender of W. Till, Grange-over-Sands, has been accepted for the erection of an electric light generating station, etc., at the Westmorland consumption sanatorium, Meathop, for £700.

Handsworth.—The Electricity Committee have accepted the tender of Belliss and Morcom for the supply of a 2,000-kw. turbo-alternator, and that of E. C. and J. Keay for the necessary ironwork in connection with the new building extension.

Portsmouth.—The Tramway Committee have accepted the tender of Pearson, Huggins, and Co., of London, for clothing for motormen, inspectors, and conductors, for £634. 4s. 6d.; and that of Berry and Co., also of London, for caps, at £18. 15s. 6d.

Stepney.—The Electricity Supply Committee recommend the acceptance of the following tenders: Tudor Accumulator Co., battery of nine cells, £64; Baxter and Caunter, Charing Cross-road, London, rubber cable, £122. 13s. 6d.; City Glass Co., arc lamp globes for one year.

Derby.—The Town Council have accepted the tender of W. Walkerdine for the construction of car-sheds in the Nottingham-road for the sum of £4,998. 16s.; and that of the British Thomson-Houston Co., amounting to £82. 10s., for the supply of an additional Tirrill regulator for the electricity department.

London, N.—The London County Council have accepted the tender of Dick, Kerr, and Co. for the rebuilding of the two bridges carrying Caledonian-road over the Great Northern Railway and the Regent's Canal, in connection with the electrification of the tramways in that thoroughfare, for the sum of £6,895. 11s.

Rathmines (Ireland).—The Rathmines and Rathgar Urban District Council have accepted the following tenders for the annual supplies: T. Heiton and Co., Dublin, coal; Veritys, Limited, London, W.C., arc lamp carbons; Edison and Swan United Electric Light Co., incandescent lamps; W. H. Wilcox and Co., London, S.E., engine-room stores.

London.—The London County Council have received the following tenders for the supply and delivery of about 525 tons of track rails and fastenings required for the reconstruction of the tramways from Brixton-road to near Camberwell Green:

W. Scott, Limited, Leeds*	£3,978	2	6
Bolckow, Vaughan, and Co., London, E.C.	4,053	11	3
Barrow Hæmatite Steel Co., London, E.C.	5,062	1	3

* Recommended for acceptance.

Holloway.—The following tenders have been received by the London County Council for electric lighting installation at the fire station, Holloway, N.:

W. J. Fryer and Co., Bravington-road Works, Paddington, W.*	£185	0	0
Nursey and Marr, 53, Victoria-street, S.W.	200	0	0
W. G. Cannon and Sons, 107, London-road, S.E.	248	13	0
J. Bryden and Sons, 90, Gloucester-road, S.W.	256	0	0
Duncan, Watson, and Co., 102, Charing Cross-road, W.C.	275	0	0
J. O. Grant and Taylor, 63, Queen Victoria-street, E.C.	320	0	0

* Recommended for acceptance.

OPENINGS FOR CONTRACTORS.

ABERDEEN — Dwelling-house, Whitehall-place, Mr. A. Young; dwelling-house, King's Gate, Messrs. Cameron and Watt, architects.

ABERLOUR—Additions, orphanage. Plans passed by Town Council.

ACOCK'S GREEN—Elementary school, Worcestershire County Council.

AINSDALE—Additions to house, Westbourne-road, Mr. A. Wright; 20 houses, Longford-road, Mr. R. Bolton; two houses, Olive-road, Mr. A. Brown; golf-house, Liverpool-road South, Southport and Ainsdale Golf Club; eight houses, Mill-lane, Mr. J. Gibson; house, Buckingham-road, Mr. T. Holmes.

ALDERSHOT—Four houses and shop, High-street, Mr. S. Harrison; two houses, High-street, Mr. S. Mitchell; additions to premises, Garden Gate, Friary Brewery Co.

ALNWICK—Houses, Stott-street, Messrs. Wright Bros.

ALTRINCHAM—Extensions, baths, Stamford New-road, Urban District Council.

ANDOVER—Two houses, Old Wintern-road; house, Weyhill-road, Building Committee.

ANNAGHMORE—Housing scheme, Rural District Council.

ANNFIELD PLAIN—Two houses, Mr. J. H. Parker.

ARMAGH—Housing scheme (£12,600), Rural District Council.

ASHBY—Offices for Board of Guardians.

ASTON—Infirmary (£70,000), Board of Guardians.

BALLYARDS—Housing scheme, Armagh Rural District Council.

BALLYCLARE—Manse, Ballycastle Presbyterian Church. Mr. N. Fitzsimmons, architect.

BALLYMARTRIM—Housing scheme, Armagh Rural District Council.

BANTRY—Public conveniences, Rural District Council.

BARNSTAPLE—Secondary school (£10,000), Education Committee.

BARUM—Elementary school (£10,000), Devon Education Committee.

BARROW-IN-FURNESS—House, Croslands Park. Messrs. Settle and Brundrit, architects.

BECKENHAM—Battery-house, electricity generating station, Urban District Council.

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BECKENHAM—Six houses, Woodbastwick-road, Mr. T. D. Bailey; iron art school, Beckenham-road, and extension, secondary school, Local Education Authority.

BELFAST—Alterations and additions, Whitla fire station, Belfast Police Committee.

BELFAST—Villa, Malone-avenue, Mr. Thomas Houston.

BELLEEK—Labourers' dwellings (£3,405), Rural District Council.

BERMONDSEY, S.E.—Rebuilding four houses, Upper Grange-road, Mr. T. Sloman.

BETHNAL GREEN, E.—Municipal offices (£30,700), Borough Council.

BEVERLEY—Public-house, Holme, Church-lane, Messrs. Moor and Robson, Limited.

BILBOROUGH—Extensions, school (£105), West Riding County Council.

BISHOP'S CASTLE—Elementary school (£5,000), Shropshire Education Committee.

BLACKWOOD—Elementary mixed school and cookery centre, Monmouthshire Education Committee.

BOLTON—Extensions to factory, Messrs. Constantine; theatre, Deansgate, Mr. T. Hargreaves; hotel, Bradshawgate, Messrs. Sharman and Son.

BOURNEMOUTH—Pavilion (£40,500), Town Council.

BOW, E.—Additions, premises, Roman-road, Messrs. G. Elkington and Son.

BRADFORD—Car-shed and tramway offices (£5,060), Town Council.

BRAMLEY—House and shop. Mr. J. A. Webster, architect.

BRIDGEND—Public offices, District Council.

BRIDLINGTON—Elementary schools, Education Committee.

BROMLEY—Four houses, Cowper-road, Messrs. E. Peill and Sons; alterations, Swan and Mitre, High-street, Mr. A. Laurence.

BROOTALLY—Housing scheme, Rural District Council.

BUGLE—Institute and public room, Trustees.

CAMPBELLTOWN—Extensive building scheme, Main-street and Union-street (£50,000).

CANNOCK—Extensions, workhouse, Board of Guardians.

CARDIFF—St. Mary's Clergy House, Rev. Gilbert Heaton.

CARDIFF—Extension, infirmary (£30,000), Infirmary Governors.

CARDIFF—Warehouse, Frederick-street. Messrs. James and Morgan, architects.

CARLISLE—Extensions, police station (£1,250), Town Council.

CASTLEFORD—Secondary school (£14,000), County Council.

CASTLEFORD—Public baths (£69,000), fire station and mortuary (£750), Urban District Council.

CATERHAM—Extensions, Caterham Asylum, Metropolitan Asylums Board.

CHADDERTON—Public offices (£1,700), Town Council.

CHELSEA, S.W.—Electric light installation, Hortensia-road secondary school, London County Council.

CHELSFIELD—Council school, Green Street Green, Kent Education Committee.

CHRISTCHURCH—Temporary building (£210), Board of Guardians.

CHRISTIANIA—Electric power station, Commercial Intelligence Branch of Board of Trade.

CIRENCESTER—Drill hall, cottages, and villas (£16,000), Mr. D. G. Bingham.

CLYDEBANK—Church, Radnor Park, Ecclesiastical Commissioners.

COALVILLE—Farmhouse and buildings, Whitwick Glebe Farm, Whitwick Colliery Co.

COATBRIDGE—Higher-grade school, Albert street (£16,000), Education Committee.

CONSETT—Seventeen houses, Dacre-gardens, Mr. J. Coates; warehouse, Blackhill, North-Eastern Breweries Co.; stable and coach-house, Aynsley-terrace, Mr. J. Murray; house, Aynsley-terrace, Mr. J. Maxwell.

COWGATE—Alterations to property, Messrs. Esplin and Clark.

CRAIGCEFNPARC—Elementary school, Glamorgan County Council.

CROYDON—Convenience, Thornton Heath Pond, Croydon Town Council.

CULTRA—Villa. Mr. C. D. Patterson, architect.

DERBY—Extensions, asylum, Town Council.

DONCASTER—Hotel, High-street, and three shops. Mr. W. H. Wagstaff, architect.

DORKING—Electric lighting (£11,600), Town Council.

DOVER—Pavilion, Town Council.

DOWNPATRICK—Housing scheme (£54,627), Rural District Council.

DRAX—Grammar school, West Riding County Council.

DRIFFIELD—Restoration of parish church, Churchwardens.

DRINNICK ST. STEPHEN—Six houses, Mr. T. M. Stocker.

DUNDEE—Alterations and additions to property, Larch-street and Urquhart-street, Messrs. Urquhart, Lindsay, and Co.; villa, Blackness-road, Messrs. Johnston and Baxter.

DUNDEE—Additions, burgh school (£1,000), Burgh School Board.

EASTBOURNE—Conveniences (£730), Town Council.

EAST DULWICH—Additions, James Allen School, Mr. A. J. Gale.

ECCLES—Shops, Eccles Co-operative Society.

EDMONTON—Infirmary, Board of Guardians.

EGLWSWRW—Additions and alterations, Council school, Pembrokeshire Education Committee.

ELLESMERE PORT—Parish hall (£1,500), Trustees.

ELGIN—Rebuilding and extending Avenue House. Mr. R. B. Pratt, architect.

ELY—County buildings, Isle of Ely County Council.

FAILSWORTH—Elementary school, Mather-street, Lancs. Education Committee.

FENTON—Elementary school, Council.

FOLKESTONE—Extensions, North-street elementary school, Town Council.

FORFAR—Public baths (£6,000), Town Council.

FOXHOLE AND NANPEAN—One hundred and four houses, Mr. T. M. Stocker.

FRASERBURGH—Houses, King Edward-street, Mr. J. Stuart.

FREEMANTLE—Police station, Southampton Town Council.

FULHAM, S.W.—Electric light installation, Dawes-road secondary school, London County Council.

FULHAM, S.W.—Additions, St. Augustine's Church, Lillie-road, Ecclesiastical Commissioners.

FULHAM, S.W.—Houses, Broughton-road, Messrs. Gordon, Wilson, and Co.

GILLINGHAM—Alterations, Rose Inn, Britton-street, Messrs. Jude, Hanbury, and Co; shop, High-street, Messrs. Freeman, Hardy, and Willis.

GILLINGHAM—Electricity undertaking (£5,000), Town Council.

GLYNCORRWG—Extensions, Council school (£375), Glamorgan County Council.

GOOLE—Alterations, schools (£300), Town Council.

GOSPORT—Elementary school, Grove-road, Gosport Education Committee.

GRANGEMOUTH—Higher-grade school, Ronaldshay-crescent, School Board.

GRANTHAM—High school, Trustees.

GREAT TORRINGTON—Enlargement, Council school, (£625).

GREAT TORRINGTON—Business premises and house, Mr. J. Lile.

GREENWICH—Alterations, Christ Church Schools, London County Council.

GRIMSBY—Extension, Welholme Council School, Education Committee.

GUILDFORD—Buildings, waterworks, Town Council.

GUISBOROUGH—Sixteen houses. Mr. W. G. Roberts, architect.

GUISELEY—Extensions, parish church (£5,000).

HACKNEY, E.—House, Moundfield-road, Mr. S. H. Barclay.

HALIFAX—Mill and boiler houses. Messrs. Medley Hall and Son, architects.

HALIFAX—Three shops, Rawson-street. Mr. T. Kershaw, architect.

HARTISMERE—Adaptation of building for infirmary (£5,000), Guardians.

HASTINGS—House, Elphinstone-road, Mr. G. Mercer.

HAVERFORDWEST—Extensions, Rhydberth Non Provided School. Mr. H. J. Thomas, architect.

HAZEL GROVE—House, Bramhall-lane Mr. D. Wilson; house, Ethel-road, Mr. J. Wadsworth; house, Ack-lane, Mr. W. A. Holmes; two houses, Maple-road, Messrs. Corrie and Son; four houses, Neville-street, Mr. W. Pickford; additions to Red Lion Hotel, Managers; conversion of houses into shops, Mr. Boulderstone.

HEMEL HEMPSTEAD—Extensions, hospital, Joint Hospital Board.

HEOLYCYW—Permanent school, Glamorgan Education Committee.

HEYWOOD—Secondary school (£7,000), Lancs. Education Authority.

HIGHAM—Houses, York-road, Mr. R. P. Saxby.

HIGHAM FERRERS—Bakehouse and dwelling-house, York-street, Mr. R. P. Saxby.

HORNSEY—Extension of municipal electric lighting undertaking, Borough Council.

HUDDERSFIELD—Secondary school, Greenhead-road (£12,500), Education Committee.

HUGGLESCOTE—Houses, North-street, Whitwick Colliery Co.

HULL—Extensions to town hall (£14,300), Town Council.

HULL—St. Vincent's Home for Boys, Queen's-road. Messrs. Brodrick and Lowther, architects.

HYTHE—Ten houses, Bartholomew-street, Mr. F. Austen.

IDA—Housing scheme (£10,230), Rural District Council.

ILFORD—Elementary school completion, caretaker's house, Ilford Urban District Council.

ILFRACOMBE—Additions, Council school (£247).

ISLINGTON, N.—Additions, St. James's School, London County Council.

KEIGHLEY—Houses, Oakworth-road. Messrs. W. H. and A. Sugden, architects.

KEIGHLEY—Toolhouse, Steeton (£108), Town Council.

KELSO—Extensions, town hall (£1,500), Town Council.

KENDAL—Rebuilding shop and dwelling-house, Wildman-street. Mr. S. Shaw, architect.

KESWICK—Six houses, Rose-terrace, Mr. Isaac Hodgson.

KINGSTON—Workhouse, Board of Guardians.

LAMBETH, S.E.—Additions, mortuary (£1,443), Borough Council.

LAMPLUGH—Hall. Mr. P. Eden, architect.

LEADGATE—Additions, R.C. schools. Mr. G. T. Wilson, architect.

LEAVESDEN—Alterations, asylum (£1,050), Metropolitan Asylums Board.

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LEEDS — Alterations and extensions, Klostermann's restaurant. Messrs. T. Winn and Co., architects.

LEEK—Electricity undertaking (£8,250), Town Council.

LERWICK—Post Office, H.M. Commissioners of Public Works.

LEWISHAM, S.E.—Motor-house, Leyton-road, Mr. J. C. Thomas.

LEYLAND—Alterations and additions, George IV., Towngate. Messrs. Magee, Marshall, and Co.; house, Leyland-lane, Mr. W. Watkinson.

LINTHORPE—Secondary school, Middlesbrough Town Council.

LITTLE COATES—Mission church, Hargrave-street, Primitive Methodist Building Committee.

LIVERPOOL — Enlargement, Southern District Post Office, Commissioners of H.M. Works.

LLANDAFF—House. Mr. R. B. Batchelor, Cardiff, architect.

LONDON, E.C.—Additions, house, New Bridge-street, Mr. A. F. Briggs.

LONDON, S.W.—Electric cables, Council's tramways, London County Council.

LONGTHORNE—Additions, Primitive Methodist chapel, Trustees.

LONGTON — Ten houses, Hamilton-road, Messrs. Tomkinson and Bettelley; six houses, Ludwall-road, Mr. C. Smith.

LUTON—Six dwelling-houses, Asburnham-road, Mr. J. Warren; two houses, Conway-road, Mr. A. Carter; two house, Reginald-street, Mr. F. Chandler; four houses, Westbourne-road, Messrs. Brown and Co.; engine-house, Town and County Press, Limited; two houses, Naseby-road, Mr. A. Smith.

LYDBROOK—School, Camomile Green, Gloucester Education Committee.

LYNTON—Wesleyan church (£3,000), Trustees.

MARCH—Alterations to refreshment room, G.E.R. Station, Managers.

MARGATE—Head post office, H.M. Commissioners of Public Works.

MARSDEN—Elementary school, West Riding Education Committee.

MEADVILLE (U.S.A.)—Municipal electric plant, City Council.

MERTHYR—Elementary school, Education Committee.

MERTHYR VALE—Fifteen houses, Dryden Building Club.

MILLFIELD—Entrance lodge, Millfield Asylum, Metropolitan Asylums Board.

MOHILL—Workmen's dwellings (£24,166), Rural District Council.

MORLEY—Alterations, Grove Mill, Messrs. D. Bradley, Limited.

MOUNTAIN ASH—Elementary school, Carnetown, Mountain Ash, Education Authority.

MOUNT CHARLES—Four houses, Union-road, Mr. R. Hopper.

NAVAN—Post Office, H.M. Commissioners of Works.

NEWBIGGIN—Six almshouses, Mr. C. Pickering; additions, Church institute, Trustees.

NEWBURN—Stores, Westerhope, Throckley Co-operative Society.

NEWCASTLE-ON-TYNE—Slaughter-houses, etc. (£8,449), City Council.

NEW ROSS—Housing scheme (£39,172), Rural District Council.

NEWTON ABBOT — Additions, railway station (£25,000), Great Western Railway Co.

NORMANTON—Grammar school, West Riding County Council.

NORTH BERWICK—Alterations, Bertram's Cottage, Forth-street, North Berwick, Town Council.

NORWOOD—Houses, Hamilton road, Messrs. H. Longton and Co.

OKEHAMPTON—Elementary school, Devon Education Committee.

OLDHAM—Theatre, King-street, Mr. J. Bewley.

OSSETT—House, Wesley-street. Messrs. C. H. Marriott and Son, architects.

OSWESTRY—Two elementary schools (£12,000), Shropshire Education Committee.

OXENHOPE—Residence, Gate-lane. Messrs. Moore and Crabtree, architects.

PAISLEY—Extensions, French cleaning house, Cyril-street, Messrs. Gibson and Reid; additions, Claremont, Blackhall; saloons at the rear of houses in Moss-street, Town Council.

PAISLEY—Industrial school, Thornly Park, Peterhill, Governors.

PONTYPRIDD—Extension, Hopkinson Infant School, Education Committee.

PONTYPRIDD—Cottage hospital, Governors.

POOLE—House, St. Osmund's-road, Mr. O. H. Goater; house, Ravine-road, Mr. T. Stevens; additions, Morwenstow, Haven-road, Mr. T. G. Hill; house, Mount-road, Mr. W. Andrew; alterations and additions to premises, Commercial-road, Mr. A. Manuel; house, Balston-road, Mr. James Mitchell; house, King's-avenue, Mr. G. W. Jackson; church room, Kingston-road, Mr. A. E. Bastable; pair of houses, Wimborne-road, Mr. G. F. Ivemy; two houses, Glenair-road, Mr. W. Andrew.

PRESTBURY—Institute, Pearle-street, Messrs. R. Massey and Sons.

PRESTWICK—New church of the Church of Scotland (£5,000). Mr. P. Macgregor, architect.

PRINCETOWN—Four houses at station, G.W.R. Co.

PUTFORD—Additions, school (£400), Education Committee.

RADCLIFFE—Public offices (£12,000), Urban District Council.

RAMSBOTTOM—Rebuilding New Jerusalem Church (£5,160).

RATHVEN—Caretaker's house, Hillhead Cemetery, Parish Council.

RAWTENSTALL—Electricity works, Corporation.

RICHMOND—Extensions, gasworks (£2,000), Town Council.

RIPON—Secondary school (£5,130), West Riding Education Committee.

RISHTON—Eight houses, Cliffe-street, Rishton Industrial Co-operative Society.

ROCHDALE—Rebuilding headquarters, Salvation Army.

ROCHESTER—Additions, police station, City Council.

ROCHFORD—Extension, workhouse, Board of Guardians.

ROMILEY—Three houses and stable, Guywood-lane, Messrs. Lomas and Co.

RUGBY—Two houses, Craven-road, Mr. Chandley.

RUGBY—Theatre, Albert-street, Managers.

RUNCORN—Public baths (£1,700), Urban District Council.

SADDLEWORTH—House and motor-shed, Diggle, Mr. Broadbent.

ST. CYRUS—Improvements, school (£300), School Board.

ST. IVES—Roman Catholic church (£4,000), Church Presbytery.

ST. MARYLEBONE, W.—Houses, Glentworth-street, Messrs. C. Wall, Limited.

SALFORD—Alterations, etc., at the branch fire station, Gardner-street, Pendleton, Fire Brigade Committee.

SCARBOROUGH—Reconstructing hippodrome, St. Thomas-street, Mr. M. Peacock, of York and Harrogate Theatres.

SELLY PARK—Elementary school (£2,850), King's Norton District Council.

SHEFFIELD—Public convenience, Bolsover-road, City Council.

SHERINGHAM—Depôt, Cremer-street, Urban District Council.

SHOEBURYNESS—Alteration, etc., barracks.

SHREWSBURY—Two secondary schools (£18,000), Shropshire Education Committee.

SIRHOWY—Additions, Railway Inn, and dwelling-house, Mr. O. Newcombe.

SKEWEN—Rebuilding the Collier's Arms. Mr. J. C. Rees, architect.

SOLIHULL—New official and administrative building, workhouse, Guardians.

SOUTHAMPTON—Grammar school (£5,000), Education Committee.

SOUTHEND-ON-SEA—Alterations and additions, sanatorium, Balmoral-road, Corporation.

SOUTH HACKNEY, E. — Additions, elementary schools, London County Council.

SOUTH SHIELDS—Music hall, Market place, Proprietors.

SOUTHWARK—Alterations, Borough Polytechnic, London County Council.

STAINES—Hospital, Rural District Council.

STANLEY—Five dwelling-houses, Bircham-street, Mr. W. B. Wood; house and shop, Pine-street, Mr. J. Priestman; four houses, Beamish-street, Mr. R. J. W. Bloom; five houses, Back Mulberry-street, Mr. Lubbock.

STEETON—Elementary school, Victoria-street.

STIRCHLEY—Public baths (£10,000), King's Norton Urban District Council.

STOCKPORT—Municipal secondary school, Greek-street, Education Committee.

STOCKTON—Motor garage, Yarm-lane, Mr. T. Whorlton.

STOKE-ON-TRENT—Extensions, infirmary, Board of Guardians.

STOKE-UPON-TRENT—Alterations, union offices, Board of Guardians.

SUTTON-IN-ASHFIELD—Chapel and Sunday school, Mansfield-road (£2,000), Trustees, Baptist Church.

SWANSCOMBE—Fire station, Church-road, Parish Council.

TADCASTER—Alterations, schools (£1,779). West Riding County Council.

TAUNTON—Technical school, County Council.

TONGWYNLAIS — Elementary school (£6,000), Glamorgan County Council.

TRURO—Showroom and offices, City Council.

TYWARDREATH—Four houses, Messrs. H. Griffin and J. T. Dunn.

UNSWORTH—Additions, parish church, Churchwardens.

UTTOXETER—House, Balance-hill, Mr. A. Parr; alterations to house, New-road, Mr. A. J. Williamson.

WALTHAMSTOW—Extensions, Public Library, Urban District Council.

WANDSWORTH, S.W.—Buildings, Mitcham-road, Mr. C. G. Baker.

WEEDON—Extension, Church Schools (£1,500).

WELLINGBOROUGH—Six houses, Melton-road, Mr. E. Popham.

WELLINGTON—Elementary school (£9,000), Shropshire Education Committee.

WESTBURY—Two houses, Eden-vale, Mr. Holdaway.

WESTON-SUPER-MARE—Sunday schools in connection with Primitive Methodist Chapel.

WHITECHAPEL, E.—Buildings, Lolesworth-street, Messrs. Dolley and Altman.

WIMBLEDON—Elementary school, Pelham-road (£15,428), Borough Council.

WINCHMORE HILL — Pavilion, Isolation Hospital, Enfield and Elmonton Joint Hospital Board.

WOODLEY—Two houses and shop, Bents-lane, Woodley Co-operative Society; eight houses, Back-lane, Councillor J. Bramall.

WOOLFARDISWORTHY—Extensions, Council schools, Devon Education Committee.

WORSLEY—Blocks of houses, Worsley Green, Earl of Ellesmere.

WORTHING—Hotel, Marine-parade (£40,000), Messrs. Robbins and King; hotel, Littlehampton-road (£3,000), Mr. J. K. Nye.

YARDLEY—School, Church-road, Worcestershire County Council.

YORKLEY—School, West Dean, Gloucester Education Committee.

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PROVISIONAL PATENTS, 1908.

FEB. 28.

4549. Improvements in guides for pulleys of trolley heads in connection with electric wires for tramcars and the like. Tom Pidd, 18, Fulham-place, Paddington, London.

4550. Improvements in and relating to means for electrically igniting gas burners or lamps. Alfred John Hill and Frederick Cyril Duncombe Mann, 60, Queen Victoria-street, London.

4557. Apparatus for automatically stopping motors when the required amount of cooling medium is not supplied. Jean Stroganoff, 6, Lord-street, Liverpool. (Complete specification.)

4560. Improvements relating to automatic telegraph instruments. Antoine Damaskinos, 7, Southampton-buildings, London.

4563. Improvements in electric arc lamps. Charles Arthur Taylor and Edwin Richard Albert Broom, trading as the New Century Arc Light Company, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

FEB. 29.

4571. New and improved method of automatically protecting human life, and electrical machines in mines and the like. Harry Joseph Fisher, Burn House, Herrington Burn, Fencehouses, co. Durham.

4589. Improvements in telephone switchboard cords. William Aitkin, care of British Insulated and Helsby Cables, Limited, Milton-road, Edge-lane, Liverpool.

4590. Improvements in telephone instruments. William Aitkin, care of British Insulated and Helsby Cables, Limited, Milton-road, Edge-lane, Liverpool.

4597. Improvements in or relating to switches and fuses for starting three-phase electrical motors and the like. Vernon Hope, 55, Market-street, Manchester.

4602. Improvements in discs for influence or static induction and condenser machines. Alfred Wehrsen, 100, Wellington-street, Glasgow. (Complete specification.)

4608. Improvements in or relating to holders for electric lamps. Frank West Suter, Chancery-lane Station-chambers, London.

4617. Improvements in electrical igniting apparatus. John William Mackenzie, 40, Chancery-lane, London. (Henry Ford, United States.) (Complete specification.)

4621. Improvements in the manufacture of heat interchangers by an electrolytic process. Ernest Friedheim, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 4, 1907, being date of application in France.) (Complete specification.)

4635. Improvements in electrically-operated horns and trumpets. William Alfred Ayles, 33, Cannon-street, London.

4637. Electrically-driven trackless train. Fritz Wagner, 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 16, 1907, being date of application in Germany.) (Complete specification.)

4644. Improvements in and relating to the reduction of metallic compounds and furnaces therefor. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on March 19.)

1907.

4123. Systems for wireless telegraphy. Stone. (Date applied for under International Convention, Feb. 27, 1906.)

4333. Selective continuous electric wave telegraphy. Webb.

4397. Construction of automatic electric circuit breakers. Eckstein and Heap.

4425. Time-limit electric circuit breakers. Scott.

4470. Electric power generating plants. Lautenbach.

5012. Electrical protective apparatus. Cook.

5506A. Operation as generators of alternating electric current commutator type motors having series characteristics. Lamme. (Date applied for under International Convention, March 15, 1906.) (Date applied for under Rule 13, March 7, 1907.)

5508A. Operation as generators of alternating electric current commutator type motors having series characteristics. Lamme. (Date applied for under International Convention, Aug. 2, 1906.) (Date applied for under Rule 13, March 7, 1907.)

5513. Relays or cut-outs for use in electric circuits. Siemens Bros. Dynamo Works and Bolton.

7992. Electric-magnetic separators. Blackmore.

8284. Electric accumulators. Thiellet and Denard. (Date applied for under International Convention, April 12, 1906.)

13354. Method of attaching filaments to the leading-in wires of electric incandescent lamps. Driver.

18661. Electric arc lamps chiefly for use in searchlight projectors. Siemens Bros. Dynamo Works and Holmes.

17697. Switch mechanism for electrically-propelled vehicles. Allgemeine Elektricitats Ges. (Date applied for under International Convention, July 26, 1906.)

18843. Electrical switch or commutator applicable to railway signalling. Gudgeon.

19340. Signalling telegraphs. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, Dec. 17, 1906.)

19558. Electrical locking apparatus for railway signalling. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

20600. Wedges for closing the core slots of dynamo-electric machines. Heitmann and Young. (Date applied for under International Convention, Oct. 18, 1906.)

21467. Maximum demand indicators for electric supply meters. (Elektrizitats Akt.-Ges. vorm. Schuckert und Co. Date applied for under International Convention, Oct. 19, 1906.)

22833. Armature windings for dynamo-electric machines. Conrad. (Date applied for under International Convention, Nov. 3, 1906.)

23319. Frequency meters, speed indicators, relays, and other resonance apparatus. Hartmann und Braun Akt.-Ges. (Date applied for under International Convention, Oct. 27, 1906.)

24923. Method and apparatus for telephonic communication between railway trains and stations. Dugasz, Kaldor, and Szende.

1908.

796. Electrically-controlled apparatus for igniting and extinguishing lamps. Aubert and Aubert.

MARCH 2.

4657. Improvements in the manufacture of electrical resistances. Charles Ruzicka, 6, Staple-inn, London. (Complete specification.)

4666. Improved electric current leakage indicator. James Percy Winn, 55, Market-street, Manchester.

4668. Improvements in arc lamps. Arthur Holman, 44, West George-street, Glasgow.

4683. Improvements in electrical terminal connections. Samuel Robinson Ridgway, Frederick John Ridgway, and Colin Mosley Brunt, Prudential-buildings, Corporation-street, Birmingham.

4689. Improvements in electric clock systems. Alfred Réné Upward, 18, Luxemburg-gardens, Brook Green, London.

4692. Improvements in brush-holders for electrical machines. Siemens-Schuckertwerke G. m. b. H., Queen Anne's-chambers, Westminster. (Date applied for under Section 91 of the Act, March 2, 1907, being date of application in Germany.) (Complete specification.)

4696. Improved electric locking and interlocking indicating push-button switch primarily designed for use in connection with push-button-operated electric lifts. Arthur Herbert Curtis, Alfred Henry Mackley, and Adams Manufacturing Company, Limited, 11, Southampton-buildings, London.

4717. Improved electric signalling apparatus for railways. Henry Robert Richardson, 8, Quality-court, Chancery-lane, London.

4739. Improvements in the construction of the supports or grids for the electrodes of secondary batteries. Henry Garde, 38, Chancery-lane, London.

4744. Improvements relating to the electrolytic deposition of metal on hollow articles. Ernest Friedheim, 18, Southampton-buildings, London. (Application for patent of addition to No. 7563/07. Date applied for under Section 91 of the Act, March 4, 1907, being date of application in France.) (Complete specification.)

4757. Improvements or relating to electric bells. Edward Alfred Graham, 46, Lincoln's-inn-fields, London. (Complete specification.)

4760. Improvements in and relating to the manufacture of a conducting connection for use in electric incandescent lamps. Harold Williamson Lake, 7, Southampton-buildings, London. (Elektrische Gluhlampenfabrik Watt, Scharf, Loti, und Latzko, Austria.) (Complete specification.)

4762. Improvements in electrodes for arc lamps. Allgemeine-Elektricitäts Gesellschaft, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, March 1, 1907, being date of application in Germany.) (Complete specification.)

MARCH 3.

4774. Improved key switch lampholder for electric light. G. H. Ide, 152, Sherlock-street, Birmingham.

4799. Improvements in and relating to controllers for electric motors. Crompton and Co., Limited, and Claud Crompton, Arc Works, Chelmsford.

4819. Fixings for electric fittings. John Joseph Rawlings, 34, High Holborn, London.

4844. Improved apparatus for plotting resonance curves for determining the damping and frequency of electric oscillations. Otto Scheller, 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 4, 1907, being date of application in Germany.) (Complete specification.)

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4843. Improvements in apparatus for receiving undamped electric oscillations. Otto Scheller, 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 4, 1907, being date of application in Germany.) (Complete specification.)

4852. Improvements in alternating-current commutator dynamo-electric machines. Wladimir Doinikoff, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

4867. Improvements in automatic electric winding devices for clocks and the like. The firm of One Year Electric Clock Company, Grundke and Lazarus, 31, Bedford-street, Strand, London. (Date applied for under Section 91 of the Act, March 4, 1907, being date of application in Germany.) (Complete specification.)

MARCH 4.

4883. Improvements in liquid magnetic compasses. Charles Batty and William Batty, 4, Clayton-square, Liverpool.

4884. Improved electrical block signalling system for railways. George Herbert Brown, 100, Wellington-street, Glasgow. (Application for patent of addition to No. 10687/07.)

4885. Improvements in electrically-controlled gas-lighting devices. James Charles Andrews Maddick, 34, Castle-street, Liverpool.

4891. Electromagnetic slides and shutters for theatre lighting. Robert Bright, the younger, 13, Lonsdale-road, Sunderland.

4895. Improvements in and connected with the electro-deposition of metals. Frank Iorns Gibbs, 128, Colmore-row, Birmingham.

4909. Improvements in electrical switches for use in flash signalling. George Herbert Butterworth and Edmund Veevers, 9, Tempest Hey, Liverpool.

4922. Improvements in connection with electric lamps and their circuits. Charles Henry Stearn and Charles Fred Topham, 47, Lincoln's-inn-fields, London.

4932. Device for automatically firing guns on ships by means of electricity. Heinrich Treude, 116, High Holborn, London.

4940. Process for producing positive storage battery plates. Johaff Rády d'Várad and Adrienne Meislinger-Meszlényi, 18, Southampton-buildings, London. (Complete specification.)

4948. Improvements in alternating-current translating devices. Lemuel Frederic Howard, Westinghouse Building, Norfolk-street, Strand, London. (Date applied for under Section 91 of the Act, April 25, 1907, being date of application in United States.) (Complete specification.)

4950. Method of regulating dynamo-electric generators and motors. Carl Heinrich Prött, Thanet House, Temple Bar, London. (Complete specification.)

4956. Improvements in the manufacture of incandescent bodies for electric lamps. Francois Jean Planchon, 40, Chancery-lane, London. (Complete specification.)

4957. Improvements in connection with enclosed arc lamps. William James Davy, 40, Chancery-lane, London.

4962. Improvements in and relating to electric controllers or switches. Claude William Atkinson and Edmund Garside, 1, Queen Victoria-street, London.

4964. Improvements relating to electrically-controlled railway points and signals. Siemens Bros. and Co., Limited, and Luis de Moraes Gomes Ferreira, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

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4977. Improvements in electric arc lamps. Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

4987. New or improved appliances or devices for indicating and recording electric currents. Arthur Barry and Fred Ferrand, 51, Deansgate-arcade, Manchester.

4995. Improvements in electric resistances. Walter Frederick Jones, 166, Wellington-road, Eccles.

5004. Improvements in electric winding engines. Henry James Shedlock Heather, 6, Highbury-terrace, Highbury, London.

5017. Improvements in electrodes for electric welding, soldering, or brazing. George Harrison, 11, Southampton-buildings, London. (Electric Railway Improvement Company, United States.) (Complete specification.)

5025. Improved means for covering or protecting underground electric cables. Ludwig Moser, 11, Southampton-buildings, London.

5029. Improvements relating to electric arc lamps. Johnson and Phillips, Limited, and Sydney Patterson, Birkbeck Bank-chambers, Southampton-buildings, London.

5040. Improvements in metallic filaments or rods for electric incandescent lamps. Francois Jean Planchon, 40, Chancery-lane, London. (Date applied for under Section 91 of the Act, Nov. 9, 1907, being date of application in France.) (Complete specification.)

5043. Improvements in printing and sight-reading telegraph apparatus. Ernest William Beech, 173, Fleet-street, London.

5054. Improvements in electric clocks. James Neale and Edwin Powell, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70 000	1	..	½-⅝
—— Ord., 1,125 000	1	..	¼-⅜
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1	..	23/32-27/32
—— Ordinary, Nos. 1 125,000	1	..	¼-⅜
British Aluminium Co., Ordinary, 2 001 40 000	5	..	3⅜-4¼
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4⅜-4½
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4½-4⅝
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3⅝-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5s per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	97-100
British Insulated and Helsby Cables, Ord., 1-100 000	5	..	6⅜-7¼
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	83 87 xd
British Westinghouse Elec. and Manuf. 10 per cent. Pref., 275 001-475 000	3	..	⅛-¼
—— 4 per cent. Mortgage Debenture Stock	100	..	44-49
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2	..	0-½
—— Non. Cum., 6 per cent., Pref.	2	..	⅛-⅜
—— 4½ per cent 1st Debenture Stock	100	..	77-80 xd
—— 4½ per cent. 2nd Debenture Stock	100	..	63-66
Callender's Cable, Debentures	100	..	106-108
—— Ordinary	5	..	10⅜-11⅜
—— 5 per cent. Pref.	5	..	5⅜-5½
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	5	..	1 13/16-2 1/16
—— 5 per cent Debentures	100	..	92-96
Dick, Kerr and Co., Ordinary, 1 250 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1 1/16-1 5/16
—— 4½ per cent. Debenture Stock, Red.	100	..	99 102
Edison and Swan United, "A" Shares, 1-99 261	5	..	¾-1
—— "A" Shares, 01-017,139	5	..	1⅛-2⅛
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112 100	2	..	⅛-⅜
—— 7 per cent. Cumulative Pref.	2	..	1⅛-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100	..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅜-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	11⅜-12⅜
—— 4½ per cent. Preference	5	..	4⅜-¼ xd
—— 4½ per cent. Debentures	100	..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10	..	15¼-15½
—— 4 per cent. Debentures	100	..	99-101
National Electric Construction Co., 1-170,000	1	..	⅛-⅜
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	32¼-33⅜
—— 4 per cent. Bonds	100	..	100-105
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4¼-5 xd
Bournemouth and Poole, Ordinary	10	..	11-12
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	10-11
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	10-10½
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Bromley (Kent) Electric Light and Power Co	5	..	4⅜-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-98
Brompton and Kensington, Ordinary	5	..	7⅜-8⅛
—— 7 per cent. Preference	5	..	7-8
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6½-7
—— Nos. 80,000-100,000	5	..	5⅜-6⅜ xd
Cambridge Electric Supply Company, £10 Ord.	8	..	12¼-13¼
Canadian General Electric Co., Common Shares	$100	..	90-91
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	97-100
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	4¼-4⅜
—— 4½ per cent. Cum Pref., 1-80,000	5	..	4¼-4⅜
—— 4 per cent. Debenture Stock, Red.	100	..	97-100
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¼-4⅜
—— ditto (1903) 40,001-80,000	5	..	4⅜-4⅝
Chelsea Electricity Supply	5	..	3⅛-3⅜
—— 4½ per cent. Debentures	100	..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	11¼-11⅝
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent. 2nd Deb. Stk., Red.	100	..	100-103
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0	..	50-53
Corjobs Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3-3⅛
—— 5 per cent Preference, 1-50,000	5	..	4⅜-4⅝
County of London Elec. Supply, Ordinary	10	..	7⅜-8¼
—— 6 per cent. Cum Pref.	10	..	11-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	105-108
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	97-100
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	⅛-¼
—— 6 per cent. Cum Pref.	5	..	¼-1⅛
—— 4½ per cent. First Mort. Deb.	100	..	60-70
Electrical Development Co. of Ontario. 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	—		72¼-75½ p.c. xd
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2¼-2⅜
—— 5 per cent Debenture Stock, Red	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	91-94
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4⅜-5⅛
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-13 000	5	..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	98-101
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100	..	92-96
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	⅛-¼
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	8-9
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅞-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5	1¼-1⅜
—— 6 per cent. Pref.	5	4½-5
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. stock, Red (Prov. Certs), all paid	100	92-95
Metropolitan Ordinary, 100,001- 00,000	5	5½-5⅝
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4⅝-5¼
—— 5½ per cent. Mortgage Debenture, Red	100	85 90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000	—	76-78 p.c.
Mexican Light and Power Co., Capital stock	$100	53-55
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	81-86 p.c.
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6⅝-6⅞
—— do., 57,010-75,000	5	6⅝-6⅞
—— do., 75,001-87,500 (issued at 22 prem., 16s. paid	5	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5	5¼-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	5¼-5⅜
Notting Hill Electric Lighting	10	11-12 xd
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5⅜-5½
—— 4 per cent. Debenture Stock	100	93-96
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	¾-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red	100	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5	4⅜ 5¼
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅜-5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¾-1¼
—— 4 per cent. Debenture Stock	100	70-74
South London, Ordinary	5	2¼-3
South Metropolitan Electric Light and Power, Ord.	1	⅞-⅞ xd
—— 7 per cent Cum Pref.	1	1⅛-1⅜ xd
—— 4½ per cent 1st Mort. Deb.	100	101-104
St. James's and Pall Mall, Ordinary, 101-20,080	5	7½-8¼ xd
—— 7 per cent. Pref.	5	6½-7 xd
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1½ 2¼
—— 5 per cent. Cumulative Preference, 50,001 80,000	5	2-2¼
Westminster, Ordinary	5	7⅜-8¼ xd
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	5-5½

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,007	5	6-6¼
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	8-8¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	129-132
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	103-106
Barcelona Tramways, Ord., 1-20 000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	13/16-15/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk, Red.	100	93-96
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	9¾-10¼
—— 4½ per cent. Deb. Stock, Red.	100	95-97
Brisbane Tramway Invest., Ord., 1-75,000	5	3¾ 4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4 11/16 4 15/16
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	97-101
British Columbia Electric Railway Co., Ord Def.	100	127-130
—— Ord. Pref.	100	106-110
—— 5 per cent. Cum. Perpetual Pref. Stock	100	104-108
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	101-104
—— 4½ per cent. Vancouver Power Deb.	100	100-103
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10	4¼ 4⅜
—— 5 per cent. Perpetual Debenture Stock	100	97-101
—— 4½ per cent. 2nd Deb. Stock	100	72-76
Bueno Ayres and Belgrano Trams	5	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	95-93
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	100-104
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	92 95
Calcutta Tramways, Ord., Nos 1-137,610	5	6¾-7⅛
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5	5-5⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	101-105
Cape Electric Tramways, Nos. 1-480,000	1	5/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4⅜-7⅛
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	98-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5 3/16-5 7/16 xd
—— 4 per cent. Deb. Stock, Red. 1985	100	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	89-93
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	80-85
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5	¾-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100	87-91
—— 6 per cent. "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £286,500 2nd Mort. Deb. Stock	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	¼-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	¼-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	82-86
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436 25 000	5	4½ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100	87-92
Metropolitan Elec Trams., Defd., 1 000.001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref., 500,001-1,000 000	1	25/32 29/32
—— 4½ per cent. Deb. Stock, Red.	100	98-100
Mexico Trams. Co., Gen. Cons 1st Mort. 50-year 5 per cent. Gold Bonds	—	82-84 p.c. xd
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-106
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10,000 and 34 001-74,000	5	⅜-1⅛
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅜-9
Perth Elec. Tramways (W.A.). 5 per cent. 1 Mrt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary. 1-245,000	1	¼-⅜
—— 5 per cent Cum Pref., 300,001-545 000	1	¼-⅜
—— 4½ per cent Debenture Stock	100	93-96
Provincial Tramways Co., Ordinary. 1-24 912	10	4¼-5
—— 6 per cent. Cum. Pref., 1-10.000	10	9¼-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum Pref. 1-30,000	5	5-5¼
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	96-98
Sao Paulo Tramway, Light, and Power Co.	$100	121-125
—— 5 per cent. 1st Mort Deb., Red. 1929. 1-11,000	$500	95½-97½ p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	¾-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100	78-82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	70-75
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,251	5	3¼-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid.	Last price.
	£	£
Central London, Ordinary	100	64-67
—— 4 per cent. Pref.	100	82-84
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	100-103
City and South London, Consolidated Ordinary	100	38-40
—— 4 per cent Debenture Stock	100	101-104
—— 5 per cent. Pref. Stock '91	100	114-117
—— " " " '96	100	112-115
—— " " " '01	100	110 113
—— " " " '03	100	108-111
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50,000	10	3⅜-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	84-86
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	40-44
—— Deposit Receipts	—	40-44

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53 001-78,000	$1 000	86-88
Anglo-American Telegraph Co., Ordinary	100	54-57
—— 6 per cent. Preferred Ordinary	100	98-100
—— Deferred Ordinary	100	13½-14
Anglo-Portuguese Telephone Co., 5 per cent 1st Mort. Deb. Stock, Red.	100	98½-101½ xd
Chili Telephone Co., 1-44,000	5	7-7½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	87-90
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	7-8
—— 10 per cent Preference, 1-6 000	10	16-17
Direct Spanish Telegraph Co., Ordinary	5	3¼-3⅜
—— 10 per cent. Cum. Preference	5	8¼-9¼
—— 4½ per cent. Debs., 1-600	50	99½-102½
Direct United States Cable Co.	20	13⅜-14⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	98-101
Eastern Extension, Australasia and China, 1-300,000	10	12⅜-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp	100	99-102
Eastern Telegraph Co., Ordinary Stock	100	130-135
—— 3½ per cent. Preference Stock	100	83-86
—— 4 per cent. Mortgage Debenture Stock	100	101-103
Great Northern Telegraph Co. (of Copenhagen)	10	31-33
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	99-102
Indo-European Telegraph Co.	25	54-57
Marconi's Wireless Telegraph Co., Nos 255,128-284,190	1	⅛-⅜
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	¾-1
National Telephone, Preferred	100	107-109 xd
—— Deferred Stock	100	107-109 xd
—— 6 per cent. Cum. First Pref.	10	10-12 xd
—— 6 per cent Cum. Second Pref.	10	10-12 xd
—— 5 per cent. Non Cum. Third Pref.	5	5⅜-5⅝ xd
—— 3½ per cent. Deb. Stock, Red.	100	97-99
—— 4 per cent. Deb. Stock, Red.	100	100½-102½
Oriental Telephone and Electric Company	1	1⅛-1⅛
—— 6 per cent. Cum. Pref	1	1 3 32-1 7/32
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5	6¼-7
—— 5 per cent. Cum. Pref., 1-40,000	5	4⅜-5¼
—— 4½ per cent. Debenture Stock, Red.	100	98-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½	1 15/16-1 13 16
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	98 101
West India and Panama Telegraph Co., Ordinary	10	17/32-21/32
—— 6 per cent. Cum. 1st Preference	10	8-8¼
—— 6 per cent. Cum. 2nd Preference	10	8-8¼
—— 5 per cent. Debs., Red., 1-800	100	100-103
Western Telegraph Co., 1-207,930	10	13⅛-13⅜
—— 4 per cent. Debenture Stock, Red.	100	98½-101⅛

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Mar. 4	1,216	1,241	− 25	− h	27½	27½	May 31	72,605	17,676.000	1,529.682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 7	180	177	+ 3	−	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 7	3,125	2,350	+ 775	+ 7,339	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 8	997	961	+ 36	+ 521	23·63	23·63	March 31	55,408	11,686,691	1,394,743	—	—	—	6·1
Birmingham Corporation	Feb. 29	6,181	5,319	+ 862	—	56½	5*½	,, 31	18,557	5,252,088	215,345	·87	16·2	9,228	—
Blackburn Corporation	Mar. 4	963	926	+ 37	+ 3,670	23·60	23·60	,, 25	54,961	10,094,088	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 5	373	394	− 21	− 1,141	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	− 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	Mar. 8	2,076	1,975	+ 101	+ 6,691	42	42	March 31	111,294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 4	1,306	1,317	− 11	+ 2,182	29¼	24½	,, 31	83,665	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	Feb. 29	4,039	4 134	− 95	+ 5,332	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	Mar. 8	668	698	− 30	− 3,822	17·191	17·191	,, 31	50,662	10,759,310	1,798,905	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 6	4,473	4,625	− 152	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	Feb. 29	1,114	1,085	+ 29	—	19½	19½	,, 31	62,699	11,967,418	1,206,850	1·31	12 48	5,825	8·21
Burton Corporation	Mar. 8	249	246	+ 3	− 641	9½	8½	,, 31	15,576	3,383,527	421,317	1 07	8·87	1,718	6·14
Cardiff Corporation	,, 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,560	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	,, 7	139	144	− 5	+ 91	8·5	8·5	Dec. 31	10,264	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 7	6,121	6,404	− 283	− 2,522	6	6	,, 31	349,298	43,057,997	1,279,688a	1·85	62·29a	55,367	35·22a
Charing X, Euston, & Hamp. Ry.	,, 7	3,170	—	—	—	7½	6½	—	—	—	—	—	—	—	—
City and South London Railway	,, 8	3,190	2,989	+ 401	+ 3,235	9	6½	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	Feb. 26	160	151	+ 9	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Mar. 5	380	402	− 22	− 207	15½	15½	Dec. 31	85,032	5,966,364	891,998	—	6·74	—	4·78
Croydon Corporation	,, 6	1,185	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,602,408	1·08	9·76	3,125	6 67
Darwen Corporation	,, 6	228	2'5	− 7	− 58	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	− 1,124	4½	4½	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Mar. 6	88	95	− 7	+ 15h	6½	6½	—	—	—	—	—	—	—	—
Dublin U.T.	,, 6	4,626	4,570	+ 56	+ 1,835	54½	48½	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 4	1,069	1,049	+ 20	+ 2,182	22	22	May 15	57,672	15,554.905	1,162 792	·878	11·9	4,358	7·3
East Ham Corporation	,, 7	805	229	− 24	+ 432	14	14	March 31	47,140	15,049,240	1,052,151	·74	10·49	3,636	7·14
Glasgow Corporation	,, 7	16,660	16,844	− 184	+18,251h	177½	169	May 31	887,381	224,063,088	20,360,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 4	208	265	− 57	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 7	5,430	3,995	+1,435	+16,741	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,996	18,899,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	Feb. 29	1,456	1,4 1	+ 45	+ 3 343	35½	35	,, 31	81,196	15 252,150	1.804,745	1·22	10·79	2,770	5·32
Hull Corporation	Mar. 7	2,428	2,3.6	+ 111	+ 6,765	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	Feb. 29	374	406	− 32	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	Mar. 4	127	121	+ 6	+ 419	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Feb. 26	251	228	+ 23	—	7½	7½	May 15	13,702	4,640,618	466,919	6·2	7·56	1,723	4·95
Lancashire United Tramways	Mar. 4	1,140	1,117	+ 23	+ 865	39	38	—	—	—	—	—	—	—	—
Leeds Corporation	Feb. 29	5 990	5,866	+ 34	+12,832	96½	96½	March 31	327,794	73,024,253	7,358,185	1·06	10·69	3,352	5 58
Leicester Corporation	Mar. 7	2,114	2,142	− 28	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	Feb. 29	10,487	10,394	+ 93	+ 803	104	104	Dec. 31	563 793	122,094,528	12,115.934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	Mar. 8	1,390	1,406	− 16	+ 54h	9·25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	Feb. 22	29,822	27,050	+2,772	+232,772	98	98	March 31	1378,014	314,227 090	30,120 297	1·05	10 98	—	8·56
Lowestoft Corporation	,, 29	139	130	+ 9	—	3½	—	Sept. 30	11,079	2,622,922	343,190	1·03	7 9	2,156	6·39
Maidstone Corporation	Mar. 5	137	90	+ 47	—	3½	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 7	13,890	13,343	+ 547	+716,372	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 7	9,165	8,102	+1,063	+ 9 465	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 8	15,154	14,232	+ 322	+ 1,038	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 7	118	131	− 13	− 41	2¾	2¾	March 31	7,709	2,035,300	203,203	·86	8 64	1,882	8·69
Newcastle-on-Tyne Corporation	,, 7	3,740	3,858	− 118	+ 661	59½	57½	,, 31	210,491	45,536,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	Feb. 29	566	564	+ 2	+ 3,081	14½	14½	,, 31	32,421	7,760,403	772 753	1 03	10 01	1,525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35½	35½	,, 25	84,948	18,647,731	1,818,444	1·19	12·53	2,603	7·259
Portsmouth Corporation	Jan. 18	1,470	1,416	+ 54	—	28½	28½	,, 31	98,911	20,668 825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	− 788	13½	13½	,, 31	32,661	8,130 179	918,825	95	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6·03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10·45	2,691	7·38
Salford Corporation	Mar. 2	4,219	4,317	+ 2	+ 6,774	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537.845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 1	5,123	5,339	− 186	+11,452	65½	65½	March 25	276,907	73.966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	,, 4	890	826	+ 63	+ 3,187	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 4	257	252	+ 5	+ 204	9	9	,, 31	20,076	4,431,728	390,538	1·07	12·33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·949
Sunderland Corporation	,, 8	1,116	1,266	− 150	− 2,673	20	20	,, 31	72,396	17,483,132	1,535,495	1·006	11·261	3,667	6·37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,958	7·79
Torquay Tramways	,, 5	181	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 7	757	714	+ 43	+ 768	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965 296	429.785	—	10·724	1,989	6·95
West Ham Corporation	Feb. 27	2,124	2,066	+ 58	+ 2,256	14·7	14 7	,, [31	1?2,881	35,202,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 26	809	742	+ 67	+ 607	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·095

* 1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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MEASURED RATE.

It is useless to attempt to get away from telephony at present, and perhaps it is just as well it should be so. In our last issue we deliberately left ourselves open to the rejoinder, which was at once forthcoming, that certain household requisites can be and often are ordered by telephone. Compared with the ordinary business use of the telephone, these household requisites loom small, and it is not every housewife who has the privilege of having two accounts to play off one against the other, and the household goddesses are few who would transfer an order because "Engaged" was the reply of the moment. The fact that "Engaged" is the reply goes a long way to show that the "young man" is at his work, and is not inefficient. Besides, there is a law of averages, and if housewife No. 1 transfers her orders from A. to B, it is just as probable housewife No. 2 transfers her order from B. to A. We venture to differ from Mr. Webb's conclusion that transfers of this kind happen by thousands hourly within the confines of the kingdom. We do not argue for infallibility of business men, but we do argue that on the whole they know better how to use their tools in business than their would-be teachers who are not in business. In many cases the only way to deal with a statement without trespassing too much upon space and patience is by a flat denial. Mr. Webb unfortunately says too much about his years and experience, because there are others by no means chickens either in years or experience, and their word is as good as his. He makes dogmatic statements, and we dogmatise in reply. We ask why and how in order to see upon what basis the statements are made, but we neither get the why nor how. Thus, again, why should measured rate raise efficiency? Is it simply because with the flat rate the telephone may be used frivolously? Is frivolity a customary phase in business work? An ineffective call is due to many causes—not always because the line is occupied with business communications. If it is merely a question of number of calls in a given time, the business man is keen enough to determine if the actual loss warrants his doubling his line. The number of calls per hour differs considerably with the particular hour of the day, and neither measured nor flat rate will alter the congestion at certain hours. Unless Mr. Webb can prove the frivolous calls increase the congestion at particular hours, his argument about one rate increasing efficiency and the other reducing it falls to the ground, and we feel bound to emphatically dogmatise that business men are keen enough to see that it is business first and frivolity afterwards with their telephones. We absolutely agree with Mr. Webb that there does exist a minority of business men who in all kinds of ways act against their own interests. Grant it be so, the majority ought not to be punished for the sins of the minority. Now for another dogmatic assertion. We do not believe there exists and we challenge Mr. Webb to give a single case in the whole world wherein the small user does not benefit at the expense of the large user. It is evident that the economics of production have been forgotten in his assertion that the loaf, or the book, or the paper are *the* unit. Certainly each forms a derived unit—convenient for common use—but neither, if we may so term it, is a basic unit. The price of unit loaf is derived from the prices of the sack or quarter of flour, and the number of four-pound loaves that can be made per sack, and the cost of making and distributing such a number of loaves in addition to the profit thereon. The price of a loaf is not based upon the cost of that single loaf, nor should the price of an effective telephone message be by

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implication based upon the cost of one message. We have asked how is the price per message obtained. We think we know how it might legitimately be obtained, but that is not the point. Here is a sample of the information wanted in concrete form. A girl who gets, say, 25s. a week can easily deal with from 4,000 to 4,500 calls per week. Is the wages cost per measured rate determined by the division of 25s. by 4,000 or 4,500? Are the other factors of cost similarly obtained, and, if so, what are the real figures? Is Mr. Bennett right, and the measured rate introduced simply to get more profits? Has telephonic exploitation hitherto been profitable to the exploiters? If so, and business men find a measured rate increases the cost, why should they not infer that the rate chosen is too high? Why should they not agitate to have the rate lowered if its imposition means additions to the large profits of the exploiters? If the question merely concerns a Government department, surely the Post Office, either with its letter-carrying, telegraphic, or telephonic business, is not intended to be a "get-all-you-can department" for the Treasury? It is not a trading concern, and while it should not be carried on at a loss or inefficiently, it should not be merely a profit-making concern. Mr. Bennett gives figures to show that the proposed or actual measured rate is much greater than need be when compared with other rates with which he has had experience. The users, or, at any rate, those who have spoken publicly, say that the exchanges to which he refers are efficient. If that is true, all assertion to the contrary, it is certain that the ordinary telephonic charges in this country are too high. No one objects to a measured rate as a measured rate; the objection is that it is far too high, and means more profit to the exploiters without any betterment of the user. What is the objection in giving the actual prime cost so that business men can determine whether the rate imposed is too high or too low?

LATE HALIFAX TRAM ACCIDENT.

All concerns, be they municipal or company, must work out their own salvation. Last week there was a dress debate in the Halifax Council concerning its tramway system, which, according to most of the members, is in a most unsatisfactory state of organisation. Due attention has not been given to maintenance, initial mistakes were many and costly, the lines were not designed so as to be worked with the greatest economy, and the new brooms are said to be making a clean sweep with a rush. That is as it may be, and we rather commend the new manager and the new chairman of committee for stating forcibly and bluntly the true state of affairs, but we do not approve nor agree with the attempt to saddle the Council and the general rate with the loss due to the tramway accident at Pye Nest. It is quite certain that no company could come upon a third party to foot its accident bill. All such losses must go against revenue or reserve, or some other account connected exclusively with the undertaking. It is of no importance to elaborate this view at length, as the Halifax Council, while sanctioning a capital expenditure of £8,500, did so upon the understanding that this was not to be saddled on the rates. Still, if the money is spent and things do not improve, as it is hoped they will, it may be that ultimately the rates will have to face the loss. The position, however, seems fairly simple. In the long ago the tram system was prosperous, then came the strike and the accident; things were left undone that ought to have been done till matters got to be in a bad way, and to put matters right money must be spent. Those who know best say the money will be well laid out, it will bring about the return of prosperity, and the revenue will meet the demands upon it. May it be so.

THE LEEDS RATES.

The Leeds Corporation Finance Committee have considered their budget for the ensuing year, and propose to reduce the rates by one penny in the pound. According to the *Yorkshire Evening Post*, this reduction is secured by a timely rearrangement of accounts. To quote from our contemporary: "For several years past there has been a big surplus on the city fund account, and a bigger deficiency on the consolidated rate account. Now a complete transformation is proposed to be brought about, by which a surplus of over £160,000 on the city fund account shall be changed into a deficiency of £2,067, while a deficiency of over £100,000 on the consolidated rate account shall be wiped out, and a surplus created of £2,570. These calculations also allow for the nucleus to be set aside for the forming of four reserve funds—viz., £5,000 for the water department, £3,000 for the gas department, £4,000 for the tramways department, and £3,000 for the electric lighting department—a total of £15,000." The far-seeing policy of the Finance Committee thus provides for a contribution of £4,000 to the tramways reserve, which is a poor return for the £85,000 taken from this reserve fund last year. We look forward to the report of the Council at which this proposal is to be considered.

ROYAL HUMANE SOCIETY'S MEDAL

We have to congratulate Mr. F. Hope Jones, M.I.E.E., on a matter which is not directly connected with engineering. On Jan. 4 he, with some hundred others, was skating at the Welsh Harp, when a Mr. E. P. Brand fell through the ice into the River Brent. The water at this point was some 12ft. deep, and Mr. Hope-Jones made a gallant attempt to rescue the unfortunate gentleman. He dived five times in his attempt to find Mr. Brand, without being successful. The risk of diving through an opening in the ice is extremely great, and we are pleased that the Royal Society have awarded their bronze medal to Mr. Hope Jones This was presented last week by Dr. Danford Thomas, the coroner for the district, who, knowing the full facts of the case, was pleased to be the intermediary between the Royal Humane Society and our engineering friend. We have admired his pluck before in pushing his excellent schemes for the distribution of standard time, and are pleased that his courageous attempt to save life has been suitably acknowledged.

A CARBON-FILAMENT MERCURY-VAPOUR LAMP.

A form of mercury-vapour lamp in which the colour effect is improved by the presence of a carbon filament, forming an integral part of the lamp, has been recently patented in Italy. The carbon filament is enclosed in a U-tube, which also contains a little mercury. On closing the circuit the carbon filament glows and gradually vaporises the mercury, which then takes a prominent part in the illuminating effect. The energy consumption is only slightly increased because the presence of the vapour somewhat cools the filament, so that its resistance rises and the total combined current taken by the filament and the vapour does not increase appreciably. The lower temperature of the filament gives it a red glow, and so serves to provide the necessary red rays.—*Der Elektrotechniker.*

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VECTOR ALGEBRA FOR ALTERNATE-CURRENT PROBLEMS.

BY WILLIAM CRAMP AND C. F. SMITH.

The notation which has been introduced by C. P. Steinmetz for dealing with alternating-current problems (as set forth in his books) has but one disadvantage—viz., that it does not discriminate between a unit vector in a particular direction or along a particular axis and the operator called j. This follows in consequence of the foundation of the system, in which the unit vector along the horizontal axis is denoted by 1, and this unit is operated upon by j, so that the unit vector along a vertical axis becomes

$$j \times 1 = j.$$

This leads to no confusion when the system is once thoroughly understood, until it is necessary to multiply a vector by a vector, when an extension to the notation has to be adopted to cover the observed physical results, involving a distinction not easy for the average electrical engineer to understand. To avoid this difficulty it is only necessary to discriminate clearly between unit vectors along particular axes and the operator j, and also to discriminate between complex numbers (such as impedances, admittances, etc.) and vectors.

In what follows the notation of Steinmetz as regards complex numbers has been rigidly adhered to, but when it is necessary to obtain relative values of two vectors with reference to a particular axis, this axis is called the "axis of reference," and is denoted by a single '. Similarly vectors measured along an axis at right angles to this are denoted by ". The time of the diagrams is reckoned counter-clockwise, and j becomes simply an operator which rotates any vector through 90deg. counter-clockwise. In such a scheme the signs ' and " may be taken to represent the designation of a unit vector along a particular axis. Thus a vector A may be written

$$a_1' + a_2'',$$

where a_1 and a_2 are the actual numerical values along the respective axes of the components of the vector. It is evident also from the definition of j that

$$j\, a_1' = a_1''$$

i.e., multiplying a vector marked by a single dash (') by j gives a similar vector marked with a double dash ("). It follows also that $a_1'' \times j = -a_1'$, and so on.

To illustrate the advantages of this system the transformer has been chosen as being the most generally useful example in alternating-current work, and the explanations attached to each equation should serve to make the system of notation quite clear. Throughout, large letters signify vectors and complex numbers and small letters denote numerical values only.

General Equations of the Transformer.—In the transformer the volt-amperes appearing in the secondary circuit (whether useful or waste) are all supplied from the primary through the medium of the magnetic flux. It is necessary, therefore, to consider the relationship which exists between the equations of the two circuits, and also to carefully distinguish between the secondary voltage and current, E_2 and C_2, and the voltage and current which in the primary circuit represent E_2 and C_2. In other words, it is necessary to realise the difference between E_2 and a voltage which, applied to the primary circuit, produces that magnetic flux setting up E_2; and also between C_2 and that current which flowing through the primary windings produces ampere-turns to counterbalance those due to C_2 in the secondary coils. We can best approach this relationship by considering the secondary circuit independently, afterwards tracing its influence upon the primary input. We know (1) that the secondary current, C_2, sets up ampere-turns producing through the transformer core a magnetic reaction. (2) This reaction is opposed and balanced by a current in the primary, C_s, producing an equal number of ampere-turns. (3) The total primary current, C_1, is the vector sum of the current balancing the above reaction and of the current producing the magnetic flux corresponding to E_2, the secondary E.M.F.

Fig. 1 expresses the voltage equation for the secondary circuit. In vector notation this is

$$E_2 = C_2 Z_2 + C_2 Z \quad . \quad . \quad . \quad . \quad . \quad (1)$$

meaning that E may be resolved into two components, one of which is absorbed by the load impedance and the other by the secondary impedance. These two components are $C_2 Z$ and $C_2 Z_2$.

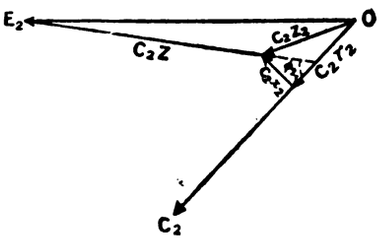

FIG. 1.

Fig. 2 shows the corresponding equation for the primary current. Here C_1, the primary current, is resolved into two components: (1) that part which balances the reaction

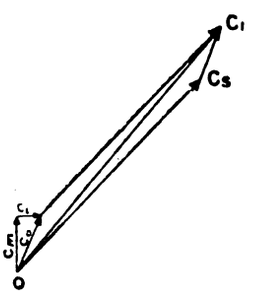

FIG. 2.

due to the secondary current, C_2—this is marked C_s, and is equal to

$$-\frac{1}{k} C_2,$$

where k is the ratio of turns $= \frac{\text{primary turns}}{\text{secondary turns}}$; (2) that part which provides the flux producing E_2, marked C_0. Thus

$$C_1 = C_s + C_0 = -\frac{1}{k} C_2 + C_0 \quad . \quad . \quad . \quad (2)$$

Fig. 3 shows the diagram for the equation of the primary E.M.F. In it E, the applied primary pressure, is resolved

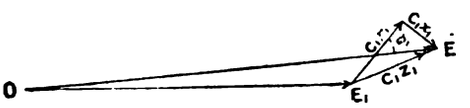

FIG. 3.

into two components: (1) that which balances the back E.M.F., called E_1, where $E_1 = -k E_2$; (2) that part which is absorbed by the impedance of the primary windings, written $C_1 Z_1$. In vector notation the equation is

$$E = E_1 + C_1 Z_1 = -k E_2 + C_1 Z_1 \quad . \quad . \quad (3)$$

Expanding equation (3) by means of (2), we get:

$$E = E_1 + C_s Z_1 + C_0 Z_1 \quad . \quad . \quad . \quad . \quad (4)$$

Since $E_1 = -k E_2$, and $C_s = -\frac{1}{k} C_2$, we may write equation (1):

$$E_1 = k^2 C_s Z_2 + k^2 C_s Z.$$

Substituting in (4)

$$E = k^2 C_s Z_2 + k^2 C_s Z + C_s Z_1 + C_0 Z_1 \quad . \quad (5)$$

The meaning of C_s must never be forgotten. It is a vector opposite in direction to C_2 of an arithmetical value $\frac{1}{k}$ times that of C_2.

Equation (5) is the general equation for every form of alternate-current transformer. In it the relationship between an impedance in the primary and an impedance in the secondary is clearly expressed. Z_2 is a number of ohms in the secondary

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circuit, so also is Z. C_s is a current in the primary circuit. In order to express the pressure drop in the primary due to Z_2, we find it necessary to multiply Z_2 by k^2 as shown. Returning to equation (5), we may call attention to the fact that $C_0 Z_1$ is usually a small quantity; so small that many neglect it altogether. It is, however, the very advantage of vector algebra that it is quite easy to take everything into account.

We may now select some axis of reference for the vector diagram. In choosing such an axis it will naturally be found advantageous to select that vector most often occurring in the equation to be expressed, for care in this respect often simplifies the resulting expressions. In this instance it is, therefore, an advantage to adopt C_s as the axis of reference. We take it as horizontal and mark it as a vector c_s'. The actual value of this vector is $c_s = \frac{1}{k} c_2$ amperes.

In order to find the value of e, we shall need C_0 in terms of either C_2 or C_s. We know that

$$C_0 = E_1 Y = k^2 C_s (Z_2 + Z) Y,$$

which means that if we operate upon the vector C_s first with the complex number $(Z_2 + Z)$ and afterwards with the complex number Y we obtain the vector C_0, representing the current supplied to the transformer for magnetising and for iron losses. This expression is very interesting as showing the connection between load and magnetising current. Substituting in (5) this value of C_0, we get

$$E = k^2 C_s Z_2 + k^2 C_s Z + C_s Z_1 + k^2 C_s (Z_2 + Z) Y Z_1 \quad (6)$$

All the vectors which compose E are now in terms of C_s.

It is to be noted that directly we define the position of a quantity by inserting the dashes (′ and ″) which indicate a vector parallel or normal to the assumed axis we change the letter indicating a vector from the large letter to the small one, for the dashes decide the direction and the small letter gives the numerical value. Hence the small letter with the dash is equivalent to a number of units with the direction in which those units are acting defined—*i.e.*, a small letter with a dash is a vector and completely replaces the capital letter. Another way of looking at this matter is to consider the small letter as the number of units and the ′ as a unit vector in a particular direction. This explains also why, when referring to the numerical value only, the ′ or unit vector is omitted.

Example to illustrate the use of the symbolic equations for obtaining the vector relations in an actual transformer.—A core-type single-phase 50-frequency transformer has the following constants: net core section, 20 square inches; length of mean magnetic line in the core, 60in.; maximum magnetic density, 45,000 lines per square inch; primary turns, 1,500 of reactance $r_1 = 7$ ohms; secondary turns, 100 of resistance $r_2 = 0{\cdot}025$ ohm; primary reactance, 14 ohms; secondary reactance, 0·036 ohm. Find the symbolic expression for the no-load admittance, and assuming the flux common to primary and secondary as constant, give the equations for, and value of, the primary input corresponding to a secondary output of 20 amperes (non-inductive load).

From the above dimensions we have: core weight = 324lb. approximately. With 50 frequency and the density given, the iron loss will be about one watt per pound. Hence iron loss = 324 watts.

45,000 lines per square inch needs six ampere-turns per inch in good iron (imbricated joints).

Hence primary magnetising ampere-turns = 6 × 60 = 360.

Primary magnetising idle current

$$= \frac{360}{1{,}500} = 0{\cdot}24 \text{ ampere (maximum)}$$

$$= 0{\cdot}17 \text{ R.M.S.}$$

Now the maximum flux = 45,000 × 20 = 9×10^4 lines.

Hence primary volts (indueed)

$$= \frac{4{\cdot}44 \times 1{,}500 \times 50 \times 9 \times 10^4}{10^8}$$

$$= 3{,}000 = e_1.$$

Energy current for iron loss $= \frac{324}{3{,}000} = 0{\cdot}108$ ampere.

From definition of no-load conductance and susceptance

Energy current $= g e_1 = {\cdot}108$ ampere.

$$\therefore g = \frac{{\cdot}108}{3{,}000} = {\cdot}000036 \text{ mho.}$$

Idle current $= b e_1 = 0{\cdot}17$ ampere.

$$\therefore b = \frac{{\cdot}17}{3{,}000} = {\cdot}000057 \text{ mho.}$$

Whence $Y = g + j b = {\cdot}000036 + {\cdot}000057 j$

= primary admittance on no load.

If the flux common to the two coils is constant, so also is the magnetising idle current and the iron loss energy current.

Ratio of turns = 15 = k.

Secondary induced volts, $e_2 = \frac{3{,}000}{15} = 200$.

The current $c_s = \frac{1}{k} c_2 = \frac{1}{15} \times 20 = \frac{4}{3}$ ampere.

We shall now proceed to make use of equation (6), and for convenience we shall consider the parts of this expression independently. Writing out the expressions for the impedances in full we have:

$$Z_1 = r_1 - j x_1 = 7 - j\ 14$$

$$Z_2 = r_2 - j x_2 = {\cdot}025 - j\ {\cdot}036.$$

So $Z_2 + Z = (r_2 + r) - j (x_2 + x) = {\cdot}025 + r - j ({\cdot}036)$,

for the load is non-inductive—*i.e.*, $x = 0$.

From equation (1) we get with C_2 as axis of reference,

$$E_2 = c_2' (Z_2 + Z).$$

Substituting the values already obtained,

$$E_2 = c_2' ({\cdot}025 + r) - {\cdot}036\ c_2''.$$

The real value of c_2 being 20 amperes and of e_2 200 volts, we get

$$200 = ({\cdot}5 + 20 r)' - ({\cdot}72)'',$$

from which by the usual process we get the real value of r.

$$\sqrt{({\cdot}5 + 20 r)^2 + ({\cdot}72)^2} = 200$$

$$r^2 + \frac{1}{20} r = 100 - {\cdot}00192.$$

The last figure is obviously negligible in this case. This shows that the secondary resistance is very small compared with the load resistance, r, which should always be the case in well-designed transformers, so that

$$r = 9{\cdot}999 \text{ ohms, or practically 10 ohms.}$$

Also, if θ_2 = the angle of lag of the secondary current behind the secondary induced E M F.,

$$\tan \theta_2 = \frac{x_2}{r_2 + r} = \frac{{\cdot}036}{10{\cdot}025} = {\cdot}00386, \text{ and } \theta = \text{about } 0\ 2\text{deg.}$$

It is hardly necessary to call attention to the impossibility of measuring such an angle from a diagram, but vector algebra gives it us exactly

Terminal volts $= c_2 z = 199{\cdot}9$.

We have, then, from the first part of the expression for E from equation (6)

$$k^2 C_s . (Z_2 + Z) + C_s Z_1$$

$$= k^2 C_s \{(10{\cdot}025) - j\ {\cdot}036\} + C_s (7 - j\ 14)$$

$$= C_s (2{,}263 - j\ 22{\cdot}1)$$

$$= c'_s . 2{,}263 - c''_s . 22{\cdot}1$$

$$= \left(\frac{4}{3} . 2{,}263\right)' - \left(\frac{4}{3} . 22{\cdot}1\right)''$$

$$= (3{,}016)' - (29{\cdot}5)''.$$

The second part of E from equation (6) becomes

$$k^2 C_s (Z_2 + Z) Y Z_1 = C_s (2{,}256 - j\ 8{\cdot}1) Y Z_1$$

$$= C_s . (2{,}256 - j\ 8{\cdot}1) \left(\frac{36}{10^6} + j \frac{57}{10^6}\right) (7 - j\ 14).$$

This may be multiplied out according to the ordinary rules for multiplication of complex quantities, and gives

$$C_s (2{\cdot}368 - j\ 0{\cdot}245) = (3{\cdot}114)' - (0{\cdot}327)''.$$

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The latter is the voltage necessary to maintain the magnetising current through the impedance of the primary winding. It is obvious that this might be obtained from the expression $C_0 Z_1$, where C_0 has the value $0{\cdot}108 + j\ 0{\cdot}17$ already worked out. The complete expression for E is then

$$E = (3{,}016)' - (29\ 5)'' + (3{\cdot}114)' - (0{\cdot}327)''$$
$$= (3{,}019)' - (29\ 83)''.$$

So that $e = \sqrt{(3{,}019)^2 + (29{\cdot}83)^2} = 3{,}020$ volts.

So for a load of 20 amperes on the secondary of this transformer the applied voltage must be raised from 3,000 to 3,020 if the flux is to be kept constant. At this load the applied voltage leads the load current, C_s, by an angle such that

$$\tan \theta_1 = \frac{29{\cdot}83}{3{,}019} = {\cdot}01 \text{ (nearly)}$$
$$\theta_1 = 30 \text{ (about)}.$$

It will be noticed that, by neglecting the last part of equation (6), the primary voltage would come out 3,018, or about 0 06 per cent low. This is, of course, less than the error of a very good voltmeter, so that neglect of this factor is usually justifiable.

The total primary current in the transformer is

$$C_0 + C_s.$$

C_s we already have as $\frac{4}{3}$ amperes; C_0 we also have in the form $E_1 (g + j\ b)$

$$= {\cdot}108 + j\ 0{\cdot}17.$$

The temptation under the ordinary Steinmetz notation is to add these direct. But this is only correct if C_s and E_1 are in phase, which practically never happens; and this temptation is guarded against in the notation here suggested, because we know that we can only add directly components along the same axes of reference. We chose C_s as the axis of reference and wrote it $= \frac{4}{3}'$. But C_0 in the form given above is in terms of E_1 as axis of reference, so that it cannot be written.

$$\cdot108 + 0\ 17\ .$$

Now it has already been shown that

$$C_0 = k^2\ C_s\ (Z_2 + Z)\ Y$$
$$= C_s\ (2{,}256 - j\ 8{\cdot}1)\left(\frac{36}{10^6} + j\ \frac{57}{10^6}\right)$$
$$= C_s\ (\ 08 + j\ 0{\cdot}128)$$
$$= \left(\frac{4}{3}\ {\cdot}08\right) + \left(\frac{4}{3}\ 0{\cdot}128\right)'$$
$$= 0{\cdot}107' + 0\ 171';$$

which is very near the value given above, showing that E_1 and C_s are nearly in phase. We get now

$$C_1 = C_0 + C_s$$
$$= \frac{4}{3}' + {\cdot}107' + {\cdot}171'$$
$$= 1{\cdot}44' + {\cdot}171\ .$$

Hence $C_1 = \sqrt{(1\ 44)^2 + (\cdot171)^2} = 1{\cdot}45$ amperes.

The tangent of the angle of lag of C_1 behind C_s

$$= \tan \theta_3 = \frac{\cdot171}{1{\cdot}44} = {\cdot}119$$
$$\theta_3 = 6\text{deg. nearly.}$$

And it has already been shown that the applied voltage leads C_s by $\frac{1}{2}$deg. Hence the applied voltage leads the total primary current C_1 by

$$\phi = \tfrac{1}{2}\text{deg.} + 6\text{deg.} = 6\tfrac{1}{2}\text{deg.}$$

So that the power factor $= \cos \phi = 0\ 99$.

The watts input may be obtained either by the product

$$e\ c \cos \phi = 3{,}020 \times 1{\cdot}45 \times 0\ 99 = 4{,}340 \text{ watts},$$

or by direct vector multiplication thus:

$$\text{Input} = E\ C_1 = (3{,}019\ - 29\ 8'')\ (1{\cdot}44' + {\cdot}171'').$$

In such an expression only vectors measured along the same axes can produce power—*i.e.*, of the total product of the above four factors only.

$3{,}019' \times 1{\cdot}44' - 29{\cdot}8'' \times {\cdot}171''$ can represent power. For such factors as $3{,}019' \times {\cdot}171''$ represent the product of vectors at right angles—*i.e.*, they may be written

$$3{,}019 \times {\cdot}171 \times \cos 90\text{deg.},$$

which is obviously zero. Thus by direct multiplication we get

$$\text{Watts input} = 4{,}342 \text{ watts}.$$

In this way is that difficulty of products always present in the Steinmetz notation completely eliminated by this system.

HIGH-VOLTAGE INSULATOR MANUFACTURE.*

BY WALTER T. GODDARD.

(Continued from page 373.)

So much space has been given to discussing the value of the insulator when under rain that its pleasant weather qualities may seem to have been overlooked, but there are sudden and severe demands upon the insulator in the pleasantest weather, mainly from lightning and switching. When a rise of potential far above normal working voltage comes upon a perfectly dry insulator, the stress between line wire and pin is very sensibly increased, and that this stress shall not be too severe the distance between line wire and pin should be made ample by the introduction of several shells of porcelain. The specific inductive capacity of porcelain or its flux-carrying capacity is a perfectly

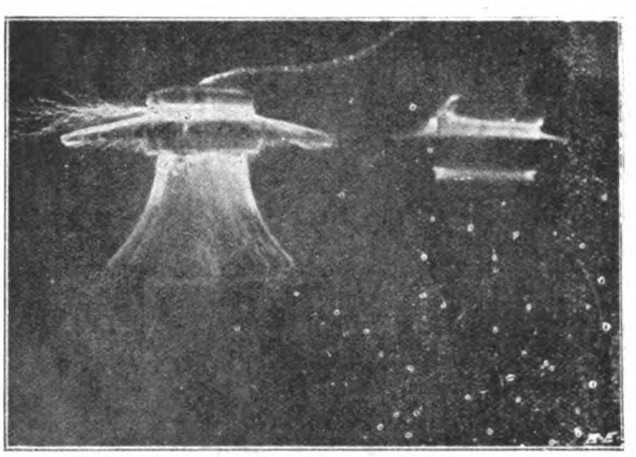

FIG. 9. FIG. 10.

definite thing, compared to air about 4·4, so that for any given potential, area of contact, and thickness of shell the density is determined. Porcelain, however, unlike some dielectrics, give due notice when overburdened by a pale violet light over its entire surface. Fig. 9 shows two porcelain shells subjected to 100,000 volts, their very evident distress being photographed by their own light. Fig. 10 shows better than can words how it is that so many lines have trouble with central shells breaking down. The designers in this case had failed to provide against the great concentration which will in time disrupt the finest porcelain. From these experiments it appears that, to avoid getting into serious trouble when potentials somewhere near the arcing-over capacity of the insulators are applied, it is necessary to provide considerable body of insulating material between line and pin.

Mechanically, insulators can be designed for any load by the proper disposition of material. Good electrical porcelain has a crushing strength in excess of 15,000lb. and tensile strength ranging between 1,500lb. and 2,000lb. per square inch. The latest development in excessively high-voltage insulators is but a reversion to a type long since discarded by lower-voltage engineers — *i.e.*, the underhung or suspended type of insulator. Reference to old telegraph manuals shows that the first English telegraph systems were insulated by underhung insulators of bowl-shaped porcelain. To come down to the present, all our trolley wires are suspended below the supporting device. For

* Paper read before the Canadian Society of Civil Engineers.

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years wireless telegraph companies have been using strain insulators in series, so the newest high-voltage insulator is, in reality, the oldest. Fig. 11 shows a modern development of the underhung insulator of five units designed to operate at 100,000 volts, grounded neutral, with a factor of safety of 4. It is intended to allow the conductor to swing freely in any direction. Figs. 12 and 13 show towers for a 100,000-volt line using suspended insulators. The reason for using suspended insulators is largely a matter of cost, since it is entirely possible to build porcelain insulators of the conventional type of sufficient size to successfully operate at any voltage, but the extreme height and diameter of a pin-type insulator for 100,000 or 150,000 volts makes the cost prohibitive. A suspended type of insulator has several advantages which it is well to understand before going into details of design. Of paramount importance is the unit formation making it possible to increase the effective insulation whenever it is desired to raise the line voltage, or wherever it seems desirable to present extra

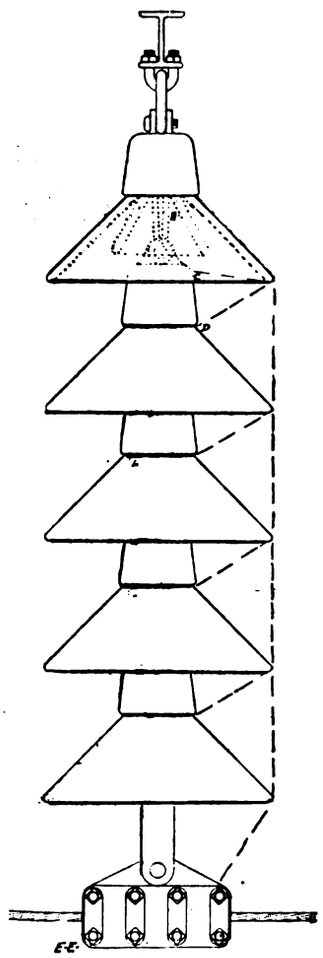

FIG. 11.

leakage surface because of salt fogs or smoke from railways and factories. Many lines start operation at much lower potential than designed for because the initial load is light, and the potential need be increased only when regulation demands it. With the pin type of insulator there is no alternative but to invest at the start in the largest insulators which the line will ever need, whereas in the suspended form additional units may be introduced whenever the growth of power business warrants an increase in potential. In the pin type of insulator the nearness of line wire and pin must always prove a weak point for lightning assaults as well as an aggravator of line charging current difficulties. The suspended type gets away from both difficulties by a wide separation of line conductor and supporting structure. incidentally the position of the conductor below the cross-arm permits the supporting structure to act as a lightning rod, and so to relieve the line of much lightning stress. Mechanically, provision must be made to prevent the swinging conductor from coming too near the tower structure, but the extra length of cross-arm necessitated by this feature is more than compensated for in cost by the fact that there are no twisting strains upon the arm. Insulator unit formation presents another very positive advantage in the matter of breakage. When a shell of a pin-type insulator becomes cracked or broken the whole device is rendered worthless, as it is utterly impossible to break the cement joint forming the bond between shells. Further, the cracking of a shell, especially an inner shell, may cause immediate shut-down, or at least shut-down during the first severe rainstorm. On the contrary, the breaking or cracking of one of the shells of a suspended unit type insulator takes away but that one unit from the series. Thus, in the case of a five-unit 100,000-volt insulator, a broken unit reduces the total strength but 20 per cent.

With these very evident advantages it is small wonder that with voltages reaching toward 100,000 the underhung insulator should be adopted. The first question, that of mechanical strength, was promptly disposed of by so designing porcelain parts that strains were all compression. The next question, that of electrical strength under normal operating conditions, was not so easily solved. In the first designs single shells of porcelain of $\frac{5}{8}$in. thickness were used, but when a series of five such shells was subjected to a 300,000-volt test a new condition was found to have been introduced in the way of a potential rise around the first units, and it was found by repeated test that any sudden application of potential, or even change in potential

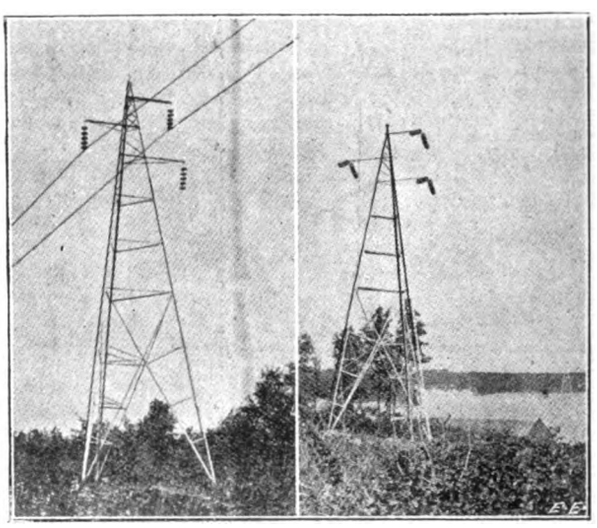

FIG. 12. FIG. 13.

already applied, would puncture the end shells, which, if made of economical pottery size—*i.e.*, 14in. diameter—would have a flash-over potential of approximately the ultimate puncture strength. This condition analyses somewhat as follows: The shells and metallic connecting links form a condenser of certain definite capacity, which for the sake of analogy may be likened to a mass of rubber or other elastic material. Carrying out the analogy, the rubber is struck a smart blow with a hammer. The surface struck, and layers of material immediately adjacent to it, feel the force of the blow most severely, and if the mass be thick and of great inertia, the force of the blow is barely preceptible on the surface opposite to that where the blow was struck. Moreover, the elastic material is no sooner struck and compressed than it attempts to return to its normal shape. This property of inertia is duplicated in the action of condensers in series. Call it what you wish, dielectric hysteresis or anything else, the effect is there, and if proper precautions are not taken, the outer layer of resisting medium, in this case a porcelain shell, will be disrupted. Unquestionably the dielectric strength of the unit must be increased, and the proper method is by supplying an inner protecting shell so that the puncture strength of the built up unit shall be far in excess of its flash-over potential. A unit so constructed is practically indestructible, and will carry continuously its flash-over potential without heating or its surface being covered with static, which impairs the efficiency by shortening the leakage path. Under normal

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operating conditions the end unit is the only one which is subject to unusual strains, but the failure either by mechanical breakage or arcing over may at any time put similar strain upon other units, so it is a wise provision to guard all shells against possible puncture. Having made the unit secure against puncture, the next concern is with leakage distance, which must be made of sufficient length to prevent any considerable current flow when the entire surface is covered with a thin film of water. Here, again, cost governs, since the unit construction permits the use of a few large or several small parts. As noted before, 14in. is an economical size for the potter to produce, and as the metal parts are the same for any diameter of shell, it is this size which returns most in insulation for each dollar invested. Fig. 14 shows the construction of a unit of a modern 100,000-

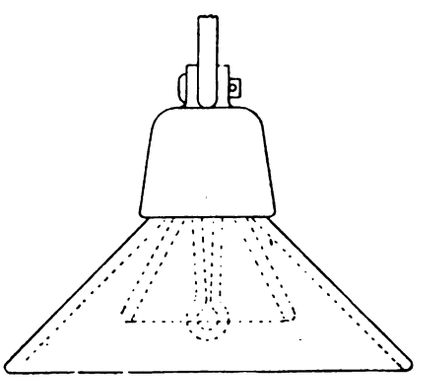

FIG. 14.

volt insulator. The shape of the shells is not of importance, since in testing to flash over under working conditions pains were taken to wet all surfaces thoroughly and so produce artificially the worst possible conditions; but it must not be taken for granted that leakage over an insulator is a desirable thing—in fact, the time when an insulator will leak sufficiently to dry itself should be postponed as long as possible by logical designing. To accomplish this it is, of course, necessary to permit as little water as possible to spatter on the underside of the shells, and this is best effected by deflecting the water away rather than toward the insulator. If this were the only thing to consider, the best shape of shell would still be in question. There are, however, other conditions. When, in the course of a severe storm the under as well as the upper shell surfaces have become thoroughly wet and leakage has

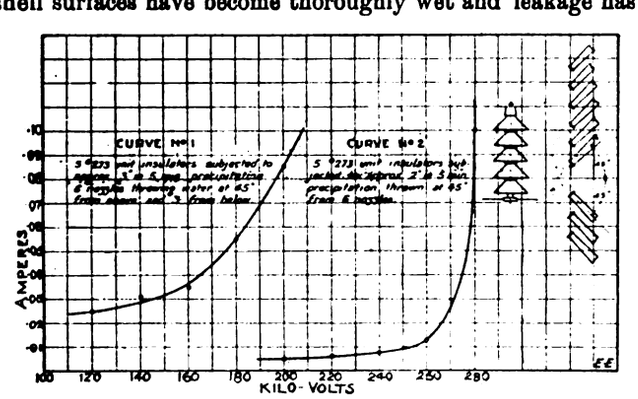

FIG. 15.

commenced, the first spot to become dry is the inside of the innermost shell at the point of smallest cross-section, A in Fig. 11, and a small arc is at once formed which, if allowed to persist, will heat and crack the shell. To avoid this the edge of the shell is brought down till the point B is of such a distance as to induce the arc to play between B and the malleable iron cap, C, of the unit immediately below. An arc of considerable magnitude may be maintained between these two points without heating the shells above sufficiently to cause cracking, since the air currents established tend to keep down the temperature. Current sufficient to support an arc between B and C will, unless the rain be very heavy indeed, dry a portion of the surface between D and E, which causes the arc to straighten out, and if there be sufficient current at high voltage, it will eventually be held between the conductor and the supporting structure. Fig. 11 shows the progressive breaking down between the beginning of actual leakage and the maximum arc, which is not sufficiently close to the insulator to damage it With only 500 kw. at 300,000 volts available the above deductions were found to be true, and the ability of the design to rid itself of arcs formed upon it demonstrated beyond question. The suspended insulator thus becomes an automatic relief valve, which may be relied upon to discharge the line safely and effectively without damage to itself or

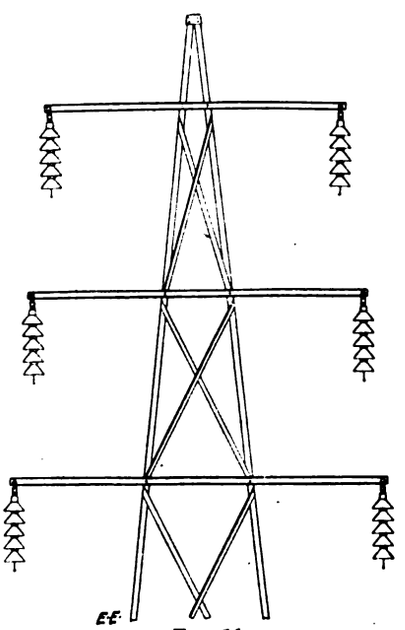

FIG. 16.

serious interruptions to the service. The curves of Fig. 15 show action of a five-unit insulator under partially wet and wholly wet conditions, and permit of estimate as to probable operating safety factor. The current values which were used in plotting these curves were obtained by means of a Thompson voltmeter, calibrated in amperes, introduced into the high-voltage winding at its middle

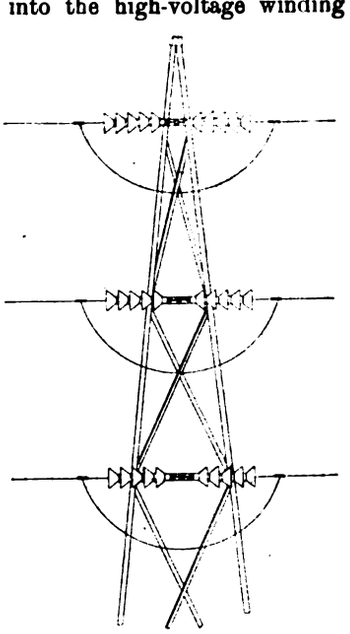

FIG. 17

point. One side of the instrument was well earthed in order to protect the operator. Voltages were gotten by means of a needle gap carefully protected from air currents.

The method of utilisation of freely suspended insulators may be of interest. Fig. 12 shows a modern 100,000-volt line using suspended insulators, this particular tower carrying vertical load only, due to weight of cable and such side strain as may come from wind pressure. Fig. 13 shows a dead ending tower for use wherever the tower arrangement departs from a straight line. Figs. 16 and 17

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show in detail how this dead-ending is accomplished, and how the cable is passed from one end clamp to the other. The underhung system of insulation works out with pleasing directness and simplicity, and its comparative cheapness argues for its wide adoption for the higher voltages. The cost of such insulators, as at present manufactured, ranges from 1·60dol. to 2dol. per unit, depending on the nature of the fittings. At least two 14in. units would be required for 60,000 volts, and as a good 60,000-volt insulator can be secured for prices ranging between 1·70dol. and 2·30dol. each, the question of the use of suspended units for voltages below 75,000 to 80,000 is largely one of safety factor and investment. The foregoing has given little which could be used in the determination of the proper insulator to use for any particular voltage, and it is quite in point to add here that every case is special. Insulators well suited to one locality are out of reason, in safety factor provided, for use elsewhere. A single transmission line of less than 100 miles in length may easily pass from high, clear mountain air to foggy, smoky, surroundings which are a constant menace to continuity of service. Again, the cost of complete immunity may well be balanced against cost of possible shut-downs—a point well illustrated in the line operating between Niagara Falls and Syracuse, all branch lines of which are equipped with much smaller and, consequently, cheaper insulators than those upon main lines. It is not intended to convey the idea that every line should have a special insulator, but that the characteristics of the proposed line should be made known to the designer in order that all points may be well guarded against. It is quite likely the resulting recommendation will be upon an old-established type of which all characteristics are known, and though its use for any specific case may not call into use all it is capable of, it will quite likely prove cheaper to produce a standard article of larger size than to make a special design of just sufficient capacity.

A forecast of the future of any business, though never safe, is always interesting. Concerning the highest practicable voltage, without reference to anything but insulators, it is safe to say that insulators for the heaviest mechanical strains and for the highest electrical stresses can be manufactured at moderate cost, so that limitations of transmitting voltages must at the present time be looked for in other directions than in insulator design, porcelain insulator design in particular. Wherever the word insulator has been used porcelain insulator is implied, for no other material has been so universally used in the past, and none gives such promise for the future. Its one bad characteristic—that of brittleness—is overcome by good designing, otherwise the material is very nearly ideal, for it is cheap and comparatively easy to manufacture. Of prime importance is its permanency, and of no other manufactured dielectric can as much be said. Porcelain is made under extreme conditions of heat, which effects the cementing together of stable elements which have been in their present form for thousands of years, and under the conditions at present obtaining on the surface of this planet will remain unchanged. Moreover, the porcelain is homogeneous and of a uniform texture throughout, and consequently of uniform specific inductive capacity throughout, so that electrical strains are evenly distributed. On the other hand, organic materials are subject to very rapid deterioration; many unite with oxygen at ordinary temperatures, or are attacked by rain water in a very short time. Heating by condenser action also aids in oxidation processes, and hastens the end. A favourite method of insulating against low voltage is by means of compositions of rubber, guttapercha, pitch, asbestos, ground mica, shellac, and the like, but the result is always the same, and a moment's contemplation of the reasons of failure would seem to argue against their use for permanent exposed insulation. The past is full of unhappy experiences in the attempt to insulate high-voltage lines with glass, rubber, mica, etc, and occasionally an engineer is found who is willing to erect lines of high pressure on insulators of material other than porcelain, but such engineers are so rare as to make it safe to say that, as a permanent dielectric, porcelain to-day stands alone.

WOLVERHAMPTON ELECTRICITY WORKS EXTENSION.

The Wolverhampton Corporation have extended their generating station and installed three-phase plant, which is primarily intended for the supply of power in bulk to large firms within the district. Wolverhampton is essentially a manufacturing area, and power supply on economic lines should greatly add to the prosperity of the town. The plant added consists of turbo-generators, and the order for the turbines was placed with Messrs. Willans and Robinson, of Rugby.

The two steam-turbines were ordered to the specification of Mr. C. E. C. Shawfield, M.I.M.E., the Corporation electrical engineer, and have been manufactured at the contractors' Rugby works. The machines are of 1,000 kw. capacity, running at a speed of 1,500 r.p.m., and will work with a normal steam pressure of 150lb., a superheat of about 100deg. F., and exhaust into a vacuum of 27½in. The turbines are of Messrs. Willans and Robinson's standard type, and are fitted with the Willans shrouded blading in a similar manner to some 200,000 h.p. of turbines already made at Rugby. The turbine exhausts direct into a surface condenser of Messrs. Willans and Robinson's manufacture, the condenser being supplied with brass tubes ⅝in. diameter, 18in. gauge, circulating water being drawn out of the canal which is adjacent to the electricity works. The circulating water is supplied to each condenser by means of an electrically-driven pump of the Rees-Roturbo self-regulating pattern. Each pump is capable of supplying 2,800 gallons of water per minute to the condenser. The advantage of this type of pump lies in the fact that it will regulate itself to variations in height of the water quantity without the difficulties usually met with in centrifugal pumps—that is to say, a decrease of head in the pump will not lead to an increase in the power required, as in the case of pumps of ordinary construction—but pumps of this type can be left to themselves to an extent which is quite impossible with the ordinary type of centrifugal pump. Each pump is coupled on a common bedplate to a Parker "C" type direct-current motor working at 460 volts. This motor is so arranged that all parts are easily accessible, and the top half of each motor can be lifted off, leaving the armature exposed without taking the shaft out of its bearings. Each surface condenser is supplied with a three-throw air-pump of the Edwards type, the air-pump being driven by means of Parker "C" motor through gearing, the motor pinion being of specially-prepared paper. The plant has been recently set to work, and we understand that the results obtained have been in every way up to the anticipation of the parties concerned.

The whole of the electrical plant was supplied by the Electric Construction Company, of Wolverhampton, and the drawings reproduced herewith show the details of the generators. The results obtained on trial and the careful mechanical construction, which is explained below, will convince any engineer that the Wolverhampton Corporation have consulted the best interests of the ratepayers by placing their order with the Electric Construction Company.

There are two three-phase alternators, each of 1,000 kw., three phase, 6,600 volts, 50 periods, 1,500 r.p.m., 85 power factor. The overload capacity of these alternators is 1,500 kw. for two hours. They are excited from motor-generators at 75 volts. The efficiency of these generators is exceptionally high, the figures guaranteed and obtained being at 50 per cent overload, 95 per cent.; at full load, 94 per cent.; at three-quarter full load, 92 per cent.; and at half-load, 89½ per cent.

The accompanying drawings (Fig. 2 and 3) show the construction of these machines, and we would draw especial attention to the design of the revolving parts, which are specially constructed to resist the high pressure due to centrifugal force. The rotor is of the cylindrical smooth-core type, with distributed windings in open slots. A special feature of the E.C.C. design is that the ordinary Continental practice of radial slots is not adopted, the slots being sunk parallel, as shown in the accompanying

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sectional drawing. One of the advantages of this method is that the former-wound coil can be placed directly in the parallel slots without disturbing the form of the coil. The winding in each slot is subdivided into two or three sections according to the depth of the slot, and each section is kept in position by phosphor-bronze wedges. The end connections of the field spool are secured by strong steel plates and phosphor-bronze keys, as shown in the drawing, and each element is thus supported individually. The field winding consists of flat strip wound on edge, and compressed after having been placed in position. The stator of the machine is protected by a strong cast-iron frame with air suction and delivery openings, cold air being drawn in at the base of the machine and discharged from chimney-shaped openings at the top. This scheme of ventilation ensures noiseless running. The armature winding does not present any special feature, except that the windings are held in position by strong brass brackets (two per coil) as shown in the drawing.

The Electric Construction Company also supplied the motor-generator, consisting of a synchronous motor and a continuous-current generator direct coupled and provided with two bearings only. The motor is designed for three-phase supply at 6,000/6,600 volts, 50 periods, and the generator to give a normal continuous output of 500 kw. 460/500 volts, the speed of the set being 600 r.p.m. The overload capacity is 25 per cent. for four hours and 50 per cent. for one hour. This set is started up from the direct-current side by means of a totally enclosed oil-type starting switch. The starting switch has slow-motion arrangement of the ratchet type, by means of which each section of the resistance is cut out by one stroke of the hand lever. The switch is fitted with a no-voltage release which will release the switch from any position during the starting-up operation or from the full on position. The high-tension switchgear in this station was manufactured by the Electric Construction Company at their Bushbury works. The arrangement and design of the switchboard is shown generally in Figs. 4 to 8. The gear consists of operating board (Fig. 4), which carries all instruments, operating levers, and low-tension switches. All high-tension apparatus and connections are mounted in moulded concrete cells (Fig. 5) placed against the wall behind the board. The cells are closed with expanded metal lock-up doors. The instruments for indicating and recording the high-tension circuits, which are mounted on the operating board, are all operated from the secondary side of transformers, which are fixed in the cells, and the whole arrangement is, therefore, such that in the ordinary working of the board the high-tension connections and apparatus are inaccessible to unauthorised persons, and absolutely safe to the operator.

The switchboard is arranged to control two generators and three feeders. There is also one section of the board which controls a combined generator and feeder, and another section controlling both a motor-generator and feeder. The synchronising and voltmeter panel complete the equipment. The contractors have provided for each generating circuit the following instruments: one indicating wattmeter for unbalanced loads, three ammeters, one three-pole reverse time-limit relay, one cable box, three current-reducing transformers, one three-pole isolating switch (in 'bus bars), one three-pole oil circuit breaker, one single-phase potential-reducing transformer and protecting fuses, one double-pole field-breaking switch and discharge resistance, one double-pole synchronising plug receptacle, one field circuit ammeter, and one main alternator field regulator. Each feeder circuit is provided with one integrating watt-hour meter for unbalanced loads, two current-reducing transformers for ditto, three ammeters, one three-pole overload time-limit relay, one pilot voltmeter (suitable for alternating current or direct current), one power-factor indicator for unbalanced loads, one set of plug sockets (so that the power factor of any phase can be observed), one three-pole oil circuit breaker, two three-pole isolating switches (one in 'bus bars, one in feeder), one set of static dischargers, three current-reducing transformers (for ammeters, power-factor indicator, and relays), and one cable box.

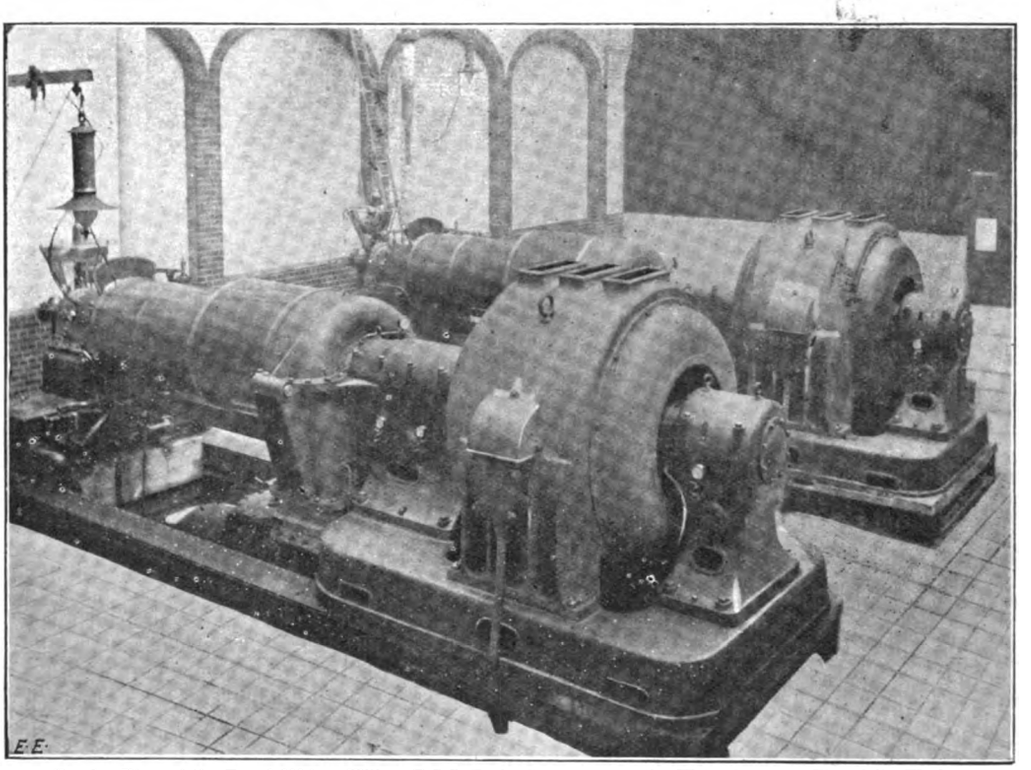

FIG. 1.—View of the Two 1,000-kw. Willans-H.C.C. Turbo-Generators at the Wolverhampton Electricity Works.

The combined generator and feeder circuit is provided with one indicating wattmeter for unbalanced loads, three ammeters, one three-pole reverse time-limit relay, one cable box, three current-reducing transformers, one three-pole oil circuit breaker, one single-phase potential-reducing transformer and protecting fuses, one double-pole field-breaking switch and discharge resistance, one double-pole synchronising plug receptacle, one field circuit ammeter, one main alternator field regulator, one integrating watt-hour meter for unbalanced loads, two current-reducing transformers for ditto, one power-factor indicator for unbalanced loads, one set of plug sockets (so that the power factor of any phase can be observed), two three-pole isolating switches (one in 'bus bars, one in feeder), and one set of static discharges.

The combined converter and feeder circuit is provided with three ammeters, one three-pole reverse time-limit

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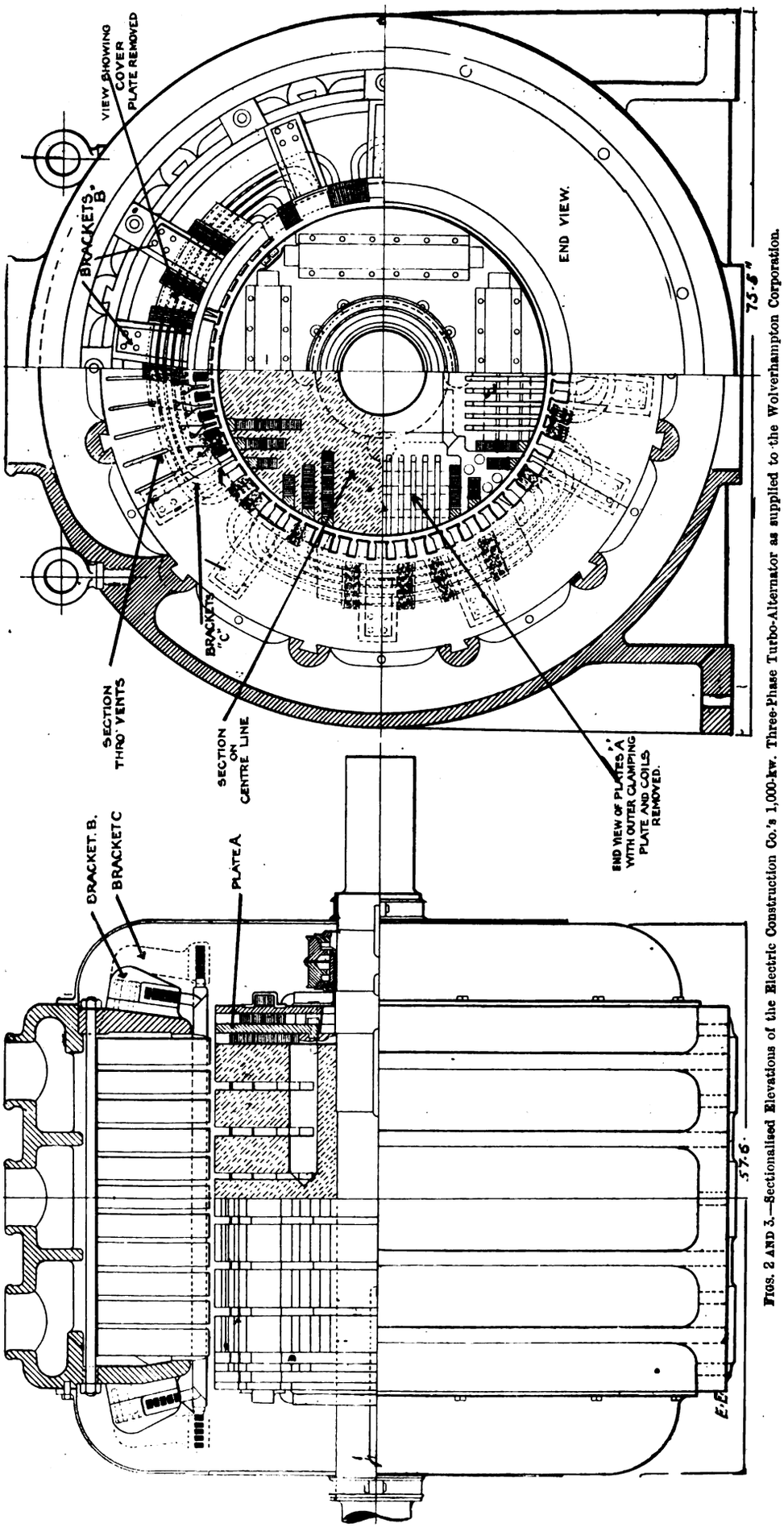
relay, one cable box, three current-reducing transformers, one three-pole oil circuit breaker, one single-phase potential-ammeter, one main alternator field regulator, one integrating watt-hour meter for unbalanced loads, two current-



FIGS. 2 AND 3.—Sectionalised Elevations of the Electric Construction Co.'s 1,000-kw. Three-Phase Turbo-Alternator as supplied to the Wolverhampton Corporation.

reducing transformer and protecting fuses, one double-pole field-breaking switch and discharge resistance, one double-pole synchronising plug receptacle, one field circuit reducing transformers for ditto, one pilot voltmeter (suitable for alternating current or direct current), one power-factor indicator for unbalanced loads, one set of plug

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sockets (so that the power factor of any phase can be observed), two three-pole isolating switches (one in 'bus bars, one in feeder), and one set of static dischargers.

On the synchronising and voltmeter panel there are one rotary synchroniser with synchronising lamp (mounted on swivel bracket), one lamp relay, two voltmeters mounted on swivel bracket, one three-phase high-tension ground detector with protecting fuses, one two-phase potential-reducing transformer with protecting fuses, and one isolating switch (in 'bus bars).

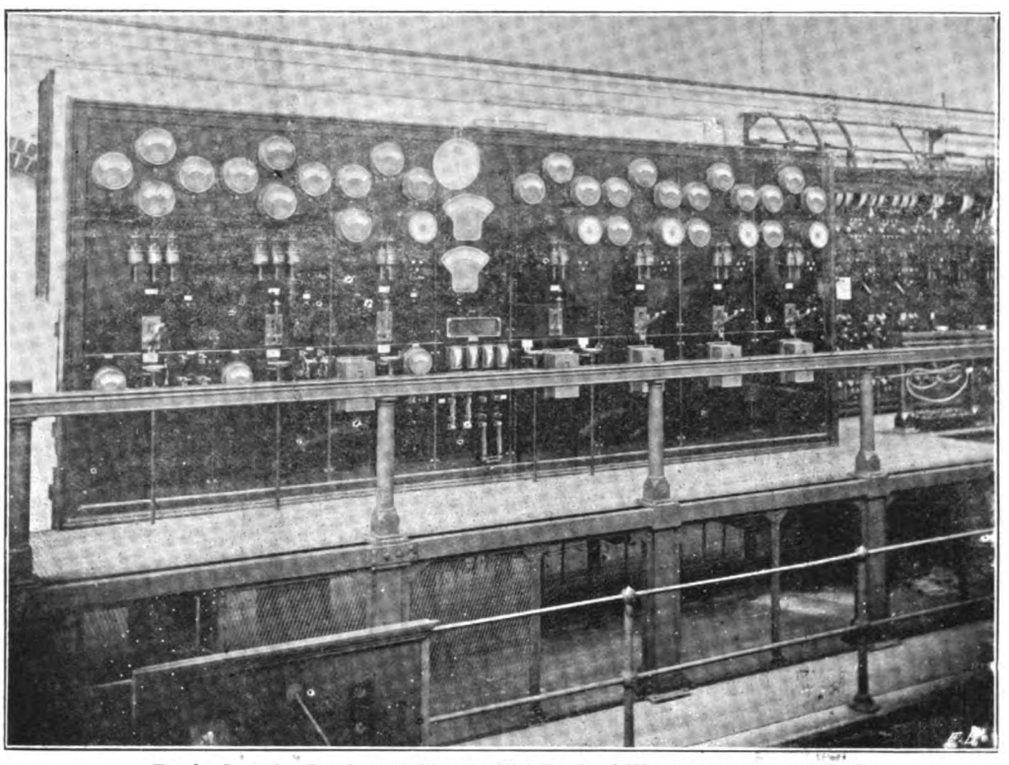

FIG. 4.—Operating Boards controlling the High-Tension 6,600-volt Generators and Feeders.

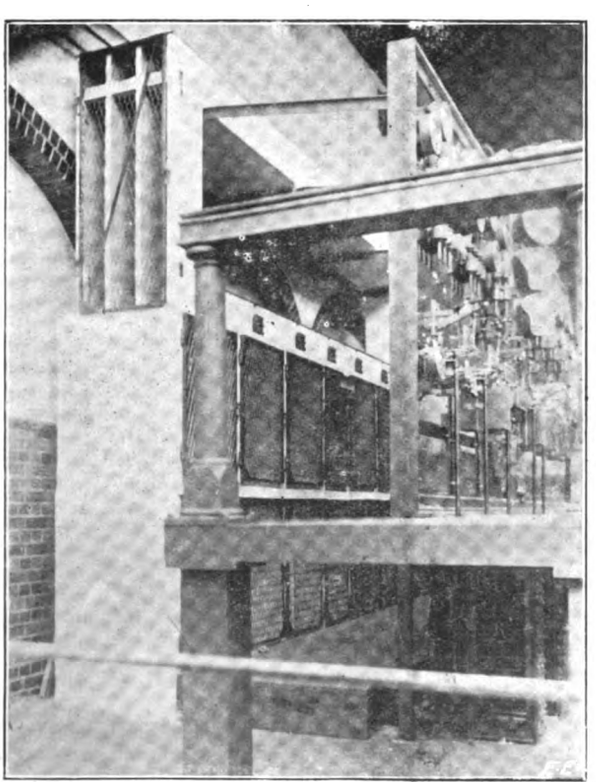

FIG. 5.—End view of the High-Tension Switchgear, showing Cellular Construction.

Coming now to the switchgear, the cells (Fig. 6) consist of moulded reinforced concrete, each cell forming an independent unit. Each cell is provided with two expanded metal lock-up doors. These doors are carried on hinges, but so arranged that they can be lifted off same. The expanded metal is of 1½in. by ½in. by ½in. mesh, No. 24 metal. The 'bus bars consist of ·5 square inch bare copper throughout the main and return portions. Each phase of the 'bus bars is totally enclosed in a separate concrete cell, and the arrangement is such that extensions could readily be made. Two exciter 'bus bars are provided on the three generator panels. These are mounted on porcelain insulators from the uprights of the operating board framework, and fixed below the platform level. The isolating switches are so arranged that the three poles are operated together, this being more convenient in the case of the 'bus bars than single-pole switches. It will be noted that the switches in the 'bus-bar circuits isolate the circuits in addition to fulfilling the function of dividing the 'bus bars. The isolating switches in the 'bus bars are equal in carrying

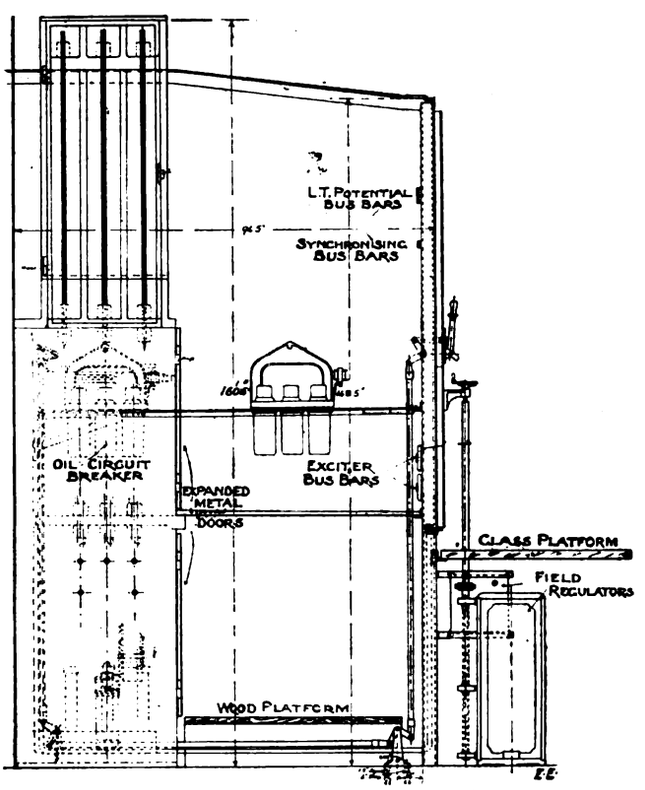

FIG. 6.—Cross Section of the Switchboard.

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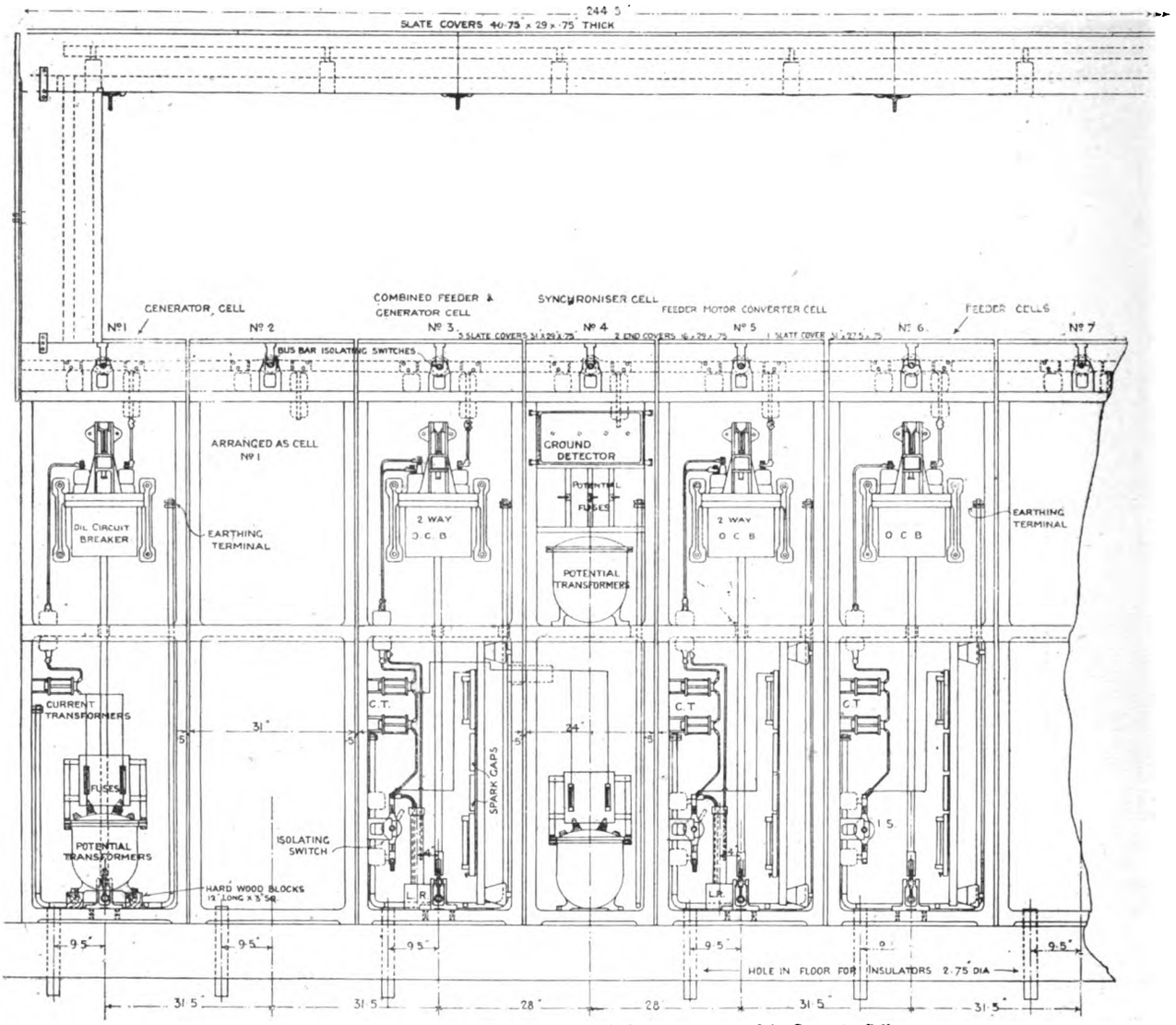

FIG. 7.—Front view of the High-Tension Switchgear as arranged in Concrete Cells.

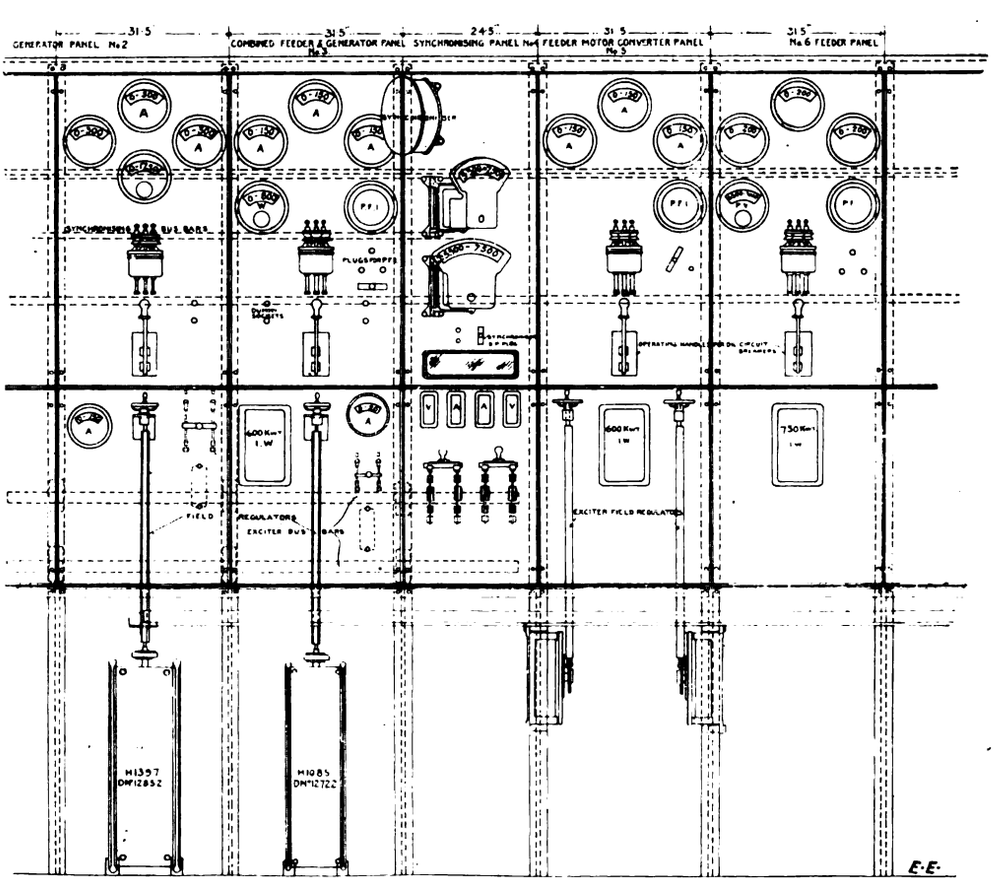

FIG. 8.—View of a Portion of the Front of the Control Board, showing the Arrangement of Instruments.

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capacity to ·5 square inch wrought copper, while those at the cable ends of the feeders are equal to carrying 200 amperes. These latter are of the same design as the 'bus-bar switches, and one key only is provided for all switches.

The circuit breakers are of the E C.C. standard 6,600-volt type, which has been tested and found capable of breaking easily up to 2,000 kw. at 10,000 volts. The circuit breakers are fitted with tripping coils wound for direct current. The arrangement of the operating lever is such that the switch cannot be held closed under an overload. Should the switch trip automatically the handle on the operating board immediately moves to the "off" position, thereby indicating that the circuit has opened. Each phase has a double break in a separate oil tank. A set of rails for supporting the circuit breakers when drawn out of the cell is provided. Both the reverse and the overload time-limit relays are of the British Thomson-Houston Company's standard type.

All instruments, other than relays, included in the Electric Construction Company's tender are by one maker—viz., Messrs. Everett, Edgcumbe, and Co. The two main voltmeters are of their "Sector" pattern with scales 12in. long. The alternating-current indicating instruments and the pilot lamps are of their round pattern with 8in. dials. The field ammeters have 6in. dials. All the above instruments have cast-iron cases, black enamelled, and with nickelled facings. The rotary synchroniser is of their standard switchboard type (Model No. 2) without coloured signals. It is fitted with a synchronising lamp on top. The ground detector is of electrostatic type connected direct to the high-tension 'bus bars. This is mounted in the cellwork, and a glass pane is provided on the operating panel so that it could be observed from the front of the board. The potential transformers are of the E.C.C. standard type for this voltage, and contained in cast-iron cases filled with suitable oil.

It will be noted that one single-phase transformer has been provided in each generator circuit and a two-phase transformer in the synchronising cell, this latter to furnish all current to the potential circuits of all indicating wattmeters, integrating wattmeters, power-factor indicators, and one side of the synchroniser. The current transformers are of the E.C.C. standard open type.

The framing is constructed as shown in Fig. 6, and consists of 6in. by 3in. channel base and 3in. by 3in. vertical H-section joists. A 3in. by 3in. angle is provided for carrying the platform in front of the switchboard, also horizontal angles at the back for carrying the portable platform and the rails for removing the oil switches, and polished teak moulding top and bottom to match the existing low-tension board. The panels consist of paraffined slate 1½in. thick, the height of the panels being the same as the existing low-tension panels. The ammeter switches, field break switches, and synchronising plugs are of the contractors' standard types. The high-tension fuses for breaking the potential circuits are of glass tube dust type, held in clip contacts. All high-tension connections between the 'bus bars and the cable boxes are of hard-drawn, high-conductivity copper rod. The low-tension connections between the transformers in cells and the instruments on the operating board are of fireproofed insulated cable, run in Simplex tubes. The static dischargers are of the British Thomson-Houston Company's standard 7,500-volt type.

The following switchgear and instruments for two exciters are mounted on the lower portion of the synchronising panel: two 6in. dial voltmeters, two 6in. dial ammeters, two double-pole quick-break main switches, four fuses, and two field regulators for the shunt circuits.

This new section of the Wolverhampton Electricity Works was formally opened by the Mayor on Monday last.

ELECTRICITY IN FACTORIES AND WORKSHOPS.

Inquiry into Home Office Draft Regulations.

Mr. James Swinburne reopened the inquiry into the draft regulations proposed by the Home Office for the generation, transformation, distribution, and use of electrical energy in premises under the Factory and Workshop Act, 1901, on Monday morning in Caxton Hall, Westminster.

At the outset Mr. VESEY KNOX, K.C., on behalf of the Mersey Docks and Harbour Board, submitted that exemption (*d*), which had been amended to apply to railway purposes, should be extended so as to apply also to docks having statutory powers. He mentioned that, as a matter of law, dock premises did not come within the definition of factory, and were expressly excluded from the regulations of the Factory and Workshops Act, 1901.

Mr. DOWNING, on behalf of the Barry Railway Company, concurred with the foregoing proposal.

Mr. J. H. GRAY could not say at the moment whether the proposal of the Mersey Docks and Harbour Board would be agreed to, and promised to consult his advisers on the matter.

Mr. A. P. TROTTER, chief electrical inspector to the Board of Trade, was thereupon called by the Home Office to make a statement on the question of overlapping of the two departments. He stated that he was authorised by the Board of Trade to suggest one or two amendments to the Board of Trade regulations, which would have the effect of obviating overlapping. He suggested adding to the Board of Trade Regulation 1(*a*), which relates to pressure supply for power purposes, the following:

> "Provided that this regulation shall not apply to the supply of energy to any factory or workshop or mine."

It was also proposed, he said, to repeal Regulation 3 (Board of Trade), which relates to extra high-pressure supply to consumers' premises, and to substitute the following:

> "An extra high-pressure supply shall not be given to any consumer's premises other than a factory, mine, or electric traction works. Where the consumer's premises are electric traction works the supply shall only be given with the consent of the Board of Trade, and shall be subject to such regulations as the Board of Trade might prescribe."

Mr. Trotter thought that these modifications would practically obviate any overlapping between the two sets of rules.

Mr. Vesey Knox drew Mr. Trotter's attention to Regulation 6 of the Board of Trade rules, which provides for the maintenance of insulation so as to prevent leakage, and he submitted that it clashed with Regulation 2 of the Home Office rules. Mr. Trotter, however, did not think that this was so. He pointed out that a certain point at which the jurisdiction of the Home Office and the Board of Trade met was the consumer's terminals. Counsel urged that there would be conflict on the question of stations and sub-stations, and Mr. Trotter admitted that he had considered the question mainly on the factory side. It would be necessary to exclude from the Board of Trade regulations ordinary generating stations. The Board of Trade regulations applied mainly to the distributing mains in the streets and to the safety of the public. He was next questioned on the Board of Trade regulations as to the construction and ventilation of sub-stations, and it was pointed out to him that the Home Office and the Board of Trade would have power to make whatever regulations they required, both sets of which would be enforceable by penalty. He replied that an undertaker would have to obey the strictest code, but he did not think that the two sets of rules would ever come into conflict. Mr. Trotter told Mr. Knox that the Board of Trade regulations had been altered from time to time as experience had been gained.

Mr. GUTTERIDGE, who appeared for the London County Council, wanted to know if a station in which extra-high pressure was generated for the sole purpose of supplying power for tramways would be subject to the two sets of rules, and was informed that it would, assuming it was a factory.

Mr. PRITCHETT, for the Incorporated Municipal Electrical Association, questioned Mr. Trotter as to the definition of low pressure. He said that if the declared pressure at the consumer's terminals was 250 volts, the supply at the station end would probably be about 260 volts, and he asked whether such a supply would come within the meaning of the Board of Trade regulations.

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Mr. TROTTER thought the case would present no practical difficulties. Under the Home Office regulations the supply would be a medium pressure supply, but he could not say that it would be a low-pressure supply under the Board of Trade regulations; it might be medium pressure at the generating works. He informed Mr. Gutteridge that a Board of Trade inspection might be for the purpose of ensuring continuity of supply. In Section 8 of these they asked that every high-pressure main, conductor, or other apparatus should be protected by a suitable fuse or automatic circuit breaker. This need not necessarily clash with the Home Office requirements, for they might merely ask for further details of the apparatus. In answer to Mr. Morse, he said it was not their intention to hand over to the Home Office the authorisation of extra high-pressure systems, and if the effect of his proposed amendment to the regulations would mean that, he would be pleased to consider an alternative proposal. After some questions as to the size of transformer boxes, which were aimed at showing that the size to which these boxes were limited as a result of a recent legal action would not comply with the Home Office regulations, and which were ruled out of order by Mr. Swinburne, the latter thanked Mr. Trotter for his evidence.

Returning now to Rule 12, Mr. GRAY stated that at a previous sitting it was said that there were no no-volt release apparatus suitable for alternating-current motors being made in this country, and he proposed to call evidence refuting this statement.

Mr. EDMUND GARSIDE, managing director of Engineering Instruments, Limited, said his firm had been making alternating-current no-volt release circuit breakers for many years. The smallest size standardised was 50 h.p. The difference in the price of a plain hand switch and a switch with no-volt release was about £5. All the no-volt apparatus supplied by his firm were used on motor circuits, mostly in coal mines, and some in factories. His company made only the completely enclosed type, which was the only type for which there had been any demand. He was asked by Mr. Gray how the prices of apparatus would work out for motors of sizes less than 50 h.p., and replied that for motors ranging from 1 h.p. to 3 h.p. he estimated that a switch with no-volt release could be made for £2 more than a plain hand switch. His company had supplied no-volt release switches for alternating-current motors ranging from 50 h.p. to 200 h.p. during the past three years, and had had repeat orders from some customers. He stated that no-volt releases were made by other makers. Answering Mr. Vesey Knox, he said that the price of a plain hand switch, enclosed, for a 50-h p. motor made by his company was £3, and for a switch with no-volt release, complete in cast-iron case and interlocked, his price was £8 to £9. During the past three years his company had sold these switches for motors aggregating 2,000 h.p. The number of switches supplied was 44, of which 26 were for three-phase motors, a good many being for the Tyneside district. Pressed for the names of the firms on Tyneside to whom these had been supplied and where they could be seen in use, Mr. Garside said he supplied them particularly to electrical contractors and manufacturers, and the only name mentioned was that of Messrs. Ernest Scott and Mountain, who, it was pointed out, were manufacturers of electrical plant, and might have obtained the apparatus for experimental purposes. Counsel claimed that on Mr. Garside's own showing the use of no-volt apparatus was treble that of a plain switch, and in the case of a small motor particularly would amount to a serious item. Questioned by Mr. A. B. Caine, Mr. Garside said that he had sold some of this apparatus in London, and the only customer named was the Union Electric Company, Limited. He could not say approximately how many he had supplied to this company, but it would hardly be more than four. Nor could he tell off-hand any place in London where the apparatus was to be seen working. Counsel submitted that as the motors decreased in size the relative cost of these switches increased. Mr. Garside said that the no-volt releases for small motors were listed by other manufacturers. In reply to Mr. Morse, he said he had not seen his apparatus in use in a factory.

Mr. KNOX then raised the question of the future course of the inquiry, and asked that before coming to counsels' speeches the Home Office should hold a conference to consider the points raised by the objectors, and to reprint the regulations in their amended form. Mr. GRAY thought the proposals reasonable, and promised to consider them.

Mr. GRAY thereupon submitted the following in substitution of the second paragraph of Rule 12 of the draft regulations:

> "Where necessary to prevent danger through the automatic restarting of a motor, every electrical motor, or group of electrical motors, shall be protected by a release which will automatically break the circuit if the current is interrupted, such release being suitably placed and arranged in view of the danger to be prevented."

He explained that "in view of" means with regard to the danger, etc.

Mr. Ram was about to be called for cross-examination upon Rule 13, when it was suggested by several of the parties that this should be deferred a while so that the objectors could consult among themselves as to the course and appoint a small committee to meet a deputation of the Home Office with a view to endeavouring to find a means for disposing of some of the objections to the remaining rules. Both Mr. Swinburne and Mr. Gray agreed to this course, Mr. Swinburne pointing out that any of the objectors who did not acquiesce to any arrangement arrived at would be at liberty to cross-examine the witness in the ordinary way. After a little further consideration, it was announced that the following gentlemen had been chosen to represent four groups on the committee: Mr. C. H. Merz, for the power companies; Mr. C. P. Sparks and Mr. Frank Bailey, for the London electric lighting companies; Mr. Cozens-Hardy, for the users; Mr. Siller, for the London Chamber of Commerce; Mr. W. W. Lackie, Mr. H. Talbot, and Mr. H. Faraday Proctor, for the Incorporated Municipal Electrical Association; and Mr. Thomas Rolls, for the Bradford Corporation.

At Tuesday's sitting Mr. GRAY stated that the committee appointed on the previous day had succeeded in coming to an arrangement with regard to a number of the regulations, and it was agreed to adjourn the inquiry until the following day to enable the committee in the meantime to continue their consideration of the regulations. Subjoined is a list of the amended regulations which the objectors represented on the committee have agreed to accept, and which the Home Office advisers are prepared to recommend for adoption. As amended:

Regulation 1 will read: "All apparatus and conductors shall be sufficient in size and power for the work they are called upon to do, and so constructed, installed, protected, worked, and maintained as to prevent danger so far as is reasonably practicable."

Regulation 2 will read: "All cables shall either be covered with insulating material, and further efficiently protected where necessary, or shall be so placed and safeguarded as to prevent danger so far as is reasonably practicable."

Regulation 3 will read: "Every switch, circuit breaker, and isolating link shall be (*a*) so constructed, placed, or protected as to prevent danger; (*b*) so constructed and adjusted as accurately to make and to maintain good contact; (*c*) provided with an efficient handle or other means of working, insulated from the system, and so arranged that the hand cannot inadvertently touch live metal; (*d*) so constructed or arranged that it cannot accidently fall or move into contact when left out of contact."

Regulation 4 (paragraph 1) will read: "Every switch intended to be used for breaking a circuit and every circuit breaker shall be so constructed that it cannot be inadvertently left in partial contact."

Regulation 4 (paragraph 2) will read: "Every switch intended to be used for breaking a circuit and every circuit breaker shall be so constructed that an arc cannot accidentally be maintained."

Regulation 5 will read: "Every fuse and automatic circuit breaker used instead thereof shall be so constructed and arranged as effectively to interrupt the current before it so exceeds the working rate as to involve danger. It shall be of such construction or be so guarded or placed as to prevent danger from overheating, or from arcing or the scattering of hot metal or other substance when it comes into operation. Every fuse shall be either of such construction or so protected by a switch that the fusible metal may be readily renewed without danger."

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Regulation 6 will read as follows: "Every electrical joint and connection shall be of proper construction as regards conductivity, insulation, mechanical strength, and protection." (No change was made in this regulation.)

Regulation 7 will be: "Efficient means, suitably located, shall be provided for cutting off all pressure from every part of a system as may be necessary to prevent danger."

Regulation 8, subject to discussion on Regulation 13, shall be altered to read as follows: "Efficient means, suitably located, shall be provided for protecting from excess of current every part of a system as may be necessary to prevent danger."

Regulation 9 to be altered to read as follows: "Where a conductor of a system is connected to earth, no single-pole switch other than a link for testing purposes or a switch for use in controlling a generator shall be placed in such conductor or any branch thereof."

Regulation 10 to be altered to read: "Where one of the main conductors of a system is bare and uninsulated, such as a bare return of a concentric system, no switch, fuse, or circuit breaker shall be placed in that conductor, or in any conductor connected thereto, and the said conductor shall be earthed."

Regulation 11 to read as follows: "Every motor, converter, and transformer shall be protected by efficient means, suitably placed, and so connected that all pressure may thereby be cut off therefrom and from any apparatus in connection therewith, provided, however, that where one point of the system is connected to earth, there shall be no obligation to disconnect on that side of the system which is connected to earth."

When the inquiry was opened on Wednesday morning it was announced that an agreement had been arrived at in respect of the following resolutions:

Regulation 12—Paragraph 1, which was agreed to without alteration, reads as follows: "Every electrical motor shall be controlled by an efficient switch or switches for starting and stopping, so placed as to be easily worked by the person in charge of the motor." It was proposed and agreed that a new paragraph should be inserted in place of the second paragraph: "To prevent danger through the automatic restarting of a motor every electrical motor or group of electrical motors shall be protected by a release which will automatically break the circuit if the current is interrupted, such release being suitably placed with regard to the danger to be prevented. Provided that no release shall be required for any motor which has an attendant constantly at the controller of such motor while at work." Paragraph 3 as altered will read as follows: "In every place in which machinery is being driven by any electric motor, there shall be means at hand for either switching off the motor or stopping the machinery."

Regulation 13 was agreed to, and as altered will read: "Every flexible wire for portable apparatus shall be connected in a system either by efficient permanent joints or connections or by a properly constructed connector. Adequate precautions shall be taken against shock due to leakage or other cause in all places where the person handling the portable apparatus is not insulated from earth. In such places and in any place where the pressure exceeds low pressure, the portable apparatus and its flexible wire shall be controlled by sufficient means suitably located, and capable of cutting off the pressure."

Regulation 14 as altered will read as follows: "The general rrangement of switchboards shall, so far as reasonably practicable, be such that (*a*) all parts which may have to be adjusted or handled are readily accessible; (*b*) the course of every conductor may where necessary be readily traced; (*c*) conductors connected to different systems are kept well apart and can when necessary be readily distinguished; (*d*) all bare conductors are so placed or protected as to prevent danger from accidental short-circuit."

Regulation 15 as altered will read as follows: "Every switchboard having bare conductors normally so exposed that they may be touched shall be located in an area or areas set apart for the purposes thereof, or where necessary suitably fenced or enclosed. No person except an authorised person, or a person acting under his immediate supervision, shall for the purpose of carrying out his duties have access to any part of such area."

Regulation 16 now reads: "All apparatus appertaining to a switchboard and requiring handling shall, so far as practicable, be so placed or arranged as to be operated from the working platform of the switchboard, and all measuring instruments and indicators connected therewith shall, so far as practicable, be so placed as to be observed from the working platform. If such apparatus be worked or observed from any other place, adequate precautions shall be taken to prevent danger."

Regulations 17 and 18 were postponed for later consideration.

Regulation 19 as altered will read as follows: "All parts of generators, motors, transformers, or other similar apparatus, at high pressure or extra high pressure, and within reach from any position in which any person employed may require to be, shall be, so far as reasonably practicable, so protected as to prevent danger."

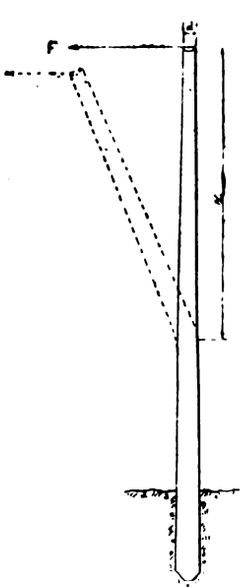
Regulation 20 now reads: "Where a high-pressure or extra high-pressure supply is transformed for use at a lower pressure, suitable provision shall be made to guard against danger by reason of the lower pressure system becoming accidentally charged above its normal pressure by leakage or contact from the higher pressure system."

Mr. SWINBURNE stated that when the committee had finished their work the inquiry would be resumed for hearing any evidence, if necessary, then counsel would deliver their speeches on the general points.

At this stage the inquiry was adjourned until Tuesday, March 24, when it will be held at the Surveyors' Institution, 12, Great George-street, Westminster, at 10.30 a.m.

WHY WOODEN POLES BREAK ABOVE GROUND.

It is a matter of observation that most tall wooden poles of, say, 40ft. and over in length, when blown over by storm, will break a considerable distance above ground, writes Mr. Clinton B. Smith in the *Electrical World*. This fact would lead one to think that the weakest section is not at the ground level, but at some higher point on the pole. The following investigation shows that a pole of uniform taper and free from knots and other local weaknesses is weakest at a definite distance from the top, this distance being independent of the pole length. This distance is $x = d \div 2\,t$, in which all distances are in inches, and in which d = diameter of pole top; t = taper of pole, or increase in diameter in inches per inch of length; F = horizontal stress due to wires on cross-arm. The pole is weakest where the fibre stress is greatest.



Therefore, in order to find the weakest point, it is necessary merely to locate maximum fibre stress for any value of F. At any section along the pole at a distance x from the top,

$$F\,x = \frac{I f}{c}$$

$$= \cdot 098\, d_x^3\, f \text{ (for round section)},$$

where I = moment of inertia of section;
f = stress in outer fibre;
d_x = diameter of pole at distance x from top;

But $$d_x = d + t\,x.$$

Therefore, $$f = \frac{F}{\cdot 098} \frac{x}{(d + t\,x)^3}.$$

It will be observed upon differentiating that f reaches its maximum value when $x = d \div 2\,t$. This is the critical value of x corresponding to the maximum value of f, the fibre stress; the pole, if free from local weaknesses, will break at this distance from the top. Taking the case of an Idaho cedar pole having a top diameter of 8in. and an average taper of ·01in. per inch,

$$d = 8,$$

$$t = \cdot 01;$$

whence $$x = d \div 2\,t = 400\text{in}.$$

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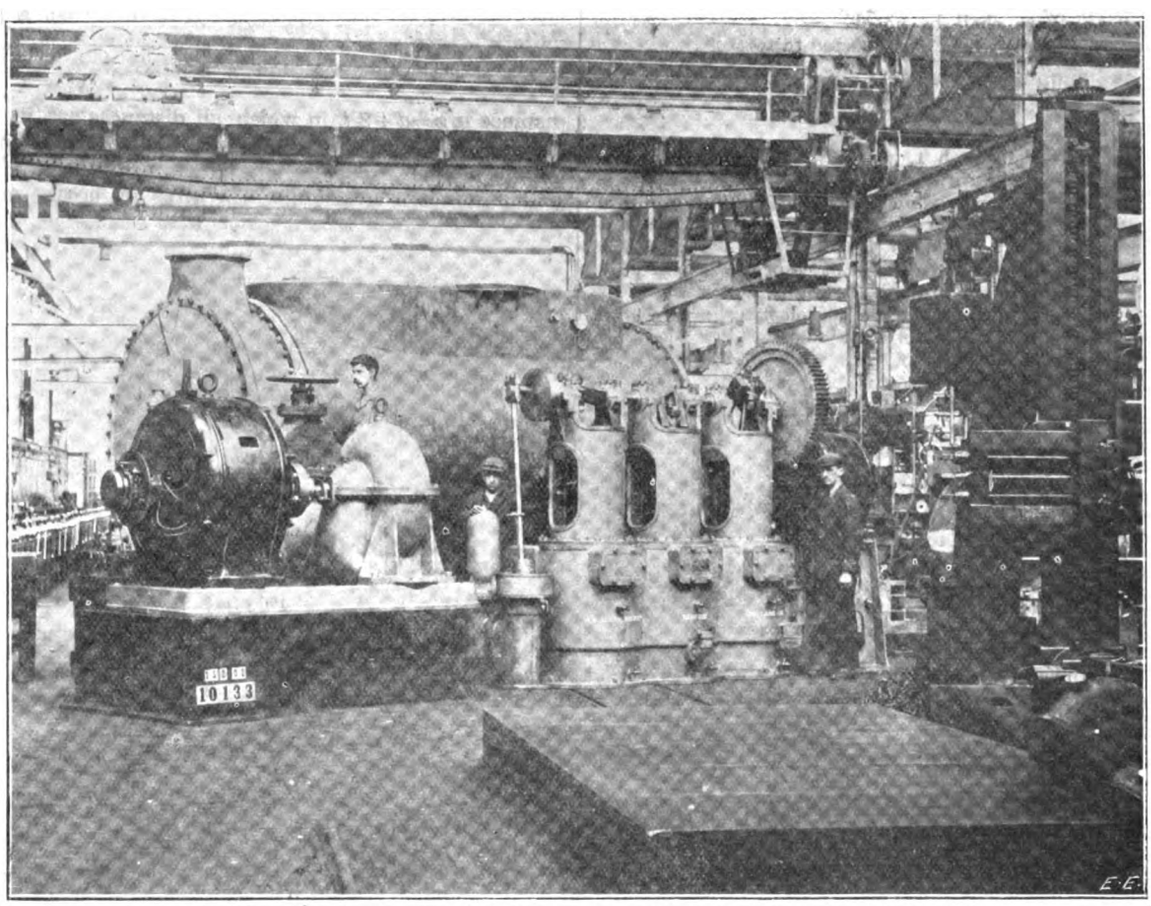
Hence the pole will break 33ft. 4in. from top, no matter how long the pole may be, provided the pole has at least this length above ground. A pole shorter than this length above ground will break at the ground.

CONDENSING PLANT.

The accompanying photograph, taken in the makers' works, is of a large condensing equipment, which is one of a set of five complete equipments which have been recently designed and constructed by Messrs. W. H. Allen, Son, and Co., Limited, Queen's Engineering Works, Bedford. The five sets are all constructed exactly to the same drawings, and each is capable of dealing with 66,000lb. of exhaust steam per hour, and of maintaining a vacuum within 2in. of the barometric pressure when supplied with circulating water at a temperature of 70deg. F. A large and almost unequalled experience in this class of apparatus, which extends over a great many years and in all parts of the world, together with the expert knowledge obtained through years of careful experimental work carried out by their own staff at Bedford, places Messrs. Allen in the very fortunate position of being able to decide the correct proportions of the various parts of a condensing equipment with the greatest possible accuracy, so that the transfer of heat from the exhaust steam to the circulating water may be carried out in the most expeditious manner possible, and with a minimum expenditure of power.



One of Five Condensing Plants made by Messrs. W. H. Allen and Co Each plant will deal with 66,000lbs. of exhaust steam per hour.

As regards the details of the very large plant which we illustrate, in the first place it has been designed to deal with the exhaust from a steam-turbine, and this has necessitated the employment of a very large steam opening in the top of the condenser body. The latter is of cylindrical form, and of cast iron, and of ample stiffness—extra stress being placed in the casing where necessary. The tube plates are of rolled brass, and are carefully stayed. The tubes are of solid-drawn brass, the total surface being 10,000 square feet. The circulating water enters the lower part of the condenser through the water-box which is situated at one end and circulates from end to end of the same water-box. The supply of cooling water is effected by one of Messrs. Allen's well-known "Conqueror" centrifugal pumps, having suction and discharge branches 20in. in diameter, and capable of supplying 66,000 gallons of water per hour against a total head of 20ft. The pump casing is of cast iron, and the impeller of gunmetal, the spindle being of forged naval bronze. It is direct driven by means of a three-phase motor of 67 b.h.p. running at 410 r.p.m., and receiving current at 220 volts and 60 periods.

The air-pump is of the three-throw "Allen-Edwards" type, and is of Messrs. Allen's very latest and improved design. The three barrels are exactly similar, having a diameter of 18in., the plunger having a stroke of 14in., the crankshaft making 135 r.p.m. This is driven by means of a three-phase motor of 19 b.h.p. running at 575 r.p.m., and receiving current at 220 volts 60 periods. The air-pump delivers the condensed steam into a surge tank situated in the lower part of the air-pump casing, and at the near end of the pump, shown in the photograph. This water is withdrawn by means of a single-acting force pump having a plunger 17in. in diameter, the stroke being 10in., and capable of delivering against a head of 10ft. The arrangement of this pump is well shown in the photograph, the drive being effected from an outside disc crank on the end of the air-pump crankshaft. The crankshaft and motion work of the air-pumps are of the best open-hearth mild steel, the bearings being lined throughout with white metal, with the exception of the cross-head bearings, which are of gunmetal. The lubrication, as will be seen in the photograph, is effected by means of "Stauffer" spring grease cups. The cross-head guides are cylindrical, and bored at one setting with the facing of the trunk in which they are fixed, thus ensuring a perfect alignment. The air-pump buckets are of cast iron, and are fitted with a solid gunmetal ring; the air-pump barrel is also of solid gunmetal, as well as the valve plate, the valves being of the "Kinghorn" metallic type, resting on accurately-faced seatings

The force pump is also fitted with gunmetal plunger and

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liners; the air-pump casing is fitted with the usual accessories in the way of shifting valves, drain cocks, and relief valve, all of which may be seen in the front of the casing in the photograph. A large sluice valve is also provided on the discharge side of the circulating pump, in accordance with the specification for the plant. Careful examination of the photograph will convince of the admirable way in which the arrangement of the plant has been carried out so that easy accessibility of all the working parts is ensured.

The water-box covers on the condenser are also easily removable for cleaning the tubes, and are provided with small inspection covers which permit of easy access to the interior of the water-boxes for inspection only.

INCREASE OF BOILER CAPACITY AT HAMMERSMITH ELECTRICITY WORKS.

The tenders submitted for the supply of two boilers to the electricity works of the Hammersmith Borough Council, when analysed, show some interesting figures as to relative output in steam per hour of the boilers of various makers.

The manufacturers were invited to submit schemes and tenders based upon utilising the space to the best advantage. There were two spaces available, one at each end of the existing battery of boilers. Alternative prices were asked for a boiler to fit in the smaller space "B" (part of space "C"), but the output of a boiler to occupy this space was so small that it would be uneconomical to install such a boiler, and the borough electrical engineer did not recommend the acceptance of any tender for same. Only the proposals for utilising spaces "A" and "C" were considered, and the results appear in the following schedule:

1.—Scheme A.

	Grate area.	Heat surface	Output.	Lbs. per sq. ft. heat surface.	Price.	Per 1,000 lbs.
Stirling Boiler Company	67·5	4,890	18,100	3·7	£1,439	£80
Babcock and Wilcox	67·5	4,226	15,800	3·7	1.285	81
Clarke, Chapman, and Co.	60	2 970	12,000	- -	1,173	99
Davey, Paxman, and Co.	36	1,316	7,279	5·9	580	80

2.—Scheme C.

	Grate area.	Heat surface	Output.	Lbs. per sq. ft. heat surface.	Price.	Per 1,000 lbs.
Stirling Boiler Company	86·25	6,203	22 910	3·6	£1,671	£76
Babcock and Wilcox	84	5 346	20,000	3·7	1,450	72
Clarke, Chapman, and Co.	83	4,125	16,500	3·9	1 504	94
Davey, Paxman, and Co.	48·5	2,200	11,840	5·3	1,200	109

3.—Increased Output with Hot Air.

	Scheme A			Scheme C		
	Output.	Lbs. per sq. ft. heat surface.	Price per 1,000 lbs.	Output.	Lbs. per sq. ft. heat surface.	Price per 1,000 lbs.
Stirling Boiler Company	25,428	5 2	£56	32,255	5·2	£54
Babcock and Wilcox	21,975	5·2	58	27,799	5·2	52
Clarke, Chapman, and Co.	15,500	5·2	75	214,500	5·2	70
Davey, Paxman, and Co.	10,528	8	55	17,600	8	68

It will be seen that the output results are in some cases extremely good. The relative figures of merit were obtained taking the capital cost per 1,000lb. of steam per hour, and are shown in the last columns of Tables 1 and 2, "C." The expected output of these boilers when fitted with hot-air supply is shown in Table 3 It was found that the Davey-Paxman boiler would not, in this case, make the most economical use of the space occupied, and the Electricity Committee have recommended that the tender of Messrs. Babcock and Wilcox in the sum of £1,285 be accepted for scheme A and the tender of the Stirling Boiler Company in the sum of £1,671 be accepted for scheme C.

ELECTRIC INCANDESCENT LAMPS.

A meeting of the London section of the Electrical Contractors' Association was held on Thursday, March 12, at the Restaurant Frascati, Oxford-street, W., when Mr. Leon Gaster, M.I.E.E., delivered an instructive address on carbon and metallic filament lamps. Mr. C. L. Troup, chairman of the London section, presided.

Mr. Gaster prefaced his address with some interesting historical data respecting electric lamps. He said the first question that one would naturally ask was, "What is the advantage of the metallic-filament lamp to the trade?" The supersession of the carbon-filament lamp was due to a variety of causes, chief among which were its failure to withstand variation in pressure and lack of standardisation. An improvement had recently been made in this type of lamp by graphitising the carbon filament, which had succeeded in reducing the wattage consumption to 2½ watts, but even this result was not good enough.

Dealing with metallic-filament lamps, he said these were the results of the greatest investigators who had conducted their work in the best scientific laboratories. The tantalum lamp was a great achievement, in spite of the drawbacks when it was used on high voltages, but he thought a solution to the problem of burning tantalum lamps on alternating-current circuits had yet to be made. It had been explained that the frequency under which the current worked had a detrimental effect upon the lamp, and the higher the frequency the worse the effect upon the lamp. Referring to the new 16-c.p. 110-volt tantalum lamp consuming 1·7 watts per candle, he said this was a tremendous advantage, the more so if the lamp could be used on direct current as well as on alternating current.

The Osram lamp was a marked difference from previous practice, and Mr. Gaster spoke at some length upon the advantages and disadvantages of this lamp. One of the reasons he thought for commencing with the higher-voltage lamps and coming down gradually, as they were now doing, was to reconcile the public and the central station, and to avoid a sudden drop in the consumption by the too wide application of these lamps to the disadvantage of shareholders in electric lighting undertakings.

Mr. Gaster next dealt with the question of house transformers for transforming the current received from the mains, and explained how they had enabled the difficulties with regard to low-voltage current required to be overcome. He also alluded to the question of blackening of the metallic-filament lamps. This was a serious drawback, and he said there was no need for this phenomenon. This question of breakage of the lamps, either in packing or in transit, was also one which required the attention of manufacturers. Among the lamps shown by Mr. Gaster was a 35-c.p. "Z" metallic-filament lamp, which showed great promise. This lamp was of French origin; its filament was drawn from tungsten and was electrically welded. The filaments were held in loops, so that the lamp could be made to burn in any angle. The current consumption was stated to be one watt per candle.

Mr. Gaster concluded his address with some very useful remarks as to the sale of metallic-filament lamps by contractors. Before deciding to install them, he urged them to consider whether the conditions in each case warranted the use of metallic-filament lamps. Price was a direct function of the price of the current, and if current was at 2d. per unit they might be certain that carbon lamps would do just as well. Such extraordinary progress was now being made with these new lamps that he had little doubt but that in a short time they would materially assist in the development of the lighting industry. Contractors should advise people when to use the lamps and how best to use them, instead of selling them indiscriminately. Further, they should try to avoid having two voltages in one place.

There was a general discussion after the address, in which the speakers included the Chairman, Mr. Rawlings, Mr. A. Rashleigh Phipps, Mr. Berry, and Mr. Broadbent, and others. Stress was laid on the importance of avoiding various voltages, and on the necessity of taking means to obviate breakage and blackening of metallic-filament lamps. On the question of over-running and under-running, more than one speaker said that he was satisfied from his experience that it was an advantage to under-run, and it was recommended that 100-volt lamps be burned on 105-volt circuits. The provision of 220/240-volt 16-c.p. metallic-filament lamps, it was thought, would give an impetus to the trade. It was also pointed out that in wiring a low-voltage job for metallic-filament lamps the area of wiring should be increased.

The meeting terminated with a vote of thanks to Mr. Gaster.

ELECTRICITY AND TRAMWAY BILLS.

The Board of Trade's report on the Bills and provisional orders relating to railways, canals, tramways, harbours, and tidal waters, and the supply of electricity, gas, and water introduced into Parliament during the present session, has just been issued. In all, 98 Bills have been presented, compared with

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101 in the session of 1907; the total amount of money proposed to be raised is £16,674,719, as compared with £42,380,282, a decrease of £25,705,563.

There are seven Bills relating to the supply of electrical energy, the proposed capital stated amounting to a total of £7,600,000. Procedure for powers for the supply of electrical energy is usually by provisional order under the Electric Lighting Acts, but in the majority of these Bills the powers sought are beyond the scope of those Acts. There are, of course, the three Bills relating to the supply of electricity in London—*i.e.*, the London and District Electricity Supply with a proposed capital of £6,000,000, the London Electric Supply (Companies) with a capital of £1,000,000, and the London (Westminster and Kensington) Electric Supply Companies. The Dublin and Central Ireland Electric Power, with a proposed capital of £600,000, is seeking to incorporate a company to supply electrical energy to authorised undertakers and to persons for power purposes within the county of Dublin, Kildare, etc. The Finchley Urban District Council Bill seeks to extend the area within which the Council is authorised to supply electrical energy by including parts of the urban district of Friern Barnet. The Great Eastern Railway (General Powers) Bill seeks to authorise the company to give a supply of electrical energy to any of its tenants or to occupiers of premises connected by a siding with any of its railways, or to any local or sanitary authority or company authorised to supply electrical energy. The remaining electrical Bill provides for the transfer of the South Wales Electrical Power Distribution Company to the Treforest Electrical Consumers Company.

Twenty-seven Bills relate to tramways. By them the construction of 31 miles of tramway and the raising of sums of money amounting in the aggregate to £1,074,760 is proposed. As compared with 1907, the number of Bills shows an increase of nine, and the capital proposed a decrease of £478,124. Eighteen of these Bills relate to tramways in England and Wales and one to a tramway in Ireland. Among the most important of these is one for the incorporation of the Croydon and Southern Districts Tramway Company for the construction of tramways in Surrey which will form continuations of the existing tramways of the Croydon Corporation. The Leeds Corporation proposes, *inter alia*, to construct new tramways in Horsforth, Rawdon, Yeadon, and Guiseley. The London County Council propose to carry out certain extensions and to make new tramways, the total length of track being 2 miles 9 chains double and 2 miles 15 chains single. The Metropolitan Electric Tramways, Limited, propose to construct a new tramway in Paddington. New tramways are proposed for the West of London and part of Surrey, the total length being 2 miles 61 chains double and 5 miles single by a new company which it is sought to incorporate under the West London, Barnes, and Richmond Tramways Bill.

ELECTRICAL EXHIBITION TO BE HELD IN MANCHESTER, 1908.

Since the notice which we gave to the above scheme in our last January issue great progress has been made, and it is satisfactory to note that despite the difficulties which at first presented themselves to the Executive Committee, it may practically be said that they have now been overcome, and that final details in connection with the forthcoming exhibition have assumed definite shape. At the first meeting of the Executive Committee, held on Jan. 27 last at their offices, 2, Queen Anne's-gate, S.W., one of the most important matters dealt with was the question of a suitable site, and Messrs. Davenport and Northcote were instructed to bring forward alternative particulars as to available land in Manchester, and at a special meeting of the executive, which it was arranged should be held at the town hall, Manchester, on Feb. 8, plans of the proposed buildings were considered, and a scheme was drawn up on which the management were asked to obtain definite tenders.

At a well-attended meeting of the executive held on Feb. 8 in Manchester, the management reported that, in addition to various suitable sites on which they had obtained options, the Parks Committee of the city of Manchester had expressed their willingness to consider an application for the use of some spare land situated on the Platt's Fields estate, which is immediately adjoining one of the main roads and leading from the city of Manchester, and is in the heart of one of the most important residential districts. The committee decided, therefore, to make application to the Corporation for its use.

Since the above date several informal meetings have taken place both in London and Manchester, with the result that on Monday, March 9, the committee met at their London offices, and received a definite offer from the Manchester Corporation for the use of the land in Platt's Fields. After carefully considering the matter it was unanimously decided to accept the offer made by the Corporation, and after various builders' estimates had been dealt with, based upon the plan and scheme already decided upon by the committee, it was agreed that the matter should go forward.

A general meeting is being called in Manchester on Tuesday, March 24 next, with a view to adopting the resolutions of the sub-committee and putting same into effect. In the meantime, draft prospectus and plans of floor space available for exhibitors are being prepared, and it will materially assist all those interested in the organisation of the scheme if would-be exhibitors will advise the management as to their desire to take part in the movement, which has already received sufficient promises of support to warrant an assured success.

We would remind our readers that the scheme at present being dealt with is on a far larger basis than the first electrical exhibition organised by the trade itself, which was held at Olympia in 1905, and as the total floor space which the proposed building accommodates equals in round figures a matter of some 100,000ft., it is obvious that not only will there be room for a thoroughly representative display of electrical apparatus, but also of machinery and mechanical plant to which electricity as a motive power may be readily and successfully applied. In view of the time and attention which the committee appointed by those interested at the end of December last have given to the scheme, it is hoped that their efforts will be rewarded by receiving the loyal support of the industry and trade generally.

PARLIAMENTARY.

Tramway Bills.

Two Tramway Bills were last week considered by the Standing Orders Committee of the House of Lords on petitions praying for dispensing with the Standing Orders.

In the case of the West London, Barnes, and Richmond Tramways Bill, the application for suspension of the Standing Orders was opposed by the Barnes Urban District Council, whose consent the promoters had failed to obtain. The committee decided that the Standing Orders ought to be dispensed with.

A similar application was made in the case of the Croydon and Southern District Tramways Bill, and it was opposed by the Croydon Rural District Council, through whose district it was proposed to carry certain of the tramways. After hearing arguments, the committee decided that this was not a case in which the Standing Orders ought to be dispensed with. This decision is likely to lead to the withdrawal of the remaining portions of the Bill.

London Electric Supply.

When the Lords' message, "That the London and District Electricity Supply Bill, the London Electric Supply Bill, and the London (Westminster and Kensington) Electric Supply Companies Bill be referred to a Joint Committee of both Houses of Parliament," came before the House of Commons on Tuesday night, Mr. Lloyd-George moved that the House disagree with the Lords. He expressed no opinion on the merits of the Bills, but he did not think that the method proposed was the best method of investigating their details. Something ought to be done—and done quickly—to settle the question of supplying London with electricity for power purposes, and he thought it a scandal that something had not already been done. If the Lords' suggestion were adopted the Bills would go before the Joint Committee, which would arrive at a conclusion before opinion was mature for a consideration of the problem. He thought before a committee considered the Bills a conference between the various parties ought to take place. Therefore, he was opposed to the proposal that a Joint Committee be set up. He moved that the House disagree with the Lords' message. This was carried without a division.

THE ELECTRICAL ENGINEERS, R.E. (VOLS.).

Orders for week ending Saturday, March 28.

MONDAY, MARCH 23.—"A" Coy.—Infantry drill, 6 p.m.
Technical drill, 7 p.m.

TUESDAY, MARCH 24.—"B" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.
Medical examination for recruits, 7 p.m.

WEDNESDAY, MARCH 25.—"A" badge examination, 6 p.m.

THURSDAY, MARCH 26.—"C" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

FRIDAY, MARCH 27.—"D" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

FORTHCOMING EVENTS.

SATURDAY, MARCH 21.

Royal Institution.—At 3 p.m., "Electric Discharges through Gases," by Prof. J. J. Thomson. (Lecture III.)

Junior Institution of Engineers.—At 6.30 p.m., reception at Caxton Hall, Westminster.

Institution of Electrical Engineer (Manchester Students' Section).—Visit to General Electric Company's Works, Witton.

MONDAY, MARCH 23.

Institution of Electrical Engineers (Newcastle Local Section).—At 8 p.m., at the Armstrong College, "The Design and Use of Telephone and Telegraph Cables," by Mr. F. Tremain.

TUESDAY, MARCH 24.

Home Office Electrical Inquiry.—At 10.30 a.m., at the Surveyors' Institution, 12, Great George-street, Westminster, S.W.

Faraday Society.—At 8 p.m., at the Institution of Electrical Engineers, 92, Victoria-street, S.W., presidential address by Sir Oliver Lodge, "Some Aspects of Lord Kelvin."

Institution of Electrical Engineers (Manchester Students' Section).—At 7.30 p.m., at the Municipal School of Technology, "Some Notes on Power Station Equipment and Design," by Mr. C. W. Crosbie.

Liverpool and District Electrical Association.—At 8 p.m., at the Common Hall, Hackins Hey, Dale-street, Liverpool, "Static Transformers in Practice."

WEDNESDAY, MARCH 25.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., at 92, Victoria-street, S.W., "The Motor Converter," by Mr. H. W. Gregory.

THURSDAY, MARCH 26.

Royal Institution.—At 3 p.m., "Standardisation in Various Aspects, (2) Electrical Engineering," by Dr. R. T. Glazebrook.

FRIDAY, MARCH 27.

Electro-Harmonic Society.—At 8 p.m., smoking concert at Cannon-street Hotel (in the Great Hall).

Physical Society.—At 5 p.m., at the Northampton Polytechnic Institute, Clerkenwell—(1) "Notes on the Plug Permeameter," (2) "On the use of Shunts and Transformers with Alternate-Current Measuring Instruments," (3) "On Wattmeters," by Dr. C. V. Drysdale.

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate, St. James's Park, "Combustion Processes in English Locomotive Fireboxes," by Dr. F. J. Brislee, D.Sc., and "Combustion Processes in American Locomotive Fireboxes," by Mr. L. H. Fry.

Motor Exhibition at Olympia.

SATURDAY, MARCH 28.

Royal Institution.—At 3 p.m., "Electric Discharges through Gases," by Prof. J. J. Thomson. (Lecture IV.)

Institution of Electrical Engineers.—At 10 a.m., students' visit to Thames Ironworks.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE TESTING OF ONE DIRECT-CURRENT MACHINE.

SIR,—In the *Electrical Engineer* for March 6, 1908, there appeared an abstract of an article on the testing of dynamos by Herr A. Kolben in the *Elektrotechnik und Maschinenbau*. This was followed by a letter in the next number of the *Electrical Engineer*, in which the writer, Dr. W. Lulofs, made reference to similar tests at present being carried out by him at Birmingham University.

It may be of interest, therefore, if I describe two somewhat similar methods for testing a single direct-current machine. The object of these tests was to investigate on a single dynamo the heating and commutation under full-load conditions when only losses are supplied to the machine.

The first of these methods is as follows: In a multipolar machine, let all the north poles be connected in series and all the south poles in series, and let one of the circuits so formed be reversed. Then, according to whether we reverse the one branch or the other, all the poles in the machine will be north or all will be south Suppose, for example, we make all poles north, and, with the armature short-circuited through an ammeter and running at normal speed, let the full-load exciting current be sent through each of the parallel paths.

Under these conditions no current whatever will flow in the short-circuited armature, providing everything is symmetrical. Then, if we keep the current in the one field branch constant, we can, by either slightly increasing or slightly decreasing the current in the other, cause full-load armature current to flow through the ammeter. The path of the flux lines corresponds in direction to the actual case, but, owing to the weakened field, the commutation conditions are less favourable than under actual working conditions. As regards heating, however, with the exception of the armature core, practically the correct conditions obtain.

To examine the sparking and the heating of the armature core we pass over to the second method. This method applies chiefly to lap-wound armatures without equalising connections, or (in the case of new machines) to armatures to which the equipotential rings have not yet been connected. Disconnect all brush spindles from one another, then from a *low*-voltage battery (or machine) send the full-load brush current into one brush and withdraw the same from another brush *at the same potential—e.g.*, if the current is introduced at a negative brush it must be withdrawn from a negative brush—it is preferable, of course, to select the brushes so that the current distribution is symmetrical. Throughout the test the machine is run at full speed, and excited normally as for full load. In the above case proper commutation will take place at the brush where the current enters the armature; with positive brushes the correct conditions obtain where the current leaves. Practically, the only altered condition in this arrangement is the absence of half the short-circuit currents in the commutating zones, owing to the fact that the brushes on either side of the brush being tested carry no current. (This, of course, does not apply to chord-wound armatures.) Whether this makes any practical difference only experiments can show, but, at any rate, a very fair idea of the behaviour of the machine with regard to sparking can be obtained. At the same time, since the machine is run under normal full-load excitation throughout, both field heating and armature core heating can be measured. This second test might well be taken immediately after the first, so that the commutation will be at its maximum working temperature when the sparking conditions are examined. Of course, in the above test, when one set of brushes is being tested, the other need not be interfered with.

In conclusion, I may say I carried out several tests last autumn in Stafford, on machines built by Messrs. Siemens Bros. Dynamo Works, to find out how far the above methods might be carried; but on account of the manifold

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difficulties of carrying out such an investigation when one is engaged in practical work I have not been able to complete the series.—Yours, etc, STANLEY P. SMITH.

Stafford, March 16, 1908.

THE TELEPHONE QUESTION.

SIR,—In your issue of March 13 you insert a long letter on this subject from the pen of Mr. Herbert Laws Webb, who occupies the distinguished position of chief of the contract department of the National Telephone Company. Mr. Webb, as he has often done before, prescribes certain remedies for the telephone evils which are so strongly complained of, and he naturally advocates suppression of the flat-rate tariff and the substitution of measured rates. Such a change, as calculated to extract the greatest amount of money from the pockets of telephone users, naturally suits his—*i e*, the company's—standpoint, but then the company's and the subscribers' interests are not identical. No amount of special pleading—and Mr. Webb's pleading is very special—can cover up the fact that those municipalities which instituted telephone systems of their own have demonstrated that a good, trustworthy telephone service, satisfactory to the subscribers, can be maintained with profit by giving telephone users the choice of a flat rate, which in different places has varied from £5 to £6. 6s. per annum, and of a measured rate of £3 per annum and 1d. for each call. No settlement of the telephone question should be entertained that does not give British users these terms. The new Post Office rates are simply outrageous. The lowest is £5 for 500 calls, and the smallest user must pay that, although he may only require to originate 50 or 100 calls per annum. In the first case he would pay, under the municipal system, £3. 4s. 2d., and in the second £3. 8s. 4d., as against the Post Office £5 minimum. All this could be proved before a Select Committee if the Post Office would consent to one being appointed, but they, like their colleagues of the contract department of the National Telephone Company, are too intent on squeezing the last penny out of the user. The chambers of commerce have taken up the question very energetically of late, but personally I do not think that anything short of a full thrashing out of the matter before a Parliamentary Committee will produce any tangible result.—Yours, etc.

A. R. BENNETT.

TELEPHONY.

SIR,—My wife, who is a sensible woman (in many ways), does her shopping by telephone. For a large proportion of household requirements she deals with two large stores, say Jarrods and the Double Service. Often the attempted call for, say, Jarrods is "ineffective," either because Jarrods are "engaged" or because Jarrods's young man is so careless and inattentive, so hopelessly inefficient. The order then promptly goes to the Double Service. This is a clear case of a lost call meaning lost business. It happens often in my little sphere. I venture to say it happens thousands of times hourly all over the United Kingdom, with all kinds of business, from doughnuts to dynamos.

I do not gibe at business men. But do you, Mr. Editor, pretend that all business men are infallible, and that all know how to use well the tools which science and enterprise provide? You ask, do I believe that business men ever act against their own interests? Of course I do; I have seen it done often, in all kinds of ways, and so have you. As regards the telephone, there are 20,000 telephone people in the United Kingdom who will tell you that business men in every town in the country habitually misuse their telephone service, habitually block their lines, habitually lose business through blocking their lines, and in many cases refuse to adopt an effective remedy. You give a flat contradiction to statements of mine based on long experience. That is hardly civil, and is certainly not argument. The measured rate raises efficiency by reducing the ineffective call; the flat rate reduces efficiency by increasing the ineffective call. That is universal telephone experience, and it is idle to deny it.

As to the large and small user, it is the invariable practice in all business to give the large user more favourable terms than the small user. That is such a commonplace that I cannot see the object of stating the contrary.

As regards units, certainly the unit in the bakery is the loaf or the pound, and in the newspaper trade the single paper, and in the publishing trade the book. Why not? Certainly the unit of the local telephone service is the effective call. What else should it be?—Yours, etc.,

HERBERT LAWS WEBB.

Westminster, S W., March 14, 1908.

LIVE-STEAM FEED HEATING.

SIR,—Being a partner in the firm of Hamilton and M'Master, Belfast, who have during the past eight years fitted over 500 live-steam feed-water heaters, as well as a great number of exhaust steam heaters, I am naturally very much interested in Prof. John Goodman and Mr. D. R. Maclachlan's trials. Their trials, which lasted for 12 hours, apparently contradict our trials and whole experience extending over a period of eight years. We have found that wherever the feed enters the boiler at a temperature which is below that of the steam in the boiler, live-steam heating shows economy. But we cannot agree with Mr. Wilkinson, that the efficiency of live-steam heating falls off if the difference of temperature is too great. Our experience is just the opposite: we find that the benefit of live-steam heating depends upon this difference of temperature, and the greater the difference the greater the benefit. This seems to me such a natural and self-evident proposition, that I think the falling off in efficiency which Mr. Wilkinson experiences must be due to the form of apparatus which he tested, and not to any general law governing live-steam heating.

Knowing as an absolute fact, from personal observation in hundreds of cases, that live-steam heating does give economy, it only remained to examine the particulars of these trials to find out why they had failed to reveal the saving which must have been made by raising the temperature of the feed 200deg. with live steam. This examination at once reveals the fact that, although a very great and minute amount of pains was taken to ascertain all the usual data of a boiler test, no thought whatever appears to have been given to the heater itself, or to any special points peculiar to this trial. It was quite useless making such accurate and careful tests of the quantities of water and fuel and analysis of the flue gases when "a small quantity of steam escapes with the discharge of the air, but this quantity was not measured, being practically negligible." How can *any* quantity of steam escaping during a test be negligible? I know that this form of loss is inseparable from this type of heater, and also from internal heaters which have a pipe through which the air is supposed to escape to the atmosphere.

In a paper which I read last month before the Engineering and Scientific Association of Ireland, I pointed out that this source of loss was strongly prejudicial to the use of all heaters where it occurred, and if the authors had pointed out that the failure to show a saving in this trial was owing to the form of apparatus used, I should have had nothing more to say. But they have drawn deductions about live-steam heating in general which the nature of their trial does not justify. That the quantity of steam blown out in attempting to get rid of the air which accumulates in this type of heater is *not* small, and, therefore, not negligible, may be seen from the following considerations.

The heater was placed at the highest point in the feed system. It was filled with steam from the boiler, and the feed was sprayed into it. Under these conditions all the air in the feed water will be released in the heater, and will remain there until blown out into the atmosphere. If this air could be blown out of the heater without any loss of steam, the loss of heat from this cause would have been small, and could have easily been calculated and allowed for. This should have been done if the trials were to be of any scientific value. But it is not possible to blow out the air from a heater of this type without blowing out a very large quantity of steam with it. Water under atmospheric pressure and temperature contains about 5 per cent. of its volume of air and other gases in solution. These are all retained in a heater such as is described, and,

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if not blown out, fill the heater in quite a short time, so that no steam can enter, and the heating action ceases. To prevent this we are told "cocks are fitted to the heater to discharge the air."

I do not, of course, know where these cocks were placed in this particular case, but I strongly suspect that they were placed at the top of the heater. I do not know why engineers always make this mistake, but in all cases where they wish to draw air from a chamber containing air and steam they place the opening at the top, evidently expecting the air to float on the top of the steam like cream on milk. Why do they expect this? Do they not know that air is much heavier than steam? That steam is only about five-eighths the weight of air? If it were possible to separate the air and steam by gravity, the air should be taken from the bottom of the vessel and not the top. This error is not of much importance, however, for steam and air cannot be separated by gravity. When any gases are confined in a certain space, each of the gases will diffuse throughout the whole space exactly as if no other gas was present. This is the law of the diffusion of gases, and in consequence of it the air and steam in the heater must be equally mixed throughout, and, therefore, anything blown out of the heater to get rid of the air must have been a mixture of air and steam.

No tests appear to have been made to ascertain the mixture of air and steam actually in the heater, nor the quantity blown out. But, as the air would have no heating value, the mixture in the heater must always have contained a large proportion of steam each time it was blown out, otherwise the temperature of the feed could not have been kept within 12deg. of the temperature of the steam. Surely to throw away this steam with all the heat, both latent and sensible, which it contained makes the great care expended upon the other details of the test appear absurd. Why catch the drip from the feed pump and put it back in the tanks when a greater amount of water, and an incomparably greater amount of heat, is treated as "negligible"? The drip from the feed pump was, perhaps, equal during both tests, and, therefore, was not of nearly the same consequence as the steam which was only lost in the one test.

There is another point which has been passed over by the authors, which also shows their want of appreciation of the physical facts occurring during the tests. We are told that 27lb of water escaped per hour through the blow-off cock. This loss is presumed to be equal in each test The quantity of water lost may or may not have been equal, but I am quite certain that the quantity of heat lost was not equal. Why was the temperature of the water which leaked out not taken? It almost seems that it was not taken, and that the loss from blowing off the heater was not taken, because there did not happen to be any place for them in the standard form for boiler trials which the authors used. It is hardly necessary to point out to engineers that where a boiler is fed with a cold feed the cold feed goes to the bottom, and that the water in the bottom of the boiler is much colder than the rest of the water in the boiler. And that where the boiler is fed at a high temperature there will be no cold water at the bottom, simply because there is no cold water in the boiler—it is all one temperature.

In these trials the feed entering the boiler without the heater was at a temperature of 124·8deg. F. and with the heater it was 325deg. F., a difference of 200deg. The cold feed simply streams down to the bottom of the boiler and gathers where the circulation is poorest, and this is at the blow-off cock. Therefore, we may take it for granted that the temperature of the water leaking out during the trials was about 200deg. more during the trial with the heater than during the trial without the heater. This represents a loss of about $200 \times 27 \times 12 = 64{,}800$ heat units lost, and unobserved by the authors. Of course, the difference of temperature may not have been the full 200deg. We do not know what it was; there was no place for it on the form. But my contention is that the whole test is useless when we know that the authors were capable of overlooking the two points to which I have drawn attention. It is impossible to know that other things of equal importance were not overlooked also. I would point out, what the authors have not done, that the diagrams show a very much steadier steam pressure with the heater on than without. This is a characteristic of live-steam heating, and is a source of economy in itself, as every steam user knows.

Another interesting fact revealed in these diagrams is this steadier steam pressure was carried during the test with the heater, in spite of the fact that temperature of the flues was allowed to fluctuate a great deal more during this test, and also the steadier pressure while using the heater was 1½lb higher than during the test without the heater.

I should sum up the results of these trials as follows: With heater the steam pressure was very much steadier and 1½lb. higher; this *must* show an economy in the engine, an economy which the man who pays for the coal would find out, although it did not come within the scope of these trials. The evaporation in the boiler was increased by the amount of steam and heat blown out of the heater when getting rid of the air. This was not measured. The use of the heater made good the extra heat lost in the leakage from the blow-off cock. This was not measured. The use of the heater made good all losses due to radiation, owing to its being situated outside the boiler. All these losses are owing to the inherent defects of the type of heater used in these trials, and would not have occurred if an internal heater had been used, and the gain made by the heater would have been shown as a net gain, and not merely as balancing the losses. I am aware that there are internal heaters where the same attempt is made to blow the released air into the atmosphere, but this part of such apparatus is never seriously used; if it were, it would probably counterbalance the saving made to a great extent.

The theory of live-steam feed-water heating, which I introduced in 1902, was touched upon during the discussion. In this theory I stated that heat was taken up more rapidly by evaporating water than by water which was not evaporating. The figures on which I made this statement were found experimentally by the late Sir Frederick Bramwell and Mr. William Anderson, and can be found in D. K. Clark's "Rules, Tables, and Data for Mechanical Engineers," p. 466, third edition. I showed that this fact, ascertained by them, was the natural outcome of well-known physical laws, which I shall restate here, so that those who oppose the theory may know what they have to disprove: (1) the rate at which heat will pass through a plate depends upon the difference of the temperature on the two sides of the plate; (2) that all liquids produce cold (or extract heat) when evaporating—and to this I would add that no amount of scouring or circulation can produce the cold which evaporation does.

My opponents must either disprove these statements, or show that evaporation in a boiler does not follow the general law of evaporation.—Yours, etc.,

AUGUSTUS W. HAMILTON,
Hon. President, Belfast Association of Engineers.
Prince's Dock, Belfast.

QUESTION No. 1,043.

SIR,—I beg to call your attention to a misprint in "M. M.'s" answer to Question No. 1,043 in the *Electrical Engineer* for March 13 which may prove rather misleading. I think the current should $= \frac{746 \times 100}{210 \times 70} = 5$, and not $\frac{7 + 6 \times 100}{210 \times 70}$ as stated in the answer.—Yours, etc.,

F. GRESHAM CROW.

OBITUARY.

We regret to announce the death of Mr. William Ormiston Callender, the founder of Callender's Cable and Construction Company, Limited, which took place at his residence in Bournemouth on the 14th inst. Mr. Callender was born in Leith in 1827, and was consequently 81 years of age at the time of his death. He settled in London in

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1866, and shortly thereafter became connected with the paving industry. As manager of the Val de Travers Company, he introduced asphalt into London as a material for street paving in 1869. Subsequently he became managing director of the Seyssel Mines Company, and had much to do with street-paving contracts in France, in Germany, in Russia, and Roumania. He was largely responsible for the introduction into Europe of asphalt from the well-known pitch lake in Trinidad. In 1879 he patented an insulating material in which Trinidad bitumen formed the chief ingredient, and this material has become widely known as a dielectric for underground mains, under the name of "vulcanised bitumen." The Callender's Bitumen Telegraph and Waterproof Company was founded in 1882 to develop this invention. The present company, Callender's Cable and Construction Company, Limited, is its successor, and is too well known to our readers, and the electrical industry throughout the world, to require further reference from us. Mr. W. O. Callender ceased to take a part in the working management of the company's affairs in 1893, but remained an active member of the Board until 1903, when he resigned his seat as director, but was appointed special director of the company. Mr. W. O. Callender has been twice married, and by his first wife had a family of 10 children, all of whom, as also his widow, survive him.

PUBLICATIONS RECEIVED.

The *Journal* of the Institution of Electrical Engineers, February, 1908, vol. 40, No. 187. London: E. and F. N. Spon, 57, Haymarket, S.W. Price 5s.

"Railway Shop Up-to-Date." A reference book of up-to-date American railway shop practice compiled by the editorial staff of the *Railway Master Mechanic*. Crandall Publishing Company, Security Building, Chicago, U.S.A.

"Boiler Construction," by Frank B. Kleinhaus. London: Archibald Constable and Co., Limited, 10, Orange-street, W.C. 12s. 6d. net. [Described as "a practical explanation of the best modern methods of boiler construction from the laying-out of sheets to the completed boiler."]

HACKNEY CORPORATION ELECTRICITY SUPPLY UNDERTAKING.

The accounts of the fifth complete year of the working of the electricity supply undertaking of the metropolitan borough of Hackney were presented at a meeting of the Council last week, and duly passed by them. Some interesting statistics relating to the undertaking appear in the statement presented by the borough electrical engineer, Mr. L. L. Robinson, from which we extract the following.

At March 31, 1907, there was an equivalent of 151,222 lamps of 8 c.p. connected to the mains, including 372 motors with an aggregate of 1,670 h.p. The number of units generated reached a total of 3,953,453, of which 449,117 were used for works lighting and power, battery, and on distribution. For public lighting 716,860 units were sold, at an average price of 1·31d. per unit; for private lighting 1,557,749 units were sold, at an average price of 3·11d. per unit; for private power 1,092,771, at 1·07d. per unit; and for destructor power 136,956 units, at 1d. per unit; the average price per unit being 2·02d.

The works costs amounted to 0·50d. per unit, and the total cost of generation, distribution, and management amounted to 0·73d. per unit, a reduction of 0·11d. per unit on the result for the year ended March 31, 1906. With these costs Hackney, for the fifth year in succession, secures the record for the lowest costs of generation and distribution of electricity in the metropolitan area. The following table shows an analysis of costs during the past two years:

	1906. £ s. d.	1907. £ s. d.	Cost per unit sold 1906.	1907.
Coal and fuel	3,876 3 4	4,120 16 9	0·32d.	0·28d.
Oil, waste, water, and stores	286 15 3	325 13 6	0·02d.	0·02d.
Wages of workmen	1,588 18 1	1,597 6 9	0·13d.	0·11d.
Repairs and maintenance	1,127 1 3	1,262 7 8	0·10d	0·09d.
Total works costs	6,878 17 11	7,306 4 8	0·57d.	0·50d.
Rent, rates, and taxes	1,380 19 2	1,524 1 6	0·11d.	0·11d.
Management expenses	1,839 16 3	1,756 19 4	0·16d.	0·12d.
Total works and management costs	£10,099 13 4	£10,587 5 6	0·84d.	0·73d.

With regard to public lighting, the cost of carbons (trimming and cleaning) was £764 (0·25d. per unit supplied) and repairs and maintenance amounted to £773 (0·26d. per unit), including £76 for Nernsts.

The financial results of the year's working are shown in the following statement:

Total revenue	£31,417	6	10
Total working expenditure (including expenses in connection with public lamps)	12,124	10	7
Gross profit for the year	19,292	16	3
Add interest on money on deposit	338	2	9
Gross profit plus interest	19,630	19	0
Loan charges—repaid principal and interest, £12,444. 19s. 1d.; accrued due but not payable, £4,299. 19s.	16,744	18	1
Amount transferred to credit of the reserve fund	£2,886	0	11

The capital expenditure of the undertaking at March 31, 1907, being £292,078. 9s. 3d., the gross profit, £19,292. 16s. 3d., is equivalent to 6 6 per cent. on such capital. The reserve fund started the year with a credit balance of £15,327. 10s. 4d., and was increased at the end of the year to £18,629. 17s. 7d. Out of this £1,800 was spent in battery renewals, and £503. 9s. 2d. in promoting the Hackney Electricity Bill, 1906. There was transferred to general rate accounts in respect of amounts contributed during the years 1901 and 1902, on account of the deficiency of the undertaking, the sum of £3,374. The total amount standing to the credit of the reserve fund is equivalent to 44·3 per cent. of the amount which the Council may set aside as a reserve fund—viz., £29,208—which is 10 per cent. of the capital expenditure. Adding to the reserve fund the total capital repaid to mortgagees—*i.e.*, £24,720. 9s.—we find the total surplus at March 31, 1907, to be £37,666. 13s. 1d.

In reviewing the report and accounts for the past year, the most satisfactory features which stand out are the great increase in the use of electricity for motive power in Hackney during the past five years, and the steady decline in the average charges to consumers of current for all purposes. In 1903 there were only 32 motor users, employing 98 motors of a total horse-power of 380, consuming 68,492 units. In 1906 the number of users was increased to 131 and the aggregate horse-power employed to 1,194, while over half a million units were sold. Last year a total of 1,670 h.p., representing 176 motor users, was connected to the mains, and the consumption was over one million units. Moreover, the inclusive working costs—that is to say, total works and management costs and loan charges—have declined from 2·71d., at which they stood in 1903, to 1·85d. in 1907. The load factor showed a slight improvement last year, standing at 18·18 per cent. On the other hand, the net surplus for 1907 (£2,886) was about £200 less than for the previous year and nearly half as much as for the years 1904 and 1905.

PERSONAL.

We congratulate Mr. S. Derwen Jones, electrical engineer for th borough of Batley, on the occasion of his marriage.

The Burslem Town Council have increased the salary of Mr. Edwards, the assistant electrical engineer, from £130 to £140 per annum from April 1 next, with a further increase next year of £10; £150 to be the maximum.

According to the *London Gazette*, the partnership between Messrs. G. A. Knapton and R. J. Bagnall, carrying on business as electrical engineers at 95, Lansdowne-road, Old Charlton, Kent, has been dissolved by mutual consent.

The fifth annual dinner of the employés of the Carlisle Corporation electricity works was held at the Silver Grill on Friday, March 13. Mr. C. D. Burnet, the electrical engineer, presided, and a very enjoyable evening was spent, the function proving a great success.

We regret to learn of the death of Mr. William Ormiston Callender, head of the Callender's Cable and Construction Co., which took place last Friday, the 13th inst., at his residence in Bournemouth. Reference is made in another column to the career of deceased.

Mr. J. P. M'Mahon, of Northampton Corporation tramways, has been appointed engineer and manager to the Dumbarton Burgh and County Tramways Co. The generating station and electricity supply business at Dumbarton of the Electric Supply Corporation will continue to be managed by Mr. W. A. Ritchie.

The *London Gazette* announces that the partnership between Messrs. W. L. Jones, J. T. Westwood, and T. H. Jones, carrying on business as electrical and general engineers at Neville Works, Elland-road, Leeds, under the title of Jones-Westwood Electrical Manufacturing Co., has been dissolved by mutual consent.

On Saturday last the annual meeting of the two elevens representing the General Electric Co., Witton, Birmingham, and Robertson Electric Lamps, Limited, met on the ground of the latter at Old Oak-road, and after a good hard game the lampmakers were defeated 3 to 1. After the game both teams sat down together to dinner in the staff dining room at Brook Green works, followed by a fancy dress dance in the larger hall, at which 350 people were present.

The Stepney Borough Council have under consideration but have not yet confirmed a recommendation of the Electricity Committee to increase the salary of Mr. W. C. P. Tapper, the borough electrical engineer and manager, from £600 to £650 per annum, with annual increments of £50 until a maximum salary of £750 per annum is reached. It is also proposed to increase the salary of Mr. Squire, the chief clerk in the electricity department, from £200 to £210 per annum, with annual increments of £10 until a maximum of £250 per annum is reached.

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LEGAL INTELLIGENCE.

POSTMASTER-GENERAL v. NATIONAL TELEPHONE CO.

A case raising a question of great importance as to the extent of the monopoly enjoyed by the Postmaster-General under the Telegraph Act, 1869, came before the Master of the Rolls and Lords Justices Moulton and Buckley in the Court of Appeal on Wednesday week. The case was that of the Postmaster-General *v.* the National Telephone Co., and it came before the Court on an appeal by the defendant company against a decision of Mr. Justice Swinfen Eady in the Chancery Division.

Section 4 of the Telegraph Act of 1869 provides that the Postmaster-General should have the exclusive privilege of transmitting telegrams within the United Kingdom, but certain descriptions of telegrams were excepted by Section 5. By that section the exceptions were telegrams in respect of which no charge was made, and transmitted by a telegraph maintained or solely used for private use and relating to the business or private affairs of the owner thereof, and, secondly, telegrams transmitted by a telegraph maintained for the private use of a corporation, company, or person, and in respect of which or of the collection, receipt, and transmission or delivery of which no money or valuable consideration shall be or promised to be made or given. The National Telephone Co. hold a licence for 31 years from Jan. 1, 1881, granted in 1884, by the then Postmaster-General to work and use telegraphs of which the transmitting and receiving instruments are to be telephones, for the purpose of enabling persons to communicate with one another by means of spoken words, and a royalty of 10 per cent. is payable to the Post Office on sums received. A portion of the defendants' business was the supply and maintenance for annual payments of telephonic lines and instruments constructed between two places so as to afford communication between those two places alone. Although these lines are maintained by the defendants they are worked and used without the intervention of any of their servants. In the special case which had been stated instances were given of lines between different places of business where allied trades or businesses were carried on—viz., connecting fire brigade stations and other buildings, and lines connecting a theatrical ticket agency with theatres and a number of hotels. In each case the agreement with the defendants was executed and the rent paid by one only of the two parties so connected by the defendants' line. The first question for the Court to decide was whether the defendants in respect of these lines were liable for the royalties under their licence, or whether the telephones in question did not fall within the first exception to the Postmaster-General's privilege, since the "owner" or person paying for the line was not maintaining it solely for private use for messages relating solely to his business or private affairs. The second question was whether the defendants by supplying and maintaining lines and apparatus for the fire system by means of boxes placed in the streets, so as to enable anyone to communicate with the fire station, were concerned in transmitting telegrams in contravention of the plaintiff's privilege under the Act of 1869. Mr. Justice Swinfen Eady answered both questions in the affirmative, hence the defendants' appeal.

Sir Robert Finlay, K.C., Mr. Danckwerts, K.C., and Mr. H. H. Gaine appeared for the appellants; and the Attorney-General, the Solicitor-General, and Mr. Casserly for the Crown.

Sir ROBERT FINLAY, K.C., in opening the appeal, stated that the question raised related to the scope of the exemptions contained in the Act relating to the transfer of the telegraphs to the Postmaster-General and the monopoly thereby conferred upon him. Put shortly, the point was whether, as Mr. Justice Swinfen Eady decided, the "exception" was confined to the case of telegraphs connecting different parts of the establishment of the same person. That was to say, whether the only exception from the monopoly of the Postmaster-General was the case of telegraphs connecting a man's house with his stables or connecting two offices which the same merchant had.

Lord Justice MOULTON: What is the distinction between the two?

Sir ROBT. FINLAY said that it was very difficult to see any distinction. If the exception was confined to the case where a man was sending a message to himself or his employés at another place, then the provision that no charge was to be made for sending the message was totally meaningless. No man ever charged himself for sending a message to his stables from his house or from his house to his office in London. What Mr. Justice Swinfen Eady had held was that although the wires were established for the use and convenience of a particular merchant or firm, yet if those who communicated with the owners at the other end were independent persons and not in the "owner's" service the exemption did not apply. If the view of the Crown was right it would bring in the electric door-bell, and if any person who thought he had business with the proprietor of the house, but whom the proprietor did not wish to see, touched the button, the privilege of the Postmaster-General was infringed. He contended that the provision stating that "no charge was to be made" showed that it was never contemplated that "private wires" should be confined to connecting different parts of the premises of the same occupier.

Mr. DANCKWERTS followed on the same side.

In reply to a question by the Court, Sir ROBERT FINLAY said he would admit that if, in the case of theatrical agents, the apparatus were used for the purpose of putting the hotel people in communication direct with the theatre, that would not be covered by the exception.

The ATTORNEY-GENERAL supported the judgment of Mr. Justice Swinfen Eady. He said there might be 150 lines, and in such a case it would always be possible by some simple mechanical contrivance to put 150 persons in communication with each other on the private lines. That illustration showed the importance of construing the word "private" strictly in accordance with the intention of the Act. He contended that these private wires must be used strictly for the private business of the lessee. To bring the wire within the exception, the dominant factor was that the line was to be for the private use of the lessee. The moment they got the line used for the private use of two or more persons they got outside the exception.

Lord Justice BUCKLEY said he understood the learned counsel's argument to be that if he telephoned to his servant to send him a pair of boots, that came within the exception, but if he telephoned to his bootmaker to make him a pair of boots, that did not come within the exception.

The ATTORNEY-GENERAL said that was his contention. He submitted that the moment they got outside the private use into business use they got outside the privacy contemplated by the section.

The MASTER OF THE ROLLS asked Sir Robt. Finlay what he would say if the Court held that the proper construction of the licence was such as to make the company liable for royalties whether the instances given fell or did not fall within the exception.

Sir ROBT. FINLAY said that the Crown had never taken that point before. He wished to know whether they now took it.

The ATTORNEY-GENERAL: The Crown take anything.

In the result their Lordships allowed Sir Robt. Finlay an adjournment in order that he might consider the position.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION.

In the Chancery Division on Saturday last Mr. Justice Neville sanctioned a petition by the South London Electric Supply Corporation for a reduction of its capital.

Mr. GATEY stated that the capital of the company was £65,000 in £5 shares, and the proposal was to reduce the nominal value of the shares to £4 each. The company was incorporated in December, 1896, to purchase the Lambeth electric lighting order and carry out certain contracts. The loss incurred had been chiefly in connection with the erection of a dust destructor, which had resulted in the company being involved in heavy legal proceedings and an end being put to the destructor works.

CARSHALTON TRAM ACCIDENT.

In the King's Bench Division on Monday last, before Mr. Justice Lawrance and a special jury, the claim was heard of Mr. Henry James Sayer, a Sutton coachbuilder, who sought to recover compensation on behalf of himself, his wife, and child, from the South Metropolitan Electric Lighting and Tramways Co., in respect of injuries and loss sustained by reason of the overturning of one of the defendant company's tramcars at Carshalton last Easter Monday.

The only question for the jury was as to the amount to be awarded, the parties not having been able to come to terms.

The jury awarded £360 compensation—£300 for the husband, £50 for the wife, and £10 for the child.

NORWICH CORPORATION v. NORWICH ELECTRIC TRAMWAYS CO.

In the Court of Appeal on the 13th inst. the case of the Corporation of Norwich *v.* the Norwich Electric Tramways Co. came before the Lord Chief Justice and Lord Justices Farwell and Kennedy, on appeal by the tramways company from a judgment of Mr. Justice Bray in favour of the Corporation. Mr. C. A. Russell, K.C., Mr. Danckwerts, K.C., and Mr. Boydell Houghton appeared for the tramways company in support of the appeal, whilst Mr. MacMorran, K.C., and Mr. Ernest E. Wild appeared for the Corporation.

Mr. RUSSELL said the appeal was brought for the purpose of determining the rights of the parties, who disagreed as to the extent of their liabilities as to the repair of the streets through which the company's tramways passed. The question first came before Mr Justice Phillimore, who decided the dispute in favour of the Corporation, but the company then raised the point that the General Tramways Act provided for the settlement of the dispute by arbitration before a referee appointed by the Board of Trade, and, in consequence, the question was referred to the Hon. Alfred Lyttelton, K.C., who made an award in favour of the Corporation for a sum of £320, with an addition of 5 per cent. and costs of the arbitration, holding that under Section 57, Sub-Section 5, of the Electric Tramways Act, 1897, the company were bound to keep the junction between the granite setts on which the line was laid and the road which was maintainable by the Corporation in a proper state of repair, and that if they failed to do so the Corporation was entitled to do the work themselves after giving statutory notice to the company, and to recover a reasonable sum therefor. The Divisional Court upheld that award. Mr. Russell's contention was that both the award and the decision of the Divisional Court were wrong, on the ground that the company were only bound to maintain and repair the part of the roads upon which the tramline ran.

Without calling upon the other side their Lordships dismissed the appeal, with costs.

MIDDLESEX TRAMWAYS ASSESSMENT COMMITTEE.

In the King's Bench Division Mr. Justices Darling and Phillimore gave judgment in the case of the Assessment Committee of Hendon *v.* Sir Ralph Littler and others (reported in the *Electrical Engineer*, March 6), in which the Assessment Committee of Hendon applied for a rule *nisi* calling upon Sir Ralph Littler, K.C., Sir F. Cory-Wright, and other justices of Middlesex to show cause why a writ of prohibition should not issue precluding them from sitting on the Bench when the appeal of the Metropolitan Electric Tramways against the assessment of their undertaking was heard.

Mr. Justice DARLING explained that the Metropolitan Electric

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Tramways worked a tramway which was leased to them by the Middlesex County Council, and one of the terms of the lease was that the County Council should receive 45 per cent. of the net revenue of the undertaking, which was arrived at by deducting, among other things, the rates which were paid by the tramway company. Sir R. Littler, Sir F. Cory-Wright, and other justices of Middlesex were also members of the Middlesex County Council, and the Assessment Committee objected to their sitting as justices during the appeal, as they had a pecuniary interest. He thought the Assessment Committee had made out a case for a rule *nisi* for a writ of prohibition.

Mr. Justice PHILLIMORE concurred, and a rule *nisi* was granted accordingly.

COMPANIES' MEETINGS AND REPORTS.

COUNTY OF LONDON ELECTRIC SUPPLY.

The fourteenth ordinary general meeting of the County of London Electric Supply Co. was held on Monday, Mr. J. B. Braithwaite, the chairman, presiding.

The CHAIRMAN, in moving the adoption of the report, stated that the capital had been increased by the issue of the 15,000 preference shares which were recently offered to the shareholders. The expenditure on mains for the last seven years showed a continuous decrease, with the exception of one year. In 1902 the amount expended on mains was £74,954, and last year's figure was the lowest they had yet had—namely, £23,701. Taking the entire capital expenditure on the Company's London stations, there again there was a steady decrease going on. In 1902 they spent £143,857, and last year the amount was £57,669. This year the Company's engineer estimated that the expenditure would show a further decrease. The directors were very careful only to make capital expenditure when they saw a reasonable certainty of making a handsome profit. In 1903 the capital expenditure of £133,772 resulted in an increased profit being made of £11,727, or 8·7 per cent. on the capital expenditure; in 1904 the capital expenditure of £83,504 resulted in an increased profit of £19,307, or 23·1 per cent.; in 1905 the capital expenditure of £82,380 resulted in an increased profit of £9,661, or 11·7 per cent.; in 1906 the capital expenditure of £67,813 resulted apparently in an increased profit of £2,908, or 4·3 per cent.; but it so happened that the bulk of that capital expenditure was made towards the end of the year, and was not really effective until the following year. In 1907 the capital expenditure of £57,670 resulted in an increased profit of £12,901, or 22·3 per cent. Therefore, taking the five years altogether, the capital expenditure of £425,139 had resulted in an increased profit of £56,504, or 13·2 per cent., upon the capital expenditure. It would be seen, therefore, that they did not spend capital rashly or recklessly. The total receipts were £175,779, as compared with £156,219, an increase of £19,561, or over 12½ per cent. The increase in the works costs amounted to only £5,628, so that of that £19,561 they retained, after paying the increased cost of coal during the past year, £13,933; but against that there were certain claims to be met over which the directors had no control. The quinquennial valuation had resulted in their having to pay £911 more for rates than last year. They had also had to pay £407 more for income tax, and wages and salaries had increased by £920. The directors had written £1,311 more off suspense accounts than they did last year, raising the total figure to £3,968 written off out of revenue. They had also written £1,409 off slot meter and rental wiring installations, and made £400 extra provision for bad debts. Those items amounted together to £5,358, reducing the extra profit to £10,775, although they had placed an additional £7,000 to depreciation, and they had paid £1,741 more in interest on temporary loans. Taking the London stations, the results were even more satisfactory than if they took the Company as a whole, for there the increase in the revenue was £20,438, or 14 per cent. The turbine machinery continued to work extremely well. They had now five Curtis turbines, each of 1,500 kw. normal capacity, in use, as compared with three at the end of 1906, and these had enabled them still further to reduce the working costs. The lamp connections for the year were a record for the Company's London stations. On the basis of 30-watt lamps the equivalent lamp connections showed an increase of 120,654, being 16,603 in advance of last year's increase. The total sales showed an increase of 3,214,755 units, compared with an increase of 2,141,000 units last year. The increase, therefore, was 30 per cent. During the year they had supplied a section of the London County Council tramways with 1,716,000 units, as compared with 743,290 in 1906. The total sales of lighting units showed an increase of 14½ per cent. on last year. The increase of 876,024 units compared with an increase of 574,099 last year. The total amount of energy sold for power purposes was 7,059,714 units, and for lighting purposes 6,910,465 units. They had sold half their energy for power and half for lighting, which went a long way to dissipate the widespread idea that in London the supply companies did nothing for the poor power user. With regard to works costs, they had a further decrease of 11·7 per cent. on last year's costs, in spite of the increase in the cost of coal. The total increased expenditure for the supply of the 3,214,755 extra units which he mentioned was £5,628, of which £5,420 was the extra cost of coal. Had coal stood at the same price as it did in 1906, they would have supplied those extra units at a cost of £208. That showed that the Curtis turbine machinery was realising the economies they anticipated. The efficiency of distribution showed an improvement of 3 per cent. on last year, and was now 75·9 per cent. This improvement was due to the increased sales for power purposes. With regard to lamp connections, at Dec. 31 they had just over 1,000,000 lamps applied for, and the progress for the current year was even better. The applications were equivalent to 23,520 30-watt lamps, against 16,139 last year, showing an increase of 46 per cent. The total applied for at this moment was 1,024,691 30-watt lamps. With regard to units sold, in the northern area they had sold 1,602,808 units, against 1,782,555 last year, showing a decrease of 10 per cent., but last year's figures included 396,916 units supplied to the County Council tramways, so that, so far as their own customers were concerned, there was an increase of 14 per cent. in the amount supplied so far. In the southern districts they had sold 1,390,708 units to date, against 1,242,554 last year, showing an increase of 12 per cent. Therefore, both in the number of lamps applied for and in the quantity of current sold to their own customers, there was a satisfactory increase. Summarising the progress of the Company, he pointed out that the lamps applied for had increased from 416 292 units in 1902 to 1,001,171 in 1907, the units sold had increased from 4,868 285 to 13,970,179, the number of customers had increased from 4,139 to 12,483, the profits from the London stations had increased from £61,699 to £118,201, and the net revenue from all sources had increased from £57,668 to £104,154, whilst at the same time the average price per unit had gone down. In 1902 they realised 4·58d. for every unit they sold, whereas last year they got only 2·83d. The fact that the increase of business had synchronised with the decrease in price, and that still they were making larger profits, was again very great testimony to the soundness and efficiency of their engineering staff. Referring to the other undertakings of the Company, he stated that the Bournemouth and Poole Co. continued to pursue the even tenor of its successful way. It had just declared 9 per cent. for the half-year to Dec. 31 last, making 7 per cent. for the year. On the Coatbridge undertaking they had laid out something like £23,000 during the past year, and the business there was developing in a very satisfactory way, particularly in connection with power supply. Last year parliamentary powers were obtained for Croydon, and the supply was now available. With regard to parliamentary matters the position was decidedly better than was the case two or three years ago. At that time huge schemes for bulk supply were put forward, based mainly upon two contentions—that there was an enormous demand for electric power in London, the figure being placed as high as 636,000 h.p., and that the existing companies were doing little or nothing whatever to supply this demand. The time which had elapsed since this Bill was thrown out had made it abundantly clear that neither of these allegations could be demonstrated. There was also, he believed, a growing appreciation of the fact that the settlement of the question of electric supply for London was a matter of mutual co-operation between the various bodies now supplying electricity in the Metropolis—namely, the local authorities, the companies, and the London County Council.

Mr. A. H. SANDERSON seconded the motion, which was carried unanimously.

An extraordinary general meeting was held afterwards to consider a resolution approving a Bill to incorporate and confer powers upon a joint committee of London electric supply companies, with representatives thereon of the London County Council, to make further provisions with respect to the supply of electrical energy in London and surrounding districts, and to confer powers upon the London electric supply companies.

The CHAIRMAN, in proposing the resolution, gave an outline of the powers sought in the Bill, under which, he stated, it was proposed to issue a capital of £1,000,000 and to make the various companies who were combining to promote the Bill responsible for their quota of interest on such capital. This was calculated on their respective net revenues, and the Company's particular share was 16 per cent.; in other words, if the Bill passed through Parliament and the full £1,000,000 were raised, the Company would be liable for the interest on £160,000.

Mr. JOSEPH SHAW seconded the motion, which was agreed to.

MANSFIELD TRAMWAYS.

The first ordinary general meeting of the Mansfield Tramways Co. was held at the Town Hall, Mansfield, under the presidency of Mr. A. R. Holland.

In presenting their first annual report the directors stated that they were glad to be able to say that the receipts during the year had exceeded the estimates in the prospectus, and that the takings up to the present this year showed a regular and substantial increase over the corresponding period in 1907. The expenses during the year were somewhat heavier than anticipated, owing to the benefit of various economies in working not being felt until the year was well advanced. Certain charges had been met out of revenue, owing to obligations incurred by the light railway company prior to the rearrangement of its capital, and to the necessity for a dual administration until the various agreements between the two companies had been fulfilled, but such charges would not recur, and a benefit might be anticipated in future accounts. After payment of debenture interest to Dec. 31, 1907, and interim dividend on the 6 per cent. cumulative preference shares to June 30, 1907, the amount at the credit of the revenue account was £2,688. 15s. 2d., from which must be deducted the 6 per cent. on the cumulative preference shares for six months to Dec. 31, 1907, £1,800, leaving a balance of £888. 15s. 2d., which the directors recommended should be carried forward. The directors had not considered it necessary in the present accounts to deal with the question of depreciation, in view of the fact that the system was still under construction during a part of the year. This question would be dealt with in future accounts. In June last a short extension was completed and opened in the Woodhouse section, and the results had answered the anticipations of the Company. The directors now had under consideration the construction of a short new line, which they had every reason to believe would materially add to the revenue of the Company. The accounts showed that the traffic receipts for 1907 amounted to £16,936. 0s. 5d., and advertising, rents, etc., to £349. 14s. 10d., making a total of £17,312. 15s. 3d. After

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allowing for traffic expenses, repairs and maintenance, power, insurance, rents, salaries, etc., there was a balance to be carried forward to the net revenue account of £8,052. 9s. 11d.

The CHAIRMAN moved the adoption of the report and accounts, which was carried unanimously.

CHELSEA ELECTRICITY SUPPLY.

The annual meeting of the Chelsea Electricity Supply Co. was held on the 11th inst., Sir Irving Courtenay presiding.

In moving the adoption of the report, the CHAIRMAN stated that the gross receipts showed an increase of £3,443, but the expenses had also increased by £2,158, making the net increase only £1,285. The increase in expenses was chiefly in coal, which was £1,304 more, while rates were higher by £695. Notwithstanding the extra expenses, the works costs per unit sold were almost the same as last year, and they had increased the number of 8-c.p. lamp equivalents by 7,430, and the units sold by 240,914, making the total units sold well over 3½ millions. Very little new construction work was carried out during the year, and consequently the increase in the capital expenditure had only been small. Extensions of distribution mains were made where necessary to furnish a supply of electricity to new consumers. In this respect they were feeling the benefit of the alteration in the voltage which they made some years ago, as most of the feeding mains had, in consequence, been of sufficient capacity to serve for the supply to an extended network of distributing mains without increasing their size or number. The general character of the supply of electricity had been well maintained. As to the future of the business, there were too many uncertainties hanging over the industry for him to venture to prophesy. This was especially the case as regarded those companies who were operating in the London area, but, at the same time, he by no means regarded them as insurmountable. With regard to metallic-filament lamps, he said they fully recognised that the advent of this class of lamp, which to the customer was economical in the use of current, would make a certain disturbance in their business, but, owing to the technical and other difficulties in the way of the general adoption of the lamp at present, the effect would be partial and gradual, and, he thought, should eventually be compensated for by a largely increased use of the light through the extension of its use into the cheaper class of houses and shops, and he inclined to the opinion that when the lamp became so perfected as to be capable of general adoption, it would greatly assist them in keeping ahead in the competition with gas. Referring to the Bill in Parliament for the purpose of supplying electricity in bulk in London and the surrounding districts, he said they were advised that this could be effected by the companies with far less expenditure of capital than would be the case with a new company or a central authority, and that such a supply could be commenced at once, whereas a new authority would require some years to carry out an entirely new scheme and to erect stations and plant. That being the case, they considered it right and proper that the supply should be retained by the existing companies, and that new and unfair competition should not be introduced from outside. The existing companies had borne the heat and burden of the struggle as pioneers, and they claimed to be entitled to fair treatment and full consideration from Parliament. They hoped to get the goodwill of the London County Council on behalf of their scheme, and were ready to come to any reasonable terms with that body to ensure the success of a measure which should be to the advantage of the companies generally as well as to the people of London as a whole. Dividends were to be paid at the rate of 6 per cent. per annum on the preference share capital and 4½ per cent. per annum on the ordinary share capital for the year 1907.

Mr. W. R. DAVIES seconded the adoption of the report, which was agreed to.

Subsequently it was agreed to petition Parliament in favour of the London Electric Supply Blll.

MELTON MOWBRAY ELECTRIC LIGHT.

The annual meeting of the shareholders of the Melton Mowbray Electric Light Co. was held last week, Mr. W. J. New presiding. In their report the directors referred to the progress made during the year, the lamps connected being increased from 16,391 to 17,528. The total number of consumers was now 535. Including the balance of £79. 18s. 8d. brought forward from last year, the accounts showed a net profit of £2,014. 3s. 4d. After paying off debenture and loan interest £1.041. 7s. 6d., writing off the last instalment of £8 101 in respect to the exhibition expenses, and £75. 6s. 8d. depreciation and loss on wiring account, there was a balance of £816. 9s. 1d. The directors recommended that a dividend be declared of 2 per cent., which would require £400, that £400 be placed to reserve for renewal of plant, and the balance of £16. 9s. 1d. carried forward to next year's account.

SALISBURY ELECTRIC LIGHT.

The annual meeting of the Salisbury Electric Light and Supply Co. was held last week, the chairman of the directors (Mr. W. M. Hammick) presiding.

The report stated that the Company continued to make progress. During the year the number of consumers had increased from 983, with 31,769 lamps connected, to 1,012, with 33,560 lamps connected. The generating plant had been sufficient to meet the output, and the whole of the plant was in thorough working order and capable of dealing with a considerably increased demand. The profit on the year's working, including £59. 5s. brought forward from last account, amounted to £5,332. 9s. 6d., and after paying £1,447. 18s. interest on debentures and temporary loans, an interim dividend at the rate of 4 per cent. for the half-year, amounting to £700, and writing off £125 from exhibition account, there remained a balance of £3,059. 11s. 6d. to be dealt with. The directors recommended that a further dividend at the rate of 7 per cent. for the half-year should be paid, making, with the interim dividend, 5½ per cent. for the year, and that £1,500 should be carried to reserve, leaving £334. 11s. 6d. to be carried forward to next account. The directors desired to express their great regret at the loss sustained by the death of their esteemed colleague, Mr. William Marlow. The vacancy on the Board caused by his death had been filled by the election of Mr. C. J. Woodrow. Mr. Gripper retired from the directorate by rotation, and, being eligible, offered himself for re-election.

The CHAIRMAN, in moving the adoption of the report, said they had now 1,015 consumers. Their coal cost them more than it did last year. They used to pay 8s. 4d. per ton, whereas now they paid 10s. 7d. per ton. The tantalum lamp was being used by the consumer more largely than hitherto. The advantage to the Company was that the consumers were paying for their own lamps, but, of course, they must expect these to consume less electricity than the Nernst lamps.

Mr. GRIPPER seconded the proposition, which was carried.

TRACTION AND POWER SECURITIES.

The report of the Traction and Power Securities Co. for the year 1907 states that the net revenue for the year amounts to £19,584, which, added to £3,242 brought forward, gives a sum of £22,826 to be dealt with. The directors have applied the sum of £3,000 to make good the depreciation shown in the Company's quoted securities at the date of the balance-sheet, and have transferred a sum of £15,000 to the investment reserve fund. This leaves £4,826 to be carried forward. Two securities—the Mersey Railway 4 per cent. new first perpetual debenture stock and the Clyde Valley Electrical Power Co. (incorporated by Act of Parliament) ordinary shares of £10 each—for which there is no market quotation, remain on the books at cost, and until their outcome is ascertained the directors make no revaluation of them. Meanwhile the investment reserve fund stands at £65,000. During the past year the Company has increased its holding in the Mersey Railway debenture stock by £19,297 in fulfilment of a contract previously entered into. The earnings of the railway continue to show a steady increase. The Company has paid up further calls in respect of its holding in the Clyde Valley Electrical Power Co., the liability for unpaid calls being now reduced to £15,048. The directors have agreed to grant the Clyde Valley Electrical Power Co. a loan of up to £100,000 to enable it to extend its installation and system of distributing mains. Of this sum £29,684 had been advanced at the date of the balance-sheet.

CARLISLE ELECTRIC TRAMWAYS.

The report of the directors of the City of Carlisle Electric Tramways Co. for the year 1907 is as follows: The revenue account shows a surplus of £1,784. 12s. 11d., being a decrease of £117. 18s. 1d. as compared with last year; and the balance of profit and loss account, after providing for debenture stock interest and debenture stock trustees' remuneration, is £632. 18s. 9J., which the directors recommend shall be carried forward to next year. The car miles run in the period have been 350,704, the number of passengers carried 2,551,311, and the total receipts amounted to £9,742. 2s. 1d., being an increase of 287 miles run, a decrease of 239,368 passengers carried and £511. 19s. 9d. in receipts respectively. There is also a decrease of £394. 1s. 8d. in the working expenses. The directors who retire are Mr. T. D. Lingard and Mr. R. Creighton, who, being eligible, offer themselves for re-election. Messrs. Walter J. Kershaw and Co., the auditors, also retire, and are eligible for re-election. The revenue account shows that the cost of electrical energy was £2,673; running expenses, £3,278; maintenance and repairs, £788; and administration and general expenses, £1,216—total, £7,957. The traffic receipts were £9,105; parcel ditto, £326; advertising ditto, £225; other receipts, £5. 17s. 9d.; bank interest, £19. 13s. 5d.—total, £9,742, leaving a surplus of £1,784.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

The report of the Bournemouth and Poole Electricity Supply Co. for the year ended Dec. 31 last, submitted at the meeting on the 19th inst., states that the capital expended during the year amounted to £31,030. The balance from last account after payment of the final dividends on the preference and ordinary shares for the half-year ended Dec. 31, 1906, less income tax, was £1,634, and the balance from revenue account for 1907 amounts to £31,872, making a total available revenue for the year 1907 of £33,506. The directors recommend a final dividend on the 15,000 ordinary shares for the half-year ended Dec. 31, 1907, at the rate of 9 per cent. per annum, less income tax, leaving £938 to be carried forward.

BRITISH INSULATED AND HELSBY CABLES.

The report of the directors of the British Insulated and Helsby Cables for the year ended Dec. 31, 1907, to be submitted to the shareholders at the ordinary general meeting to be held in Liverpool on the 23rd inst., states that the profit for the year amounts to £135,619. 12s. 7d., to which has to be added the balance brought forward from last year, £36,713. 3s. 3d.—making a total of £172,332. 15s. 10d. From this have to be deducted: directors' and debenture trustees' fees and remuneration to works committee, less directors' fees receivable from other companies, £4,497. 10s.; interest on debenture stock, £22,500; depreciation on buildings, plant, machinery, etc., £22,000; transfer to reserve account, £10,000; transfer to debenture stock redemption account, £5,000; dividend on preference shares to

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Dec. 31, 1907, £30,000; interim dividend on ordinary shares to June 30, 1907, £20,000 — total, £113,997. 10s., leaving available for dividend a balance of £58,335. 5s. 10d. The directors recommend the payment of a further dividend of 4 per cent. on the ordinary shares, making with the interim dividend already paid a total of 8 per cent. for the year ended Dec. 31, 1907, together with a bonus of 2 per cent. (£30,000), carrying forward to next account a balance of £28,335. 5s. 10d. The volume of trade during the past year, especially in heavy cable work, has not been so great, owing to the high price of copper in the earlier part of the year, and to the financial stringency later on, and the profits have thereby been adversely affected. It is, however, satisfactory to be able to say that the volume of business done so far this year and orders in hand at present compare very favourably with the corresponding period of last year. A sum of £10,000, it will be observed, has been transferred to reserve account, and a further £5,000 to debenture stock redemption account, in addition to £22,000 depreciation of buildings, plant, and machinery.

BASTIAN METER.

The report of the Bastian Meter Co., together with the balance-sheet and accounts for the six months ending Dec. 31, 1907, states that during the period in question a net profit of £551. 14s. 10½d. was earned. This sum added to the balance of profit remaining from the half-year ending June 30, 1907, of £534. 8s. 2d., makes a total of £1,086. 3s. 0½d., and it is proposed to deal with this amount as follows: 2½ years 6 per cent. cumulative preference dividend to Dec. 31, 1907, £301. 12s. 11d.; dividend at the rate of 2½ per cent. on the ordinary shares, £247. 19s.; balance carried forward, £536. 11s. 1½d. The business of the Company is being well maintained, and there is every reason to believe that the year 1908 will prove a profitable one.

The annual general meeting of the shareholders of the Company was held on the 12th inst. at the Inns of Court Hotel. The report, with the accounts, were passed.

METROPOLITAN ELECTRIC TRAMWAYS.

The report of the Metropolitan Electric Tramways for the year ended Dec. 31, 1907, states that the total revenue for the year amounted to £297,223, including the £27,476, the balance of the dividends received in the year 1906 from the North Metropolitan Tramways Co. and reserved from the previous account. The directors have decided to spread this balance over the period ending in June, 1910, during which the Company would have continued to receive dividends from the North Metropolitan Tramways Co. but for the surrender by that company of its lease of the London County Council's northern tramways. In pursuance of this policy £7,850 has been brought into the present account, and the balance, £19,626, has been reserved. The traffic receipts, which amounted to £224 200, show an increase of £64,599 over the previous year. After deducting all expenses chargeable to revenue, including £10,500 for reconstruction and renewals, and writing down preliminary expenses and other items by £6,220, there remains a surplus of £49,574, making, with the £3,791 brought forward, a total of £53,365. The directors recommend to place to a reserve fund £5,000, to pay a dividend on the 391,337 ordinary shares at the rate of 4½ per cent. per annum, and to carry forward £5,755. The Company have increased their holding in the North Metropolitan Electric Power Supply Co. to 40,000 shares of £10 each, of which 30,000 are fully paid and the balance £5 paid. The dividend to be received in respect of this investment for the past year amounts to £12,285, being at the rate of 4 per cent. per annum on the amount paid up on these shares.

LIVERPOOL DISTRICT LIGHTING.

The report of the Liverpool District Lighting Co. for the year ended Dec. 31, 1907, shows that the demand for electricity still shows a satisfactory rate of increase, the units sold for the year amounting to 354,750 units, an increase of 13,325. Owing, however, to the increased cost of fuel and other causes, the resulting profit has not increased *pro rata*. In the balance-sheet the value of "free wired" installations is less than at the corresponding period of last year. This is accounted for by the fact that the directors have decided not to carry out any more of this work, as practically all the houses now being built in the Company's area are wired for electric light during construction. Two of the old installations have been purchased outright and one written off. The gross profits for the year, together with the amount brought forward, after payment of dividend, leaves a profit available for distribution of £2,315. Of this £20 has been written off the cost of fitting up the offices in Tithebarn-street and £833 set aside for depreciation, leaving a balance of £1,461, out of which it is proposed to declare a further dividend at the rate of 5 per cent. per annum, less income tax, for the half-year ended Dec. 31, 1907.

NEW COMPANIES REGISTERED.

New Vacuum Heating Co., Limited.—Registered Feb. 26. Capital, £6,500 in £1 shares. Objects: to adopt an agreement with R. E. Atkinson, and to carry on the business of heating and ventilating engineers, founders, metal workers, boilermakers, water-supply engineers, etc. No initial public issue. Registered office: New-street, Leicester.

British Brasier Motors, Limited.—Registered Feb. 11. Capital, £11,000 in 10,000 ordinary shares of £1 each and 20,000 deferred shares of 1s. each. Objects: to adopt an agreement with Chadwick and Co. to establish agencies in any part of the world for selling and dealing with motors, motorcars, vehicles, and accessories, etc. No initial public issue.

J. Bonn and Co., Limited.—Registered Feb. 19. Capital, £1,500 in £1 shares. Objects: to take over the business of engineers, mechanical and electrical instrument and appliance manufacturers, and model makers carried on by J. Bonn at 97, New Oxford-street, and 9, Lawrence-street, High-street, Bloomsbury, W.C., as J. Bonn and Co. No initial public issue. Registered without articles of association. Registered office: 97, New Oxford-street, W.C.

New Lowca Engineering Co., Limited.—Registered Feb. 12. Capital, £25 000 in £1 shares. Objects: to adopt an agreement with J. Burns, C. Walton, H. Bentley, and J. N. Bentley; to acquire the business of the Lowca Engineering Co., and to carry on the business of electrical, mechanical, civil, and general engineers, engine builders and fitters, boiler and machinery makers, steel converters, founders, etc. No initial public issue. Registered office: Lowca, near Whitehaven, Cumberland.

Schreiber Electric Battery Co., Limited.—Registered Feb. 5. Capital, £7,000 in 5,000 preference shares of £1 each and 40,000 deferred shares of 1s. each. Objects: to acquire certain inventions or processes relating to the manufacture of electric batteries, to adopt an agreement with P. Schreiber, and to carry on the business of manufacturers of and dealers in all kinds of electric batteries and accumulators and self-propelled vehicles, electricians, electrical engineers, etc. No initial public issue. Registered office: 25, Brewer-street, Regent-street, W.

W. S. Scott.—Registered March 3. Electrical contractors, 56, East-street, Brighton. Partnership for two years from Feb. 1, 1908, and afterwards till determined by six months' notice on either side (subject to general partner's right to determine at any time on giving one month's notice and repaying limited partner's contribution). General partner: W. S. Scott, 27, Prince's crescent, Brighton. Limited partner: N. E. Hill, 27, Hollingbury-road, Brighton, contributing £160 (value of stock, fixtures, fittings, and goodwill brought into ordinary partnership by him in October, 1906).

Liens Registered.

Royalberg Copper Mine, Limited.—Issue on Feb. 20 of £200 8 per cent. prior lien debentures, part of series created Dec. 3, 1907, to secure £2,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £1,500.

Guildford Electricity Supply Co., Limited.—Reissue on Feb. 20 of £500 5 per cent. debentures, part of series created Nov. 21, 1905, to secure £25,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £25,000.

Barnsley and District Electric Traction Co., Limited.—An acknowledgment of indebtedness under seal, dated Jan. 30, 1908, creating a further £1,000 debenture stock (supplemental to a trust deed, dated April 8, 1903, securing £20,000 debenture stock), charged on the light railway undertaking and other property of the company, has been registered. Trustees: Electric and General Investment Co., 1 and 2, Great Winchester-street, E.C.

Telephone Co. of Egypt, Limited.—An acknowledgment of indebtedness under seal, dated March 4, 1908, securing a further £60,000 debenture stock (supplemental to a trust deed dated July 27, 1904, and an acknowledgment of indebtedness dated Feb. 21, 1906, securing £60,000 and £40,000 debenture stock respectively), has been registered. Property charged: the company's undertaking and property, present and future, except uncalled capital. Trustees: Sir Auckland Colvin, K.C.S.I., Earl Soham, Framlingham, Suffolk, and G. F. Braithwaite, Kendal, Westmoreland.

Delhi Electric Tramways and Lighting Co., Limited.—Issue on Feb. 24 of £23,200 5 per cent. debentures, part of series created Jan. 3, 1908, to secure £50,000. Property charged: Benefit of Delhi Municipality Electric Licence, 1905, and Delhi (Municipality) Electric Tramway Order, 1906, the company's interest in certain land and buildings in Circular-road, Delhi, the tramway line and distribution system, and the company's undertaking and general assets, present and future, except uncalled capital. Trustees: R. C. Pearman, 21, Old-buildings, Lincoln's-inn, W.C., and J. Greig, 18, Belsize Park-gardens, Hampstead, N.W. Total amount previously issued of same series, £100.

APPOINTMENTS VACANT.

Premium Pupil.—Apply, Borough Electrical Engineer, Burton-on-Trent.

Premium Pupil.—Apply, Electricity Works, Canterbury. See advertisement in last issue.

Switchboard Attendant, Electricity Works, Canterbury. Applications to the Engineer by March 20. See advertisement in last issue.

Traffic Manager, Wigan Corporation Tramways. Salary, £200 per annum. Applications to Mr. H. Jevons, town clerk, by March 23. See advertisement.

Assistant Manager for electrical department of shipbuilding and engineering works. Applications to Lighting, care of Wm. Porteous and Co., Glasgow. See advertisement.

Assistant Electrical Engineer, East Indian Railway. Salary, Rs. 450, rising to Rs. 600, per calendar month. Applications to Mr. C. W. Young, secretary, 28-30, Nicholas-lane, London, E.C., by April 4. See advertisement.

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BUSINESS NOTES.

LIGHTING AND GENERAL.

Ballyshannon.—The proposed electric lighting scheme for this town has been postponed for six months.

Rosario Electric Co.—The directors have declared a dividend of 3s. per share, less tax, on the ordinary shares.

Gelligaer.—The Council have decided to obtain an estimate for electrically lighting the district of Troedrhiwfuwch.

Alloa.—The Council are about to lay cable at a cost of £419 to the hospital in order to illuminate the building by electricity.

Shoreditch.—For extensions to the electricity plant the London County Council have agreed to lend the Borough Council £7,150.

St. Marylebone.—The London County Council have decided to lend £9,172 to the Borough Council for electric lighting purposes.

Lowestoft.—The Council have decided to install mechanical stokers to two boilers at the station, which will involve an outlay of £330.

Darlington.—The Town Council have decided to put down an additional boiler at the electricity works at an estimated cost of £1,030.

Oxford Electric Co.—At the annual ordinary general meeting of this company a dividend of 7 per cent. on the ordinary shares was adopted.

Mold.—The electricity plant at Leeswood Hall, Mold, the residence of Sir John Mark, was practically destroyed by fire on the 12th inst.

Lisburn.—The advantages of electricity as an illuminant are being placed before the inhabitants of this town, though nothing definite has yet been settled.

Stoke Newington.—The Electricity Committee of the Borough Council are proposing to lay distributor cables through several roads at an estimated cost of £332.

Howard Asphalt Troughing Co.—The company have purchased outright the whole of the patents formerly belonging to the Simplified Underground Conductor Co.

Greenock.—The total units generated at the Corporation electricity works in January were 485,296, an increase of 103,946 as compared with the corresponding month last year.

Dundee.—The University College authorities have received a gift of £4,000 for the erection and equipment of a laboratory for the practice and study of the science of electrical engineering.

Wimbledon.—The Local Government Board will hold an inquiry on March 25 into the application of the Town Council for permission to borrow £17,600 for their electricity undertaking.

British Electric Transformer Co.—We are informed that the above firm have had their offices connected by telephone to the Ealing exchange, their number being 226 Ealing (Post Office).

South London Electric Supply Corporation.—The directors recommend a dividend of 4 per cent. on the full ordinary share capital for the past year, as compared with 3 per cent. for the year 1906.

Willesden.—An inquiry will be held by the Local Government Board on March 25 into the application of the Urban District Council for sanction to borrow £14,727 for purposes of their electricity undertaking.

Heywood.—At the last Town Council meeting it was reported that the Electricity Committee proposed to spend about £9,000 on extensions at the electricity work, which had become absolutely necessary.

Unstone.—The Parish Council have decided to ascertain the cost of lighting the parish, and to convene a parish meeting to consider the advisability of adopting the Lighting and Watching Act for either the whole or a portion of the parish.

Llanelly.—Attention was again called at the Council meeting to the filthy gas smells pervading the district, and it was stated that in some instances people had their drains tested, only to find that the nuisance was really due to the gas.

Release of Trustees.—Mr. Thomas Leman, of 1, St. Peter's Churchwalk, Nottingham, has been released from trusteeship in the estate of Messrs. Robson, Robson, and Co., electrical engineers, Empire-buildings, Newgate-street, Newcastle-on-Tyne.

Dublin.—The North Dublin Union Guardians are considering the lighting of the union with electricity or an improved gas system. The cost of lighting the place by electricity would be about £1,250 and the maintenance about £659 per annum.

Swindon.—At the last meeting of the Hospital Board the clerk reported that the cost of lighting for 1906 was £133. 0s. 10d., and for 1907 £84. 7s. 4d., showing that the introduction of electricity had effected a saving of £48. 13s. 6d. on the year.

Acton.—At the last meeting of the Council Electricity Committee the electrical engineer reported that since the previous meeting 16 applications had been received, equivalent to 1,355 8-c.p. lamps, making a total of 854 applications, equivalent to 32,240 8-c.p. lamps.

Portsmouth.—The Town Council have, on the recommendation of the Electric Light Committee, decided to remove two 650-kw. turbo-generators from the annexe to the new engine-room at the electric light station at a cost not exceeding £425, which will be paid for out of revenue.

King's Lynn.—The electrical engineer reported at the last Council meeting that since the previous meeting applications had been received for three additional connections, making an increase of 160 lamps of 8 c.p. or equivalent. The total numbers now are 619 connections and 29,416 lamps.

British Insulated and Helsby Cables Co.—After applying £22,000 for depreciation and transferring £10,000 to reserve, the directors, in their report, recommend a further dividend of 4 per cent. and a bonus of 2 per cent., making a total distribution of 10 per cent. for the year 1907, leaving £28,335 to be carried forward.

Durham.—The Finance Committee of the Guardians recommended at the last meeting of the Board that the union workhouse should in future be lit by electricity instead of gas on the grounds of economy, cleanliness, and hygiene. The proposition was stoutly opposed by the chairman of the Durham Gas Co., who succeeded in getting it rejected.

Buxton.—The Local Government Board have sanctioned the borrowing of £965 by the Urban District Council for electric lighting. The Board have also approved of the use of the land adjoining the refuse destructor for the purposes of the electric lighting order, where it is proposed to place the two electric light sets, which are to be worked from the destructor.

Hoole.—For some time past the gas supply has been the subject of complaint at the Urban District Council, and various suggestions have been made to the gas company. The Council are now about to ascertain the cost of an electricity supply, which will probably bring the gas company to make concessions in order to bolster up the present system of obsolete lighting.

Aberdeen.—At the Town Council meeting the Electricity Committee reported having had under consideration the question of the supply of electricity to the Cults district from the city generating station. The electrical engineer reported on the extension of plant necessary in connection with the scheme, the estimated cost being £6,644. The report was adopted.

Warwick.—The General Purposes Committee are of opinion that it would be advisable that electric lighting should be substituted for gas lighting in the court house, as the upper rooms would be thereby rendered more comfortable and cleaner and the downstairs rooms more healthy. They therefore recommended the Council to have the work carried out, and this has been agreed to.

Walsall.—The total number of consumers supplied by the Corporation electricity department on Feb. 29 last was 536, as compared with 496 at the same date last year. During the past month the total units generated at the station was 190,510, as compared with 174,272 for the same period last year. The total output from the main generators was 185,571 units, as compared with 169,347 for the same period last year.

Yarmouth.—The offer of the gas company to the Town Council to sell the existing street lamps at 50s. each for conversion to electric lighting has been accepted for 54 lamps. New lamps are to be placed in Wandsworth-place, the Conge, and Vauxhall-street. Sanction has been given to an electric cable being carried over the Suspension Bridge on payment of 2s. 6d. per annum and lighting a lamp on that structure.

Liquidations.—A general meeting of the members of the General Electric Co. will be held at 69, Queen Victoria-street, E.C., on April 22, at 1 p.m., to receive the report of the liquidator showing how the winding up of the company has been conducted and the property disposed of. A general meeting of the members of the Electric Power Development Co. will be held at 21, Ironmonger-lane, London, on April 14, at 12 o'clock noon, for the same purpose.

Kirkcaldy.—An alarming explosion occurred at Church-street, Kirkcaldy, on the 11th inst. A plumber in the employment of the Kirkcaldy Gaslight Co. was trying to locate a gas escape, and after boring the ground he applied a lighted torch, with the result that an explosion took place, tearing up the ground for some distance around. The man was severely burned about the face. The cause of the explosion, it is supposed, was the accumulation of gas in an old conduit.

Ilkeston.—Between 10 and 11 o'clock on Monday night, owing to an escape of gas in the living-room of the house of William Henshaw, Milton-street, Ilkeston, an explosion occurred, blowing a hole into the bedroom above and setting the beds and the room on fire. Three sons were in bed at the time. A police constable and a number of neighbours succeeded in extinguishing the flames before the arrival of the fire brigade, but considerable damage was done both by fire and water.

Morecambe.—Strong complaint was again made of the disgraceful gas lighting to the Town Council at the last meeting. In the Harbour Ward no less a number than 87 lamps were out during one evening. In spite of the frantic efforts of the gas manager to provide the flimsy appliances which have been invented as a last resource to save the old method of lighting from abolition, it has been shown in Morecambe that incandescent mantles, etc., are almost useless. The mayor stated at the meeting that his experience of incandescent lights was that they might expect to have half of them out after a storm.

Sunderland.—A meeting of the Electricity and Lighting Committee was held on the 13th inst. with regard to supplying electricity to the liquidator of Sir James Laing and Sons. The committee had been asked by the liquidator if and at what scale of charge they would supply electricity for the yard, and it was agreed to supply the firm for such time as the liquidator required at the scale available to ordinary customers. As soon as the firm is ready, therefore, the Corporation will resume their supply, and it is probable that electricity will be required by the liquidator up till the middle or end of June.

Hanley.—At the last meeting of the Town Council a deputation was appointed to attend a conference of local authorities to consider the desirability or otherwise of petitioning against a provisional order

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granted to the tramways company by the Local Government Board, which gives the company power to carry out certain works without respect to the wishes of the local authorities in the matter. As the result of a recent inquiry by the Local Government Board it was decided that the application to the Board to sanction a loan of £18,000 for the purposes of the electricity undertaking should be amended, and that application be made for a total of £21,969, including the amount estimated to cover the capital requirements for the ensuing 18 months.

Telephone Rates.—At the Associated Chambers of Commerce on the 18th inst. a motion was unanimously adopted acknowledging the attention which had been given by the Postmaster-General to the question of telephone rates, and expressed the hope that in view of the considerations which had been laid before him by recent deputations he would modify the flat rate, measured by stages, as applied to the needs and requirements of the commercial community in the provinces. Representatives of the London, Sheffield, Dundee, Bradford, Southampton, Leeds, Hull, Nottingham, Birstall, Birmingham, Kendal, Newcastle-on-Tyne, and Liverpool chambers were appointed as a special committee to confer, when considered necessary, with the Postmaster-General and the National Telephone Co.

Bishop Auckland.—The Local Government Board have approved of a scheme of main sewerage and sewage disposal for the Denebeck Valley, which comprises a large portion of the Rural Council's district, including South Church, Auckland Park Colliery, Grangehill, Cockton Hill, Eldon, and Eldon Lane. The work consists in the laying of several miles of main outfall sewers, the sewage from which will gravitate to the disposal works situate at South Church with the exception of the sewage from South Church, which is proposed to be pumped by electrically-driven centrifugal pumps to the disposal works. The purification of the sewage will be effected by first treating the sewage in covered liquefying tanks followed by filtration in double-contact beds, and the effluent will be discharged into the River Gaunless. The engineers of the scheme are Messrs. D. Balfour and Son, of London and Newcastle-on-Tyne.

Underground Wires.—A paragraph in the annual report of the council of the Middlesbrough Chamber of Commerce refers to the efforts made by the chamber in connection with the placing of telegraph and telephone wires underground: "The Postmaster-General (Mr. Sydney Buxton) says he is fully aware of the inconvenience occasioned by the interruptions and delays in communication caused by storms. In recent years increasingly large sums have been obtained from Parliament for the purpose of extending the backbone scheme of underground telegraphs. The expenditure on the scheme already amounts to about £1,000,000, and he is developing the system as rapidly as financial and other considerations permit. With regard to telephone lines the Postmaster-General remarks that it is unfortunately impossible to place long-distance trunk telephone wires underground. In the present state of science intelligible speech cannot be obtained on long underground wires."

Frome.—On the 11th inst. Mr. H. Ross Hooper was engaged for five hours in investigating an application by the Urban District Council for sanction to borrow a further sum of £11,100 for the purposes of their electric light undertaking. The Clerk said the total capital expenditure on the undertaking for which the Council were responsible was £44,684. 4s. 7d. Of the sum now applied for £9,824 was in respect of past expenditure. He explained that the Local Government Board were asked to hold the inquiry three years ago, but it had been delayed on account of legal difficulties which were raised by the Board of Trade. The inspector commented on the financial position of the undertaking. During the last year it earned 7½ per cent. on what was really capital expenditure, and of that the contractors had to repay 6¼ per cent. principal and interest on loan, which left them with 1¼ per cent. working expenses and profit. The inspector, after practically going into every detail of expenditure right from the beginning of the undertaking, adjourned the inquiry until March 31.

Sandown.—Mr. W. J. Board, chairman of the District Council, presided at a crowded meeting of electors held in the Town Hall, Sandown, on the 17th inst. to consider the question of the method by which the town should be illuminated, the contract with the electric light company being within a few months of expiration. Major Arnell moved: "That this meeting of parochial electors hereby signify their wish to the District Council to continue the lighting of the town by electricity." Dr. Pennington formally seconded the resolution. Dr. Langston led for the gas party, and spoke of the lower price at which the town would be effectually lighted by the scheme submitted by the company. Mr. Way supported a reversion to gas lighting, and Mr. Butcher, a member of the Council, said he should vote for gas unless there was a big majority for electricity, in which case he should do as the electors desired. Mr. Hook adduced the interesting fact that since the establishment of the electric light company in Sandown the price of gas had been reduced from 4s. 7d. per 1,000ft. to 3s. 10d. This was met with a retort from the manager of the gas company that if they secured the lighting of the town it was possible they would be able to still further reduce the price. Mr. Mayes, of the electric light company, answered several questions and made a brief statement in support of his company's scheme. There voted for electricity 165 and for gas 57. The figures were received with loud cheering.

TRACTION.

Newport.—After a long discussion of a proposal to run a service of tramcars on Sundays, the Town Council decided against it by a vote of 25 to 3.

Lytham.—The Blackpool Tramways Co. propose doubling their lines in Church-street, and are being urged on in the matter by the local authority.

Melbourne Tramway and Omnibus Co.—The directors announce a dividend for the quarter ending the 31st inst. of 4½d. per share (15 per cent. per annum).

Leith.—The receipts of Leith tramways for the week ending March 14 amounted to £480. 2s. 5d., an increase of £15. 7s. 8d. over the corresponding period of last year.

Halifax.—The Council have decided to purchase new motors and material at an estimated cost of £6,014. This is owing to the decision of the Tramways Committee to replace 50 25-h.p. motors by 35-h.p. motors.

Madras Electric Tramways (1904).—The receipts for the fortnight ended March 15, 1908, totalled Rs. 21,149, being an increase of 25·6 per cent. The gross receipts from Jan. 1, 1908, were Rs. 96,918, an increase of 16·6 per cent.

Bolton.—The promoters of the Central Lancashire tramways scheme, connecting Preston, Chorley, Adlington, and Horwich, are arranging with Bolton Corporation for a supply of current at the Horwich end of their system.

Huddersfield.—The Corporation Tramway Committee have decided to receive a deputation from the Lepton and Whitley Upper District Councils with reference to the provision of a tramway or light railway from Grange Ash to Waterloo.

Radcliffe.—At a meeting of the Electricity and Tramways Committee it was resolved that the electrical engineer prepare specification for the extension of cable from Spring-lane (Seed-street) to a point in Cross-lane, near the City Tea Co.'s premises.

Keighley.—A petition signed by 350 persons has been received by the Town Council on the subject of an extension of the tramway service to Worth Village, and the matter has been relegated to the Tramways Committee for consideration and report.

Italy.—The *Bulletin* of the French Chamber of Commerce at Milan states that a new company has been formed at Pisa for the construction and working of an electric tramway, Viareggio-Marina di Carrara, with a branch for Pietrasanta and Pontefoggi.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending March 11, 1908, were £3,853; corresponding period 1907, £3,658—increase, £195. Aggregates from Jan. 1, 1908, £37,301; aggregates from Jan. 1, 1907, £36,669—increase, £632.

Dover.—The receipts for the week ending Feb. 29 in connection with the tramways were for passengers 36,802, receipts £151. 10s. 8d., against £166. 13s. 0½d. in the corresponding week last year; for the week ending March 7, passengers 36,711, receipts £151. 7s. 0½d., against £179. 14s. 3½d. Aggregate from April 1 to date £10,554. 11s., against £11,865. 15s. 9d. last year.

Manchester.—An accident to some of the electrical machinery at the Manchester Corporation sub-station on Oldham-road at 11 o'clock on Saturday night affected all the generating sub-stations, and the tramcars from Oldham were at a standstill for half-an-hour. The accident happened at a most inopportune time, and caused much inconvenience to passengers and congestion of late Saturday night traffic.

St. Pancras.—The London County Council having agreed to the deletion of clauses in their Tramways Bill relating to a special contribution from St. Pancras towards the formation of a new street and the provision of a bridge over the King's Cross Metropolitan Railway Station between Gray's-inn and Pentonville roads, the Parliamentary Committee of the Borough Council recommend the withdrawal of their petition against the Bill.

Hampton.—The Urban District Council have decided to call upon the tramway company to carry out the widenings at High-street, Hampton Hill, in accordance with their agreements entered into with the Council, failing which the clerk is to apply to the High Court for a mandatory injunction to compel the company to complete their contract with the Council, and for damages or such other proceedings as may be necessary with that object.

Minster-on-Sea.—On Monday last a successful meeting of plot owners at the Cannon-street Hotel was presided over by Mr. Geo. Ramuz to consider the advisability of forming a company to extend the electric tramways from Sheerness. It was decided to leave the matter in the hands of a committee of six of the largest plot owners to arrange for application for order under the Light Railways Act, to be made forthwith, and the necessary money for this was promised in the room.

Edinburgh.—The work of cabling the Gilmour-place and Colinton-road route of the Edinburgh tramway system has been carried out with highly creditable dispatch, and it is expected to be ready for opening in the first fortnight of April. The alterations in the power station are practically completed, and with the open weather favouring the contractors the pits are nearing completion. The junction at Home-street is well forward, and will be completed possibly this week-end.

Newburn.—A deputation from the Urban District Council recently waited upon the Newcastle Tramways Committee to request that the tramlines should be extended from Scotswood to Newburn and Throckley. The Tramways Committee stated that if the Urban Council would make a 50ft. roadway, they would be willing to consider the matter. This, the deputation thought, would be too heavy an expenditure for the district, but promised to report and see what could be done in the matter.

Llandudno.—A poll taken of the shareholders of the Great Orme Tramway Co. at Llandudno as to the running of Sunday cars showed that 36 were in favour, 2 against, and 13 neutral. It was, therefore, decided to ask the Urban District Council to sanction the working of the trams on Sunday in accordance with the wishes of the majority of the shareholders. The Urban District Council have considered the matter, and have almost unanimously declined to accede to the company's request.

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Lanarkshire.—The Lanarkshire Tramways Co. have commenced cutting their new route from Hamilton to Uddingston, the furthest approach in this direction of the Glasgow Corporation tramways. When completed, this new track will link Glasgow by car with the great industrial centres of Lanarkshire. The line will cross Bothwell Bridge, and proceed to Uddingston by Bothwell. The first cut was made on Bothwell-road, Hamilton, where a large staff of men are now employed. The track will be completed at once as far as the Hamilton burgh boundary.

Glasgow.—A serious block of the Corporation electric car service was caused on the 12th inst. by the breaking of a live wire on Jamaica Bridge. At the time of the mishap, between three and four o'clock, the streets were very busy, and a motorcar and lorry passed under the wire as it snapped, the drivers having narrow escapes. The breakdown gang from the tramway depôt were quickly on the scene, but before the wire had been repaired and the traffic resumed the line of standing cars extended for fully half a mile. Many of the south-going cars during the block were run along St. Vincent-place, and crossed the river by Stockwell Bridge.

Walsall.—The following are particulars respecting the working of the Corporation tramways: Four weeks ending Feb. 23, 1907—number of passengers, 336,420; receipts, £1,875. 19s. 7½d.; car miles run, 46,880; receipts per car mile run, 9·60d. Four weeks ending Feb. 22, 1908—number of passengers, 368,443; receipts, £2,054. 3s. 2d.; car miles run, 48,148; receipts per car mile run, 10·24d. Wages paid, including repair of permanent way—four weeks ending Feb. 21, 1907, £594. 18s. 5d.; four weeks ending Feb. 20, 1908, £624. 11s. 8d. Negotiations are being entered into with the Wolverhampton District Electric Tramways with a view to securing certain alterations in the terms on which the Corporation cars run to the Market-place at Willenhall.

East Ham.—The Council Electric Lighting and Tramways Committee have received a letter from the solicitor of the North Metropolitan Tramway Co. stating that the offer made by the Council for acquisition of the section of track owned by them in Romford-road, within the borough, had been accepted, and the committee have directed the town clerk to call the necessary special meeting of the Council for the purpose of passing a resolution in compliance with Section 44 of the Tramways Act, 1870. They have recommended that the borough engineer and the engineer and manager be directed to prepare plans and estimates for the construction of the track and overhead equipment along the section of the Romford-road, and submit the same to a subsequent meeting. Also the committee have directed the engineer and manager to submit a report on the question of inter-running with West Ham along the Romford-road. The Council have agreed with the committee.

Coventry.—Almost from the time of the laying down of the tramways along Smithford-street, Coventry—the narrowest thoroughfare which the trams traverse—the shopkeepers as a body have made complaints of the great inconvenience which they suffer through the congestion of all traffic, and especially of the difficulty which arises through carts having to be moved from side to side in order that tramcars may pass. The agitation for a change has now reached an acute stage, tradesmen complaining that business conditions are well nigh intolerable. The widest point of the street is but 23ft. 2in., there are double tramlines the whole length of the highway, and in 12 hours of a recent day 1,169 vehicles passed along the street. The inhabitants, however, do not appear to be unanimous as to how the admitted inconvenience can be sensibly lessened; but the position of things will in all probability be shortly brought under the notice of the Council, though the tramways company are, of course, in no way exceeding the rights they obtained a few years ago.

Merthyr.—A comprehensive scheme for the collection and delivery of parcels by means of special messengers has been inaugurated by the Merthyr Electric Traction Co. On all sections of the line, including Merthyr, Dowlais, and Cefn, agencies at convenient places have been instituted, where parcels may be handed in by the public. These agencies are denoted by a neat enamel sign. In addition, packages can be handed to the conductor of any car. The rates charged are remarkably low, being as follows: 14lb. 2d., 28lb. 3d., 42lb. 4d., 56lb. 5d., especially when it is borne in mind that the figures given include collection or delivery of packages within a half-mile of the tram routes. The frequent service of cars on all routes offers unequalled facilities for quick delivery, which, combined with the smart messengers employed, furnishes Merthyr and district with a local parcel service equal to that given in any district in the United Kingdom. By this method it is quite as easy to send a parcel as to post a letter. For protection from damage, pilferage, or bad weather special waterproof hampers and bags are utilised. These are placed on the front platform and conveyed from point to point as required. Every credit is due to the directors and manager of the Merthyr Co. for their foresight and enterprise in supplying the traders and general public of the district with a long-felt want.

Handsworth.—The Tramways Committee of the Handsworth District Council report that the Board of Trade having, on March 7, 1908, approved of the proposed service of notice under Section 43 of the Tramways Act, 1870, requiring the City of Birmingham Tramways Co. to sell to the Council so much of the undertaking authorised by the Birmingham Central Tramways (Extension) Order, 1886, as is within the urban district of Handworth, the notice was served upon the company by post on the 10th inst. Negotiations with respect to the future working of the tramways in Handsworth are still proceeding, and a sub-committee have had an interview with the Birmingham Tramways Sub-Committee. The committee recommend the Council to proceed to arbitration for settling the price to be paid for the part of the company's undertaking which is to be purchased by them, and to direct that the Board of Trade be asked to appoint a referee to settle such price and the terms of the lease of the Handsworth part of the undertaking granted to the company under Section 64 (1) of the City of Birmingham Tramways Act, 1901, to expire on June 30, 1911, in the event of such terms not being agreed with the company; also to instruct the clerk to act as solicitor to the Council in connection with the arbitration proceedings and the purchase and lease; and to refer the whole matter to the Tramways Committee, with instructions to engage such professional and other assistance as they may think necessary.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Valencia.—The Municipality invite tenders for the electric lighting of the town. Tenders by March 23.

Dantzig.—Tenders are invited by the Municipality for four electric travelling cranes. Tenders by March 24.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Hackney.—Tenders are invited for the supply of lubricating oils for the electricity works. Tenders by March 26.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Cassel.—The Prussian State Railways invite tenders for a three-ton travelling crane, together with electric motor. Tenders by March 27

Whitehaven.—The Corporation invite tenders for battery, booster, and switchboard for the electricity department. Tenders by March 26

Bremen.—Tenders are invited by the Municipality for electrically-driven pumps for the sewage pumping station. Tenders by March 30.

Madrid.—Tenders are invited by the Public Works Department for the construction of electric tramways in Bilbao. Tenders by April 30.

St. Pancras.—The Borough Council invite tenders for the supply of arc lamp carbons for 12 months. Tenders to the Town Clerk by March 23.

Madrid.—The Public Works Department invite tenders for the construction and working of an electric tramway at Sevilla. Tenders by April 4.

Madrid.—The Post and Telegraph Department invite tenders for laying, etc., telegraph cable between Chefarinas and Argelia. Tenders by March 30.

Madrid.—The Post and Telegraph Department invite tenders for the construction and exploitation of the interurban telephone service. Tenders by April 2.

Czernovitz.—In connection with the water station on the Pruth river, tenders are invited for electrical machinery for driving purposes. Tenders by April 21.

Leeds.—Tenders are invited for the supply of steam coal for the power station. Particulars from Mr. H. Dickinson, engineer. Tenders by March 31.

Bray.—The Urban District Council invite tenders for the annual supply of stores to the electricity department. Particulars from the Clerk. Tenders by April 7.

Felixstowe.—The Urban District Council invite tenders for the supply of a storage battery and booster. Tenders to the clerk, Mr. F. B. Jennings, by March 25.

Nottingham.—The Corporation invite tenders for the annual supply for the tramways department. Particulars from the General Manager, and tenders by March 26.

Brazil.—The Amazonas Provincial Government invite tenders for electric lighting, power supply, and tramways for the Mañaos Municipality. Tenders by April 4.

Leek.—The Urban District Council invite tenders for gas-producer plant and one gas-driven generator. Tenders to the Chairman of the Electricity Committee by April 11.

Hobart.—Tenders are invited by the Postmaster-General for 200 wall telephones, 800 telephone recorders, and extension of common-battery switchboard. Tenders by May 11.

Newcastle-under-Lyme.—Tenders are invited for the supply and laying of about 1,000 yards of mains. Particulars from the Borough Electrical Engineer. Tenders by March 21.

Yarmouth.—The Corporation invite tenders for the supply of clothing for the tramway employés. Particulars from Mr. F. L. Turner, general manager. Tenders by April 7.

Manchester.—Tenders are invited by the Electricity Committee for the supply and erection of one 6,000-kw. turbo-alternator, with exciter and condensing plant. Tenders by March 25.

Tasmania.—The Postmaster-General invites tenders for material for extension of common battery and switchboard, 200 wall telephones, and 800 telephone recorders and cords. Tenders by May 11.

Salford.—The Town Council invite tenders for the annual supply of stores to the electricity department. Particulars from Mr. V. H. McCowen, borough electrical engineer. Tenders by March 30.

Dewsbury.—The Electricity Committee invite tenders for the supply of a surface condenser and the erection of a cooling tower. Tenders to the Chairman of the Electricity Committee by March 30.

London, E.C.—Tenders are invited for the supply of rails and fish-plates (one specification), for the Bombay, Baroda, and Central India Railway Co. Tenders to Mr. W. V. Constable, secretary, by March 24,

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Edinburgh.—Tenders are invited for the supply of stores to the electricity department for one year, commencing May 16. Tenders to Mr. F. A. Newington, engineer, by March 30. See advertisement in last issue.

Rawtenstall.—The Corporation invite tenders for the supply and laying of steel rails, points, crossings, and accessories for the permanent way of the tramways. Tenders to the Town Clerk by March 27.

Bristol.—The Electrical Committee invite tenders for a 12 months' supply of arc lamp carbons and joint and junction boxes. Tenders to Mr. H. Faraday Proctor, city electrical engineer, by April 7. See advertisement.

Rawtenstall.—Tenders are invited by the Corporation for the supply and erection of one economiser (192 tubes), and the supply of direct and alternating current electricity meters. Tenders to the Town Clerk by March 23.

Huddersfield.—The Corporation invite tenders for the annual supply of single-phase alternating-current meters. Particulars from the Borough Electrical Engineer. Tenders by March 25. See advertisement in last issue.

New South Wales.—Tenders are invited by the Postmaster-General for 8½ tons wire. hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators, best white porcelain, large. Tenders by May 20.

Ipswich.—The Electric Supply and Tramways Departments require tenders for 12 months' supply of stores. Copy of specification and form of tender can be obtained from Mr. Frank Ayton, chief engineer and manager. Tenders by March 21.

Hull. — The Electric Lighting Committee invite tenders for the supply and laying of high and low tension mains, pilots and telephone wires, casings, boxes, etc , during period ending March 31, 1909. Tenders by March 26. See advertisement.

Cardiff.—The Corporation invite tenders for the supply of coal to their electric lighting and tramways stations respectively. Particulars from the Electrical Engineer and Manager, Central Offices, The Hayes, Cardiff. Tenders to the Town Clerk by March 28.

London, S.W.—The London County Council invite tenders for the manufacture and supply of steel and cast-iron steam, exhaust, water, etc., piping, cast-iron water-tank, etc., to be erected at the Council's electricity generating station. Tenders by March 24.

London.—The London County Council invites tenders for installations of electric lighting and fans at the Dawes-road Secondary School, Fulham, and the Hortensia-road Secondary School, Chelsea. Tenders to the Clerk of the London County Council by March 24.

Ipswich.—Tenders are invited for the supply of books, forms, and stationery required for two years, commencing April 1, for the Electric Supply and Tramways Departments. Specification, etc., from Mr. Frank Ayton, chief engineer and manager. Tenders by March 24.

Sunderland.—Tenders are invited for three additional turnouts on their main lines between Philadelphia and Silksworth, for the Sunderland District Electric Tramways. Tenders to the Manager, Sunderland District Electric Tramways, Philadelphia, Fence Houses, by March 27.

Glasgow.—The Corporation invite tenders for the supply of large water-tube boilers, 1,000-kw. motor-generators and rotary converters, and sub-station extra high-tension and direct-current switchgear. Tenders to the Town Clerk by March 24. See advertisement in last issue.

Sydney.—The Government Railway Department invite tenders for the supply and installation of about 4½ miles of three-core, high-tension, paper-insulated, lead-covered feeder cable. Particulars from the Electrical Engineer, 51, Phillips-street, Sydney. Tenders by May 4.

Bolton.—Tenders are invited for the annual supply of stores to the Electricity Department, including lubricating oils, etc., joint boxes, service fuse boxes, etc., jointers' stores, mains sundries, etc , meters, motors and transformers, motor-starting switches. Tenders by March 26.

Belfast.—Tenders are invited for the supply of about 100 tons of best rolled-steel girder tramway rails, with fishplates and bolts to suit. Particulars from the harbour engineer, Mr. W. Redfern Kelly, M.I.C.E. Tenders to Mr. W. A. Currie, secretary, Harbour Office, Belfast, by March 28.

Newcastle-on-Tyne.—Tenders are invited for (Contract No. 1) supply and delivery of 400 tons steel railway rails and fishplates; also (2) for the necessary points, crossings, and manganese rails for turnouts, for the Quayside improvement and extension. Tenders to the City Engineer by March 30.

Leeds.—The Corporation invite tenders for the annual supply of stores to the electricity department, including electric lamps, fittings, and the sundries; indiarubber-covered cables, mains, boxes, and fittings and jointing and insulating materials, etc. Particulars from Mr. Dickinson, engineer. Tenders by March 31.

Lancaster.—The Electricity Committee invite tenders for the supply and delivery of coal and slack at the electricity works, Lancaster, for six, nine. and twelve months respectively from May 1. Particulars from Mr. W. A. Tester, Electricity Works, Marton-street, Lancaster. Tenders to the Town Clerk by March 23.

Madrid.—The Post and Telegraph Department invite tenders for the construction and working of submarine telegraph cable from Cadiz to Teneriffe and Las Palmas, also for installation and exploitation of wireless telegraphy service. Particulars from Direccion-General de Correos y Telegrafos, 10, Carretas. Tenders by April 3.

Wigan.—The Guardians invite tenders for an electric lighting installation at the new workhouse infirmary at Billinge. Particulars from Messrs. Heaton, Ralph, and Heaton, architects, Victoria-buildings, King's-street, Wigan. Tenders to Mr. Henry Ackerley, clerk, 9, Victoria-buildings, King-street, Wigan, by March 25.

London, S W.—The London County Council invite tenders for the manufacture, delivery, and laying of (*a*) about 32 miles of high-tension three-core lead covered electric cables, etc.; and (*b*) about 50 miles of low-tension lead-covered electric cables, etc., and about 30 miles of telephone cables for the Council's tramways. Tenders by March 21.

Gillingham.—The Borough Council invite tenders for the supply and delivery for 12 months of the following materials for use in connection with their electricity department: (*a*) electricity meters, (*b*) lubricating oils. Particulars from the Borough Electrical Engineer, Generating Station, Gillingham-road. Tenders to Mr. F. C. Boucher, town clerk, by March 23.

Melbourne (Australia).—The Postmaster-General invites tenders for the construction and laying complete of two submarine telegraph cables between the State of Victoria and the State of Tasmania. Tenders must be accompanied by a deposit of £1,000. Tenders to the Secretary, Postmaster-General's Department, 51, Spring-street, Melbourne, by April 14.

Rio de Janeiro (Brazil).—Tenders are invited by the Reparticao da Carta Maritima do Brazil, 3 rua D. Manoel, Rio de Janeiro, for the construction of lighthouses on the coast of Brazil, and the supply and installation of lighting apparatus. Information may be obtained at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E C. Tenders by March 25.

Glasgow.—The Corporation invite tenders for the supply of stores for one year from June 1, 1908, including chilled iron brake blocks, car wheels, etc.; carbon brushes; vulcanised indiarubber cables; cast-iron castings; malleable iron castings; cast-steel castings; indiarubber and asbestos goods; springs; tiebars; galvanised wires; and fuel for Pinkston power station. Particulars from the General Tramways Manager. Tenders to the Town Clerk by April 6.

London.—The London County Council invite tenders for the road-work and platelaying required for the reconstruction for electric traction, on the overhead trolley system, of the existing tramways from Brixton-road to a point near Camberwell Green, *via* Gresham-road and Coldharbour-lane, and for certain paving works of the street improvements in connection therewith. The total length of the above-mentioned lines is about 2½ miles single track. Tenders by March 24.

Christiania.—The Commercial Intelligence Branch of the Board of Trade have been informed by his Majesty's Consul at Christiania that the Director of the Kongsberg Silver Mines has issued a call for tenders for an electric power station to be erected at the said mines. Tenders, marked "Kraftoverforingsanlaeg," are to be delivered to Kongsberg Solvverks Direktorkontor by 1 p.m. on March 21. Copies of the specifications and conditions may be inspected by British firms on application at the Commercial Intelligence Branch of the Board of Trade.

Belfast —The Tramways and Electricity Committee invite tenders for 12 months' supply (ending March 31, 1909) of the following materials: (1) engine-room stores; (2) packings; (3) oils; (4) rubber goods; (5) firebricks and fireclay; (6) tools; (7) incandescent lamps; (8) arc lamp carbons; (9) galvanised wire; (10) asbestos goods. Particulars from the City Electrical Engineer, Electricity Works, East Bridge-street, Belfast. Tenders to the Chairman of the Tramway and Electricity Committee, at the office of Sir Samuel Black, town clerk, by March 23.

Manchester.—The Lancashire and Yorkshire Railway Co. invite tenders for the supply of stores during 12 months ending April 30, 1909, including signal and telegraph fittings; signal, telegraph, and electric light wires; steel springs (spiral); steel cotters and pins; steel plates (Siemens); steel sheets, etc.; steel tubes for boilers; steel tubing (cold-drawn weldless); tinned and zinc sheets, etc.; wire; wire rope, etc. Particulars from Mr. Waring, Stores Department, Osborne-street, Manchester, and tenders to Mr. R. C. Irwin, secretary, Hunt's Bank, Manchester, by March 30.

RESULTS OF TENDERS.

New South Wales.—The tender of T. W. Weaver, Goulbourn, has been accepted for overhauling steam and electric plant at the Hospital for Insane, Kenmore, for £287. 10s.

Harrogate.—The Town Council have accepted the tender of the Chloride Electrical Storage Co., Leeds, for the installation of a new storage battery for continuous current for £49. 18s.

Melbourne.—The Electric Supply Committee have accepted the tender of J. A. Newton and Co. for five arc lamps at £7. 8s. each, and that of the Allgemeine Elektricitaets-Gesellschaft for 22 recording meters at £90.

Hammersmith.—The Electricity Committee have accepted the following tenders for the annual supplies: arc lamp globes and shades, H. G. Mayer and Co.; electrical accessories, Verity's Limited; electrical insulating goods, General Electric Co.

Yarmouth.—The Electricity Committee have accepted the tender of Bessey and Palmer for the supply of 500 tons of coal for the electricity works. The Tramways Committee have accepted the quotation of the British Griffin Chilled Iron and Steel Co. for the supply of 40 steel tyres at 35s. 6d. each.

Lowestoft.—The Town Council have accepted the following tenders: Henley's Cable Co., supply of house cut-outs for the year, 4s. per pair, 10s. 6d., 6s., and 6s. 9d. per set; Railway and General Engineering Co., Nottingham, three roadway frames and covers in connection with the tramways; Underfeed Stoker Co., provision of an underfeed stoker, £330.

Castlerea.—The Rural District Council have accepted the following tenders for the following work in connection with electric lighting scheme for the town of Ballaghaderreen; suction gas plants, gas-

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engines, dynamos, battery, switchgear, overhead distribution lines, arc lamps, and service connections : Eaton and Davidson, 49, Mid Abbey-street, Dublin, electrical work, £1,525; J. Clarence, Ballisodare, co. Sligo, building work, £385.

London.—The following tenders have been received by the London County Council for special track work in connection with the Brixton-road to Camberwell Green tramways :

Lorain Steel Co., Ohio, U.S.A.	£833	10	0
Hadfield's Steelfoundry Co., Sheffield*	838	12	6
E. Allen and Co., Sheffield	888	10	0

* Recommended for acceptance.

London.—The London County Council have received the following tenders for the supply of overhead travelling crane for the Hammersmith temporary tramways sub-station :

J. Smith (Keighley), Limited, Keighley*	£159	10	0
Carrick and Ritchie, Edinburgh	201	0	0
T. Larmuth and Co., Salford	210	0	0

* Recommended for acceptance.

OPENINGS FOR CONTRACTORS.

ABERDEEN—Pavilion, King's College, stores, etc., Justice Mill-lane, additions, business premises (£5,000).

ABERDEEN—House, Whitehall-place, Mr. Alexander Young; house, North King's Gate, Messrs. Cameron and Watt, architects.

ABERGAVENNY—Two villas, Summersfield-road, Messrs. J. G. Thomas and Sons.

ANSTON—Two houses, Trustees of the Princess of Wales's Lodge, M.O.O. ; house at Lindrick Dale, Mr. W. Rose ; house and shop, Mr. G. Coggan.

ASHLEY—Additions, Manor House, Mr. Ross ; house, Kilwardy-street, Mr. T. Orton ; two houses, three shops, Bath-street, Mr. W. Slater ; house, Smisby-road, Mr. W. Smedley ; alterations, house, Shrubbery-terrace, Mr. Brunt.

ASHBY—Post office, shop, and house, Bath-street ; Mr. H. Smedley, architect.

ASKERN—Extensions, school, West Riding County Council.

BAILDON — Two semi-detached houses, Greencliffe-park. Mr. J. Harper Bakes, architect.

BALROTHERY—One hundred and ninety workmen's dwellings, Rural District Council.

BANFF—Extensions, school, Burgh School Board.

BANKNOCK—Twenty-nine houses, Banknock Coal Co.

BARKING TOWN—Electricity works (£2,400), Urban District Council.

BARNSLEY—Eight houses, Sherwood-street, one Bala-street, Mr. C. W. Plastow ; six houses, Derby-street, Mr. E. Pashley ; six houses, Blenheim-grove ; additions to house, Clarke-street, Mr. W. E. Hall.

BATLEY—Alterations and additions, girls' grammar school, Field-hill, Education Committee.

BATLEY—Gospel hall, Mount-pleasant, Nonconformist Trustees.

BIRKENHEAD—Library, Chester-street, Library Committee.

BIRKENHEAD—Extensions, workhouse (£10,092), Board of Guardians.

BLABY—Extensions, school, West Riding County Council.

BLABY-WITH-HEXTHORPE—Elementary school (£4,667), extensions, school (£269), West Riding County Council.

BLAENRHONDDA—Improvements, school, Rhondda Urban District Council.

BLAENYCWM—Extensions and alterations, school, Rhondda Urban District Council.

BLAINA—Rebuilding Hope Hall for the Forward Movement.

BLACKTOFT—Council school to accommodate 82 scholars, and teacher's house, East Riding Education Committee.

BLANCHARDSTOWN—Housing scheme, North Dublin County Council.

BLAYDON-ON-TYNE—House, Prudhoe Station, Co-operative Society.

BLOXWICH—Conversion of music hall into public hall (£500). Town Council.

BONCATH—Justices hall and two dwelling-houses, Newchapel. Mr. Griffith George, Flynone, architect.

BOSTON—Elementary school, Carlton-road, Education Committee.

BOURNEMOUTH—Refreshment shelter and boathouse (£555), Corporation.

BOYNTON—Council school and teacher's house, East Riding Education Committee.

BRIMINGTON—School, Brimington Church Council.

BRYNCETHIN — House and shop. Mr. W. Y. Davies, Coity-road, Bridgend, architect.

BURNHAM—Alterations to house, Alfred-street, Mr. Hutchin ; alterations to house, Alfred-street, Mr. Puddy ; house, Mr. T. F. Huish ; house, Mr. Pitts ; house, Stodden's-lane, Mr. Pople.

BURSLEM—Electricity undertaking (£12,000), Town Council.

CABRAGH—Workmen's dwellings, North Dublin Rural District Council.

CADDER—Additions to Lenzie Academy (£4,000), School Board.

CALDICOT—Elementary school, Monmouthshire Education Committee.

CAMPBELLTOWN—Additions to grammar school, School Board.

CARDIFF—Elementary school, Newport-road (£10,000), Education Committee.

CARDIFF—Warehouse, Frederick-street. Messrs. James and Morgan, architects.

CANNOCK—Extensions, workhouse, Board of Guardians.

CASTLEFORD—Public baths (£6,900), fire station, mortuary, etc., (£750), Urban District Council.

CASTLEKNOCK — Housing scheme, North Dublin Urban District Council.

CATERHAM—Additional quarters at asylum, Metropolitan Asylums Board.

CAWNPORE—Office for resident engineer.

CHADDERTON—Council offices, Garforth-street, County Council.

CHANDPUR (INDIA)—Police court, Public Works Department.

CHELTENHAM—Elementary school, Swindon Education Authority.

CHESTER—Elementary school, Egerton-street (£3,200), Education Committee.

CHESTERFIELD—Health offices (£650), additions to highways office (£200), and additions to slaughter houses (£400), Town Council.

CLOGHRAN—Housing scheme, North Dublin County Council.

CLOWNE—House, Spinkhill, Mr. J. T. Marsh ; two houses, Neil-street, Mr. Lilley ; eight houses, Cresswell, Mr. Lawley ; additions to house, Whitwell, Mr. D. Godley.

CLYDEBANK—Extension, fire brigade station, Town Council.

COBHAM—Residence. Mr. A. E. Delve, architect.

CONISBOROUGH—Elementary school, West Riding County Council.

CONSETT — Alterations, Wetherall House. Mr. T. H. Murray, architect.

COSTORPHINE—Six houses, Suburban District Committee, Midlothian County Council.

COUPAR ANGUS—Stores, etc., Ellerslie, Mr. Strain ; consulting-room, Dr. Davidson.

COURTDUFF—Housing scheme, North Dublin County Council.

COWIE—Sixty-four houses, Alloa Coal Co.

CRAIGIE—Vestry and session house in connection with St. Stephen's Church.

CROFTON—Extensions to Crofton School (£1,450), West Riding County Council.

CROMPTON — Four houses, Fir-lane, Mr. Meadowcroft ; house, Chamber-road, Mr. T. Milnes

CROYDON—Extensions, workhouse (£16,000), Board of Guardians.

DARLASTON—Church, King's Hill, Primitive Methodists.

DARLINGTON—Three houses, Woodlands-terrace, Messrs. G. Dickinson and Son ; eight houses, Oak Dene-avenue, etc., Messrs. Kitchin and Lee ; two houses, Cartmell-terrace. Mr. E. W. Lyall ; eight houses, Upper John-street, Mr. J. Jenkins.

DINNINGTON—Two houses, New-street, Mr. C. R. Revill ; two houses, Mr. M. A. Holmes.

DUNKELD—Restoration, cathedral, Dunkeld Presbytery.

DURRINGTON—Elementary school, West Sussex Education Committee.

EAST HAM—Extensions, hospital, Boundary-road, Town Council.

EGLWYSWRW—Alterations and additions, Council school, Pembrokeshire Education Committee.

ELGIN—Three houses, Wester Manbeen—Mr. J. Wittet, architect ; shop, etc., New Elgin—Mr. J. Jamieson, architect.

ELIE — Villa, Williamsburgh. Messrs. J. and T. W. Currie, architects.

EVESHAM—Public library, institute, and hall, Town Council.

FELIXSTOWE—Storage battery and booster, Urban District Council.

FILEY—Council school to accommodate 270 scholars, East Riding Education Committee.

FLINT—House and shop, Holywell-street, Mr. T. Lloyd ; two shops, Mr. M. S. Rogers.

FOCHABERS — Dwelling-house, Nether Auchenreath. Mr. D. J. Cunningham, architect.

FOLKESTONE—Theatre (£15,000), Local Syndicate.

GLENISLA—Mansion house, Redhall. Messrs. L. and J. Falconer, Blairgowrie, architects.

GOLDTHORPE—Extensions, school (£1,192), West Riding County Council.

GORS—Elementary school, Aberystwyth Education Committee.

GRANGE VILLA—Council schools, Grange Villa, near West Pelton, Murton Colliery, and Chopwell, Durham Education Committee.

GRAVESEND—Three shops and houses, Milton-road, Mr. G. E. Clay.

GRIMSBY—Extension, Welholme Council School, Education Committee.

GUNTUR (INDIA)—Police guardroom and press office, Madras Government.

HAREFIELD—Two houses, High-street, Mr. C. J. Filkins

HARWOOD—Seven houses, Tottington-road, Mr. J. Ramsden.

HARPURHEY—Offices, stables, etc., Factory-lane, Manchester Corporation.

HEANOR—Public mortuary, Burial Board.

HENDON—Elementary school to accommodate 1,000 scholars, The Hyde, Education Committee.

HEREFORD—Workmen's dwellings, Town Council.

HEYSIDE—Cotton spinning mill, Moss Lane Spinning Co.

HIGHER BROUGHTON — United Methodist church and schools, Leicester-road (£7,000), Trustees.

HULL—Extensions, town hall (£14,300), Town Council.

HULL—Supplying and laying electric lighting mains, Electric Lighting Committee.

INISHOWEN—Eighty-eight houses, District Council,

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KANKAKEE (U.S.A.)—Hospital (70,000dol.), Municipal Council.
KEWSTOKE—Elementary school, Somerset Education Committee.
KHAJURAHAT (INDIA)—Vernacular middle school, United Provinces Government.
KILWINNING—Alterations and improvements to buildings of Mother Lodge No. 0, Main-street (£300), Town Council.
KINGUSSIE—Alterations and additions to business premises, Duke-street, Mr. Sangster.
KINLOCHLEVEN—Factory (£100,000). Messrs. Malpine and Sons, architects.
KINLOUGH—Housing scheme (£7,200), District Council.
KIRKHAMGATE—Elementary school (£2,700), Education Authority.
KIVETON PARK—Alterations to school, County Council Education Committee.
LAMPLUGH—Clubrooms, Lamplugh Cross, Workington Brewery Co.
LANCASTER—Girls' grammar school, Town Council.
LARGS—Municipal offices, Town Council.
LEADGATE—Alterations to premises, St. Ives-road, Leadgate Social Club; alterations to Brooms Schools, Education Authorities.
LIBERTON—Dairy premises, Fivehouses, Mr. J. Barbett.
LIMEHURST—Institution, Young Men's Christian Association.
LISNASKEA—Workmen's dwellings (£6,480), Rural District Council.
LITTLEHAMPTON—Shelter (£1,500), Council.
LLANELLY—Improvements, slaughter-house (£560), Borough Council.
LONGSIGHT—Dwelling-house, Darwen-road, Mr. R. Isherwood.
LONGTON—Three houses, Mr. Tyson; two houses, Howick, Mr. J. Pitchford.
LOSTWITHIEL—Public buildings and offices, Town Council.
MAGOR—Elementary school, Monmouthshire Education Committee.
MANCHESTER—Rebuilding Royal Hotel, Moseley-street, Messrs. Lewis and Co.
MARYPORT—Mission hall, classrooms, etc., Grasslot. Mr. H. Foxall, architect.
MATLOCK—Chapel, Hackney, Trustees of the Hackney Primitive Methodists.
MAYMYO (BURMA)—Requisite office buildings, headquarters of investigating staff of Burma police.
MEXBOROUGH—Extensions, school, Doncaster-road, West Riding County Council.
MIRZAPUR (INDIA)—Additions, Dufferin Hospital.
MOGOUNG (INDIA)—Police barracks.
MOLD—Four hundred colliers' houses, Mold Collieries.
MORPETH—Alterations, workhouse infirmary (£250), Board of Guardians.
NEWBRIDGE—Elementary school, Monmouth Education Committee.
NEWBURGH—Villa. Mr. W. Davidson, Ellon, architect.
NORTHALLERTON—Elementary school (£4,297), North Riding Education Committee.
NORWICH—Secondary school for boys (£31,500), Education Committee.
ORRELL—Three houses, St. James's-road, Mr. W. T. Highton; house, Gathurst-road, Mr. S. Swift.
OUTWOOD—Improvements to Outwood School, West Riding County Council.
OXENHOPE—Residence, Gate-lane. Messrs. Moore and Crabtree, Keighley, architects.
PADDINGTON—Alterations, south block of workhouse (£2,627), Board of Guardians.
PARLICKSTOWN—Housing scheme, North Dublin Urban District Council.
PENYCRAIG—Alterations, school, Rhondda Urban District Council.
PONTARDAWE—Public hall and institute. Mr. W. Beddoe Rees, Cardiff, architect.
PONTFADOG—Elementary school to accommodate 80 children, Denbighshire Education Committee.
POOLE—Alterations and additions, municipal offices, Town Council.
PORTH—John Pugh memorial hall (£3,100) in connection with the Forward Movement.
PORTWRINKLE—Hotel, near Torpoint (£8,000), Proprietors.
POWERSTOWN—Workmen's dwellings, North Dublin Rural District Council.
PRESTON—Alterations and additions, Council school, East Riding Education Committee.
PRESTON—Two houses, Mr. J. Fowler; alterations and additions, Woodplumpton, Rev. E. Millard.
RAGLAN—Elementary school, Monmouthshire Education Committee.
RAMSGATE—Secondary school to accommodate 340 scholars, Kent Education Committee.
RAVENSTHORPE—Five houses, Clarkson-street, Messrs. Lee and Hampshire.
ROCHFORD—Additions, children's home, Board of Guardians.
ROCHFORD—Enlargement of Board-room, Board of Guardians.
ROTHERHITHE—Alterations, Holy Trinity National Schools, Trustees.
ROTHESAY—Erection of a shelter (£5,000), Town Council.
ST. ANNES—Public baths, South-drive (£12,000), Baths Committee of St. Annes Council.
ST. AUSTELL—One hundred and four houses, Foxhole and Nanpean, West of England China, Clay, and Stone Co.
SOUTHEND—Additions, electric power station (£26,690), Corporation.
SHEFFIELD—Additions and alterations, public baths, Glossop-road, Health Committee.
SHREWSBURY—Pavilion, Victoria-avenue, Severnside, Committee of the Old Shrewsbury Bowling Club.
SLOUGH—Six houses, Chalvey Court Estate, Messrs. J. and W. Hibberd; additions to laundry, Henry-road, Mr. Cross; two houses, Bath-road, Mr. C. J. Jackaman; two houses, King's-road, Mr. P. Perrin; house, Uxbridge-road, Mr. H. D. Bowyer.
STANLEY—Church, Station-road, and renovation chapel, West Pelton, Primitive Methodist Circuit.
STANLEYTOWN—Extensions and alterations, Stanley School, Rhondda Urban District Council.
STANSTED—Two houses, Great Hallingbury, Mr. L. Frere; two houses, Little Hallingbury, Mr. T. Brown.
STOKE-UPON-TRENT—Alterations, workhouse, Board of Guardians.
STONEHAVEN—House near Baird-terrace, Mr. M. A. Hamilton.
SUDBURY—Two houses, Queen's-road, Mr. C. F. Dyer; house, Melford-road, Mr. Dennington.
SUNDERLAND—Laying bitumen-insulated cable, workhouse, Hylton-road, Guardians.
SWANAGE—Motor-house, Victoria-road, Mr. J. Parsons; five shops, Station-road, Messrs. Parsons and Hayter.
TADCASTER—Conversion of grammar school into police station, etc., West Riding Standing Joint Committee.
TALGARTH—Houses on the asylum estate, Visiting Committee of the Brecon and Radnor Asylum.
THAYETMYO (BURMA)—Improvements to jail, Government.
THORNE—Extensions, school (£2,128), West Riding County Council.
THORNTON—House, Stockdove-way, Mr. A. Swarbrick; house, Marsh-road, Mr. Porter; house, Stockdove-way, Mr. Platt.
THRYBERGH—Infant school (£3,708), West Riding County Council.
TIPTON—Goods shed, Great Western Railway Co.
TON PENTRE—Seven houses, Ton-row. Mr. E. W. D. Morgan, architect.
TRURO—Offices and showroom, Truro City Council.
TURTON—Institute, Edgeworth Recreation Ground, Mr. J. R. Barlow.
ULVERSTON—Slaughter-house, Coniston, Mr. W. Barron; additions, Gawthfield, Mr. W. F. Egerton; house, Flookburgh, Messrs. T. and R. Moore.
USK—Elementary school, Monmouthshire Education Committee.
WAKEFIELD—Extensions at asylum (£1,611), Asylums Committee.
WAKEFIELD—House, shop, and office, Northgate, Mr. G. Goodall; house, Ings-road, Mr. E. A. Elvey; house, Fernandes-road, Mr. A. W Warden; two houses, Balne-lane, Mr. W. W. Hunt
WALLASEY—Masonic temple (£2,550), Local Syndicate.
WALSALL—Purchase of Bloxwich Music Hall for £600 to convert into public offices, Town Council.
WALTON—Elementary school, West Riding County Council.
WALTON COMMON—Elementary school (£4,825), West Riding County Council.
WANTAGE—Alterations, workhouse, Board of Guardians.
WARE—Pumping station, Stanstead (£3,200), Urban District Council.
WARRINGTON—Public conveniences, market hall, Sanitary Works Committee.
WESTGATE—Music hall adjoining opera house, Messrs. Sherwood and Co.
WEST HARTON—Extensions, workhouse, Guardians of South Shields Union.
WEST NORWOOD—Almshouses, Hamilton-road, Corporation of Wardens of St. Saviour, Southwark.
WESTON-SUPER-MARE—Bank, High-street, London City and Midland Banking Co.
WEYMOUTH—Pavilion, Town Council; six house, Spa-road, Radipole, Mr. F. Horsey.
WHITEBROOK—Elementary school, Monmouthshire Education Committee.
WHITEHAVEN—Alterations, workhouse, Board of Guardians.
WIDCOMBE—Vestry connected with parish church.
WILLESDEN, N.W.—Electricity undertaking (£14,727), Urban District Council.
WILLESDEN, N.W.—Municipal rifle range, Willesden Council.
WIMBLEDON—Electricity undertaking (£17,600), Town Council.
WINDSOR—Additions to Royal Victoria Nursing Home, South Ascot, and house at Ascot, Mr. Round; motor-house, etc., Ewhurst, Frances-road.
WINGATE—Enlargement, Primitive Methodist Church, Trustees.
WISSETT—Elementary school, East Suffolk County Council.
WOKINGHAM—House, Carey-road, Mr. J. B. Seward; additions, Meadowcroft, Murdoch-road, Dr. Pearce; house and shop, Station-road, Mr. R. Hosler; house, Wellington-road, Mr. H. Craig.
WOMBWELL—Two houses, Blythe-street, Mr. W. E. Wainwright; additions to foundry premises, Hough-lane, Municipal Foundry and Engineering Co.
WORKSOP—Shops and premises, Gateford-road, Mr. G. G. Middleton; house, Lead-hill, Mr. J. W. Chadwick; alterations to Criterion Hall, Mr. S. Goodman.
YELLOW WALLS—Workmen's dwellings, North Dublin Rural District Council.
YIEWSLEY—Four houses, Otterfield-road, Messrs. Johnson and Stuart.

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PROVISIONAL PATENTS, 1908.

MARCH 6.

5064. Improvements connected with electric batteries. Thomas Leslie Rowlands, 4, Clayton-square, Liverpool.

5066. Improvements in telephone instruments. William Aitken, care of British Insulated and Helsby Cables, Limited, Milton-road, Edge-lane, Liverpool. (Complete specification.)

5086. Improvements in or relating to electric tremblers. Louis Savart and Jules Graindorge, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, Oct. 31, 1907, being date of application in France.) (Complete specification.)

5097. Improvements relating to portable electric accumulators. Lars Bristol, 33, Cannon-street, London.

5099. Improvements relating to electric switches. Andreas Peter Lundberg, Gustaf Charles Lundberg, and Percival André Lundberg, Queen Anne's-chambers, Westminster. (Complete specification.)

5137. Improvements in and relating to telegraph, telephone circuits, and the like. Henry Hughes Harrison and British Insulated and Helsby Cables, Limited, 18, Southampton-buildings, London.

MARCH 7.

5158. Improvements in low-tension electric ignition apparatus for internal-combustion engines. Albion Motorcar Company, Limited, and Thomas Blackwood Murray, 121, West George-street, Glasgow. (Complete specification.)

5159. Improvements relating to electro-mechanical transmission systems for automobiles and the like. Henri Pieper, 24, Temple row, Birmingham. (Complete specification.)

5160. Improvements in or relating to electro-mechanical transmission systems for automobiles and the like. Henri Pieper, 24, Temple-row, Birmingham. (Complete specification.)

5170. Improvements in or connected with electric automusical instruments. Thomas Ernest Raymond Phillips, 15, Water-street, Liverpool.

5176. Electric cash check register. Edward Ingle, The Atlantic Hotel, West Hartlepool.

5199. Improvements in electric cables. Harold Gray, 4, Bloomsbury-square, London.

5212. Improvements in electrodes. Ernst Waldemar Jungner, 7, Southampton-buildings, London. (Complete specification.)

5214. Improved process for depolarising galvanic batteries. Ernst Waldemar Jungner, 7, Southampton-buildings, London. (Complete specification.)

5219. Improvements in and relating to heat accumulators for supplying low-pressure fluid for motive and other purposes. The British Thomson-Houston Company, Limited, and Reginal Francis Halliwell, 83, Cannon-street, London.

5223. Improvements relating to galvanic apparatus. Ernst Waldemar Jungner, 7, Southampton-buildings, London. (Complete specification.)

5225. Improvements in electrodes for arc lamps. Allgemeine Electricitäts-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, July 5, 1907, being date of application in Germany.) (Complete specification.)

MARCH 9.

5231. Improvements connected with arc lamps. Verity's, Limited, and Charles Bell Walker, 11, Burlington-chambers, New-street, Birmingham.

5262. Improvements in sewing machines and electric apparatus or motor propeller and the like. Rose Montague Holland, 89, Regent-street, London.

5264. Internal-combustion engine with magneto-igniter for actuating cycles and the like. Charles Arthur Allison, 52, Chancery-lane, London. (Société Anonyme H. and A. Dufaux et Cie., Switzerland.) (Complete specification.)

5271. Improved automatic electric fire and heat alarm. James William Butterworth, 321, High Holborn, London. (Date applied for under Section 91 of the Act, Oct. 23, 1907, being date of application in New Zealand.) (Complete specification.)

5297. Improvements in primary batteries. Wilhelm Alexander Felix Bleeck, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

5306. Improvements in alternating electric current motors. Hermann Aron, 47, Lincoln's-inn-fields, London. (Complete specification.)

5311. Improvements in apparatus for producing electrical oscillations. William Phillips Thompson, 6, Lord-street, Liverpool. (Gesellschaft für drahtlose Telegraphie m. b. H., Germany.) (Complete specification.)

5313. Improvements in and relating to incandescent lamp sockets. Frederick Augustus Swan, 72, Cannon-street, London. (Date applied for under Section 91 of the Act, March 15, 1907, being date of application in United States.) (Complete specification.)

5317. Improvements for electrolytically etching or depositing metals upon metallic surfaces and the like. Sherard Osborn Cowper-Coles, 4, South-street, Finsbury, London. (Complete specification.)

5331. Improvements in and relating to reverse-current or reverse-power devices. Michael Bert Field and Ferranti Limited, 18, Southampton-buildings, London.

MARCH 10.

5344. Improvements in and relating to fluid-controlling devices. Sebastian Ziani de Ferranti, 18, Southampton-buildings, London. (Date applied for under Rule 13, Dec. 19, 1906. An invention comprised in application No. 28,951, dated Dec. 19, 1906.)

5372. Improvements in reflectors for lamps, electric, and the like. Joseph Bein, 205A, Pentonville-road, London.

5380. Improvements in insulators. Leicester Bradney Stevens, jun., 239, Southwark Bridge-road, London.

5387. Improvements in the manufacture of electric incandescent lamps. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

5390. Improvements in lightning arresters. Jacob Baker Struble, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

5415. Improvements in incandescing or heating bodies containing or consisting of zirconium for incandescent electric lamps, heaters, and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

5416. Improvements in filaments for incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

5422 Improvements in and relating to the holders for the shades or globes of gas and electric fittings. Frederick George Whatton Coleman, 7, Southampton-buildings, London.

5425. Improvements relating to telephony. John Leslie Cloudsley, 18, Southampton-buildings, London.

MARCH 11.

5444. Electro-automatic sounding apparatus. Carlos Fernandes Varela, care of Vickers, Sons, and Maxim, Barrow-in-Furness. (Complete specification.)

5466. New or improved safety trolley head for electric traction cars. Samuel Westwood, 83, Longden-road, Lonsight, Manchester.

5489. Improvements in and relating to the electrical control of railway traffic. William Robert Sykes, William Robert Sykes, jun., and Charles Joseph Cooke, 53, Chancery-lane, London. (Complete specification.)

5497. Improvements in or relating to radio-telegraphy. Gustav Reuthe and the Amalgamated Radio-Telegraph Company, Limited, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, June 18, 1907, being date of application in Germany.) (Complete specification.)

5510. Improvements in braking systems using electric motors as generators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

MARCH 12.

5529. Improvements in mechanism for operating the controllers used on electrically-driven cranes. William Fox, 56, Talbot-road, Old Trafford, Stretford, Lancs.

5549. Improvements in apparatus for controlling electric circuits. William Ranson Cooper, 113, Tulse-hill, London.

5560. Improvements in incandescent electric lamps. Charles Henry Stearn and Charles Fred Topham, 47, Lincoln's-inn-fields, London.

5590. Improved apparatus for registering telephonic calls. William Mawdsley Herd and Alexander Esplen, 8, Quality-court, Chancery-lane, London.

5596. Improvements in mercury or metallic vapour electric lamps. Henry Andrew Kent, Harold Georgie Lacell, and the Silica Syndicate, Limited, 47, Lincoln's-inn-fields, London.

5610. Improvements in and relating to incandescent electric lamps. Allgemeine Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, March 14, 1907, being date of application in Germany.) (Complete specification.)

5611. Improvements in electric motor controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on March 26.)

1906.

19378A. Electrical signalling apparatus for use on and in connection with railway locomotive engines and the like. Bounevialle. (Date applied for under Rule 13, March 28, 1907.)

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29647. Automatic telephone exchange systems. Merk. (Rights under Section 91, Patents, etc., Act, 1907, not granted.)

1907.

2383. Electric contact make-and-break devices. Mitchell.

2587. Arc lamps. Howard.

2588. Dynamo-electric transmission gear for motor road vehicles. Albrecht. (Date applied for under International Convention, Feb. 1, 1906.)

4709. Signalling by electromagnetic waves. Fessenden.

4710. Transmission of energy by electromagnetic waves. Fessenden.

4910. Electrolytic apparatus for bleaching and scouring vegetable and animal fibres and fabrics. Dassomville.

5133. Compound-wound electric motors. Leitner.

5187. Process and apparatus for electromechanical distance transmission of half-tone illustrations, portraits, and other photographs, engravings, manuscripts, typograms, or the like. Carbonnelle.

5300. Point arrangements of the side-slot conduit system of electric traction. Garrod.

5402. Electric traction on the surface-contact system. Suchostawer.

5564. Concatenated control of alternating-current motors. Mershon.

5630. Electric switches applicable to internal-combustion engines. Ward.

5671. Control of electrically-propelled vehicles. British Thomson-Houston Company and Hopps.

5733. High-efficiency alternating-current polyphase commutator motor. Golby. (Soc. Alsacienne de Constructions Mecaniques.)

5741. Commutating poles for dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

5749. Cable for electric traction on the stud-contact system. Griffiths and Bedell.

5925. Primary cell. Triquet.

6006. Prepayment mechanism for electric and gas meters. Bowden, Robinson, and Jacks.

6135. Signalling systems for railways and the like. British Thomson-Houston Company. (General Electric Company.)

6992. Electric railway signalling apparatus. Notarianni.

8881. Intercommunication telephone systems. Parsons.

9029. Electrolytic apparatus and galvanic batteries. Borgnet.

10152. Conversation counters in telephone exchanges. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, May 3, 1906.)

11582. Apparatus for wireless telegraphy. Fleming.

11814. Electric circuit breakers. Scott.

14203. Dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

15441. Voltage regulation for electric distribution. Conrad. (Date applied for under International Convention, July 9, 1906.)

15773. Double sounders for telegraphic purposes. Powles and Moore.

16346. Electrical systems of distribution. Turbayne. (Date applied for under International Convention, July 25, 1906.)

17539. Elevated electric railways. Gilstrap. (Date applied for under International Convention, July 31, 1906.)

17832. Trolley wheels for electric traction. Sawyer.

18242. Electric fire-alarm system. Schöppe.

18243. Electric arc lamps. Szubert.

20128. Electric connections for multiple wireless telegraphy. Eisenstein.

20788. Electric batteries for medical purposes. Haddan. (Thompson and Martin.)

21407. Brush-holder for dyname-electric machines. Garratt.

21982. Trolley heads or collectors of electricity. Drewet.

22832. Armatures for electric motors. Lamme. (Date applied for under International Convention, Nov. 3, 1906.)

23603. Electromagnetic winding gear for clocks or the like. Boult. (Normal-Zeit. Ges.)

23681. Electric contact or connecting plugs. Steinthal and Jessop.

23877. Electromagnetic sound producers. Birth and Lökken.

23894. Electric condenser. Moscicki and De Modzelewski. (Date applied for under International Convention, Oct. 30, 1906.)

24587. Flexible electrical connection devices. Keller.

24697. Electric furnace for effecting fusion or for refining. Viel.

1908.

324. Electrically-heated hot-water bottles. Christian. (Date applied for under International Convention, Jan. 8, 1907.)

897. Testing installation for electromagnetically-operated sparking plugs. Robert Bosch (Firm of). (Date applied for under International Convention, March 22, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-⅝
—— Ord., 1,125 000	1	..	½-⅝
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125.000	1	..	23/32-27/32
—— Ordinary, Nos. 1-125,000	1	..	½-⅝
British Aluminium Co., Ordinary, 2 001-40 000	5	..	3¾-4
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4⅛-4¼
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4¼-4⅜
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3¾-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3,000	100	..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¾-7¼
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100	..	101-104
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock Red.	100	..	85-89
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275.001-475 000	3	..	¼-⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	¼-⅞
—— 4½ per cent 1st Debenture Stock	100	..	77-80
—— 4½ per cent. 2nd Debenture Stock	100	..	63-66
Callender's Cable, Debentures	100	..	106-108
—— Ordinary	5	..	10¾-11¾
—— 5 per cent. Pref.	5	..	5⅜-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1 13/16-2 1/16
—— 5 per cent Debentures	100	..	92-95
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1 1/16-1 5/16
—— 4½ per cent. Debenture Stock, Red.	100	..	99-102
Edison and Swan United, "A" Shares, 1-99 261	3	..	¾-1
—— "A" Shares, 01-017,139	5	..	1¼-2⅛
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112,100	2	..	¼-⅞
—— 7 per cent. Cumulative Pref.	2	..	1¼-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100	..	61-65
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red.	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7¼-8¼
—— 4 per cent. 1st Mort. Deb Stock	100	..	89-92
W. T Henley's Telegraph Works, Ordinary	5	..	10½-11¼ xd
—— 4½ per cent. Preference	5	..	4¾-5
—— 4½ per cent. Debentures	100	..	105-108
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	99-101
National Electric Construction Co., 1-170,000	1	..	½-⅝
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	31-33
—— 4 per cent. Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4¼-5
Bournemouth and Poole, Ordinary	10	..	11-12
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	10-11
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	10 10¾
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Bromley (Kent) Electric Light and Power Co.	5	..	4⅝-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-99
Brompton and Kensington, Ordinary	5	..	7½-8½ xd
—— 7 per cent. Preference	5	..	6¾-7¾ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6¾ 7¼
—— Nos. 80,000-100.000	5	..	5¾-6¾ xd
Cambridge Electric Supply Company £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	93-97
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	4¼ 4⅝ xd
—— 4½ per cent. Cum Pref., 1-80 000	5	..	4¼-4⅜
—— 4 per cent. Debenture Stock, Red.	100	..	96-99
—— "City Undertaking," 4½ p c Cum. Pref., 1-40,000	5	..	4¼-4⅜
—— ditto (1903) 40,001-80,000	5	..	4⅜-4⅞
Chelsea Electricity Supply	5	..	3⅛-3⅜
—— 4½ per cent. Debentures	100	..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref	10	..	11¼-11⅝
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent. 2nd Deb. Stk., Red.	100	..	100-105
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red. 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10 001-50,000	5	..	3-3⅛ xd
—— 5 per cent. Preference, 1-50,000	5	..	4¼-4⅜ xd
County of London Elec. Supply, Ordinary	10	..	7⅞-8⅛
—— 6 per cent. Cum Pref.	10	..	11-11¼
—— 4½ per cent. Debentures Prov Certs. All pd., Rd.	100	..	105-108
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	97-100
Edmundson's Electricity Corporation, Ordinary, 1-50 000	5	..	¼-⅜
—— 6 per cent. Cum Pref.	5	..	¼-1¼
—— 4½ per cent. First Mort. Deb	100	..	60-70
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	—		72½-75½ p.c. xd
Electric Lt & Traction Co. of Aust., 6 p.c. Cm Pf., 1-30,000	5	..	2¼-2⅝
—— 5 per cent Debenture Stock, Rd.	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100	..	91-94
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4⅜-4⅝
—— 5 per cent. Cum. Pref., Nos. 1-10 00)	5	..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-13 000	5	..	6¼-6½
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	98-101
Isle of Wight Elec. Lt and Pr., 4½ p.c. Db. Stk., Red	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	¼-½
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	..	7¼-8¼ xd.
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼

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Name.	Amount paid. £	Last price. £
London Electric, Ordinary	5	1¼-1⅝ xd
—— 6 per cent. Pref.	5	4¼-5 xd
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100	92-95
Metropolitan Ordinary, 100,001-200,000	5	5-5¼ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4⅛-5¼
—— 3½ per cent. Mortgage Debenture, Red.	100	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000	—	76-78 p.c.
Mexican Light and Power Co., Capital Stock	$100	51-53
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	84-86
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	6⅛-6⅜ xd
—— do., 57,010-75,000	5	6⅛-6⅜ xd
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	6⅛-6⅜
—— 5 per cent., Pref., 1-57,009	5	5⅛-5⅜ xd
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5⅛-5⅜ xd
Notting Hill Electric Lighting	10	11½-12¼
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5½-6 xd
—— 4 per cent. Debenture Stock	100	93-95
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red.	100	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5	4⅜ 5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	4⅜ 5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	½-1½
—— 4 per cent. Debenture Stock	100	70-74
South London Ordinary	5	2⅝-2¾
South Metropolitan Electric Light and Power, Ord.	1	⅞-⅞
—— 7 per cent Cum Pref.	1	1-1⅛
—— 4½ per cent 1st Mort. Deb.	100	101-104
St. James's and Pall Mall, Ordinary, 101-20,080	5	7½-8½
—— 7 per cent. Pref.	5	6¾-7
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1½-2¼
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	2-2¼
Westminster, Ordinary	5	7⅜-8¼
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	5-5½

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,007	5	6-6¼
—— 10 per cent. Non-Cum 2nd Pref., 260,008-280,007	5	8-8¼
—— Permanent 6 per cent Debenture Stock, 1888	100	129-132
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	10--107
Barcelona Tramways, Ord., 1-20 000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	9/ 6-11/16
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	13/16-15/16
Birmingham and Midland Trams., 4½ p. c 1st Deb. Stk., Red.	100	93-96
Blackpool and Fleetwood Tramroad	10	13⅜ 13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	9⅜-10¼
—— 4½ per cent. Deb. Stock, Red.	100	95-97
Brisbane Tramway Invest., Ord., 1-75,000	5	3¼-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅜ 5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	97-101
British Columbia Electric Railway Co., Ord Def.	100	127-130
—— Ord. Pref.	100	107-111
—— 5 per cent. Cum. Perpetual Pref. Stock	100	105 109
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	101-104
—— 4½ per cent. Vancouver Power Deb.	100	100-103
British Electric Traction, Ord. 1-300 000 & 60,001-90,000	10	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10	4⅛-4⅜
—— 5 per cent. Perpetual Debenture Stock	100	97-100
—— 4½ per cent 2nd Deb. Stock	100	72-76
Bueno Ayres and Belgrano Trams.	5	4⅜-4⅞
—— "A" 6 per cent. Cm. Pf., 1-4' .000	5	4⅜ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27 500	5	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	95-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	100-104
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	92 95
Calcutta Tramways, Ord., Nos 1-137,610	5	6⅜-7⅛
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	101-105
Cape Electric Tramways, Nos. 1-480,000	1	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4⅜-7⅛
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	98-101
City of Buenos Ayres Trams. Co. (1'04), 1-248,000	5	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red. 1985	100	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	89-93
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	12½-1⅜
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	97-100
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	80-85
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	13-14⅛
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5	⅛-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100	87-91
—— 6 per cent. "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	91-94
—— £296 500 2nd Mort. Deb. Stock	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	⅛-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	⅛-1⅛
—— 5 per cent. Mort Deb., 1-5,000 Red	100	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	82-86
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red. 1-5,635	$1 000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21 635 and 23,436 25 000	5	4¼ 5
—— 4½ per cent 1st Mort. Deb Stock, Red.	100	87-92
Metropolitan Elec Trams., Defd., 1 000,001-1 314 016	1	1/16 3/16
—— 5 per cent. Cum Pref. 500,001 1,000 000	1	25/32-29/32
—— 4½ per cent. Deb. Stock, Red.	100	97-99
Mexico Trams. Co., Gen. Cons. 1st Mort 50-year 5 per cent. Gold Bonds	—	£24-84½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74 000	5	½-1½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1	⅛-⅜
—— 5 per cent Cum Pref., 300 001-545 000	1	⅛-⅜
—— 4½ per cent Debenture Stock	100	93-96
Provincial Tramways Co., Ordinary, 1-24,912	10	4½-5
—— 6 per cent. Cum. Pref., 1-10,000	10	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5	5-5½
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	96-98
Sao Paulo Tramway, Light, and Power Co.	$100	121-125
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500	96-98 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum Pref., 19,571-169 570, Prov. Certs.	1	⅞-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100	78-82
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1 600	100	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	3-3¼
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	63-66
—— 4 per cent. Pref.	100	82-84
—— " " deferred	100	42-45
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100	100-103
City and South London, Consolidated Ordinary	100	37-39
—— 4 per cent Debenture Stock	100	101-104
—— 5 per cent. Pref. Stock '91	100	114-117
—— " " " '96	100	112-115
—— " " " '01	100	110 113
—— " " " '03	100	106-109
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50 000	10	3⅜-4⅜
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	40-44
—— Deposit Receipts	—	40-44

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price. £
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28 000 and 53,001-78 000	$1 000	85 87
Anglo-American Telegraph Co., Ordinary	100	54-57
—— 6 per cent. Preferred Ordinary	100	98-100
—— Deferred Ordinary	100	13½-14
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	98½-101½
Chili Telephone Co., 1-44 000	5	7-7½
Commercial Cable Co., Sterl. 500-year 4 p.c. Deb. Stk., Red.	100	87-90
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	7-8
—— 10 per cent Preference, 1-6 000	10	16-17
Direct Spanish Telegraph Co., Ordinary	5	3¼-3½
—— 10 per cent. Cum. Preference	5	8½ 9⅛
—— 4½ per cent. Debs., 1-600	50	99½-102½
Direct United States Cable Co.	20	13⅜-14¼
Direct West India Cable Co., 4½ per cent. Debs., Reg. within 1-1,200, Red.	100	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000, 1913	25	99-101
Eastern Extension, Australasia and China, 1-300 000	10	12⅜-13¼
—— 4 per cent. Mort. Deb. Stock, Perp.	100	99-102
Eastern Telegraph Co., Ordinary Stock	100	130-135
—— 3½ per cent. Preference Stock	100	83-86
—— 4 per cent. Mortgage Debenture Stock	100	102-103
Great Northern Telegraph Co. (of Copenhagen)	10	31-33
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100	99-101
Indo-European Telegraph Co.	25	54-57
Marconi's Wireless Telegraph Co., Nos. 255,128-284,190	1	⅜-⅝
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	⅞-1
National Telephone, Preferred	100	105½-108½
—— Deferred Stock	100	108-110
—— 6 per cent. Cum. First Pref.	10	10-12
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent Non Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	97-99
—— 4 per cent Deb. Stock, Red.	100	101-103
Oriental Telephone and Electric Company	1	1⅛-1⅛
—— 6 per cent. Cum. Pref	1	1 3/32-1 7/32
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5	6-6½
—— 5 per cent. Cum. Pref., 1-40,000	5	4⅜-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10⅞
West Coast of America, 1-30 000 and 53,001-53,008	2½	1⅜-1⅛
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	98-101
West India and Panama Telegraph Co., Ordinary	10	17/32-21/32
—— 6 per cent. Cum. 1st Preference	10	8-8½
—— 6 per cent. Cum. 2nd Preference	10	8-8½
—— 5 per cent. Debs., Red., 1-800	100	100-103
Western Telegraph Co., 1-207,930	10	13½-13⅝
—— 4 per cent. Debenture Stock, Red.	100	98½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1907.	1906.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Mar. 11	1,149	1,092	+ 57	— *h*	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 14	184	175	+ 10	—	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 14	3,005	2,355	+ 650	+ 7,379	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 15	980	976	+ 4	+ 521	23·53	23·53	March 31	55,408	11,696,691	1 324,743	—	—	—	6·1
Birmingham Corporation	,, 7	6,246	5,312	+ 934	—	56½	56½	,, 31	18,557	5,252,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 4	963	926	+ 37	+ 3,670	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 12	378	366	+ 12	- 1,142	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	Mar. 15	2,106	1,999	+ 107	+ 6 698	42	42	March 31	111 294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 11	1,383	1,269	+ 119	+ 2,301	29¼	24¾	,, 31	85,665	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 7	4,150	4 119	+ 31	+ 5,353	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 15	685	708	- 23	- 3,215	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 13	4 578	4,483	+ 95	—	53½	51½	,, 31	265,769	66,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 14	1,128	1,080	+ 48	—	19¾	19¾	,, 31	62,699	11,967,418	1,205,830	1·31	12 48	5,825	8·21
Burton Corporation	,, 15	235	261	- 26	- 667	9⅞	8¼	,, 31	15,576	3,383,527	421,317	1 07	8·87	1,768	6·14
Cardiff Corporation	,, 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,.64	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	,, 14	139	146	- 7	+ 83	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 14	6,031	6,376	- 345	- 2,867	6	6	,, 31	349,298	43,057,997	1,279,698*a*	1·85	62·29*a*	55,357	55·22*a*
Charing X, Euston, & Hamp. Ry	,, 14	3,135	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 15	3,247	2 962	+ 285	+ 3,520	9	6¼	*h* June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	Feb. 26	160	151	+ 9	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Mar. 12	369	399	- 30	- 217	15½	15½	Dec. 31	25,032	5,966 364	891,998	—	6·74	—	4·78
Croydon Corporation	,, 13	1,245	—	—	—	12 *c*	12 *c*	March 31	62,065	13,514,918	1,102,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 13	223	2 6	- 8	- 65	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1,124	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Mar. 13	98	88	+ 10	+ 25*h*	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 13	4 693	4,544	+ 149	+ 2,043	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 11	1,071	997	+ 74	+ 2 255	22	22	May 15	57,672	15,554 905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	,, 14	791	827	- 35	+ 395	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 14	16,544	16,4 1	+ 133	+18,384*h*	177½	169	May 31	887,381	224,063,098	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 11	220	222	- 2	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	,, 14	5 285	4 150	+1,135	+17 876	9¼	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,996	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	,, 11	1,431	1,442	- 11	+ 3 297	35½	35	,, 31	81,196	15 252,150	1,804,745	1·22	10 79	2,770	5·92
Hull Corporation	,, 14	2 407	2,323	+ 85	+ 6,851	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	Feb. 23	374	405	- 32	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	Mar. 11	150	119	+ 11	+ 431	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Feb 26	251	228	+ 23	—	7½	7½	May 15	13,702	4,640,618	466,919	692	7·55	1,733	4 95
Lancashire United Tramways	Mar. 11	1,183	1 069	+ 114	+ 990	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 7	5 977	6 033	- 55	+12,799	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5 58
Leicester Corporation	,, 14	2,072	2,068	+ 4	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 7	10,501	10,241	+ 260	+ 543	104	104	Dec. 31	563 793	122,094,528	12 115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 15	1,371	1,405	- 34	+ 20*h*	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	Feb 29	30,195	27,786	+2,709	+235 582	98	98	March 31	1378,014	314,227 090	30,130 297	1·05	10 98	—	8·56
Lowestoft Corporation	Mar. 14	135	124	+ 1	+ 163	3½	—	Sept. 30	11 009	2,622 922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 12	145	87	+ 58	—	3¼	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 14	14,000	13 109	+ 891	+ 48,746	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 14	9,004	8 431	+ 573	+ 10,038	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 15	15,203	14 795	+ 408	+ 1,416	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 14	121	124	- 3	- 44	2¾	2¾	March 31	7,709	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 14	3,619	3,934	- 285	+ 375	59⅛	57¼	,, 31	210,491	45,596,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 7	567	555	+ 12	+ 2,097	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10 01	1,525	6·87
Oldham Corporation	Dec. 8	1 805	1,744	+ 61	+ 4,550	35½	35½	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·259
Portsmouth Corporation	Jan 18	1,470	1 416	+ 54	—	28½	28½	,, 31	98,911	20,668 825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,651	8,130 179	918 825	95	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,516	5,743,298	618,211	1 12	10 45	2,691	7·38
Salford Corporation	Mar. 9	4 263	4,124	+ 139	+ 6,913	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 *c*	4·78 *c*	Dec. 31	7,779	1,537 845	228,235	1·21	8 2	1,640	7·01
Sheffield Corporation	,, 8	5 379	5,263	+ 116	+11 568	65¼	65¾	March 25	276,907	73,966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	,, 11	939	815	+ 123	+ 3,310	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 11	269	252	+ 17	+ 221	9	9	,, 31	20,076	4,431,728	390,578	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248 656	—	9 464	—	4·849
Sunderland Corporation	,, 15	1,054	1,216	- 162	- 2 864	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 12	191	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 7	757	714	+ 43	+ 708	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965 296	429 785	—	10 724	1,989	6·95
West Ham Corporation	,, 12	2,116	2,087	+ 29	+ 2,151	14·7	14·7	,, 31	122,881	35,102,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 11	765	765	-	+ 610	20	20	,, 31	43,823	9,276,023	966,133	—	10 886	2,159	6·095

* 1905-6 figures. † And 98 miles of interlacing track. *a* Train mile. *c* Miles of route. *h* Half-year's figures.

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L.C.C. TRAMWAYS.

It is dangerous for anyone but an expert accountant to criticise the findings of expert accountants on questions of book-keeping. We are on a little safer ground when the discussion is on questions of policy, expediency, law, or custom. The London County Council in its wisdom directed Mr. W. B. Peat, president of the Institute of Chartered Accountants, and Mr. F. W. Pixley, F.C A., to report upon, among other things, the tramways accounts. This report has been made, and lies before us. It is a very interesting document, and has already called forth much criticism. It deserves it, not, perhaps, altogether for what it says, but for what it leaves unsaid. This report is intended to consider the position of the undertaking from a commercial point of view. It does—with variations. The point of the first part of the report may be put briefly thus: A going concern carried on in an old-fashioned way is seen by a purchaser to possess possibilities if he can buy it reasonably and change its old methods for new. He buys it for x pounds, keeps the business going, converts it bit by bit at the cost of y pounds. Does the old capital, x, commercially appear as part of the total capital expended by the purchaser—viz., $x+y$? If it does not, how does he get rid of it? These gentlemen say it is loss, and should be treated as a loss. A man buys a windmill for one thousand pounds; he knows it will pay better steam driven, and converts it at the cost of another one thousand pounds. Surely his balance-sheet *must* show cost of mill two thousand pounds. He cannot write off one thousand pounds loss, because it would be a falsification. The London County Council purchased the horse tramway systems for the purpose of converting them electrically, and from every commercial standpoint the capital of the electrical system is the sum of the purchase money and the cost of conversion. To contend otherwise is to reduce commercial affairs and accounts to an utter absurdity, and that is just what the first part of this report has done. Neither of these eminent accountants can give a valid commercial instance of the preposterous method they suggest. It is useless to elaborate upon the idea that if a man buys a property for the express purpose of converting and improving the original price is total loss, because there are no visible assets. To convert from horse to electric is merely to improve the value of a property. The property is still there, but it has been improved, and the improvement is expected to increase the revenue more than in proportion to the cost of the improvement, hence to confer a benefit to the owner. It will be gathered that we do not agree with, at any rate, the part of the report dealing with the converted horse trams. The trend of mind of the reporters is summed up in this paragraph 13 as follows: 'While we recognise that the Council had no means of writing off at once the loss on the displaced Assets of the Horse System we consider that such loss should be provided for out of Revenue more rapidly than by the charging of the Annual Instalments in repayment of the Debt. Until these losses are provided for there can be no Profit applicable for relief of the rates.' As we have said, a suggestion of this kind is subversive of every principle of commerce that has existed from the foundation of the world till now. We do not agree with the idea so generally expressed that the party in power in the London County Council has made the tramway system a purely party question, but rather incline to the opinion that all their actions have in this case been of a non-party character, with an honest desire to get at the truth of the matter. It is, then, of the utmost importance that this report be considered closely from the commercial

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view, and if it flouts the ordinary notions of commercial men in any particular it should be condemned as of no value whatsoever. When its authors can show us commercial men buying properties and improving those properties and bringing the purchase up to date, but writing off the original purchase money as loss, and not including it as capital with an equivalent asset, then we will withdraw our remarks and support the authors of this report. At the present moment 'bus companies are trying to improve their position by improving their concerns by buying motor 'buses. Are these 'bus companies writing off capital as lost, or do they expect the improved vehicles to earn enough to pay dividends on the increased capital? If the motor 'buses earn enough to pay dividends on the total capital, is any part of the capital written off as lost—if not, why not? We shall have other opportunities of considering this report in its references to electric traction.

INTERURBAN TRAMWAY LEGISLATION.

There is no engineer in this country more capable of weighing up the deficiencies of our existing tramway and light railway legislation than Mr. Stephen Sellon, and hence his views on the subject should be as widely known as possible. We take the following extracts from a letter over his signature in the *Pall Mall Gazette*: "The necessity for interurban facilities has been long recognised, especially along the existing highways of traffic. The Royal Commission on Depression of Trade, with the late Lord Iddesleigh as chairman, reported in favour of every facility, but there has been no honest attempt on the part of the Legislature to frame an Act capable of dealing with this problem. Many towns are to a large extent debarred from useful connection, due to the authorities permitting the construction of lines of different gauges. Having been associated with the promotion and construction of many miles of tramways and light railways, I unhesitatingly say that under existing conditions the man is a fool who attempts to waste his money in the promotion of enterprises until the Light Railway Act has been amended, especially in respect of competition, and Standing Order 22 has ceased to exist. An essential feature for an interurban scheme is economy in promotion, in finance, and construction. Parliamentary procedure to day deliberately assists in making each of these essential conditions impossible. If you promote by means of the 1870 Tramway Act, Parliament permits the promoter to be blackmailed by virtue of Standing Order 22. It was hoped that the Light Railway Act of 1896 would have assisted in enabling promoters to obtain honest schemes and capable of being financed on an honest basis, but, except in a few isolated cases, this is not so. The excellent procedure established by the Light Railway Commissioners has been robbed entirely of its usefulness by the interference of the higher authority to an extent sufficient to freeze the enthusiasm of any commissioner. The railway companies, who never provide facilities for the creation of traffic, but wait for development first and then play with it, have only to whisper the word 'competition.' The value of this class of undertaking is shown by the enormous use made of them when constructed. No finer property exists for investment when constructed and worked on proper lines, and yet to-day nobody will look at tramway stock, which is not due to the absence of good receipts or heavy working expenditure, but to the inflated capital that has to be procured to meet ridiculous demands. There is no application to Parliament for a private Bill of any sort except tramways that requires any consent precedent to a hearing before a Select Committee. Commissions have reported against such a monstrous standing order on account of the way it has been abused. Corporations (but only since they became tramway undertakers and wanted extension into outside districts) demand its deletion. Lord chairmen of committees have sympathised with the same object. The Royal Commission on London Traffic asked for its withdrawal after having heard the views of the learned counsel to the Lord Chairman—still it remains, an effectual barrier to private enterprise, to the development of interurban propositions, to the flow of capital, to industries such as steel, cement, electrical plant, etc., and a large employment of labour." Unfortunately, the Government has so many contentious matters under consideration that it has no time to make the reforms in tramway and electric power legislation which are known to be necessary.

UNDERGROUND ELECTRIC LIGHTING BOXES.

One of the leading questions which comes to the front in the case of the French Asphalt Company *v.* the City of London Electric Lighting Company, Limited, reported in another column, is whether work that is necessary in the interests of the public, and is carried out by a party, under powers conferred upon it by a contract with the local authority, but without the knowledge or consent of the party who is primarily liable for such work, can be successfully sued for its value in the event of the last-named party repudiating the claim. Here we have a company which is under a contract with the City Corporation to keep in good repair the streets of the city. In one of these streets it is found that eight electric lighting boxes, the property of the electric lighting company, are left in a sunken condition. The asphalt company immediately set to work to raise these boxes, without knowing to what level they should be raised, without any authority from the proprietors of the boxes to do the work, or without even informing the electric lighting company of its intention to do so. The claim for the cost of doing the work was sent in to the electric lighting company, who very properly resisted it on the ground that the plaintiff company did not state that the work was going to be done, and we are glad to notice that the opposition to the claim was successful. It is established in law that there cannot be a contract unless there has been mutual assent to the terms. In this case all the elements of a contract were lacking, and the judge's decision, on a point of law, seems indisputable. This case, as counsel rightly pointed out, is one of great public importance, but it is of no less importance to electric lighting companies. The unreasonable regulations of local authorities and other bodies are quite sufficient, we suppose, for these companies to submit to, without other parties coming in and subjecting them to high-handed treatment.

NEW ALTERNATE-CURRENT INSTRUMENTS.*

BY W. E SUMPNER, D SC, AND J. W. RECORD.

INTRODUCTION.

The instruments referred to in this paper are the outcome of an investigation on the properties of iron-cored electromagnets for use in alternate-current instruments. Two papers dealing fully with the theory and testing of these instruments have already been published.† We do not propose to reproduce any matter contained in those

* Paper read before the Institution of Electrical Engineers.

† "The Use of Iron in Alternate-Current Instruments," *Journal*, Institution of Electrical Engineers, vol. 34. "New Iron-Cored Instruments for Alternate-Current Working," *ibid.*, vol. 36.

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communications, but to describe the instruments as actually constructed, and to state their uses and properties. We shall rely on the papers referred to as theoretical evidence for the truth of the assertions made. It is, nevertheless, desirable again to point out the idea which forms the basis of the whole matter. Iron-cored instruments are not new, and their advantages as regards sensitiveness are well known. But to make such instruments accurate it is necessary to have a magnet the strength of which depends upon the excitation in a manner independent of the variable physical properties of the core, such as permeability, hysteresis, etc. Such electromagnets are not to be found in commercial instruments as hitherto made. It is in this connection that the fundamental difference between the series magnet and the shunt magnet is so important. When a magnet is series excited, by a current through the field winding, the flux which is produced depends upon the current and on the physical properties of the core, but is quite independent of the resistance of the winding. The strength of the magnet caused by a given current is the same for a winding of manganin wire as for one of copper wire. But if the magnet be excited by the voltage, the flux is controlled by this voltage, and does not depend upon the properties of the core. This would be true with mathematical accuracy were it not for the resistance of the winding. Provided this resistance can be made small compared with the impedance, it does not matter whether the core of the magnet be of iron, or of brass, or of wood. In all cases the flux in the magnet will be determined by the exciting voltage and by the winding, not by the core. Variations in permeability or eddy currents affect the magnetising current, not the magnetism produced. If the voltage is doubled the magnetism must also be doubled, whether the permeability does or does not remain the same in the two cases.

With the shunt magnet the eddy currents caused in a small piece of brass do not affect the magnetism caused by the exciting voltage. In the construction of the wattmeters now to be described it is thus permissible, within reason, to use brass clamping pieces in the neighbourhood of the moving system. This is an important advantage from a maker's point of view. With a series magnet, on the other hand, the eddies induced in a piece of solid metal do affect the magnetism caused by the exciting current, and hence in the ordinary dynamometer wattmeter, or in the special quadrature current transformers referred to in this paper, it is vitally important to prevent such eddy currents arising.* The strength of the *series* magnet for a given current is dependent on the properties and the past history of its core. The field of the *shunt* magnet, on the other hand, is independent of the core, and is perfectly controlled by the voltage applied at the moment. It is not affected by any ageing effect in the core, and the field is thus even more reliable than that of a permanent magnet as used in direct-current instruments.

The field of the shunt magnet, though caused by the voltage, is not in phase with it. Special means must be devised for supplying the movable coil with such a current as to make the deflection of the instrument a correct measure of the quantity to be tested. This may at first seem difficult, but, as a matter of fact, is quite easy to do. For the wattmeter a special form of current transformer is needed. For the voltmeter any ordinary condenser may be used. These accessories we call quadrature transformers, since their function is to produce a moving-coil current which is in quadrature with the circuit current or voltage. They correspond in many ways with the shunt or series resistances used with permanent magnet ammeters and voltmeters. The indicating instrument itself has the characteristics and advantages of permanent magnet instruments. Strong controlling springs can be used. Stray magnetic fields have no influence on the readings, while the currents actually used in the coils are very small, so that the instrument, like a voltmeter, can readily be switched from one circuit to another. It will not at once be seen that the readings of the instrument are independent of frequency, and also of the wave-forms of the current and voltage A complete mathematical proof of this has been given in the papers already referred to. As regards change of frequency, it may be pointed out that the field of the magnet when excited by a given voltage will be doubled if the frequency is halved, but the moving-coil current will at the same time be halved, so that the product of field and moving-coil currents will be independent of frequency, and it is this product that determines the deflection.

* The theory of the disturbing effect of eddy currents on the action of dynamometer wattmeters was first given by one of the present authors in 1895. See *Journal*, Institution of Electrical Engineers, vol. 21, pp. 743-745.

Shunt Magnet Instruments.

The Structure of the Magnet and of the Moving System.—The design of instruments with laminated field magnets suitable for alternating current presents many difficulties, especially when a short air-gap is essential in which to swing a moving coil. The laminations themselves cannot be satisfactorily used for a base or foundation to carry other portions of the mechanism, but, on the contrary, they must themselves be most securely fastened to a framework that has been prepared to hold them together with the other parts in fixed relative positions to each other. Laminated magnets for alternating-current work likewise cannot be ground or filed, and when the laminæ are assembled to form a block, if their edges are not even, the necessary truing can only be done at the risk of separating the laminæ to clear off the burrs caused by the filing, and once more to reassemble. Almost any known form of electromagnet which would permit a coil of wire to swing between two pole-faces could

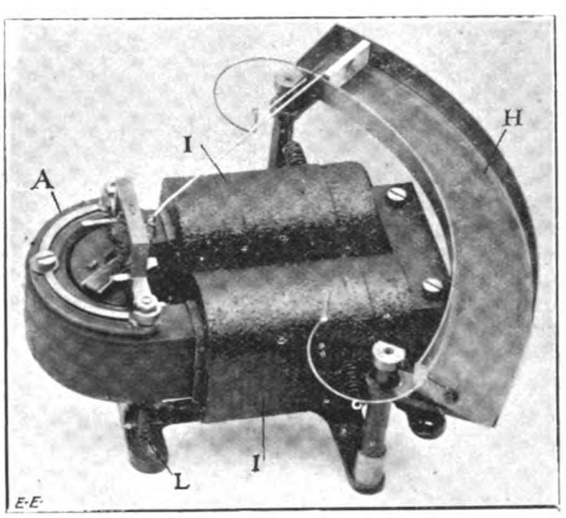

Fig. 1.

have been selected for these instruments, but partly on account of the above difficulties it was decided to design a magnet with a single air-gap, which at once lessens the difficulty of obtaining smooth, regular pole-faces. The total length of air-gap, or the distance of one pole from the other, is only 0·08in., giving a clearance of 0·02in. each side of the moving coil. It will be seen that a very slight projection of a stamping will foul the moving coil. The particular form of magnet shown in Fig. 1 has also been selected in order to reduce the magnetic reluctance of the circuit to a minimum on account of its easy mechanical construction, and to allow a large angular deflection of the pointer when necessary. The block of iron stampings, A, is securely clamped on a brass framework, L The cross-section of the iron is about one square inch, the total magnetic flux is approximately 32,000 C.G.S., and the flux density about 5,000 C.G.S. (R.M.S. values), at the normal applied voltage on 50-~ circuits. As the section of the gap is five or six times that of the iron core the flux density in it is correspondingly reduced. It is generally about 1,000 C.G.S. lines per square centimetre, and is comparable with that used in the air-gaps of good permanent magnet instruments. To reduce the copper drop to the least possible amount, the largest size copper wire that can be wound in the available space is used. About 200 ampere-turns are needed to produce the flux under normal conditions. The moving coil, B, consists of about 40 turns of fine copper wire former-wound, and fixed to an axle fitted with hardened

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steel pivots and supported between jewelled screws, D D (see Fig. 2). The effect of temperature variations on the copper windings is completely swamped by the use of about 80 ohms of manganin wire wound non-inductively, and joined up in series. This extra resistance also serves the purpose of nullifying the slight deflection which would otherwise be produced by induction if the terminals of the moving coil were short-circuited. It will be noticed that the pointer, E, and damping vane, F, are placed so that their weight as nearly as possible balances the weight of the moving coil, thus the inertia of the moving system is

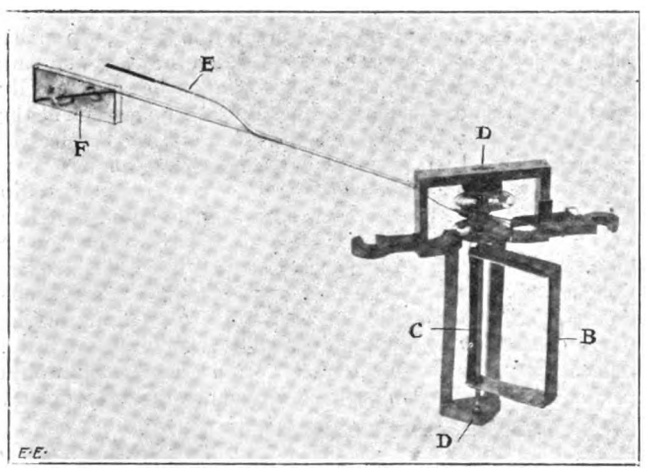

FIG. 2.

not increased by the use of extra masses for balancing purposes. Owing to very careful balancing all gravity control is eliminated, and accurate readings of the instrument can be taken without previous levelling. In order to cheapen construction and for ease in assembling the parts, the frame for holding the moving coil, controlling springs, etc., is so constructed that it can be removed completely from the iron core without disturbing the latter, and without disconnecting the connections or removing the instrument from its case. It is shown separately in Fig. 2. An air-chamber, H, for damping down the oscillations of the

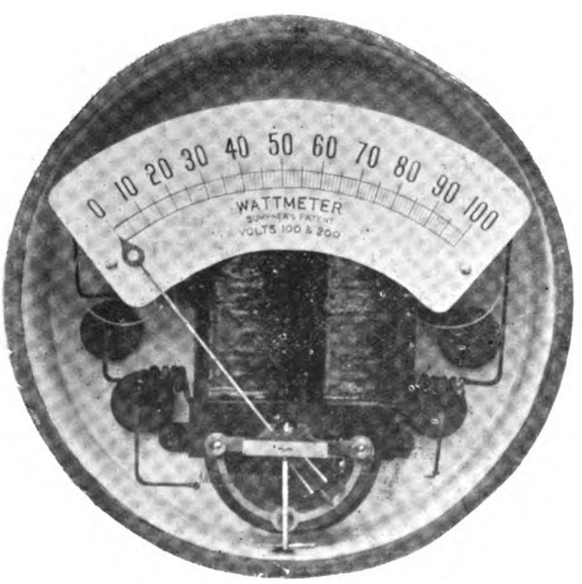

FIG. 3.

pointer is provided, and the dial of the instrument forms the top of this dash-pot. I I are the exciting or field coils of the electromagnet placed in shunt across the mains (see Figs. 1, 3, and 4). The torque on the moving-coil system is about 1·2 gramme-centimetres for 90deg. deflection, which is greater than that usually employed with instruments of the dynamometer or induction type. The accompanying photograph (Fig. 3) shows the appearance of a switchboard-type instrument with case cover removed. It will be noticed that the scale markings are very evenly paced.

The Quadrature Transformer.—In order that the instrument may read watts, it is necessary to connect the electromagnet in shunt across the mains, and to join the terminals of the moving coil to the secondary of a specially-designed current transformer. To distinguish this transformer from one of the ordinary series type we call it a "quadrature" transformer. This transformer renders the current in the moving coil proportional to the current in the mains, and the product of the moving-coil current into the air-gap flux becomes a measure of the load whatever the voltage, current, frequency, or wave-form. (The small error due to power factor is discussed later.) It is the introduction of the quadrature transformer that has made the iron-cored wattmeter possible, as it combines not only

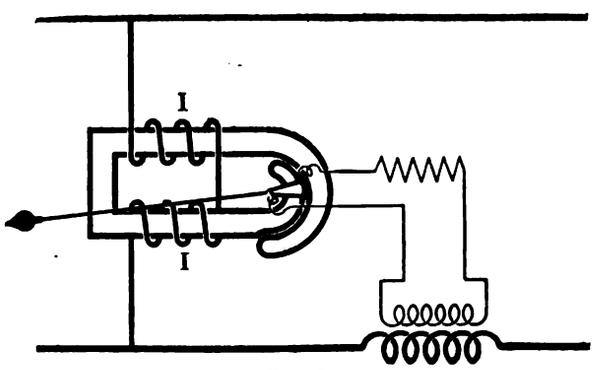

FIG. 4.

the function of producing a secondary current which is directly proportional to the primary current for all values of the latter, but also a current which is 90deg. out of phase with the primary current, and therefore in correct phase relation to the magnetic flux in the air-gap of the electromagnet. The core, A, in Fig. 5 is formed of two blocks of iron stampings with butt joints at J, J and an air-gap, G, generally about one-tenth of the length of the iron circuit. P is the primary winding and S the secondary The latter consists of a few turns of fine wire, the ends of which are joined through a high non-inductive resistance to the terminals of the wattmeter moving coil. It is this long air-gap in the quadrature transformer that renders the flux proportional to the primary current for all changes in its value, and reduces the error due to hysteresis in the iron to a negligible quantity. If we take 1,000 as an average value for the permeability of the iron, it will be apparent that the reluctance of the gap is about 100 times that of the core, so that the reluctance of the

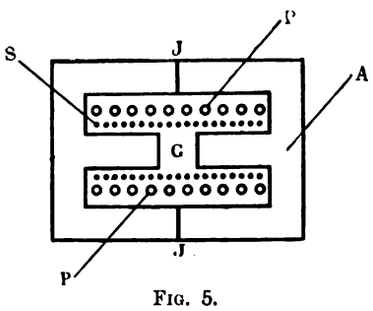

FIG. 5.

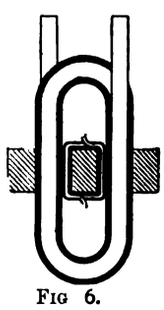

FIG 6.

magnetic circuit is essentially independent of the effects of the variable magnetic properties of the core. (For full theory see *Journal*, vol. 36, pp. 462-467.) Fig. 6 illustrates a quadrature transformer insulated for high-tension circuits. For large currents two further types of quadrature transformer are made, one in the shape of a ring, to slip over cables, the other rectangular, to slip over bus bars. It must be remembered that ordinary series or current transformers are quite unsuitable for use with these wattmeters, as their secondary currents are in phase (or 180deg. out of phase) with their primaries, but it is permissible, although not advisable, where series transformers are already installed, to connect the primary of the quadrature transformer in series with the ordinary current transformer secondary. The accuracy of the wattmeter will, however, be limited by the magnitude of the phase error of such series transformers. Switchboard designers are prone to

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actuate induction ammeters, relays, trip coils, wattmeter series coils, etc., from small instrument current transformers, losing sight of the fact that the accuracy of the wattmeters is thereby often destroyed. This practice should, as far as possible, be avoided.

Wattmeter Circuit Connections.—Fig. 7 shows how the instrument should be connected to the circuit for measuring the power of a three-phase circuit, balanced load, when the neutral point is not available. A specially designed choking coil is used, with its ends connected to two of the mains, the wattmeter itself being joined to the third main and to the junction point of the choking coil. The total power of the circuit so connected is equal to twice the wattmeter reading, or the instrument may be graduated

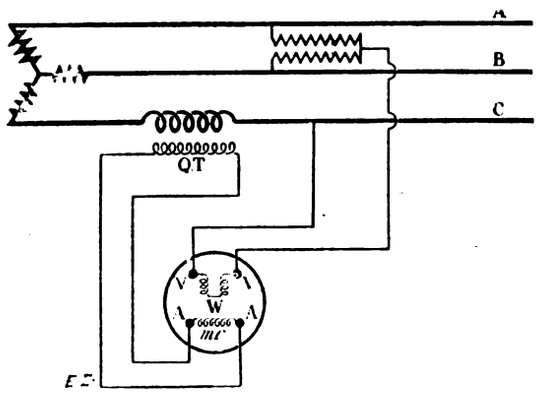

FIG. 7.

to indicate total power direct. (For theory see Note 2, Appendix.) For high-tension circuits potential transformers are necessary to reduce the potential to a safe value for the instrument. Such transformers are connected with their secondaries in opposition in order to bring the voltage into proper phase relation with the current. The connections of this are shown in Fig. 8. One quadrature transformer only is used, and two potential transformers with opposed secondaries. In Fig. 9 an equivalent arrangement is shown in which one potential transformer and two quadrature transformers are employed, the secondaries of the latter being parallel connected in opposition as regards the moving coil. The ease with which the wattmeter can be connected with, or disconnected from, the main circuit, without disturbing the latter, renders it suitable for a number of special purposes. For instance, the output of each of a number of alternators in parallel

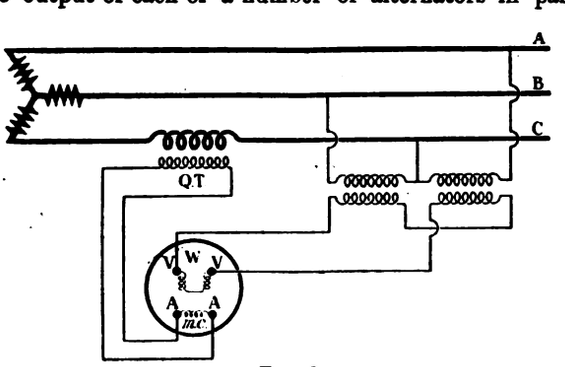

FIG. 8.

may be measured in succession by using *one* indicator and as many current transformers as there are alternators in parallel; by the addition of another transformer the total output can also be measured. Such a method is indicated in Fig. 10. A multiple switch is used to connect in turn the various quadrature transformers, QT_1, QT_2, QT_3, and QT_4, to the indicator. As an example, suppose there are three alternators having outputs of 200 kw., 500 kw., and 1,000 kw. respectively, with line voltage 2,000, on a three-phase balanced load. The line currents will be 58, 145, and 290 amperes, and total current about 500 amperes. If the quadrature transformers, QT_1, QT_2, QT_3, and QT_4 are respectively of these capacities, and the corresponding secondary resistances are properly adjusted, the wattmeter pointer will correctly indicate the corresponding power whichever one is connected by the switch, S. If the scale is divided into 100 divisions, the constants will be as follows:

QT_1	for 200-kw. machine;	output	=	instrument reading	× 2
QT_2	„ 500 kw.	„	=	„	× 5
QT_3	„ 1,000-kw.	„	=	„	× 10
QT_4	„ total output		=	„	× 20

It is quite safe to put the secondaries of quadrature transformers on open circuit, because, unlike series transformers,

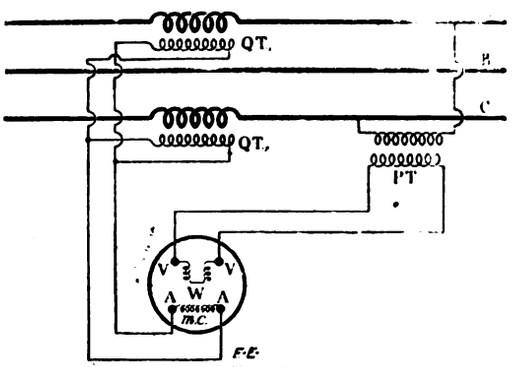

FIG. 9.

the demagnetising effect of the secondary current is *nil*. The value of this current is less than one-tenth ampere, so that an ordinary voltmeter switch may be used. Another arrangement for measuring the total output of a number of generators when it is not possible to use a transformer like QT_4 in Fig. 10 is explained in Note 1 of the Appendix.

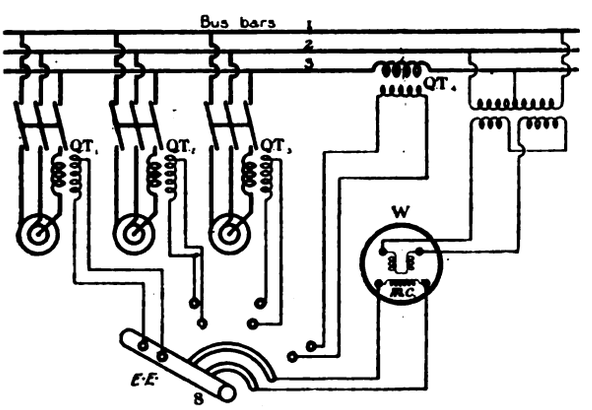

FIG. 10.

Magnetostatic Voltmeters.—The wattmeter may be used to measure volts by changing the connections of the moving coil from the secondary of the quadrature transformer, and placing them in series with a condenser of suitable capacity across the mains (see Fig 11). The readings will be correct on circuits of any frequency or wave-form, provided the ratio of voltage to frequency is not made too

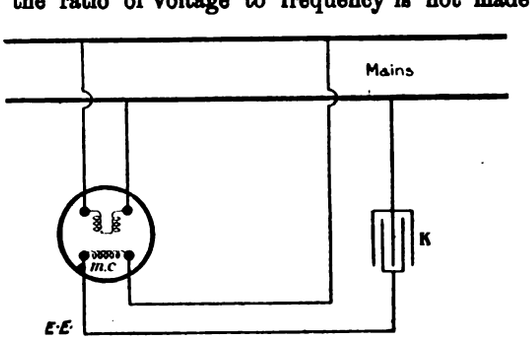

FIG. 11.

great, so that the resultant induction density in the iron is made excessive. The magnetic flux, which is proportional to this ratio, should not be allowed to exceed the normal value by more than 50 per cent. for a sustained load. An instrument designed normally for use on a circuit of 100 volts, at a frequency of 50 ~, will accurately respond to an increase of 50 per cent. in the voltage if the frequency remains at 50 ~, but on circuits of 25 ~ it is not allowable to increase the voltage above the normal. The limiting factor is the ratio of voltage to frequency. This

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ratio for the above instrument is normally 100/50, or 2, and when increased by 50 per cent. it becomes 3. On circuits of 50 ~ the maximum voltage advisable is, therefore, 150, while the lowest frequency at which it should be left subjected to 100 volts is 100/3, or 33⅓ ~.

Portable Standard Voltmeter and Wattmeter.—The laboratory portable standard instrument is most useful, and the measurements to which it is adapted are so many and varied that it can be considered an alternating-current testing set. It consists of a mahogany case containing the movement already described, and is provided with four terminals and two switches. The internal connections can be traced from Fig. 12. It will be seen that with switch A in one position the coils of the electromagnet are connected in parallel, and the pointer will deflect to its maximum position for the rated voltage; and that with switch A in the second position the coils are connected in series, and twice that voltage will be needed to produce the same deflection. Switch B is for connecting the moving coil either in series with a condenser, K, across one of the field coils or directly across terminals, T and T_1. It will be noticed that the voltage applied to the condenser is the same for the same voltage per turn applied to the field coils, whether these latter are series or parallel connected. With switch B in the position shown in Fig. 12, the instrument is a direct-reading voltmeter having two ranges; the readings are quite independent of frequency, wave-form, hysteresis, stray magnetic fields, or electrostatic influences. As the flux in the air-gap is proportional to the applied voltage, and the condenser current is also proportional to the applied voltage, it follows that the torque acting on

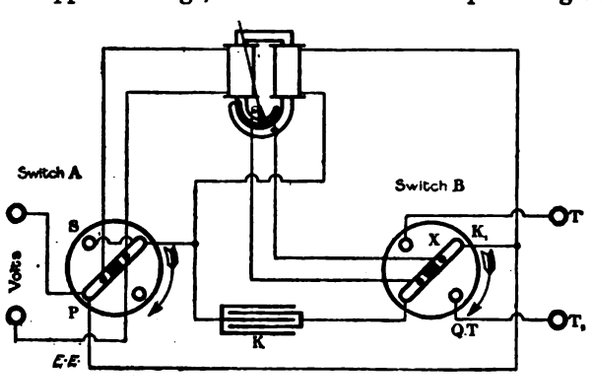

FIG. 12.

the moving coil must be proportional to the square of the voltage. A double scale typical of the portable instrument is shown by Fig. 13. A square law scale may at first sight seem undesirable, but will be found usually an advantage in practice, because readings are seldom required much above or below the normal circuit voltage. Readings near the lower portions of the scale are very little used, whilst those near the working voltage are required to be clear and open. With a laboratory instrument this does not so much apply, but it must be remembered that the portable type is fitted with a change-over switch for altering the range of the voltmeter. A useful form of quadrature transformer for portable use consists of an ordinary quadrature transformer with a subdivided primary, the ends of which are taken to separate pairs of terminals. These terminals can be connected in series, series parallel, or parallel For instance, a transformer with four separate primary coils, each wound for five amperes, will be suitable for (1) five amperes if connected all in series; for (2) 10 amperes if connected two in series and two in parallel; and (3) for 20 amperes if connected all in parallel. The full scale deflection of the wattmeter will be obtained for either of these combinations, but the reading must be multiplied by the correct constant to convert to watts.

Capacity Measurements.—When the switch B of Fig. 12 is turned to join the moving coil across T T_1, the instrument can be used for a wattmeter or for a variety of special purposes, one of the most useful being the measurement of capacity of cables and condensers. It is universally admitted that the present methods of testing capacity are both tedious and unreliable. A condenser that is leaky cannot easily be measured correctly with a ballistic galvanometer. The test is always very slow and troublesome. Errors occur due to residual absorption, and others sometimes arise from electrolytic and similar effects. Condensers are manufactured in hundreds of thousands for telephone use, and require to be quickly tested. Alternating-current ammeters are sometimes used for the purpose in preference to the slow ballistic galvanometer method, but the results are hopelessly influenced by complicated effects due to variation of wave-form and frequency. The iron-cored voltmeter here described is essentially free from all these defects. Any leakage current in the condenser, being in phase with the volts, is in quadrature with the magnetic field, and hence has no influence on the deflection, while changes of frequency and wave-form likewise cause no errors. The condenser fitted in the instrument for using this as a voltmeter can be also employed as a standard of capacity, and a special scale can be made for the instrument so that this is direct reading in microfarads for tests at any convenient fixed voltage. The readings on this capacity scale will be proportional to the readings on the watt scale, and hence proportional to the square of the readings on the volt scale. If the voltage remains constant for consecutive readings, a direct comparison of capacities can be quickly made.

If K_1 = capacity of condenser in case;
K_2 = capacity to be tested;
W_1 = deflection for the capacity K_1;
W_2 = deflection for the condenser or cable tested;

then
$$K_2 = K_1 \frac{W_2}{W_1}.$$

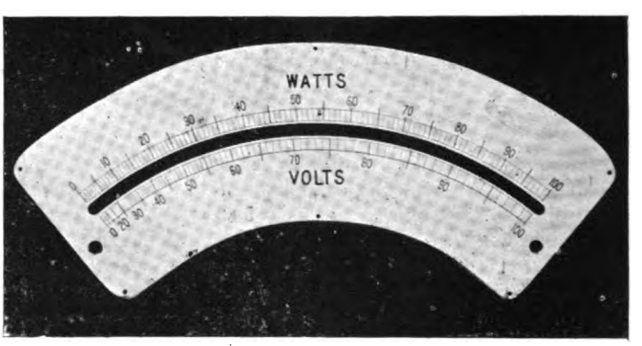

FIG. 13.—Double Scale for Portable Instrument.

The readings, W_2 and W_1, must be taken on the capacity or watt scale. Since for a given voltage W_1 is fixed, the scale can easily be graduated to make K_1/W_1 a simple constant for the specified voltage. In some cases, if the voltage used were the same for W_1 as for W_2, the capacity to be measured would be large enough to cause the pointer to deflect off the scale. The deflection, W_1, for the instrument condenser, K_1, can then be taken at some voltage, V_1, as read by the instrument when connected up as a voltmeter, either on the volt scale as V_1 or on the watt scale as ω_1. The deflection, W_2, for the unknown capacity, K_2, may be noted at a reduced voltage, V_2 (or ω_2 on the watt scale). We shall then have

$$K_2 = K_1 \frac{W_2}{W_1}\frac{V_1^2}{V_2^2} = \frac{W_2}{W_1}\frac{\omega_1}{\omega_2}K_1$$

$$= \frac{K_1}{W_1} \times \frac{\omega_1}{\omega_2} \times W_2,$$

in which the first factor is a constant of the instrument; the second factor depends on the voltages used; and W_2 depends on the condenser tested. In comparing capacities, readings are best taken on the watt scale, which is equally divided, whilst the actual voltage, when needed, can be directly read off the volt scale. Whilst speaking of capacity, it will be interesting to mention that the firm who manufacture these iron-cored instruments make the condensers used with the present voltmeters, and also thousands of others for telephone work. The above method is employed, with the most satisfactory results, for measuring the capacity of these condensers, which are made by a patented process, and have been found perfectly reliable for voltmeters of the present type.

(To be continued.)

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NOTES ON ELECTROCHEMISTRY.

Two interesting new products from the electric furnace were discovered last year by American investigators. Mr. Acheson prepared "deflocculated graphite" for general lubricating purposes, and Mr. H. N. Potter is the discoverer of silicon monoxide, or "Monox." The "deflocculated graphite" is an extraordinarily fine suspension of graphite in water, or in oils, and its inventor claims that these "solutions" can replace the ordinary oil lubricants at a much lower cost, for the cheap oils employed need not possess lubricating properties. Mr. Acheson had observed that clays could be deflocculated with tannic acid, and he was successful with the same agent in preparing graphite suspensions that would pass through the best filter paper. A useful property of the new preparation is the formation of rust-proof coatings on ironwork.

Mr. Potter's silicon monoxide is obtained by fusing a mixture of silica and silicon in the electric furnace $SiO_2 + Si = 2\,SiO$, and condenses as a white sublimate. The new oxide of silicon is one of the lightest powders known, a measured gallon weighing about half a pound, although the specific gravity of the substance (free from air) is 2·24. The finely porous nature of a layer of Monox permits air filters to be constructed which are said to surpass all others for removing dust from air. Another use for its great surface and absorbent qualities is in making lakes with colours and in accelerating the drying of printing ink with which it has been mixed. A further application in the manufacture of porcelain depends on the heat generated by its oxidation to silica, when pottery containing Monox is fired. Monox is harder than glass, and can be used as a polishing powder.

The lack of waterfalls in Great Britain available for power stations seems to deter inventors from studying electric smelting or the production of nitric acid from the air. In France an over-production of calcium carbide caused the manufacturers to seek a more profitable employment for their electric furnaces. This was found in the preparation of special steels and iron alloys. The chromium steels, nickel steels, and vanadium nickel steels are in great demand for motorcar machinery, and the electric furnace yields the best qualities. The high temperature of these furnaces is believed to be the cause of the remarkably homogeneous dense alloys obtained. Ferro-manganese, ferro-silicon, and similar alloys are now manufactured with advantage in electric furnaces. The Girod Company proposes to erect plant in St.-Gervais for a daily production of 30 to 40 tons of the steels above mentioned. The project of the Badische Anilin und Soda Fabrik to divert the course of a river in South Bavaria in order to provide power for their flame arc process of nitric acid manufacture, is still the subject of negotiation regarding water rates between the Badische Company and the Bavarian Government.

B. Naumann published last year a study of the electro-metallurgy of iron. After reviewing all the electro-smelting furnaces and processes for iron, the author states that in countries possessing plentiful coal supplies the blast furnace will not be superseded. On the other hand, in Canada, South America, and New Zealand, where pure iron ores can be obtained but coal is dear, the electric furnace is practicable. Naumann reports very favourably on crucible steel from an electric furnace of the Kjellin or Héroult type.

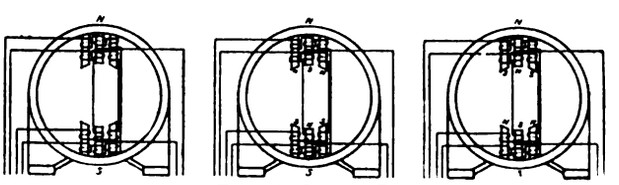
Gunther Schutze has found that tantalum electrodes behave as valves, and more completely than aluminium electrodes. The valve of tantalum requires less time than aluminium before it forms, and in all electrolytes hitherto investigated the highest efficiency is found in solutions of sodium and potassium carbonate. There is less heat than with an aluminium valve, but the tantalum is injured by breaking the circuit. Valve action was observed with electrodes of vanadium, niobium, magnesium, antimony, and bismuth.

Among the curiosities of the electrochemical patents in 1907 is the German patent 184,516 for a method of recovering zinc and magnesium from exhausted battery solutions, etc., with the aid of mercury cathodes, even in presence of free acid. The removal of tin from tinplate scrap is now usually carried out with chlorine gas, and electrolytic methods are becoming less important.

A description of a plant for removing gold from cyanide solutions has been published in the *Engineering and Mining Journal*; the capacity of the three baths is 50 tons of cyanide solution, the current density is two to three amperes per square metre. Free alkali prevents the destruction of the cyanide which occurs in neutral solution. J. W. Richards has published factory calculations of the cost of electrolytic copper refining in the "Electrochemical and Metallurgical Industry," vol. 5, pp. 399 and 458.

A NEW METHOD OF REGULATING ROTARY CONVERTERS.

In a recent paper by Mr. C. W. Stone before the American Institute of Electrical Engineers some recent developments in synchronous or rotary converters are described, from which we take the following particulars of a modified design for enabling voltage regulation to be carried out. It was first proposed by J. L. Woodbridge some time ago. It has been known for some time that the ratio of conversion between the alternating-current and the direct current sides of a synchronous converter could be changed by varying the width of the pole-face. As is well known, the direct-current potential is equal to the maximum value of the alternating-current potential, while the effective potential on the alternating-current side is only the square root of the mean square value. If, then, the ratio between the maximum and the effective



FIGS. 1, 2, AND 3.

values on the alternating-current side can be changed, the ratio of transformation would likewise be changed, and in the same degree. If means are provided for changing the distribution of the flux under the rotary so that the maximum value of the alternating-current counter E.M.F. of the rotary will be changed, the ratio of transformation will likewise be changed. This is what Mr. Woodbridge accomplishes, his method being to cut the pole into three sections, placing different windings around them, and to control the excitation of the three sections.

Fig. 1 shows a two-pole synchronous converter equipped in accordance with this idea. Each field pole is divided into three sections, on each side of which are two windings. One of the windings on each section is the main shunt winding and the other is the regulating winding. All the main windings are connected in series and excited in the ordinary manner. The regulating windings, however, are connected differently. The windings on the two outer sections of all poles are connected in series with one another, and the windings of all the central sections are connected in series with one another, and these two groups are connected in series. The voltage of the direct-current side of the converter is increased by exciting all the outer sections in a direction to assist the main shunt field, and the middle section an equal amount in opposition to the main field. This condition is shown in Fig. 2. If both these windings are excited in the opposite direction, the direct voltage will be lowered. Fig. 3 shows this condition. All that is needed in this arrangement is a field rheostat in the regulating field circuit in addition to the main field rheostat ordinarily used.

The first question that comes up with this scheme is what effect it has on the power factor? A number of machines arranged this way have been designed and placed in operation. With these machines the power factor can be held constant at all loads, yet all the range in voltage desired can be obtained. Since this method was proposed

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another and still simpler method has been brought out. This scheme was proposed by J. L. Burnham. Instead of making each pole with three sections and with two windings on each, only two sections are used On each section only one winding is used. The large section corresponds to the main shunt winding on an ordinary synchronous converter, while the regulation is obtained entirely by changing the excitation of the smaller section, exciting it in one direction to boost the voltage, and in the other to lower the voltage.

INDICATIONS OF COLLIERY ELECTRIFICATION.

For many years the problem of the electrification of collieries has been attended by altogether unusual difficulties owing to the conservatism of colliery proprietors. These were in the happy position of having a certain portion of coal to draw upon, much of it of such a quality that it could not be readily sold, and, therefore, accumulated at the pit head, and they were, therefore, considerably in favour of the use of steam for the direct driving of their machinery. Of late years, however, even this stronghold of antiquated methods has been successfully attacked, and the progress which has been made in this department can be illustrated to a certain extent by the operations of a firm which has specialised on colliery requirements. Messrs. Ernest Scott and Mountain, of the Close Works, Gateshead, early realised the possibilities and advantages of electricity in connection with colliery work, and we are able to reproduce an illustration of one of the first electrically-driven pumps which this firm turned out for the use of a colliery. It has a capacity of 300 gallons per minute, and, working against a 50ft. head, requires an expenditure of 30 h.p. at the motor. This was supplied to the Cowpen Coal Company for their North Seaton Colliery, near Blyth, in 1890, and has been in successful operation ever since.

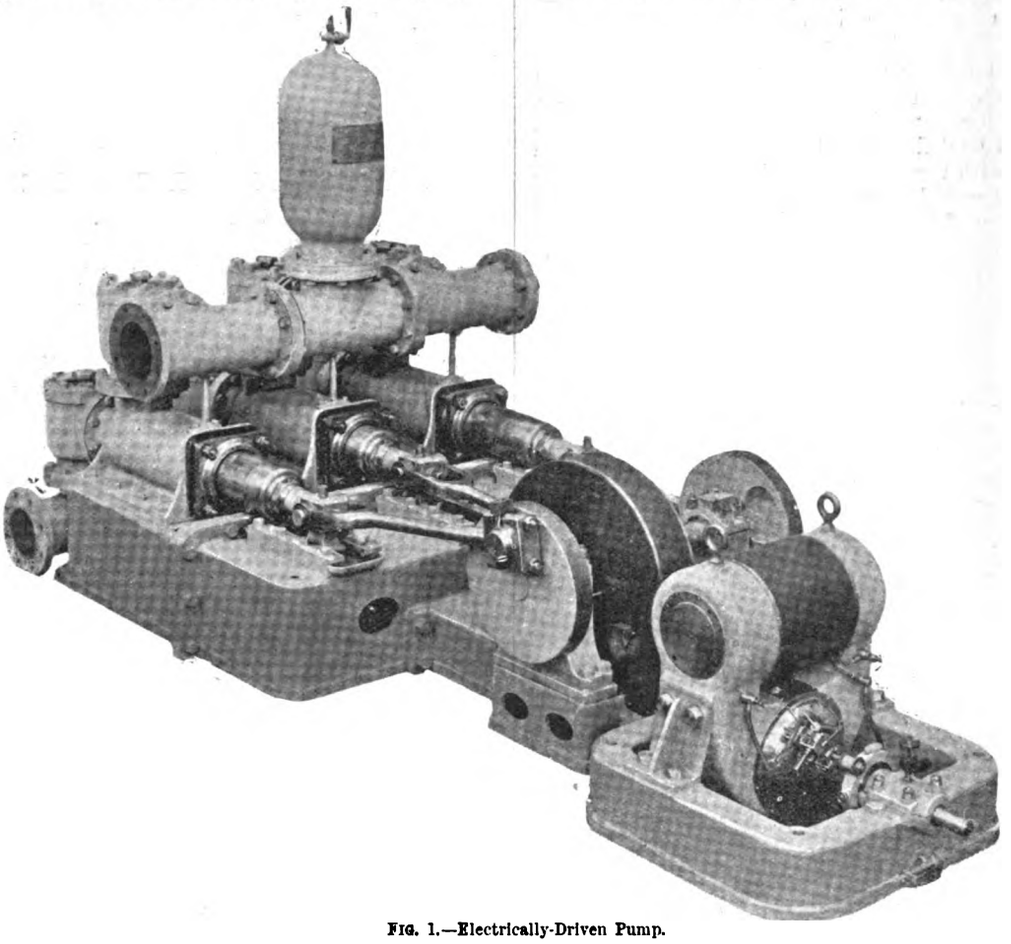

FIG. 1.—Electrically-Driven Pump.

As a contrast, however, to this small pump, and an illustration of the way in which colliery requirements have developed in recent years, it is interesting to note a recent plant which has been built for Messrs. Pease and Partners for their Eldon Collieries at Bishop Auckland. This consists of a 400-h.p. motor of the three-phase type working at 2,750 volts and a frequency of 40 cycles per minute, direct-coupled to a centrifugal pump running at a speed of 1,170 r.p.m., with a capacity of 1,200 gallons per minute against 650ft. head. One particular point about the motor is the arrangement which has been made to keep the stator and rotor windings cool. A fan has been fixed

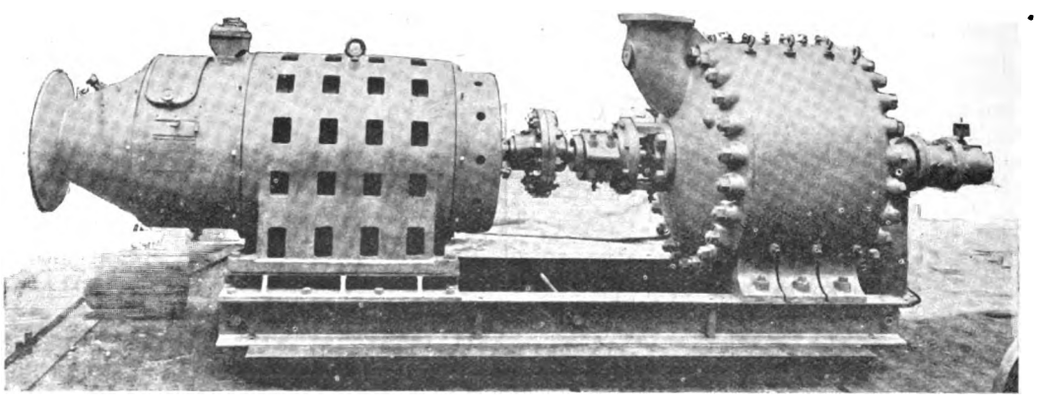

FIG. 2.—Centrifugal Pump and 400-h.p. Motor.

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to the outside end of the shaft, which blows a strong blast of air through the windings, considerably reducing the initial cost of the plant and keeping up its efficiency in continual working. This pump is one of four (two being exactly in accordance with the above particulars, and two being constructed to each deliver 750 gallons per minute against a head of 950ft.), the supply in each case being taken from the Cleveland and Durham Electric Power Company's mains. Owing to the increased demands for colliery pumping plant, Messrs. Scott and Mountain have been practically compelled to specialise on the construction of centrifugal pumps, and they have in their installed in their Aspull Collieries. The machine is of a capacity of 560 kw., running at 300 r.p.m. and supplying current at 440 volts, 50 cycles. These machines are to be driven by three enclosed compound engines supplied by steam from boilers fired by coke oven gas; the exciters for these sets are independent machines of 75 kw. capacity run at 250 volts, one exciting set being capable of supplying the field current to the three generators if required. The rotor of one of the generators, which is also shown, measures 66in. in diameter and has 20 poles. Immediately behind these parts is seen the large stator of a 1,000-kw. three-phase generator for the Coltness Iron Company of Scotland.

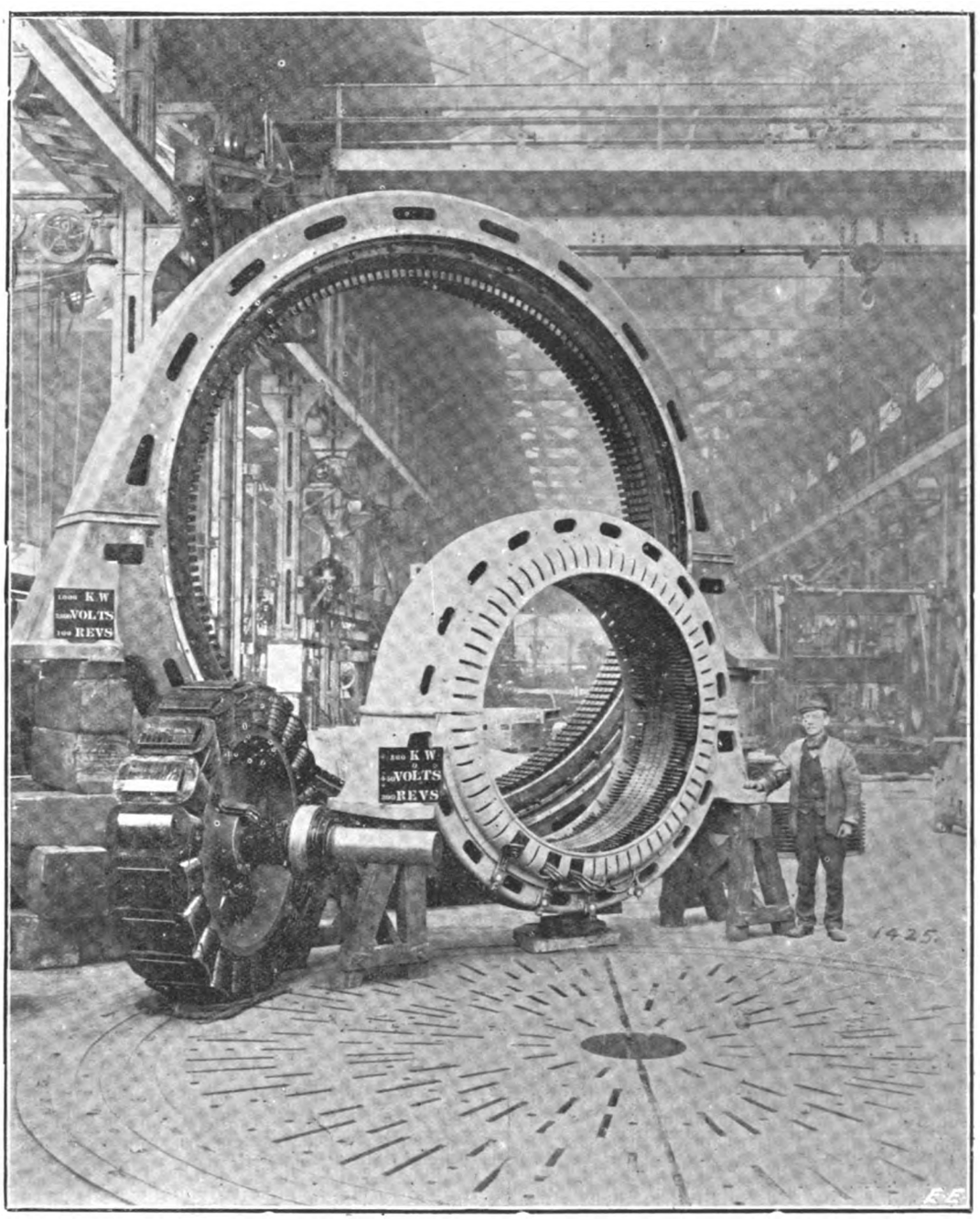

FIG. 3.—View of Messrs. Scott and Mountain's Erecting Shop, showing Main Parts of Colliery Plant.

works very complete equipment for turning out this class of article, including a special testing tank which is used for ascertaining the capacity of pumping sets of any size made by the firm.

As a further illustration of the way in which colliery proprietors are now actively devoting themselves to equipping their colliery plants electrically, our third illustration, which is a view in the main erecting shop at Messrs. Scott and Mountain's, is particularly interesting, inasmuch as it includes in the foreground the main parts of two recently ordered plants. In the immediate foreground is to be seen the stator and rotor of one of three generators for the Wigan Coal and Iron Company, which will be The machine is to run at 100 r.p.m., being driven direct by a gas-engine constructed by Messrs. Richardson, Westgarth, and Co., of Middlesbrough, of 1,200 b.h.p. to 1,500 b.h.p. These gas-engines are, by the way, being driven by blast-furnace gas from the iron company's installation. The generator is a three-phase 2,750-volt machine, giving current at 25 cycles for the purpose of supplying power to the iron and steel works and also to outlying collieries in the district. Its rotating field is 150in. in diameter, and fitted with 30 poles.

Such indications as are afforded by the machines above described show quite clearly that colliery practice is now becoming essentially a question of electrical engineering.

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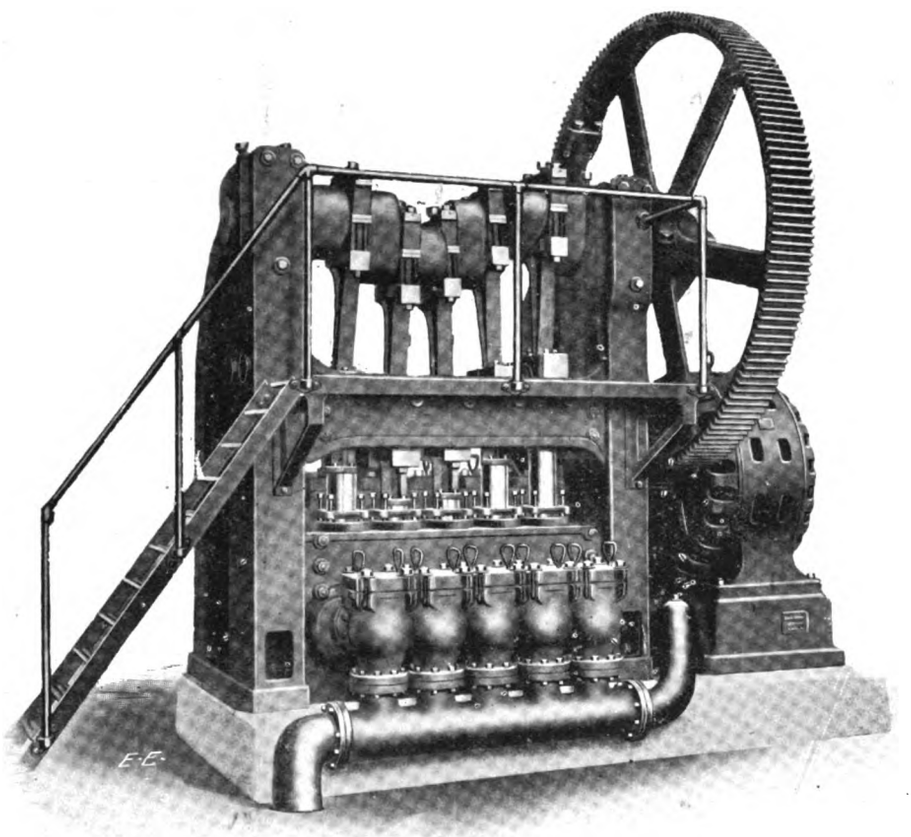
From the main winding engine through the haulage to the coal face where electric coal-cutters are used electricity is finding a very large and important sphere, while for such purposes as pumping and ventilating it is undoubtedly of considerable importance. One of the advantages which Messrs. Scott and Mountain have in this connection is that they manufacture every portion of the electrical and mechanical plant required by the collieries on their own premises, which have from time to time been enlarged in order to meet the increasing size of the plant required. In this way the responsibility for work executed is not split over various sub-contractors, and the gain in efficiency and satisfactory installation is thereby considerably enhanced.

ELECTRIC PUMPING INSTALLATION IN THE ANACONDA COPPER MINES.

An interesting electric pumping installation is being made by the Anaconda Copper Company in its mines at Anaconda, Montana. The pump, which is illustrated herewith, is a 6 by 12 Aldrich vertical quintuplex type made by the Allentown Rolling Mills, Allentown, Pa., and is designed to deliver 425 gallons of water per minute against a head of 1,100ft. This pump is to be driven by a Westinghouse squirrel-cage alternating-current motor of 150 h.p. capacity at 450 r.p m. The duty calls for heavy substantial construction, and acid-resisting material was required to be used in making the throat and plungers and other parts of the water end, on account of the bad condition of the mine water which is to be handled. The use of five plungers operating from one crankshaft, having connecting rods placed 72deg. apart, gives a uniform velocity of water in the pipes, thus adding greatly to the efficiency of the outfit. The plungers are single-acting and outside packed. It is claimed that, owing to the large size of the throats and valves and the comparatively low water velocity through all the orifices, high efficiency is obtained. This type of pump is becoming very popular in the above copper country by reason of its reliability and high efficiency, both of which are particularly important in mining operations, especially where power is purchased from transmission lines.



Electric Pump at the Anaconda Copper Mines.

COMPARATIVE TESTS ON ELECTRIC DESK FANS.

Some interesting tests carried out on seven different types of American desk fans are described by Mr. A. C Scott in the *Electrical World*. Table I. gives the electrical data and Table II the mechanical data of the various fans used. The shapes of the blades are shown in Fig. 1 The angle α in Table II. represents the maximum angular displacement of the edges of the fan blades from a plane parallel to and touching the front edges of the blades. For the purpose of measuring the volume of air delivered the fan was placed at the back of a cylinder 8¾in. long and 14¼in. in internal diameter, and the average velocity at the front of this cylinder was determined by a large number of anemometer readings in each case. Table III. shows the tests of the fans under their normal working conditions, whilst Table IV. gives the comparative results for the different fan blades, these being fitted in turn to the same motor, A, and run at 1,600 r.p.m.

Fig. 2 shows the shape of the envelope of the moving air from each fan. Each curve is plotted through points which represent distances from the fan where the velocity was zero for 5deg. angles from zero on the centre line to 60deg, which was the limiting angle where movement of the anemometer occurred for any one fan. The distance at zero angle in the several curves of Fig. 3 are as follows: A, 29ft.; B, 28ft.; C, 28ft.; D, 28·5ft.; E, 35ft.; F, 30ft; and G, 28ft. These values were obtained with each motor driving its own fan under the electrical conditions indicated in Table III. The arrangement of the apparatus for the determination of distribution of air from each fan is indicated in Fig. 4. The fan and measuring instruments were placed near one end of an empty room about 40ft. long and 30ft. wide. In front of the fan guard and close to it a small steel rod was supported rigidly in a vertical position. To this rod were fastened small strings, which radiated outward from the centre by 5deg. intervals up to 60deg. in one quadrant. Great care was exercised to be certain that the strings were stretched precisely 5deg. apart, and at such a level that the centre of the fan blades of the anemometer which was used for indicating the velocity of the air should be precisely in line with the centre of the fan. Precautions were also taken to be certain that

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each and every fan tested should have its top and bottom edges of the fan blades precisely plumb and in line with each other, and also that the plane of the fan blades was absolutely at right angles to the centre line extending outward from the centre of the fan. Tests of the velocity of the air at various distances and in various directions were also made. Thus the velocity was measured at 6in. from the fan, and at regular intervals of 2ft. thereafter up to a distance of 10ft. 6in., after which the intervals taken were 4ft. each. In Figs. 3, 4, and 5, which show the velocities from fans A, D, and F respectively, Curve *a*

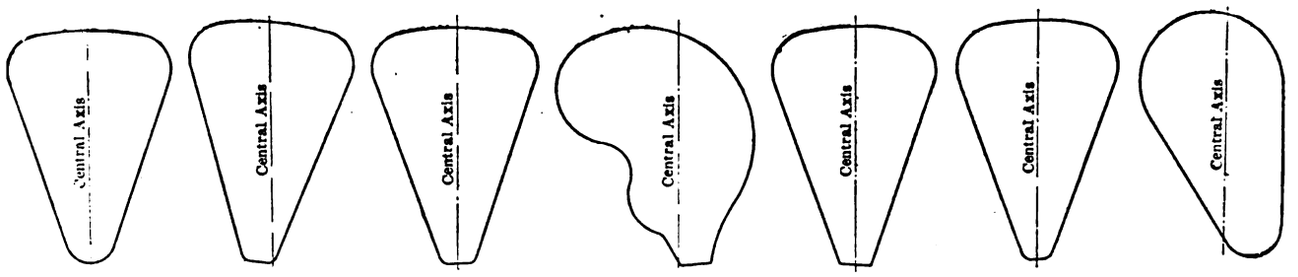

FIG. 1.—Blades for Fans A, B, C, D, E, and F.

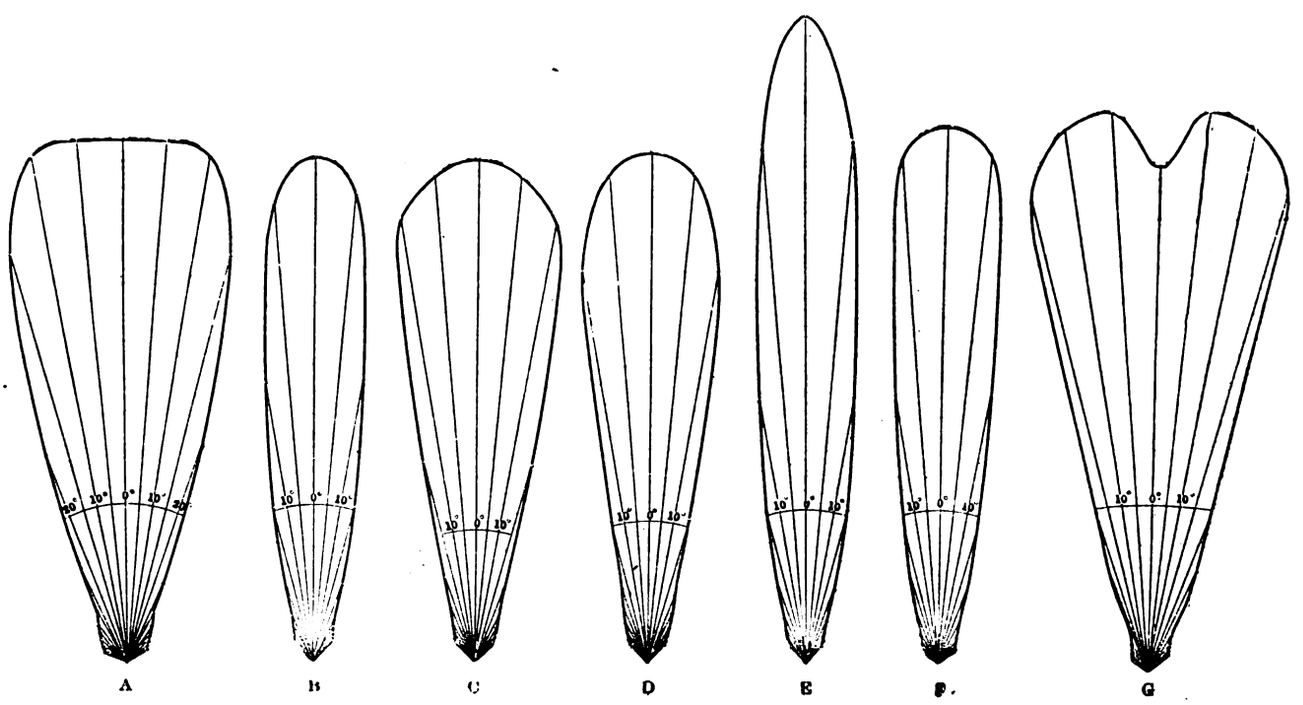

FIG. 2.

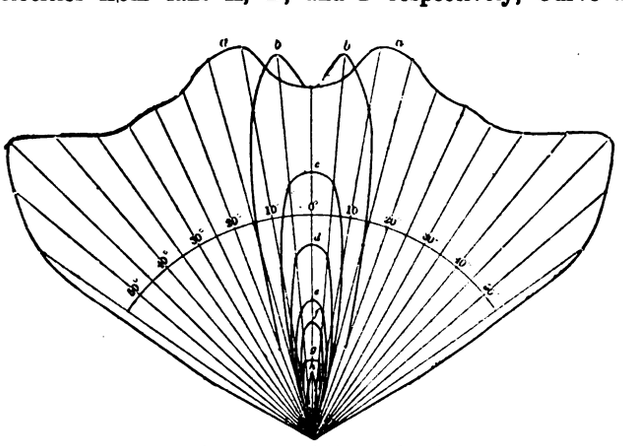

FIG. 3.—Velocity of Air from Fan A.

represents the velocity 6in. from the fan, Curve *b* the velocity 2ft. 6in., Curve *f* shows the velocity 10ft. 6in. from the fan, etc. The velocity in feet per minute at the centre 6in. from the fan (Curve *a*) for fan A is 1,195, for fan D it is 930, and for fan F it is 879.

By referring to Tables III. and IV. it is possible to consider the relation of the volume of air blown by any certain fan, because the results recorded in Table III. were obtained when each fan was operated at its normal speed, while Table IV. shows the results as to the volume delivered when the blades of each of the fans were run at a definite speed of 1,600 r.p.m. The result seems to show that the volume of air delivered per minute by any particular fan varies directly with the speed. It will be observed from

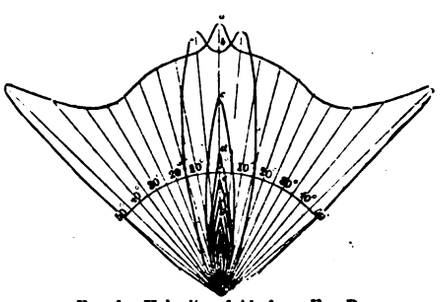

FIG. 4.—Velocity of Air from Fan D.

Table III. that the starting current for fan D is much larger than that for any other; its running current, however, is

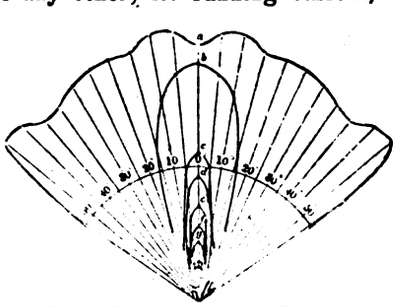

FIG. 5.—Velocity of Air from Fan F.

lower than that of any alternating-current fan. The temperature rise was highest on the F fan; it should also be stated that this fan was more noisy in its operation

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TABLE I.

Fan.	Type.	E.M.F.	Speeds.
A	Direct-current series	110	3
B	,,	115	3
C	,,	115	3
D	Alternating-current split phase	104	2
E	,, shaded pole	110–115	5
F	,, series	110–120	3
G	,, split phase	100–110	2

TABLE II.

Fan	A.	B.	C.	D.	E.	F.	G.
Length of each blade	5·19	5·4	5 35	5·6	5·38	5 4	5·7
Total diameter of fan, inches	11·53	12·0	12·0	12·4	12 0	11·87	12 25
Total area of four blades, square inches	50·18	51 36	51·12	59·78	51·16	50·7	50 56
Radius of curvature, inches	15·25	6·98	6 6	12 5	19 8	8 1	7·1
Angle α	17° 50′	17° 10′	16° 0′	13° 50′	14° 30′	14° 30′	15° 50′

TABLE III.

Fan.	Speed.	Current	Watts input.	Net watts.	Power factor.	Volume of air delivered cubic feet per minute.	Cubic feet of air per minute per watt.	Cubic feet of air per minute per net watt.	Temperature rise of frame.	Starting current amperes.
A	1,900	·405	44·2	23·11	—	1,215	27·2	52·6	2·6°	·780
B	1 520	·431	47·7	16·1	—	1,053	22·1	65·5	8·6°	·595
C	1,685	·430	47 7	21·0	—	1,155	24·2	55·0	5·4°	·750
D	1,660	·60	36	11·4	·545	878	24·4	77·0	11·4°C	3 50
E	1,460	·97	67	10·4	·628	837	12·5	80·5	5·4°	1·34
F	1,290	·74	58	23·7	·720	537	9·3	22 7	20·2°	1·00
G	1,555	·62	41·5	15·73	·601	997	24·0	62 4	8·0°	1·15

TABLE IV.

Fan.	Watts input.	Net watts.	Cubic feet of air displaced per minute.	Cubic feet of air per net watt minute.
A	30·0	14·14	1,025	72·4
B	41·7	20·44	1,119	54·7
C	39·4	18 94	1,101	58·2
D	22·2	10·00	853	85·3
E	25·2	11·45	903	78·9
F	27·9	13·34	697	52·2
G	30·6	14·74	1,024	69 5

than any of the others. It will be noted that cubic feet of air delivered per minute per net watt by the E fan was greater than that of any other fan, although the value for the cubic feet per gross watt is nearly the lowest in the list. The result is explainable by the fact that the stray power losses are greater in that fan than in either of the others. The value for the cubic feet per gross watt for the D and G fans is almost double that for the E fan. The D and E fans are provided with field windings distributed in slots—which construction gives minimum magnetic leakage—and a special contact device is connected with the rotor in such a way as to cut the auxiliary starting coils out of circuit when the rotor has reached a certain speed.

THE TRANSPORT OF TRAMWAY EMPLOYES.

The organisation of a tramways system involves a considerable amount of transference of men attached to the system from one point to another, and the process of discrimination between the journeys that are necessary on behalf of the company's business and those involved in private travelling of the employés is rather a difficult one.

Where the system is a comparatively small one, and the number of employés are not so great as to preclude personal identification by the inspectors, the simplest method is to allow all men in uniform to travel free of charge. This, of course, involves an accurate knowledge of the habits, places of residence, and other details concerning each man employed on the staff; but where an efficient system of supervision is employed it is quite possible, provided that the integrity of the inspecting staff can be relied on, to check within a very narrow margin the amount to which each man utilises the free transit facilities for his own purposes. In order to guard against the improper use of trams by employés who may be desirous of unduly using the facilities, an item should be included in the code of rules that the free use of trams by employés is limited to journeys taken on the authority's business and facilities for getting to and from home to duty. Where a certain portion of the staff is not in uniform—as, for example, the clerical portion—free passes of a permanent nature, such as a season ticket signed by the individual to whom each pass is issued, and handed out subject to inspection at any time by the officers on the tram routes appointed for that purpose, meets the case. This system, however, can only be adopted on tramways of limited extent, such as may be found in small towns.

In larger systems the difficulty may be met by issuing to each man in the service a special number of tram tickets free of charge, stamped with a discriminating letter. The employé is bound to offer one of these tickets for punching by the conductor for every journey, and no punched ticket may be used on a second occasion. The only drawback to this system is that the limits of the journey undertaken by each ticket cannot very well be defined; a man can quite easily take a twopenny tram ride with a ticket which should only legitimately be used for penny fare systems, but the system has the undoubted advantage of cutting down the waste rides undertaken by employés.

A third method, which has been adopted with considerable success in large systems, is the preparation of special counters having a definite value of the smallest amount which can be paid for a car stage. A limited number of these tallies are issued to each employé week by week, the number corresponding to the estimated journeys which such employé should take for the carrying out of his duties. One of these tallies is handed up on every occasion that a conductor demands a fare, and at the end of the week the surplus is handed in to the clerk in charge. In this way a fairly accurate check can be kept on the journeys undertaken by each employé, and should there be anything abnormal, either in the continuous behaviour of any one man or in any particular week's return, the circumstances can be readily inquired into, inasmuch as the tallies are included in the conductors' returns every day.

An illustration is given of the form of tally adopted by the London County Council for their tramway system. It consists of a celluloid disc, stamped on one side with the coat-of-arms of the Council and on the other with the fare. This is a form of tally which is cheap to produce, and which cannot be very easily forged.

ELECTRO-THERAPEUTICS.

Dr. H. Lewis Jones read a paper on "Some Practical Applications of Electricity and X-Rays" at a recent meeting of the South-West London Medical Society. Dealing first with its use for diagnostic purposes, he showed how the electrical reactions of the muscles could be utilised to demonstrate the exact situation of a lesion in the peripheral nerves or in the spinal cord. He mentioned that by electrical testing the fact that death has occurred could be definitely determined. If no one were buried till the electrical reactions of the muscles had disappeared, the fears of being buried alive could be allayed. Used formerly only for the destruction of tissue, electrolysis was now also applied to the introduction of drugs into the skin. The electrically-charged molecules of any given salt in solution migrated into and through the skin in accordance with fixed laws, acids moving towards the positive pole, metals and alkaloids towards the negative, the exact quantity of each being determined by the calculation from its electro-chemical equivalent and the strength of the current employed. Thus about three milligrammes of zinc could be administered in 10 minutes under a current of 12 milliamperes. Dr. Lewis Jones recorded several very interesting cases of the successful use of various drugs in different morbid conditions, such as lupus and diphtherial infection of wounds, and referred to the therapeutic uses of the X-rays, with special reference to ringworm.

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ELECTRICITY IN FACTORIES AND WORKSHOPS.

Inquiry into Home Office Draft Regulations.

This inquiry was reopened on Tuesday morning at the Surveyors' Institution before the commissioner, Mr. James Swinburne.

Mr. GRAY announced that the committee had arrived at certain modifications which appeared to be satisfactory to the Home Office and to the objectors. The first 20 regulations appeared in their modified form in our issue of last week. The following sub-section has since been added to Regulation 18, which deals with switchboards for high pressure or extra-high pressure:

(*d*) "Every switchboard in continuous use shall either (*a*) be so arranged that the conductors thereof can be made dead in sections, and so separated by permanent or removable divisions or screens from all adjoining sections of which the conductors are live, that the work on any section may be carried out without danger; or (*b*) otherwise so arranged as to secure that the work may be carried out without danger."

As Regulation 20 of the modified regulations has since been further altered, we reproduce it this week, together with the remainder of the modified regulations:

20. Where a high-pressure or extra-high pressure supply is transformed, suitable provision shall be made to guard against danger by reason of the lower pressure system becoming accidentally charged above its normal pressure by leakage or contact from the higher pressure system.

21. Where necessary to prevent danger adequate precautions shall be taken either by earthing or by other suitable means to prevent any metal other than the conductors from becoming electrically charged.

22. Adequate precautions shall be taken to prevent any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

23. Where necessary to prevent danger, insulating stands or screens shall be provided and kept permanently in position and shall be maintained in sound condition.

24. Portable insulating stands, screens, boots, gloves, or other suitable means shall be provided and used when necessary to prevent danger, and shall be periodically examined by an authorised person.

25. Adequate working space and means of access, free from danger, shall be provided for all apparatus that has to be worked or attended to by any person.

26. All those parts of premises in which apparatus is placed shall be adequately lighted to prevent danger.

27. All conductors and apparatus exposed to the weather, wet, corrosion, or to inflammable surroundings or explosive atmosphere, or used in any process or for any special purpose other than for lighting or power, shall be so constructed or protected, and such special precautions shall be taken, as may be necessary to prevent danger in view of that exposure or use.

[Regulation 28 deleted and replaced by Regulation 34.]

29. No person except an authorised person, or a person acting under his immediate supervision, shall undertake any work where technical knowledge or experience is required in order to avoid danger. Where a contractor is employed, and the danger to be avoided is under his control, the contractor shall appoint the authorised person, but if the danger to be avoided is under the control of the occupier, the occupier shall appoint the authorised person.

[Regulation 30 is left to be dealt with by the commissioner.]

31. Every sub-station shall be substantially constructed, and shall be so arranged that no person other than an authorised person can obtain access thereto otherwise than by the proper entrance, or can interfere with the apparatus or conductors therein from outside, and shall be provided with efficient means of ventilation and be kept dry.

32. Every sub-station shall be under the control of an authorised person, and none but an authorised person or a person acting under his immediate supervision shall enter any part thereof where there may be danger.

33. Every underground sub-station not otherwise easily and safely accessible shall be provided with adequate means of access by a door or trap-door, with a staircase or ladder securely fixed and so placed that no live part of any switchboard or any bare conductor shall be within reach of a person thereon. Provided, however, that the means of access shall be by a doorway and staircase: (*a*) if any person is regularly employed therein, other than for inspection and cleaning; or (*b*) in any such sub-station not of ample dimensions, either if there is moving machinery therein, other than ventilating fans, or if there is extra-high pressure therein.

34. Adequate periodical inspections shall be made by an authorised person to ensure that these regulations are fully complied with.

[*** To facilitate reference, the numbering has not been altered, notwithstanding the deletion of No. 28.]

The definitions and exemptions have also been modified, and now read as follows:

Definitions.

Pressure means the difference of electrical potential between any two conductors, or between a conductor and earth, as read by a hot-wire or electrostatic voltmeter.

Low pressure means a pressure normally not exceeding 250 volts.

Medium pressure means a pressure normally above 250 volts, but not exceeding 650 volts.

High pressure means a pressure normally above 650 volts, but not exceeding 3,000 volts.

Extra high pressure means a pressure normally exceeding 3,000 volts.

System means an electrical system in which all the conductors and apparatus are electrically connected to a common source of E.M.F.

Conductor means an electrical conductor arranged to be electrically connected to a system.

Apparatus means electrical apparatus, and includes all apparatus, machines, and fittings in which conductors are used, or of which they form a part.

Definition of "Cable" deleted.

Circuit means an electrical circuit forming a system or branch of a system.

Insulating stand means a floor, platform, stand, or mat
Insulating screen means a screen
Insulating boots means boots
Insulating gloves means gloves
} of such size, quality, and construction, according to the circumstances of the use thereof, that a person is thereby adequately protected from danger.

Covered with insulating material means adequately covered with insulating material of such quality and thickness that there is no danger.

Bare means not covered with insulating material.

Live means electrically charged.

Dead means at or about zero potential, and disconnected from any live system.

Earthed means connected to the general mass of earth in such manner as will ensure at all times an immediate discharge of electrical energy without danger.

Sub-station means any premises, or that part of any premises, in which electrical energy is transformed or converted, and which are large enough for a person to enter after the apparatus is in position.

Switchboard means the collection of switches, or fuses, conductors, and other apparatus in connection therewith, used for the purpose of controlling the current or pressure in any system or part of a system.

Switchboard passageway means any passageway or compartment large enough for a person to enter, and used in connection with a switchboard when live.

Authorised person means a person employed, appointed, or selected by the occupier, or by a contractor or contractors for the time being under contract with the occupier, to carry out certain duties incidental to the generation, transformation, distribution, or use of electrical energy, and competent to carry out those duties.

Danger means danger to health or danger to life or limb from shock, burn, or other injury to persons employed, or from fire attendant upon the generation, transformation, distribution, or use of electrical energy.

Exemptions.

1. Nothing in these regulations shall apply to any system the normal working pressure of which does not exceed 130 volts continuous or 65 volts alternating.

2. Nothing in Regulations 7, 8, 9, and 10 shall apply in electrical stations to any circuit or conductor used for conveying electrical energy for public supply or for traction under license or other statutory powers, or for railway purposes, or for docks constructed under statutory powers.

3. Nothing in Regulation 12 shall apply to any motor of a motor-generator or to any motor forming part of any electrical converter, regulator, or similar apparatus.

4. Nothing in these regulations shall apply on the premises of an occupier, being a consumer of an authorised electricity supply undertaking, to any service lines or apparatus on the supply side of the occupier's terminals, belonging to and under the control of the suppliers provided such suppliers are subject to Board of Trade regulations in respect of such supply.

5. If the occupier can show with regard to any requirement of these regulations that the special conditions in his premises are such as to adequately prevent danger, that requirement shall be deemed to be satisfied.

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6. Nothing in these regulations shall apply to any process or apparatus used exclusively for electro-chemical or electro-thermal or testing or research purposes; provided such process be so worked and such apparatus so constructed and protected and such special precautions taken as may be necessary to prevent danger.

Counsel for the various parties thereupon stated the attitude they were going to adopt.

Lord ROBERT CECIL said that as to the big points originally raised, they still adhered to their view, that the regulations should not apply on systems where the pressure was below 250 volts, and that existing works should be exempted. He proposed to argue that no prosecution should be allowed without the fiat of the chief electrical inspector. He wanted the exemption of underground sub-stations, and this would mean adopting some kind of proviso affecting Regulations 25 and 31 to 33. He proposed that these regulations should not apply to any system, sub-station, or transforming chamber constructed in accordance with plans passed or approved by the Board of Trade, or to any extensions of such systems similarly constructed. Then the regulations should not come into force until Jan. 1, 1909, after which 12 months should be allowed to enable the necessary structural alterations to be carried out.

Mr. VESEY KNOX said he proposed to draw attention to the same points as Lord Cecil, but he proposed to lay special stress on two things—*i.e.*, there should be no prosecution without the fiat of the chief electrical inspector, and then there should be appeal.

After various points raised were explained, Mr. PATCHELL was called to give an account of some experiments which he had recently undertaken to determine what voltages a man could safely take hold of. At one time he thought the pressures suggested by the Home Office were too low, and this was the motive of his experiments. He found that 72 volts continuous current was quite comfortable; 50 volts alternating current appeared to be equivalent to 100 volts continuous current; 16 volts alternating current and 50 volts continuous current gave the same results. When gripping copper conductors charged with 50 volts alternating current no contraction of the muscles was felt; at 65 volts alternating current there was a distinct contraction of the muscles, just as there was with 130 volts continuous current. Three of them then tried to find out how much current they could take in their bodies. One of them took 2·8 milliamperes alternating current, another took seven milliamperes alternating current. Mr. Patchell took 10 amperes alternating current without any discomfort. Experiments were then tried with continuous current. The first took 12 milliamperes, the second 25, and Mr. Patchell 27. The state of the skin was an important point in the experiments, and it was found that they became more sensitive to the currents as their hands became moistened by the perspiration which the experiments induced. These results were compared with the results obtained by the other people who made similar experiments. Dealing first with continuous current, one man took 20 2 volts 4 milliamperes, and hardly felt it; 42 volts 8·1 milliamperes was distinctly felt, and 68·5 volts 8 milliamperes caused a painful burning in the hands. The second man got a shaking with 40 volts 5 milliamperes; with 70 volts 10·8 milliamperes his muscles were much contracted, and 100 volts 20·3 milliamperes he burnt his hands. Fifty volts 8·6 milliamperes had little effect upon the third man; 70 volts 13·8 milliamperes caused pinching in his finger points, and 90 volts 20 2 milliamperes stabbing pains. Continuous current was then tried upon a workman, who could hardly feel 60 volts 12·9 milliamperes, while 90 volts 20·42 milliamperes caused him pain in the right hand. The same experiments were made with alternating currents. The workman found 9·7 volts 2·8 milliamperes disagreeable, and with 14·7 volts 4 8 milliamperes his wrists contracted.

Mr. Patchell, answering Lord Robert Cecil, said that the amount of current that could be safely taken differed for various people. One man could not stand more than 68 volts continuous current. Counsel asked why such a man was less to be protected than others. He pointed out that in the electrical inspector's report for 1906 there was only one fatality where the voltage was less than 250 volts alternating current, and there was nothing below 500 volts continuous current. Mr. Patchell said that to avoid a repetition of accidents or fatalities it was necessary to take a lower limit than that which had proved dangerous. He could call to mind no system with alternating current as low as 65 volts, though some furnaces run thereabouts. There were some continuous-current systems of 110 volts, all of which would be exempted, but no alternating-current system would be exempt. He had heard of no accident on an 105 volt alternating-current system in London. Mr. Cozens-Hardy urged that it would be reasonable to raise the voltage of the exemption as regards authorised persons having access, who would be very unlikely to be taken unawares.

Mr. SPARKS was called by Lord Robert Cecil to give evidence on general points, and stated that unless the regulation as to pressure was amended all alternating-current supply systems would come under the regulations, which would favour continuous-current systems. He saw no reason for making a distinction between the pressure of alternating-current systems and of continuous-current systems. The Board of Trade Committee in 1895, presided over by Lord Kelvin, suggested that the same pressure should be allowed for alternating current as for continuous current. There seemed no necessity for the notice as to the dangers from electricity required by Regulation 30, and these would naturally prejudice users in favour of gas. With regard to Regulations 25 and 31 to 33, he explained that in the case of the County of London sub-stations it would be impossible to comply with this, as the company had no free hand in selecting the dimensions of these sub-stations, which were prescribed by the Board of Trade. They were faced with the difficulty of the future, and they might have to put sub-stations above ground, which would be impracticable. He thought that undertakers should have one year given them to bring their works up to date. If they had to make structural alterations and carry out their business at the same time, six months was not long enough.

Mr. GRAY, in cross-examination of the witness, said that there was no reason why the time for the regulations to come into force should not be postponed until Jan. 1, 1909, and why another year should not be allowed for the carrying out of alterations. With regard to sub-stations, Mr. Sparks said his company wanted specific exemption under their particular conditions. The only difficulty as regards Regulation 25 lay in the words "adequate working space and means of access free from danger." He had no objection to Regulations 31 to 33. He thought the rules as modified were conducive to good workmanship in factories; they would not make the electrical industry uncommercial, but might make it more difficult to sell electricity for power—which had to meet the heavy competition of steam, gas, and producer gas, none of which had any such regulations to bear. The fewer regulations the greater the progress of the industry. It was not possible by any regulations to prevent danger, which must always be present to some degree. In answer to Mr. Swinburne as to the design of the County of London sub-stations, he said he considered them safe, but if he had to reconstruct them he would make them larger. The reason this had not been done in the first instance was because of their difficulty with a certain local authority.

Lord ROBERT CECIL hereupon rose to address the commissioner. He desired to point out that the whole question must be approached from the point of view of the industry. It was impossible to divide the question into safety and expense and consider it from these aspects separately. It was just as important that there should be no undue interference with the industry as that safety should be regarded. They all knew that the Act of 1882 practically postponed the introduction of electricity into this country until modified in 1888, and gave all the other countries a start over us in this respect. With regard to voltage, he alluded to the unfairness which these regulations imposed upon alternating-current systems. Whatever figure was insisted upon, there was no adequate reason for making a distinction between alternating current and continuous current. Up till 1895 there was this distinction, but when Lord Kelvin's Committee examined the question in that year

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they came to the conclusion that it should be removed, and allowed 250 volts to stand as the figure for both systems. Counsel submitted that 250 was practically safe; the result of Mr. Patchell's evidence that morning was purely negative, and he asked why the Home Office did not produce evidence of accidents at pressures below 250 volts. A large quantity of domestic supply was on 220 volts, and there would be cases of extreme absurdity if these provisions were put into force. They would not apply in a house or shop, but if in a back room of such premises two or three girls were employed the place was brought under the regulations. The occupiers would have to employ an "authorised person" to inspect the whole of their fittings and electric wiring, which would be a heavy fine, and would result in electric lighting being abandoned in favour of gas. It seemed a grotesque absurdity to say that in private houses it was quite safe to use electricity for any purposes, such as cooking, heating, etc., but that the moment three girls were working there these regulations must apply. Lord Robert Cecil argued for an appeal in the case of existing works. He said that all existing works should be taken *prima facie* safe; the factory inspector might say that this or that detail was unsafe, and report on the matter to the electrical inspector, but before an occupier was called upon to carry out alterations at a large expense, he should have an opportunity for stating his case before an independent body. No business men were going to the great expense of fighting a Government department unless they thought they had a really good case. Exemption 5 did not give them the protection, because they could not make use of it until they came before a court of summary jurisdiction. They would have to satisfy that court that the expert advisers of the Home Office were wrong and that they were right. That was not a position on which they would be fighting on equal terms. Mr. Ram recognised in principle that he had no objection to an appeal, while all the other Home Office witnesses were practically unanimous on this matter. He asked that Regulation 34 should be struck out. That every user of electricity was to have a periodical inspection made by a professional man was utterly unreasonable, and put a heavy fine on users. The Home Office, he said, should make such inspections themselves.

Mr VESEY KNOX followed on behalf of the North of England power companies. His clients supplied current at high pressure, and their position differed somewhat from that of the London companies. He thanked Mr. Gray and the Home Office advisers for the way they had been met at the conference, but he still thought that these regulations, as any other regulations, would have a detrimental effect upon the industry. In "pushing" the sale of electricity they had the greatest difficulty with users who had no electrical knowledge, and were at times apt to regard it as unsafe. If the regulations were put into force at all, they should be protected by every safeguard that would prevent the industry being injuriously affected by them. He would be content that the rules should not apply to pressures under 250 volts. He did not say that some regulations were not desirable, but he strongly urged that there should be no prosecution without the fiat of the chief electrical inspector, and that there should be the right to appeal. [Counsel had not finished his address when the sitting was adjourned.]

On Wednesday morning Mr. Knox resumed his address to the commissioner on the question of the fiat, and urged that before proceedings were taken there ought to be a definite certificate from the electrical inspector that in his opinion something ought to be done. The question of fiat, he said, was one to which he attached the utmost importance, for if anyone were permitted to put proceedings in motion it would be a serious matter for the industry. In every factory there was already power to proceed under Section 17 of the Factory and Workshops Act; there would still be that power to proceed after the regulations were adopted, and in the case of low pressure Section 17 was ample. The Home Office could say that certain alterations were necessary for the purpose of Section 17 of the Factory and Workshop Act, and in the case of high pressure a memorandum was quite sufficient. Dealing next with the question of appeal, counsel agreed that an appeal on every detail was unreasonable, but, as to past or future work, requirements involving considerable sums of money ought to be some reason for appeal. A ground for this was that the electrical inspector was apt to become the prey of every inventor, and he thought the evidence on the subject of no-volt releases for three-phase motors furnished a case in point. Such an example was not likely to occur, however, if there was power to appeal to arbitration before an expert. A court of petty sessions was not an efficient tribunal to deal with intricate electrical questions; moreover, the expense in connection with an appeal before such a tribunal would be very great, for expert evidence would have to be brought, probably from some distance, before some country bench of magistrates, and the same might have to be repeated before a quarter sessions bench, with whose decision on technical problems no engineer could feel satisfied. The power of arbitration, said counsel, was very useful, and he pointed to the small number that had taken place under the Factory and Workshops Act as proof of where that power exists it effectually prevented manufacturers being subjected to unreasonable requirements. It was not sufficient, in the case of the electrical power companies, that the right should exist for past work, and he urged that there should be the right for future work. As to exemption No. 5, it seemed to him insufficient, and he argued that the question as to whether the special conditions on premises are such as to adequately prevent danger should be left open to be decided in each case without the onus of proving it being distinctly put upon the occupier.

At the conclusion of Mr. Knox's address, Mr. PROCTOR gave evidence as to the exemption of systems where the normal pressure was less than 250 volts. He said that for 250 volts alternating current or continuous current the regulations were unnecessary. In his experience extending over 19 years, and concerned with pressures ranging from high to low, he had never experienced an accident at 250 volts or below that. Since the previous day he had heard by telegraph from the chief engineers of some of the largest electrical undertakings that they had not had one death at 250 volts, and only one non-fatal accident had occurred. His view was that nothing would be gained by having regulations at the low pressures proposed. With regard to Regulation 30, he thought it would be an injustice to the electrical industry generally if the proposed notices were to be put up where electricity was used at low pressures.

Mr. PRITCHETT then addressed the commissioner on behalf of the Incorporated Municipal Electrical Association and the Associated Municipal Electrical Engineers of Greater London, which represented practically the whole of the municipal electrical undertakings in this country. Many of these were owned by local authorities who had statutory powers to deal with questions affecting the health of the public, and it was unlikely that they would oppose these regulations if they were calculated to enhance the safety of a section of the public. Moreover, as owners of electricity works, accidents on their own works would likely be prejudicial to the use of electricity outside. He was willing to assume that some regulations were necessary, but urged that they should not, in the first instance, be made too stringent, but should be more of a tentative nature to allow for any modifications that experience might prove necessary. They did object to the regulations on the ground of expense if there was to be no co-ordinate benefit, but when alterations were necessary in the interests of the workpeople, they would carry them out even at a great expense. He next argued in favour of the exemption of premises using low pressure, then dealt with the question of arbitration. He did not suggest that there could not be danger at 250 volts, but, he said, the danger from the use of a low pressure was not exceptionally great compared with the danger in other trades. He contended that it was necessary to have an appeal before an arbitrator in the case of future apparatus as well as in the case of existing apparatus. The quarter sessions was not a suitable tribunal for dealing with intricate technical questions. It had been suggested—though, he hoped, not seriously—that Mr. Ram would

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actually be the arbitrator in cases of objection; but that would be like combining the *rôles* of Lord Chief Justice and chief prosecutor in one person.

After the adjournment Mr. GUTTERIDGE made a speech on behalf of the London County Council. He claimed also to represent the very large number of users of electric power within the County Council area. He supported the contention of other counsel that there should be a certificate issued by the Home Office before proceedings were commenced. He also argued in favour of arbitration rather than bringing disputed cases before the magistrates.

Mr. DOWNING, representing the Barry Docks, urged that all docks should be exempted in terms from the regulations, because they were already subject to other regulations which protected the workers.

Mr. W. B. WOODHOUSE, speaking for all the power companies other than the Newcastle-on-Tyne Company, said that they were practically starting new industries, and had to do pioneering work which called for new departures in the design of of switchgear, etc. This made it exceedingly difficult to frame the regulations to cover not only the existing conditions but future progress also. This was shown by the large number of the regulations. He thought their rivals would use the regulations as 33 arguments against the use of electric power. He drew a parallel between the danger of a fatal shock from voltages below 250 with the danger from drowning in 6in. of water. The Home Office had not yet insisted on life-belts being placed round roadside puddles.

Mr. SIDNEY MORSE reviewed the many legislative difficulties which the electrical industry had had to bear, and urged that these regulations would form an additional heavy burden. With voltages under 250 he contended that the danger was much less than the ordinary dangers of common life.

Mr. J H. GRAY, replying for the Home Office, repeated his introductory remark that the sole object of the regulations was the protection of the workman. They were not intended to protect his life alone, but also to protect his health, and to reduce the risks from non-fatal shocks and burns. He did not propose to meet the arguments of the other side, which were to the effect that unless there had been a large number of deaths there was no need for regulations. The other regulations of the Home Office—such as the fencing of machinery — aimed at preventing injury to the person. Still, of the fatal shocks which were referred to in Mr. Ram's reports for the last five years, 24 out of 84 were caused by voltages below the limits of low pressure (250 volts). On the arbitration question, Mr. Gray pointed out that the 1901 Act contained no suggestion of arbitration, and that the 13 sets of regulations which had been issued under this Act contained no provision for appeal to an arbitrator. The arbitration clause in connection with the regulations for the earthenware and the china trades under the older Acts did not give any appeal against the Home Office inspector's decision. In fact, in no case was there any appeal to an outside expert.

Proceedings were then adjourned until Thursday.

Mr. GRAY resumed his address on Thursday morning, when he summed up his arguments on the question of voltage, retrospection or existing works, and appeal. He submitted that on the question of voltage, all that the commissioner had to consider was whether the regulations in their modified form were oppressive or not. If in his opinion they were not oppressive, he asked him to say that the voltages which were prescribed in the regulations should remain. The demand for appeal might appear in some way more or less reasonable, but he pointed out that there were already 13 sets of rules in operation under the Factory and Workshops Act, in none of which was there any appeal such as was asked for in this case. It would be impossible to properly administer these rules if there was right of appeal. He proposed to add to Exemption 5 the following words: "and the Secretary of State may by order direct that any class of special conditions defined in the order shall be deemed for the purposes of all or any of the requirements of these regulations adequately to prevent danger." The effect would then be that the Department might exempt factories in which there were special conditions. The County of London sub-stations, for instance, would be exempted. Mr. Gray promised that the Department would assist, as far as possible, to prevent prosecutions being taken by parties outside the Home Office. On the question of overlapping, he had not yet heard from Mr. A. P. Trotter as to the exclusion of generating stations from the Board of Trade regulations, but he thought that the commissioner in his report might recommend that some sort of arrangement might be carried into effect. He suggested that sub-sections (*a*), (*b*), and (*c*) of the Board of Trade Regulations A (1) should not apply to factories.

A discussion then took place as to precedent for arbitration It was urged that if anyone had a *bona fide* technical ground of objection, there should be a certificate from the electrical inspector before a prosecution was given. On behalf of the underground electric railways and others who took power from Lots-road it was pointed out that there should be arbitration. At the sub-stations the conditions, though perfectly safe, did not comply with the rules, and there should be the right to appeal. Mr. Gray replied that the commissioner was being asked to suggest an entirely new practice under these rules without having been shown any necessity for it. He thought it would be unworkable and unpracticable. He proposed that the regulations should come into force on Jan. 1, 1909, with the proviso that a year should be allowed to enable the companies to bring their works in conformity with the regulations.

After expressing some words of appreciation of the way Mr. Swinburne had conducted the inquiry, the proceedings terminated.

The following further modifications have been approved of by a committee of some of the objectors and Home Office representatives:

Exemption 4.—This exemption was altered, and as altered reads as follows: "Nothing in these regulations shall apply to any service lines or apparatus on the supply side of the consumer's terminals or to any chamber containing such service lines or apparatus where the supply is given from outside under Board of Trade regulations; provided always that no live metal is exposed so that it may be touched."

Regulation 4.—The first paragraph of this regulation was amended, and as amended reads as follows: "Every switch intended to be used for breaking a circuit and every circuit breaker shall be so constructed that it cannot with proper care be left in partial contact."

Regulation 12.—The third paragraph as altered reads as follows: "In every place at which machines are being driven by any electrical motor there shall be means at hand for either switching off the motor or stopping the machines."

THE POSITION OF A MECHANICAL ENGINEER IN A CENTRAL STATION.

The report of the Board of Trade concerning the explosion of a boiler at Greenwich contains some recommendations which may very possibly lead to drastic alterations in the personnel of some central-station staffs. It recommends that in the management of electrical power stations—where the chief engineer is, as he should be, an electrical specialist—arrangements should be made so that the engineer's responsibility for the safe working of the boilers should be lessened or transferred to an engineer having a thorough knowledge of the working of boilers.

This opinion, it may be suggested, is a somewhat accentuated view of the case, and while designed to remove a possible danger introduces one still more serious—that of divided authority. That it should be seriously recommended that responsibility should not be centred in one man can only be explained by the fact that the authority who recommended this division was, perhaps, a little too much impressed with the immediate disaster which it had under contemplation. The fallacy of the position will be seen when the status of the chief engineer of the central electric lighting station is examined in detail. His duties are multifarious. He must be a good commercial manager in order to make the station pay, and this can only be achieved by good all-round practical experience of electrical and mechanical work. However an engineer may scheme to get business, his efforts are no use at all unless

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his commodity can compete against all antagonists in price and usefulness. In addition he is expected to carry out any duties of civil engineering work, consulting and estimating for extensions, and the correspondence work of his office. Above all, he must possess unlimited tact and patience in order to keep on good and peaceful terms with the committee, council, and ratepayers, whose servant, in the case of a municipality at any rate, he is. He has not one supreme superintendent of unbiassed mind, but very often a lot of inexperienced people who make his life a burden, and when this is considered it is obvious that he should at any rate have supreme control and responsibility in regard to his station.

It can safely be asserted that the majority of our chief engineers are the most fitted to hold the positions which they occupy. Their experience has been throughout their career a special one in that class of work, and they have made their way up step by step to the top of the tree. During their time of probation and promotion they have become intimately connected with every part of the work required in the central station, including the boiler-house. Their knowledge will tell them whether any section of the undertakings under their control is being conducted in a right or wrong manner, and whether their men carry out the work in the best and most expeditious manner possible. The composition of the staff is generally left to the judgment of the chief engineer, and for his own protection it will be found that in the branches in which he is not so well versed he will add to his staff in the strongest degree. If he does not select men of the capabilities required who will support him thoroughly in his work, then he knows that if he is the most expert man in the country on boilers or anything else he will fail. Briefly, then, one man must be supreme, and it is not very easy to see how he can be a boiler expert—such as the commissioners producing this report appear to expect, but will find it hard to discover—as well as an electrical expert, mechanical expert, and business expert.

Taking now the alternative of securing a separate authority, whose special business would be the management of the boiler section, there is likely to be a considerable amount of confusion. The price at which electricity has to be sold nowadays can only be realised by strict economy in regard to the working of the station, and the boiler expert is not always an economy expert. Hence, from the moment the contract is fixed for the supply of coal at the best figure in relation to quality until the current is delivered to the consumer, the chief engineer must watch every step in the transformation and see that the best results are obtained. Suppose, for the moment, that a boiler expert obtains an independent authority, the man selected for the post will probably be drawn from the men who pass the Board of Trade examination for sea-going engineers, and apart from the fact that the passing of an examination, say, 20 years ago is not an altogether fair criterion as to whether the man has subsequently kept in close touch with steam-raising developments, it must be difficult to say what commercial experience a man has who has spent all his younger days at sea. His profession of wandering from point to point on the globe precludes his knowledge of all that is taking place in land practice in Great Britain, and there is considerable difficulty, at any rate at the outset, for him to put his seafaring knowledge to valuable account in a central station for the supply of electricity. His operations at sea are confined to an area of a few square yards, to a very specialised type of engine and boiler, and to men under him who are considerably more under control and subservient than when on land. It would, therefore, be rather a mistake to put too much weight of responsibility on such a man when placed in the highly complex conditions of land practice. To make him equal or independent of the electrical man, who, as the commissioners say, should be at any rate nominally at the head of the concern, would be to introduce a considerable danger to the satisfactory working of the supply.

It is justly pointed out that a man of the working class, such as a boiler-house foreman, is insufficient for the proper supervision of the plant; but, except in very small stations, whose finances will not permit of much expense in salaries, it will be found that the boiler portion of the plant is in charge of a thoroughly qualified engineer, and it would hardly seem advisable to upset the present arrangement of things, which in the large majority of instances works out in a very satisfactory manner, without a considerable amount of further inquiry as to the probable results of a recommendation such as that passed as the result of the inquiry.

LONDON COUNTY COUNCIL TRAMWAYS.

The report of Mr. W. B. Peat, the president of the Institute of Chartered Accountants, and Mr. F. W. Pixley on the tramway undertaking of the London County Council has been issued this week, and has attracted a great deal of attention in the daily Press. This report is too lengthy a document to reproduce in full, and hence we propose to give a brief *résumé* of the same with a few verbatim extracts. The first portion of the report deals with the horse tramways which the Council had to buy. On this point the report states: "The Council includes in its capital account up to March 31, 1907, the outlay on both the horse traction and the electric traction tramways, the latter including the expenditure on street improvements, etc.—namely: horse traction, £2,380,736. 13s. 1d.; electric traction, £4,356,000. 12s. 4d.—total, £6,736,737. 5s. 5d. This principle in our opinion is not sound, because there are practically no existing assets to represent the horse system of traction so far as it has been displaced. It is suggested that a certain residue of value exists in some of the displaced horse traction assets, but in our opinion this value cannot alter the fact there is a large loss not provided for on the displacement of the horse traction system."

After reviewing the various items of expenditure on the horse tramways which have been displaced, the report concludes that there is still an approximate loss of over one million on this head. Since 1897, £293,592 from the earnings of the horse tramways have been applied to the relief of rates, which, in the opinion of these experts, should have been placed against the above loss. Clauses 17 and 18 of the report read: "Until the revenue of the tramways has been charged with (1) the losses on displaced assets of the horse system; (2) a full provision for renewals on the system now in force; (3) the charges in respect of the outstanding debt; and (4) a proportionate amount of the full central office charges, we are of opinion that no sum will be available for relief of rates." "In the balance-sheet the loss referred to should appear as loss on conversion of the horse system to electric traction."

Then dealing with the renewal and reserve fund for the electric tramways, Messrs. Peat and Pixley state that "What provision should be made out of revenue for renewals of the electric undertaking is a very difficult question to decide when the life of the assets forming part of such undertaking has not yet been ascertained by experience. It is impossible for us to fix a rate. The Council has been advised by its officers that at least 1d. per car mile run should be provided for the renewals reserve fund, this being in addition to any general repairs of the undertaking and the renewal of the machinery, plant, and buildings of the generating stations."

The subsequent remarks show that the County Council have not adopted the above standard, and that in consequence the reserve fund is lower than it would have been if 1d. per car mile had been satisfied. Clause 29 of the report gives some interesting figures as to the total net cost of repairs of the electric system averaged per car mile run. These figures are: for 1903 4, ·808d. per car mile; for 1904-5, ·899d.; for the next year the figure increased to 1·141d., and for 1906-7 to 1·319d. per car mile. The fact that these amounts have been met out of revenue is not emphasised in the report.

The central office establishment charges against the tramway system are found to be correct. There then follow seven pages of the report dealing with street improvements. Individual cases are gone into of improvements for the purpose of general traffic, in respect of which over one million has been spent. The authors state that

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in their opinion a considerable yet ascertained portion of the cost of these improvements should be charged to the tramways capital account. When dealing with the valuation of the tramways undertakings dated Jan. 16, 1907, Messrs. Peat and Pixley agreed that applying a multiplier to an ascertained net income is a fair and usual way for arriving at the value of the goodwill of an undertaking. They assume that this basis is a fair one for the London County Council tramways, and then find fault with the multiplier adopted by the valuer. While this basis may be fair for a company undertaking, where the object is to make the net income as large as possible, we fail to see that it can be equally fair for a municipal undertaking. In this case the object of the committee is to earn just sufficient net income to meet capital charges after providing for reserve. The report concludes with an approval of the methods adopted by the London County Council in keeping its accounts.

NATIONAL PHYSICAL LABORATORY.

On the occasion of the meeting of the General Board of the National Physical Laboratory on Friday last the opportunity was afforded, by the invitation of Lord Rayleigh, the chairman, to view the laboratories. The whole of the premises were thrown open to inspection, and the various appliances and the uses to which they are being put were explained to the visitors by Dr. R. T. Glazebrook, the director, and other members of the staff. The new electro-chemical buildings, which were commenced in the summer of 1905, are now nearing completion, and during the past year that work was installed under the new conditions.

The report of the executive committee gives an outline of the work carried out last year, and is supplemented by the report of the director, and by reports from Dr. T. E. Stanton, the superintendent of the engineering department, Mr. W. Rosenhain, the superintendent of the department of metallurgy and metallurgical chemistry, and by Dr. Chree, the superintendent of the observatory department at Kew, and also by an illustrated description of the new electrotechnical buildings and equipment. In regard to research work, the physics department in the past year was engaged on several important inquiries in connection with the electric measurements. The research on the electro-chemical equivalent of silver and on various forms of silver voltmeter is complete. Very few observations have been made with the ampere balance during the past year. Some check observations were made in April and in June, and from these it was concluded that the E.M.F.'s of most of the National Physical Laboratory cadmium cells were keeping constant Some progress has been made with the Lorenz apparatus which the Drapers' Company are to present in memory of Prof. V. Jones. The photometric division was further equipped. During the year a large number of life tests have been made on the basis of the Engineering Standards Committee's specification, each lamp in a batch being run at such a voltage that initially all are burning at the same watts per candle. New metallic-filament lamps have been much in evidence, and have mostly given very satisfactory results when operating as low as 1·2 watts per candle. In the metrology division progress has been made with the testing of gauges, etc., for the Engineering Standards Committee, but the new building, though finished, is not yet occupied, it being of the highest importance that it should be thoroughly dry before the instruments, which are largely of polished steel, are moved into it. The laboratory has also been entrusted by the Chief Commissioner of Police with the testing of taximeters, and to facilitate this work a new testing station has been opened at Lambeth. In the engineering department Dr. Stanton's research on wind pressure has advanced a further stage, and another important research has shown that there is a marked change in relative resistance of materials to impact according as they are subjected to a few heavy blows or to many light ones. In the metallurgical department various researches are in progress on certain alloys. The total number of instruments tested in the physics department was 4,155, as against 2,488 in the preceding year. In the engineering department the number was 269, against 68 in 1906, and in the metallurgy department 70 against 6. Among the more interesting inquiries was an examination of a large number of old and new rails for the Great Northern Railway Company, and the investigation for the Board of Trade into the cause of failure of a thermal storage drum at Greenwich. As a result of the report of the committee appointed by the Treasury last year, in the future, with certain exceptions, tests on materials will only be carried out on the receipt of a request on an official form addressed to the director, and the conditions under which such tests are undertaken will be printed on this form, with a statement, to be signed by the appellant, that his application is made subject to those conditions.

As to the financial position of the laboratory, the income for the year increased from £14,319 in 1906 to £17,058, and the fees for work done increased by £3,274 to £9,324. The receipts from donations were, however, less than in 1906. The expenses, including £500 placed to the general equipment fund, amounted to £16,757, so that the balance on the year's working was £301. The sums paid during the year for new buildings, including equipment, amounted to £15,463, and there are outstanding liabilities of about £2,000. These it is proposed to defray out of the grant of £5,000 for buildings and equipment which the Treasury has intimated is to be placed on the estimates for 1908-9.

TESTS ON GERMAN TUNGSTEN LAMPS.

The *Electrical World* publishes the following particulars of tests made by a European central-station correspondent on some of the new metal-filament lamps. The lamps were run on a circuit for 1,020 hours. One went out at the end of 380 hours, while another broke at the end of 585 hours; the rest kept up their life, and it was not thought necessary to test further than 1,020 hours. The lamps were 25 c.p., and the maker claimed they could be used in an inclined position. Five of the lamps were placed in a vertical position, while the other five were inclined at an angle of 45deg. The one that broke at 380 hours was in a vertical position, while the other that broke at 585 hours was in an inclined position. A curious fact pertaining to these lamps is that at the end of 1,000 hours they have a candle-power higher than at starting. The 25-c.p. lamps as sold by the maker were tested before they were inserted on the circuit and gave a mean of 19 candles with 1·6 watts per candle; at the end of 10 hours they advanced to 21 candles, at 20 hours to 22·5 candles, at 30 hours to 24 candles, and after 1,020 hours they gave a mean of 27 candles with a mean of 1·13 watts per candle. The correspondent adds that lamps with such a characteristic and which will stand the current for such a long length of time are sealing the doom of the carbon lamp. The tests were made on a service circuit with a variation of 2 to 3 per cent. in the voltage.

INSTITUTION AND SOCIETY NOTES.

Institution of Electrical Engineers.

At a meeting of the Institution of Electrical Engineers held on the 19th inst. the following were elected associate members of the Institution:

R. Blackmore, Generating Station, Tame Valley, Stalybridge; A. L. Boyle, 10, Bridge-avenue-mansions, Hammersmith, W.; K. M. Faye-Hansen, 20, Cromwell-avenue, Stretford, Manchester; J. Hey, 4, Burchett-terrace, Leeds; D. James, 153, Palmerston-road, Bowes Park, N.; H. C. Ogilvie, Lancashire Electric Power Company, 196, Deansgate, Manchester; B. Smith, 35, Victoria-avenue, Barrow-in-Furness.

Royal Institution.

On Thursday next, April 2, at three o'clock, Mr. R. Lydekker will begin a course of two lectures at the Royal Institution on (1) "The Animals of Africa"; (2) "The Animals of South America." The Friday evening discourse on April 3 will be delivered by the Right Hon. Lord Montagu of Beaulieu on "The Modern Motorcar"; and on April 10 by Prof. J. J. Thomson on "The Carriers of Positive Electricity." On April 17 and 24, the Fridays in Passion and Easter weeks, there will be no Friday evening meetings.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE FUTURE OF THE TELEPHONE SERVICE

SIR,—Mr A. R. Bennett is mistaken with regard to my relations with the National Telephone Company. My connection with that company is purely advisory, and I do not hold the "distinguished position" referred to, or any position in the company's organisation.

Mr. Bennett lives in a telephone world of his own, and presents the remarkable spectacle of a man who not only does not learn from the experience of others, but apparently does not learn from his own. The Glasgow municipal telephone system—the only one in which the experiment was tried on a serious scale—was run according to Mr. Bennett's theories, and it was such a hopeless failure that the Glasgow Corporation (who do not give up easily) were glad to sell it at a loss after a working life of a little over three years. No more convincing proof of the incorrectness of the theories could be desired.

There could be no surer way of making the telephone service of a large city both inefficient and unprofitable than to adopt a tariff having a low flat rate and a low message rate. Such a tariff positively encourages the users to make the service inefficient, and at the same time prevents the administration from making a profit.

The Imperial German Post Office has tried for some years the experiment advocated by Mr. Bennett, has found it a failure, and is reverting to an exclusively measured-rate tariff. In Berlin last January the Under-Secretary of State told me that his principal argument for the measured rate was that it would raise the efficiency of the service, which was being ruined by the excessive use of the flat-rate lines.

And that is my argument—more, my absolute conviction. The measured-rate tariff, as well as encouraging the development of the telephone, improves the efficiency of the service. To the commercial community the important point is a highly efficient service, and the precise amount of the rate is a minor point. Any man in a large way of business will tell you the same thing, and that is the whole telephone question in a nutshell.

As to your editorial remarks, it certainly is unprofitable to argue with one who "feels bound to emphatically dogmatise." I am sorry if I have said too much about my experience, but experience is usually considered more valuable than abstract theory, or even than dogmatism. The point is, that experience in the telephone business teaches one that what you, Sir, from the vantage of the editorial chair, say does not happen, *does* happen. Business men of all kinds habitually misuse their telephone service, and it is extremely difficult to get them to keep their telephone facilities up to the demands of their telephone traffic.

You say that I make dogmatic statements, and that you "ask why and how in order to see upon what basis the statements are made, but we get neither the why nor how." With all respect, this is an unfair statement, as I have given my reasons in every case. The measured-rate principle raises efficiency because — by making low rates for additional equipment—it encourages the large user to take adequate facilities to accommodate his traffic.—Yours, etc.,

HERBERT LAWS WEBB

[We are not much concerned with Webb *v.* Bennett *v.* Glasgow, though our interpretation of the action of Glasgow is not quite that of our esteemed correspondent. First, as to editorial remarks. These, as Mr. Webb knows, are not intended to possess any sting. There is too high an appreciation here of the Webb family's work electrically during the last half-century to admit of any shadow of suggestion as to lack of experience or ability; but Mr. Webb wrote of "long experience," hence it was absolutely necessary to suggest that others of quite as long experience held antagonistic opinions. Mr. Webb, again, knows that editorial remarks are seldom, very seldom, individual opinions, but the concentrated essence (good) of various opinions expressed by experienced men. A short time ago we heard the remarks made at a meeting of some hundreds of telephone users to the effect that the flat rate did not conduce to inefficiency neither was it unprofitable. Our pages (Feb. 28) 307-8 show Bradford business men's views. Are those views wrong? Are these men in a large way of business? "Making a profit." We would rather tackle the question upon its merits, but can Mr. Webb read the balance-sheets of the National Telephone Company and say that they do not show the "making a profit"? A Government department ought not to think of profit, simply efficiency with no loss. According to the Bradford views, the flat-rate system necessitates "the large user to take adequate facilities to accommodate his traffic"; and, further, they say the flat rate is cheaper than the measured rate for additional equipment. The views of Mr. Webb and of the Bradford business men are in direct opposition. Which are right? We simply want to see the most economical and the most efficient system in use, and have no predilection one way or the other provided this be obtained.—ED., *E. E.*]

THE KAPP-HOPKINSON TEST ON ONE DIRECT-CURRENT MACHINE.

SIR,—In answer to Mr. Stanley P. Smith's letter which appeared in the *Electrical Engineer* of March 20, 1908, I should like to make the following remarks. It appears that his method requires an auxiliary motor to run the machine under test at full speed in order to excite the fields in parallel; the voltage across the north poles as well as across the south poles has to be reduced to half the normal value; also a low-voltage supply is necessary for the second test. It seems to me that a test requiring all this adjustment is certainly more complicated than the method which I have suggested.

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But, leaving this point out of the question, Mr. Smith makes the same mistake as Herr A. Kolben in not considering the armature reaction when the armature carries full-load current. As I explained in my letter of last week, this armature reaction sets up a field weakening one pole and strengthening the opposite, and, therefore, the armature rotates in a field which may be far different from the usual condition, and will alter the hysteresis and eddy-current loss in the armature core. The magnitude of the error is the greater the less saturated the fields and the higher the armature ampere-turns are. For this reason Mr. Smith's method may give appreciable errors. It is obvious, although Mr. Smith does not state this, that in his second test the poles which were altered in his first test have to be brought back to their original polarity, otherwise no appreciable iron loss will occur in the armature.—Yours, etc.,

W. LULOFS.

Birmingham University, March 23, 1908.

NO-VOLT RELEASE ON SWITCHES FOR POLYPHASE MOTORS.

SIR,—With regard to the recent controversy which has arisen with respect to the provision of no-volt release adjustments to polyphase motor switches, we desire to state that we have had considerable experience in this direction, especially in connection with high-tension switches, which we have now so far standardised that we can supply as a thoroughly tested and commercial article a form of starting gear for two and three phase motors fitted with no-volt release. This apparatus we can put forward with our fullest guarantee as to entirely satisfactory operation. You may remember that we sent you in the autumn of last year our large high-tension catalogue No. 67, which includes full details of the apparatus in question.—Yours, etc.

THE UNION ELECTRIC COMPANY, LIMITED.
(Justus Eck, General Manager and Engineer.)

FORTHCOMING EVENTS.

FRIDAY, MARCH 27.

Electro-Harmonic Society.—At 8 p.m., smoking concert at Cannon-street Hotel (in the Great Hall).

Royal Institution.—At 9 p.m., "Radioactive Change in the Earth," by the Hon. Robert John Strutt.

Physical Society.—At 5 p.m., at the Northampton Polytechnic Institute, Clerkenwell—(1) "Notes on the Plug Permeameter," (2) "On the use of Shunts and Transformers with Alternate-Current Measuring Instruments," (3) "On Wattmeters," by Dr. C. V. Drysdale.

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate, St. James's Park, "Combustion Processes in English Locomotive Fireboxes," by Dr. F. J. Brislee, D.Sc., and "Combustion Processes in American Locomotive Fireboxes," by Mr. L. H. Fry.

Motor Exhibition at Olympia.

SATURDAY, MARCH 28.

Royal Institution.—At 3 p.m., "Electric Discharges through Gases," by Prof. J. J. Thomson. (Lecture IV.)

Institution of Electrical Engineers.—At 10 a.m., students' visit to Thames Ironworks.

Association of Engineers-in-Charge.—At 7 p.m., annual dinner.

TUESDAY, MARCH 31.

Institution of Electrical Engineers (Manchester Local Section).—At 7.30 p.m., at the University, "Electrolytic Corrosion," by Prof. W. Gee.

Finsbury Technical College Old Students' Association.—At 8 p.m., smoking concert at Anderton's Hotel, Fleet-street, London.

THURSDAY, APRIL 2.

Institution of Electrical Engineers.—At 8 p.m., "High-Speed Electrical Machinery," by Mr. G. Stoney and Mr. A. H. Law.

Civil and Mechanical Engineers' Society.—At 8 p.m., at Caxton Hall, "Efficiency of Boiler Heating Surface," by Mr. C. H. Wingfield.

SATURDAY, APRIL 4.

Royal Institution.—At 3 p.m., "Electric Discharges through Gases," by Prof. J. J. Thomson. (Lecture V.)

HYDRO-ELECTRIC WORKS IN SWITZERLAND.

From 1891 to 1903 the average height of waterfalls in Switzerland utilised in connection with electric power schemes varied from 140ft. to 480ft. During the last four years, however, the falls of less average height have been made use of, giving round figures of 168ft. to 266ft. In most cases to have increased the latter falls would have entailed expensive earth works and long deviations. The following table contains the average prices per horse-power and other statistics of some works using falls of only 13ft. to 27ft.:

Name of works.	Cost of installation (hydraulic and electrical) not including lines.	Horse-power installed.	Maximum horse-power demanded.	Cost per horse-power installed	Cost per horse-power demanded.
La Goule...	£57,300	3,650	1,700	£15·6	£34·6
Geneva ...	280,000	12,000	8,100	17·5	25·8
Lintnal ...	16,500	1,000	510	16·6	32·4
Hauterive .	260,000	7,200	4,900	36	54
Montbovon	232,000	5,400	2,650	44	88
Kubelwerk.	270,000	4,200	3,000	49	69
Tihl	104,000	2,000	1,960	51	52
Wynau ...	120,000	5,750	2,800	32	42·7
Hagneck...	216,000	5,200	2,700	41·5	80
Beynau ...	341,000	11,700	8,450	29	40

In order to avoid the inconvenience due to the variations of the different seasons of the year, several of the stations are provided with steam plant, whilst at the Ruppoldingen works during the hours of light load a supply of water is pumped up to the high reservoir. Statistics prove that in connection with some of the works capable of dealing under normal circumstances with 180,000 h.p. were reduced at the time of the minimum supply of water to 135,000 h.p., showing thus a deficiency of 45,000 h.p. which ought to be available in gas or steam plant, but only 11,850 h.p. was so supplied. It is evident, therefore, that the steam plant should be largely increased, and one realises that even hydro-electrical works are largely dependent upon coal. The case might even be twisted to show that these large hydro-electrical works have created huge demands for power, which will in due course necessitate bringing larger quantities of coal into Switzerland than hitherto in order to meet the demands of low-water periods.

Electrical energy in Switzerland has not, therefore, reduced the consumption of coal, but has provoked a greater consumption whilst substituting the electric motor for the thermal engine in small workshops, reserving the use of the latter to the large installations, where greater efficiency can be obtained. In Switzerland it is looked upon as a misfortune, where it had been believed that the costly mineral product was to be banished. Eventually, however, it must prove to the nation's advantage the fact that there is an incentive to increase manufacturing undertakings.

A PRIMARY STANDARD OF LIGHT BASED ON ENERGY RADIATION.

In a contribution to the *Proceedings* of the American Institute of Electrical Engineers, Prof C. P. Steinmetz suggests the use of a three-colour primary standard of light based on the amount of light produced by a radiation of energy at the rate of one watt as measured by bolometer or otherwise. It requires, however, a definition of the quality of radiation, since the physiological effect of radiation has no direct relation to the energy of radiation. One watt of radiation of a wave-length from the centre of the visible range gives a far higher physiological effect—that is, more light—than one watt of a wave-length near the ends of the visible spectrum. This is not merely a function of the quality or colour of the light, as light of the same intensity and same colour, identical physiologically, may be entirely different physically, and, therefore, represent a different amount of power. For

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instance, the physiological effect of white light is produced by the combination of all colours of the spectrum, but also by an infinite number of combinations of two, three, or more spectrum colours; and these physically different forms of white light, while indistinguishable on the photometer screen, and thus physiologically identical, represent different amounts of radiation power per unit of physiological effect, or per candle-power. The same reasoning applies to coloured light. The power of the visible radiation is, therefore, not a measure of light. A satisfactory primary standard may, however, be produced by selecting three primary colours of the visible spectrum, all of definite wave-length and about equidistant from one another, and of such character that they can be absolutely reproduced at high intensity as the spectrum lines of a luminous gas or vapour. The unit of light can then be defined as that given by the watt of power radiated at these three wave-lengths in definite proportion, chosen so as to give white or yellowish-white light on a white photometer screen. The adoption of this standard of light would eliminate the sources of error which now affect the primary flame standard. The radiation density or light flux intensity of the three primary colours is measured separately before they are combined on the same photometer screen, and the accuracy of determination would be limited only by that of physical measurement of radiation energy, by bolometer or otherwise.

This standard of light requires three sources of monochromatic radiation, which can be maintained constant with any desired exactness. This requirement seems fulfilled by the mercury lamp. When reasonably protected from air draughts, changes of surrounding temperatures, etc., the intensity of radiation of a mercury lamp remains extremely constant at constant current, and, for minor variations of current, varies directly as the current, while that of the incandescent lamp varies as a high power of the current. It must be considered that a reproduction of the same intensity in the lamp is not required, as is the case with standard lamps, since the mercury lamp is merely the source of monochromatic light, and its intensity is measured and adjusted.

The most prominent spectrum lines of mercury are in the blue (43·55 wave-length), green (54·6), and yellow (57·8), but at high temperatures, such as occur in the Heraeus quartz lamp, red rays appear with the wave-length of about 69·1. Two low-temperature mercury lamps would be required for the blue and the green, and one high-temperature quartz lamp for the red. These would be maintained at constant radiation by maintaining the current constant, and also the condition of ventilation and surrounding temperature. Resolved by a prism, the blue line of the first, the green of the second, and the red of the third lamp are thrown on the same white screen, and their radiation energy measured separately. What energy proportion to select for the three colours, to give a colour suitable for a primary standard, remains to be investigated. Probably a yellowish-white would industrially be most convenient.

STATIC DISCHARGES FROM BELTS.

In an article of the *Chemiker Zeitung* of Dec. 18, M. M. Richter discusses the production of static electric charges by the friction due to belt driving. Such static charges are produced especially if some resinous material is applied to the belt to cause adhesion. By means of electroscope measurements belt potential difference of 13,000 volts were detected, the flywheel being negatively charged and the leather belt being positively charged. The effect is influenced largely by humidity in the air and on the belt. In chemical works, where the atmosphere contains vapours of oils and chemicals, dangerous explosions may be produced by sparks due to such electrostatic charges. These electrostatic charges may be avoided if the belt is smeared with acid-free glycerine, since its hydroscopic nature keeps the belt moist and prevents the formation of static charges. This mixture, which may be applied by means of a sponge while the belt passes around, should be renewed weekly.

ARTIFICIAL LOAD FOR TESTING ELECTRICAL GENERATORS.*

BY R. K. MORCOM AND D. K. MORRIS, MEMBERS.

The question of artificial load is one which is often under consideration by manufacturers and electrical station engineers, and simple though the problem is, there seems to be little information of a practical nature to enable the designer of such plant to avoid the errors of his predecessors. Of all methods of obtaining a load for testing purposes probably the water resistance has been most used, and the first portion of this paper will treat of the use of

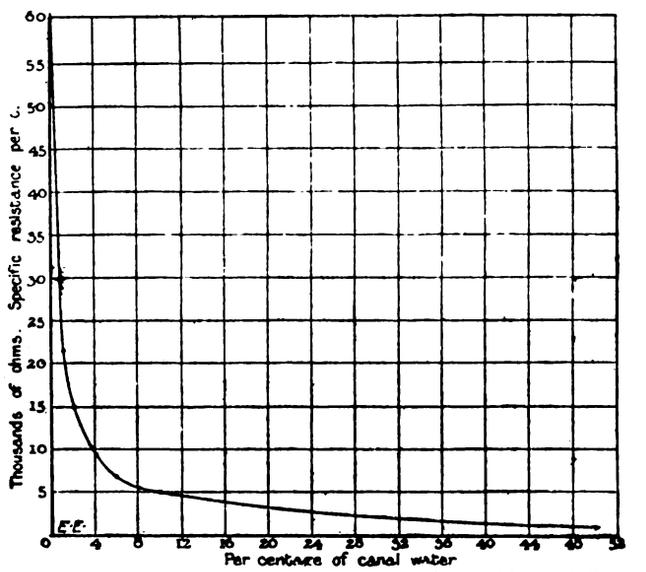

FIG. 1.—Specific Resistance of Condenser Water Diluted with Canal Water at 60deg. F.

water resistances. The theory of the flow of current through conducting solids and laminæ can be worked out mathematically for various ideal forms, and deductions of a useful kind can be made to apply to the less ideal conditions of practice. Such deductions, however, require some checking by experiment, as boundary conditions are apt to confuse calculation. The quality of water to be used is, of course, the first consideration. It is necessary to find its specific conductivity. A knowledge of the chemical properties of the water is a useful guide to its conducting properties, as illustrated by the following experiment. Steam from an engine was condensed in a surface condenser by means of canal water of high conductivity. The specific resistance of this pure condensed

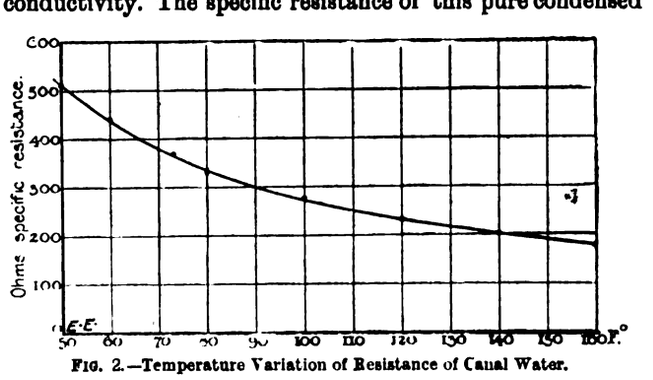

FIG. 2.—Temperature Variation of Resistance of Canal Water.

water was taken, canal water was then added by 1 per cent. at a time, and a curve of resistance was obtained. The resistance was found to fall in a very regular manner, so that with a standard apparatus the presence of impurity in the condensed water could readily be detected and its quantity estimated. Where superheaters are in use the impurity will probably be due to leakage from the condenser tubes, and the percentage of leakage water can be immediately calculated (see Fig. 1). If superheaters are not in use, it is possible that priming from the boilers will vitiate the results. A great deal of work has been done by various chemists on the conductivity of water containing mineral matter in solution, and some neat practical

* Paper read before the Institution of Electrical Engineers.

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applications and deductions have been brought to the author's notice by Mr. Pollard Digby, who will shortly be publishing some particulars of his work. It is also necessary to know the correction for temperature. The resistance-temperature curve is not a straight line (see Fig. 2). For practical purposes it is useful to consider the correction as a percentage reduction from the resistance at 60deg. F. for the intended rise of temperature, say 70deg. F. The following table gives some approximate characteristic figures:

Source.	Degree of hardness.	Mineral matter in solution.	Specific resistance per cm.³ at 60° F.	Factor for 70° F. rise.
	Deg.	Parts in 100,000	Ohms.	Per cent.
Distilled	—	—	600,000	—
Condensed from an engine	—	About 2	66,000	—
Birmingham tap water	3·2	6·2	13,200	50
50 % Birmingham tap and 50 % Birmingham canal	—	—	965	—
Birmingham canal	52	143	435	50
Blackburn water	—	—	17,000	—
Glasgow water	—	Particulars supplied by Mr. Digby.	17,500	—
West London water	—	—	2,800	—
Rugby water	—	—	2,400	—

In 1904, Mr. J. P. Kemp published results giving corrections for samples heated by direct current and alternating curreut. The divergence of the results is probably due to gradual solution of iron in the former case. This action causes a fall of resistance beyond that due to temperature, because the higher the temperature with a given current the less the amount of cooling water to dilute the iron solution. In the same article is given the useful figure that for a rise of temperature of 70deg., approximately, five gallons of cooling water per kilowatt-hour are required. Where possible salt or soda should not be used to increase the conductivity, but the plant should be designed to use the most abundant local supply. Without any special treatment of the problem of current flow in the water, it is useful to make one or two simple deductions from the general case. First, a very large body of water cannot give a high resistance even when the electrodes are very far apart. Secondly, if the tank be long in proportion to its cross-sectional dimensions the extent of the electrode immersion makes very little difference to the resistance, provided that the area of the electrode is not very small compared with the cross-sectional dimensions of the water. If, however, the distance between the plates be small, then their area of opposition has a great influence on the resistance. In this connection it should be noted that proximity to the side of the tank has a great effect with narrow plates in large tanks, as illustrated by the following experiments (see Fig. 3). The resistance in position A is 50 per cent. greater than in position B. This is due to distortion of the lines of flow. Part of the distortion is equivalent to shielding the back and sides of the plate, an effect illustrated by the following experiment (see Fig. 4). Assuming the current with plates as at A to be equal to 100, the current in case B is equal to 95, in case C to 81, in case D to 76, and in case E to 57 (Fig. 3). This effect gives one means of varying the load. The position of the plates for this experiment was that marked B in Fig. 3. Another convenient method of reducing the load from a given tank is by dropping diaphragms between the plates. As an example the following experiment (see Fig. 5) shows the effect in a particular case. Current as at A being 100, current as at B is only 26·5.

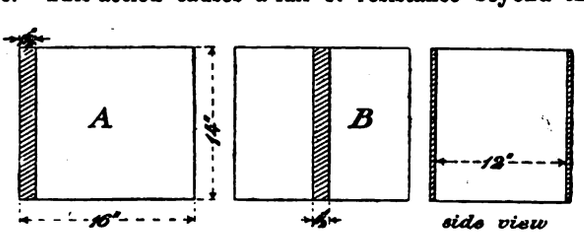

FIG. 3.—Experiments showing Effect of Proximity of Sides on Resistance between two Narrow Plates, ¼in. wide.

Various modifications of the baffle method will suggest themselves by which the resistance of the path may be increased without upsetting the cooling arrangements or complicating the tank, but the possibility of charring by excessive voltage drop in a short length must be kept in mind. The proximity of the plates to the side of the tank is also a factor in the permissible volt drop per foot of water. It is found that where the line of flow from the electrode along the tank side differs but little in length from the shortest line, the voltage drop per foot should not exceed 600 volts, and should be lower than that unless the walls are well insulated and free from metal. This point must be watched with high-tension work, and also in low-tension work where plates that are close together are carried near the side of the tank. A further limiting condition indicated by experience is the maximum permissible current density per square inch of an iron electrode. It will be found advisable not to run at greater densities than one ampere per square inch. Trouble from bubbling and rapid corrosion is likely to occur if this be exceeded.

Very much of the foregoing may appear so simple as to be obvious, but it is the neglect of these simple points that often causes a great waste of ingenuity and of money. The dimensions required having been determined, the materials must be chosen. Mention has already been made of iron electrodes and wooden tanks in connection with the experiments, and the reasons in their favour are strong ones. Wooden tanks are cheap and easy to obtain; they can, with proper precautions, be made durable and water-tight, and as the sides can be rendered practically non-conducting, there is no difficulty in obtaining light loads. Metal tanks, on the other hand, are either expensive or perishable, and light loads are hard to obtain owing to the low resistance path afforded by the walls, unless unduly large tanks are used. Cast-iron electrodes are cheap and satisfactory, though scrap metal of various sorts may in certain cases be substituted for sake of convenience. The success of wooden tanks depends largely on the method of construction and the proper attention to details. The following is the description of a tank (Fig. 6) which has done excellent service: The dimensions are 7ft. by 1ft. 6in. by 1ft., and it is used for high-tension work. The sides and bottom are constructed of good spruce, tongued and grooved; all joints are tarred and caulked. Sides, ends, and bottom are made double of 1½in. timber, the two layers being built up at right angles, as shown in the sketch. The whole is screwed together in such a way that no screw comes within ¾in. of the water, and all timber is tarred all over. The water inlet is through a canvas hose brought over at the outlet end, and carried along the bottom of the tank for its full length. The outlet is over a sectional wire 6in. from the end of the tank, and then through a hole in the bottom of the tank. One trouble thus avoided is the charring of the wood, which usually occurs along seams to which water has access: proper caulking prevents this. Also, any metal in the wood to which water has access corrodes and causes charring. This is prevented by using end screws, a hose-pipe inlet, and a plain hole outlet. The hose-pipe inlet obviates troublesome short-circuits to earth, and the weir also provides for adjustment for water-level. The double sides prevent leaking and undue bulging. For tanks of larger dimensions iron stays may be used, but these should be carried outside the tank—an obvious but often neglected precaution.

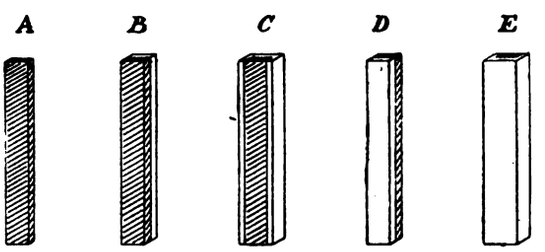

FIG. 4.—Experiments showing Effect of Shielding.

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As this tank is for high-voltage work it is supported on insulating pedestals. These can conveniently be constructed of Doulton's glazed earthenware "acid tiles," built about 3ft. high, with a rubber pad between each horizontal face to prevent slipping. The water from the outlet hole is carried to a funnel or tray just above the floor level. A lead-lined saveall is provided. The operator has a wooden platform supported on earthenware blocks, and covered by a rubber mat. The electrodes are of iron, and are well insulated from their supports, which take the form of stout wooden cross-bars which can be slid along the tank top. The plates are clipped to 'bus bars carried at a considerable height, and the connections are so guided as to be neat and safe. Such an arrangement can be cheaply made, and gives satisfaction up to 6,000 volts. A low-voltage tank construction can easily be deduced from the above, but probably the area will have to be obtained by using a number of electrodes in parallel, in which case, for variable loads, a suitably-arranged switchboard is a great convenience. There are many ways of arranging the plates satisfactorily, but so much depends upon the type of testing for which they are constructed that a description of any particular arrangement will be of but little service.

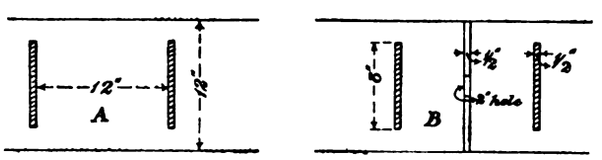

FIG. 5.—Experiments showing Effect of Diaphragm.

One point, however, should not be forgotten with iron electrodes—namely, that if they are placed less than 2in. apart there is danger of an unsteady load, and a considerable splutter from short-circuiting by rust flakes; in fact, 3in. should be aimed at as a minimum. Sometimes for very low-voltage work the size of the tank available is insufficient. A useful form of load can then be constructed from metal strip submerged in water. Strip iron ½in. wide × 19 S.W.G. supplied in 40ft. lengths and doubled into zigzag shape will make very convenient units for low-voltage loads. With a current density of about 25,000 amperes per square inch (the unit being immersed in moderately high resistance water) an average life of 100 hours may be expected. If, however, the cooling water is of relatively low resistance, such as canal or river water, the life is very much reduced. In actual use a unit of this form has been run at a current density in the

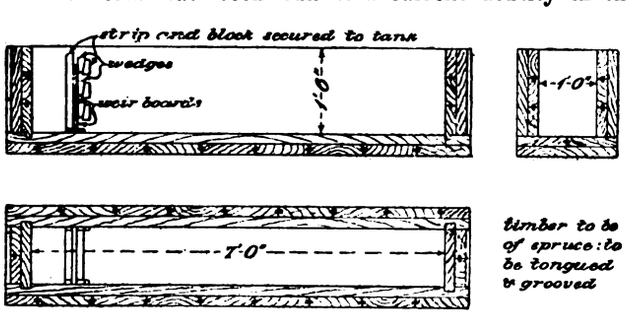

FIG. 6.—Construction of Wooden Tank for Water Load.

iron winding of 52,000 amperes per square inch in canal water of a specific resistance of 440 ohms per cm.^{3} at 60deg. F., and broke down after an eight hours' run. Under these conditions the rapid wasting of the strip caused a gradually falling load. It is very convenient, when using these units, to have a small water load in parallel for fine adjustments. Obviously the relatively short life and lack of facility of adjustment are the chief disadvantages of this form of load.

The convenience of the water resistance for absorbing a test load can be enhanced by providing a suitable apparatus for producing inductive load. Transformers and inductive motors are, of course, ideal, but in their absence choking coils of cumbersome and expensive design have been constructed, usually as and when required. A cheap, reliable, and easily adjustable method of obtaining varying power factors under varying conditions is a desideratum. Such a method and construction after considerable experiment has been worked out and patented in various forms. A description of the apparatus and of the method of using it, together with an account of experiments made with it, will constitute the second portion of this paper. Choking coils for this purpose have hitherto been constructed by placing a suitable winding on an iron core having a small and sometimes adjustable air-gap. The object of the air-gap has been to render the out-of-phase magnetising current as large as possible. In the choking coils to be described below no air-gap at all is used, but the iron is instead worked at a flux density so high that its permeability is quite low, and the magnetising current is correspondingly large. There is, in fact, an equivalent air-gap all round the magnetic circuit. As compared with ordinary choking coils, this construction has two distinct advantages. The flux density can be very much greater than is practicable with the older coils (three to four times). The induced voltage per turn is, therefore, correspondingly increased, and the necessary number of turns reduced. Also the magnetic reluctance is so uniformly distributed all round the magnetic circuit that the magnetic leakage is very small, and every turn of the winding is equally utilised. The alternating magnetic energy, which corresponds to the out-of-phase current waves, is stored by reason of the magnetic state of the core itself, and not by the magnetic stress in a narrow air-gap. The result of this design is to give an exceedingly compact choking coil for a given number of kilovolt-amperes.

Energy Loss in the Iron.—On account of the high flux density it is important, in order to avoid eddy currents, to use the thinnest laminations and to reduce hysteresis by employing the best iron. As is well known, heavy iron cores cannot be worked at 50 ~ for long at flux densities exceeding, say, 8,000 without very special means being taken for cooling them, and at the flux densities which are being used in these new coils described in the paper such cooling is an essential condition. It may here be pointed out, however, that the object of cooling the core is not that the iron itself may be rendered cool, but that it shall not impart too much heat to the windings which surround it. The loss in the iron itself is, in fact, very substantially reduced by a rise of temperature of the core, partly on account of the reduced hysteresis, but much more by the increased resistance of the iron and consequent reduction of the eddy-current loss, which, in cores worked at very high flux densities, is otherwise disproportionately large. Two methods, beyond those ordinarily used for transformers, suggest themselves for working such high flux density choking coils continuously without overheating: (1) The whole coil and winding may be immersed in water kept in circulation and slowly flowing to waste. (2) The limbs of the iron core may be surrounded by coils of flat copper tube, closely fitting, in which water is continually flowing, and absorbing any heat which might otherwise reach the winding from the hot core; such coils being coupled by rubber pipes to supply and discharge, so that no current shall be induced in them. Coils have been worked out by the authors using both these methods. In cases where the voltage permits it there is great advantage in the first method. Not only does it provide a satisfactory means of getting rid of the heat in the core, but it allows of the use of very high flux densities in the winding. Copper for the windings may even be dispensed with altogether, and the coil wound with iron strip worked at current densities which would be high even for copper if not specially cooled. Such coils are in the highest degree economical to construct and prove perfectly satisfactory if the voltage of the generator to be tested does not exceed 1,000-2,000. Coils of this type have been designed by Mr. Walshe for Messrs. Belliss and Morcom, and the authors are indebted to him for much ingenuity in designing apparatus and taking records for the purpose of this paper. For voltages much higher than these, or where a more durable apparatus is necessary, it is preferable to use water-cooled cores of the type described above.

Comparison between a Transformer and a Choking Coil wound on the same core and worked at the same flux current densities.—Consider a low-voltage 10-kw. transformer of standard design. Its "magnetising" current, by which is meant the out-of-phase component of its no-load current of, say, 1 per cent., is such that at the peak of the waves

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there is a field of, say, H = 1, giving a maximum of flux density of, say, B = 5,500. Now replace the primary and secondary windings by a single winding of double the carrying capacity, and increase the primary terminal pressure to four times its former amount. The single winding must now take current enough to make B = 22,000, which requires, say, H = 200, so that the current taken is two hundred times as great as the old magnetising current, and twice as great as the normal full-load current of the old transformer. This current passes through a winding of twice the old carrying capacity. With the current doubled and the voltage quadrupled, the kilovolt-amperes of the apparatus now are eight times as great as those for which the transformer was built, or 80 k.v.a.; and this with the same current densities as before. To test a 1,000-kw. set at 0·8 power factor requires approximately 1,250 k.v.a. and 750 k.v.a. of idle current, or three 250-k.v.a. choking coils. With the special cooling described above, these inductive coils can be constructed on cores not exceeding in size those which would be used for three 25-kw. transformers.

(To be continued.)

THE INTERNAL STRUCTURE OF METALS.*

BY WALTER ROSENHAIN, B.A., B.C.E.

Mr. Rosenhain began by explaining the manner in which metals are examined under the microscope, briefly describing the methods of grinding, polishing, and etching specimens, and the modes of illumination which are used for the study of these opaque objects. Some special forms of microscope, designed for this purpose, were described, and special reference to the manner in which the "vertical illumination" of metal specimens is obtained. The lecturer then described the typical crystalline structure of a pure metal, illustrating this structure by a series of lantern slides from photo-micrographs representing some of the evidence upon which is founded the conclusion—now generally accepted—that the structure of metal is always crystalline. The manner in which a molten metal solidifies and the growth of mutually interlocking and interpenetrating crystals from numerous centres of crystallisation in a cooling metal were dealt with, and in this connection the lecturer explained how largely the mechanical properties of a metal depends upon the manner in which these crystals grow, thereby explaining the influence of such factors as casting temperature and the presence of minute quantities of foreign bodies, occurring either as impurities or purposely added.

The typical structure of binary alloys was then discussed and illustrated by a series of lantern slides showing the structure of a series of lead-tin alloys; the general character of the "eutectic" body frequently found in such binary alloys was explained, and its influence upon the mechanical properties of the alloy was described. Passing on to the subject of the mechanical deformation and ultimate fracture of metals, the lecturer described the observations made by Prof. Ewing and himself some nine years ago, which resulted in the discovery of "slip bands" and a recognition of the manner in which metals undergo deformation by the slipping or sliding of the elements of each crystal over one another, each of the crystals of the metal thus accommodating itself to the new shape imposed upon it by the circumstances of the deformation. A series of lantern slides was shown illustrating the nature and appearance of slip bands, and serving to prove conclusively the truth of the explanation advanced by the lecturer. These slides included several representing actual transverse sections of slip bands obtained by Mr. Rosenhain by the aid of his process of embedding metal specimens in electro-deposited copper whenever it was necessary to preserve an edge or a surface intact during the process of cutting and polishing a transverse section.

In connection with the subject of slip bands, the semi-plastic condition which, in iron and steel, follows upon plastic deformation was referred to. Muir's work on the recovery from this state produced by exposure to the temperature of boiling water was described, and from these facts an explanation was advanced of the causes which lead to the well-known phenomena of fatigue in edge tools and the recovery of their cutting power after prolonged rest. The advisability—from a metallurgical as well as a sanitary point of view—of dipping a razor into boiling water was also mentioned.

In the last part of the lecture, the various modes of fracture of iron and steel under tension, shock, bending, and alternating stresses were described, and the microscopic features of the fractures illustrated by a series of sections of actual fracture, also obtained by the aid of the electro-embedding process. The lecturer laid great stress on the importance of the systematic investigation of fractures, more particularly of failures occurring in actual practice, since in that way the most useful information could be obtained as to the characteristic behaviour of the materials under various circumstances not readily reproduced in laboratory tests. Special reference was made to the manner in which metal fails under the effect of alternating stresses. The crystalline appearance of the fractures produced in this way was explained on the basis of deformation by slip, and the view that vibration of alternating stresses could cause metal to "become crystalline" was characterised as an entirely groundless and most improbable assumption.

In conclusion, the lecturer admitted that the subject he had dealt with was not of an essentially "electrical" interest, but that in thinking of the body he was addressing he had relied upon the word "engineers" rather than on the "electrical," and since they necessarily used metals for mechanical purposes in all their machines and appliances, the properties and nature of metal must be of some importance to them. The microscopic study of metals might, however, find some direct electrical applications. The connection between the micro-structure of alloys and their electrical resistance and their resistance temperature coefficient was given as one instance, while in another direction it was pointed out that there was certainly some connection between the magnetic properties of iron and its micro-structure. Material showing high permeability and low hysteresis losses generally had a large crystalline structure. There appeared to be some resistance to the magnetic flux at the inter-crystalline junctions, but this was a subject deserving of much further investigation before any definite conclusions could be reached.

* Abstract of lecture delivered before the Manchester Section of the Institution of Electrical Engineers by Walter Rosenhain, B.A., B.C.E., superintendent of the department of metallurgy in the National Physical Laboratory, March 10, 1908.

CROYDON ELECTRICITY WORKS DINNER.

We were again this year honoured with an invitation to the annual dinner of the Croydon electricity works staff. It was held at the Greyhound Hotel, and Mr. A. C. Cramb occupied the chair. The mayor (Councillor Moore) and a number of aldermen and councillors supported their engineer-in-chief at the high table. The speeches were short and the toasts few, but the excellent musical programme filled up a long evening.

Mr. Cramb, in proposing the toast of "The Corporation of Croydon," spoke of the satisfactory nature of the past year's work. The total working cost was lower than it had been before, and the surplus was the highest they had had, in spite of a large allocation of revenue in the way of wages and depreciation. Their capital was approximately £345,000, and against that they had in reserve £22,000 and a sinking fund of £50,000. Considering they had only been working 10 years he thought that was highly satisfactory. That year he anticipated that the capital expenditure would be about £8,000, and they hoped to repay £10,000 to sinking fund. The committee had decided to purchase meters out of the revenue account. He was glad the committee and the Corporation fell in with that view, as everything was piled into capital account previously. They should do all they could to strengthen the undertaking, and then they could reduce their charges and later relieve the rates. He also alluded to the improvements he expected this year, both in street-lighting and in the accommodation provided for the staff at the power-house. The staff sick club, with its 108 members, had had a healthy year, as only £6 was paid away in sick pay. The Mayor, when replying to the toast, complimented the staff on their work. He seemed to be somewhat confused by the heated controversies which have taken place in Croydon as to the relative cost of gas and electricity. His audience partly endorsed the statement that electricity was the cheaper illuminant.

Some other speakers advocated a more forward business policy for the department, such as has been urged on his committee by Mr. Cramb.

PERSONAL.

Messrs. Estler Bros. inform us that they have removed to 3, Crosslane, Eastcheap, E.C.

We are informed that Messrs. C. A. Parsons and Co. have removed to 8, Victoria-street, Westminster, S.W. Their telephone number will still remain 586 Westminster.

Sir Thomas Rowe, M.P., chairman of the Urban District Councils' Association, will be the guest of the evening at a house dinner of the Municipal and County Club to be held to-night, the 27th inst.

Mr. S. T. Allen, chief assistant to the electrical engineer of the Plymouth Corporation, who is about to take up the duties of city electrical engineer at Carlisle, has been presented with a silver fruit dish, suitably inscribed, from the staff and employés of the electrical engineer's department, and a silver inkstand from the principal electrical contractors of Plymouth, as a mark of their esteem.

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PHYSICAL SOCIETY.

At the meeting held on March 13, 1908, Dr. Charles Chree, F.R.S., president, in the chair, a paper on "The Distribution in Electric Fields of the Active Deposits of Radium, Thorium, and Actinium" was read by Mr. S. Russ. The first experiments were made with the active deposit produced from radium emanation. Whereas the amount of active deposit directed to a cathode decreases as the pressure in the containing vessel is reduced after a certain pressure is reached, it was found that the amount going to an anode shows a corresponding increase under the same conditions. A comparison was made over a range of pressure extending from ·01mm. to 1·2mm., between the amounts of active deposit obtained on a rod made positive or negative when exposed to the same quantity of radium emanation for equal periods of time. The main feature brought out by this comparison is that at the lowest pressure reached almost as much activity is obtained on the anode as on the cathode, while at atmospheric pressure the activity of the latter is about 20 times that of the former. Similar experiments conducted in hydrogen, air, and sulphur dioxide—three gases differing considerably in density—indicate that the collisions between the active deposit particles and the gaseous molecules play an important part in the ultimate distribution of the active deposit in electric fields. Experiments on similar lines with thorium and actinium show that while at atmospheric pressure nearly the whole of the active deposit particles of thorium are directed to the cathode, this is not necessarily the case with actinium, for it was found that under certain conditions the activity of the anode was fully one-half that of the cathode. Some observations made more recently than those cited above indicate that the sign of the electrical charge exhibited by the active deposit particles of actinium is a function of the distance that these particles have travelled through the containing gas before reaching the electrodes.

Dr. C. H. Lees expressed his interest in the paper, referring especially to the fact that the amount of active deposit which diffused on to a neutral rod varied with the pressure.

The Chairman referred to the radioactivity of the atmosphere, and remarked that the author's experiments might be of use to meteorologists in enabling them to settle the question of the source of the radioactivity. He expressed his interest in the results obtained with actinium.

Mr. Russ, in reply to Dr. Lees, said that the fact that the quantity of active deposit on a neutral rod varied with the pressure was being investigated mathematically by Mr. Bateman. With regard to the chairman's remarks, he observed that the source of the radioactivity of the atmosphere was an interesting question. The radioactivity due to thorium presented more difficulties than that due to radium, because of the long life of the radium emanation. He suggested that the results might be due to the active deposits themselves, which had longer lives than the emanations.

A "Note on Certain Dynamical Analogues of Temperature Equilibrium," by Prof. G. H. Bryan, was read by the secretary. The note calls attention to the following results of a method described by the author in 1900 (Archives Néerlandaises) under the title of "Energy Accelerations": (1) in a system of uniformly distributed particles, a stationary state of statistical equilibrium cannot exist under the Newtonian law of force whether the forces between the particles be attractive or repulsive except when the particles are at rest in a state of unstable equilibrium; (2) for energy-equilibrium to exist the force between the particles, if repulsive, must vary according to a higher power of the inverse distance than the square—*e.g.*, the inverse fifth power—if attractive it must vary according to a lower inverse power than the square of the distance; (3) in a system in which the kinetic energy cannot be expressed as a quadratic function of the velocities with constant coefficients, the equations of energy-equilibrium no longer take the form of linear relations between the various components of kinetic energy, so that the commonly assumed analogue between temperature and kinetic energy becomes inapplicable.

Prof. Cassie discussed the method and results of the paper, and remarked that the results of experiments appeared to indicate that the forces between particles varied with the distance according to some law more rapid than the inverse fifth power.

APPOINTMENTS VACANT.

Third Engineer-in-Charge, Ilford Urban District Council. Applications to Mr. J. W. Benton, clerk, by April 7.

Car-Shed Foreman, South Shields Corporation Tramways. Applications to Mr. J. Moore Hayton, town clerk, by March 30.

Assistant Electrical Engineer, East Indian Railway. Salary, Rs. 450, rising to Rs. 600, per calendar month. Applications to Mr. C. W. Young, secretary, 28-30, Nicholas lane, London, E.C., by April 4. See advertisement in last issue.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Brush (U.S.A.).—The Brush Electric Light and Power Co. propose to construct a plant of 3,000 kw. capacity.

Wishaw.—The Caledonian Railway Co. have withdrawn their petition against the Wishaw Burgh Electricity, etc., Bill.

Denver (U.S.A.).—The electric company are about to make improvements in the lighting plant, involving an outlay of 50,000dol.

Hope (U.S.A.).—The City Council are about to erect a power-house and to install an engine and dynamo to increase the lighting plant

Saffron Walden.—At the request of the Town Council, the Board of Trade have sanctioned the continuance of the provisional order for another 12 months.

Bexhill.—The Local Government Board will hold an inquiry on April 1 into the application of the Council for power to borrow £2,800 for electric lighting purposes.

Worthing.—The Local Government Board will hold an inquiry on March 31 into the application of the Town Council for sanction to borrow £1,710 for electric lighting purposes.

Crompton.—The question of applying for an extension of time for the electric lighting order has been considered by the Council, who eventually decided to apply for an extension.

Canterbury.—An inquiry will be held by the Local Government Board on April 2 into the application of the City Council for sanction to borrow £1,000 for their electricity undertaking.

Ossett.—The Town Council have agreed to offer a strip of land in the destructor field at 6s. per yard to the Electrical Distribution of Yorkshire for the purpose of erecting a sub-station.

Carlisle.—The Town Council are seeking sanction to a loan of £5,000 for the purposes of their electricity undertaking, and an inquiry will be held by the Local Government Board on April 2.

Red Deer (Canada).—Alberta Government will build a telephone line to Pine Lake almost at once, as all requirements with regard to numbers have been complied with for the construction of such a line.

Tramway Scrap Metal.—The Borough Council of Croydon are about to offer for sale 7¼ tons scrap trolley wire and 12½cwt. of gun-metal overhead line fittings. For particulars see our advertisement columns.

Stirling.—The engineer's monthly report at the last Council meeting showed that in February 40,761 units of electricity were generated at the power station, as compared with 38,958 for the same period in 1907.

Bridgend.—The Urban District Council have deposited in the Private Bill office of the House of Lords a petition praying to be heard against the proposed alteration in the South Wales Electrical Power Distribution Bill.

Liquidation.—The *London Gazette* announces that creditors of the York Electrical Co. are required to send all particulars of their claims to Mr. C. A. Rymer, the liquidator, Yorkshire Bank Chambers, Nessgate, York, by April 11.

Hull.—At a meeting of the Hull Corporation Telephones Committee the chairman stated that 257 additional instruments had been fixed during the past year, and 170 during the past three months. This was the largest increase of any quarter.

St. Marylebone.—The Electric Supply Committee report that, pursuant to his agreement with the Borough Council, Mr. A. Wright, their consulting electrical engineer, has received in commissions on capital expenditure since his appointment a total sum of £24,862.

Sunderland.—The firm of Sir James Laing and Sons, shipbuilders, Sunderland, are now securing a supply of Corporation electricity, satisfactory arrangements having been come to between the company and the Electricity Committee. It is expected that 1,200 or more men will at once resume work.

Croydon.—The Lighting and Electricity Committee of the Corporation have received 37 applications for private lighting, being equivalent to 1,080 8 c.p. lamps. New consumers connected numbered 17, equivalent to 1,734 8-c.p. lamps, and the reconnections numbered nine, equivalent to 391 8-c.p. lamps.

Oldham.—At a meeting of the Electricity Committee of the Corporation the engineer reported that the units sold were: for lighting and power 59,994, and for traction 160,002, a total of 219,996. The number of lamps connected to date were: arc, 354; incandescent, 24,458; motors, 387—equivalent to 116,566 of 8-c.p.

Mansfield.—At the last meeting of the Town Council the engineer reported 43,519 units passing through station meters during February, an increase of 7,468 on the year; traction units generated 45,589, increase 3,624—total increase, 11,092. The question of the provision of an economiser was left with the chairman and a sub-committee.

Huddersfield.—At the last meeting of the Borough Council the electrical engineer reported that the number of consumers during the past month was 2,666, and the number of lamps connected 196,604, increases of 20 and 1,015 as compared with the previous month. The tender was accepted of Messrs. Schofield and Taylor for a plant governor.

Long Eaton.—At the last meeting of the Urban District Council a letter was read from the Local Government Board stating that they had received a report from the inspector who held an inquiry as to the proposed loan for the extension of the electric light works. They had sanctioned the borrowing of £5,858 for engine and dynamo, £3,337 for mains, and £500 for meters.

Hammersmith.—Agreements with the Franco-British Exhibition Committee and with the Kensington and Knightsbridge and the

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Notting Hill Electric Lighting Companies as to the supply of electrical energy to the Franco-British Exhibition have been exchanged with the Council electricity department, and the Exhibition Committee have paid a deposit of £1,000 as arranged.

Lochee.—A family living in a house in George-street last week had a narrow escape from gas poisoning. It appears that gas escaped through a pipe near the house and filled the building to suffocating. One member of the family was discovered in a state of collapse. This occurrence is still another proof of the folly of distributing poisonous elements through pipes in the public streets.

Release of Trustees.—According to the *London Gazette*, Mr. S Wells Page, 30, Lichfield-street, Wolverhampton, has been released from trusteeship in the estate of Mr. K. C. Moran, electrical engineer and contractor, 80A, Teddesley-street, Walsall, Staffs. Mr. E. P. Jobson, 199, Wolverhampton-street, Dudley, has been released from trusteeship in the estate of Mr. C. W. Stafford, electrical engineer, 59, Toll End-road, Ocker Hill, Tipton.

India.—Preliminary work has been commenced in connection with the establishment of the projected series of wireless telegraph stations along the Benadir coast. The apparatus will be of a greatly improved type. The station at Mogadoxo is expected to have a range of about 1,800 miles, and may even be able to communicate with India. Italy will thus be the first to introduce the advantages of the wireless telegraph to the Indian Ocean.

Stoke.—The following comparative statement of the use of electricity by the Board of Guardians for the last two years was submitted by the consulting engineers at the last meeting of the Board: Number of units—1906, 98,251; 1907, 105,081—difference, 7 per cent. increase. Coal—1906, 904 tons; 1907, 609 tons—difference, 33 per cent. decrease. Pounds of coal per unit—1906, 20·6; 1907, 13—difference, 37 per cent. decrease. Cottage houses, units not taken—5,435 units.

Cranbrook (Canada).—A large power and hydraulic plant is under construction at Bull River. The power plant when installed will have a capacity of not less than 8,000 h.p., and will be used for generating electricity, for power and lighting purposes, to be transmitted to every city, town, and camp in South-East Kootenay. The hydraulic plant will be the largest in the district. Bull River will be diverted so as to enable the company to wash the bed of the river, also the old channels.

North Metropolitan Electric Power Supply Co.—Sir Ernest Spencer, presiding at the meeting of this company, said the revenue for 1907 was £59,373, as against £44,191 in 1906. There was an increase in expenditure, but that was satisfactorily explained by various circumstances. One of the most important causes was the increased cost of coal. The units sold during the year amounted to 11,183,316, as compared with 7,999,367 units in 1906, and he was pleased to say that there was every indication for a further satisfactory expansion of business during the current year.

Toronto.—Application is being made to the Legislature for a charter incorporating the Lorne Power Co., who desire to establish their base of operations at Wabageshik Falls. The petitioners ask to be given the right to generate and distribute electricity, to operate mines, and construct an ore-reducing plant. In addition it is asked that they should be given powers to construct a railway, to be operated either by steam or electricity, from a point near the falls to the township of Denison.

Cavan and Monaghan.—A representative of the Post Office has been making inquiries in the urban districts of these counties with a view to ascertaining what amount of support would be accorded the installation of a telephone system linking Cavan, Clones, Belturbet, Carrickmacross, Ballybay, Crossmaglen, Castleblayney, Cootehill, and other towns with the trunk lines, thus bringing them into touch with the principal cities and towns in Ireland. The support of the local Boards in the districts has also been asked for. It is understood that a considerable number of contracts have been signed in each of the towns visited.

Salford.—The Education Committee have decided, on the grounds of safety, economy, and efficiency, to rewire the whole of the institute with the exception of that portion in which rewiring has recently been carried out. The work will be done in sections, and provision will be included in the estimates for the current year in which the work is to be carried out. This sum will total £300, and be provided in the estimates for the ensuing year. The Electricity Committee have been instructed to request the borough electrical engineer to prepare a complete scheme, as far as possible, as to the order in which the work of the various sections should be carried out.

Flint.—Progress is being made with the proposed scheme for lighting the town by electricity, and with this object in view Mr. Louis Hunt, Sandycroft Foundry Co. (who has been engaged by the Council to furnish a preliminary report), in company with another expert, and Mr. A. C. Williams, architect, Chester, on Wednesday made a tour of the borough. The district is admirably adapted for the installation of electricity, and with a superabundance of water flowing to waste the opinion is expressed that the proposed scheme will be anything but a costly one. The scheme is one which meets with general favour, and the preliminary report is looked forward to with much interest.

Claremont (Australia).—During last year the Municipal Council floated a loan of £4,000 at 4½ per cent. in order to carry out an extension of the electric lighting plant. The installation of a battery for supplying a continuous service of current was the most important work accomplished. The last annual report of the engineers showed that the total number of units generated was 102,487, as against 90,099 for the previous year. The number of consumers was 281, as against 205 for 1906; and the number of street lights was 237, covering 16¾ miles. The result of the year's business gave a surplus over working costs of £1,004. The works have been in existence since Feb. 22, 1905.

Dorking.—On behalf of the Local Government Board, Mr. H. R. Hooper, M.I.C.E., held an inquiry on Tuesday into the application of the Urban Council for sanction to borrow £11,600 for purposes of electric lighting. The clerk said the area of the urban district, which was the area of the supply, was 1,339 acres, and the population at the last census 7,670, probably 8,000 now. The annual assessable value was £48,209. The total indebtedness of the Council for all purposes was £41,981. The general district rate each half-year was 1s. 8d. and the poor rate 1s. 6d., making a total of 6s. 4d. per annum. After the usual evidence was tendered, the inspector stated he would report.

Fareham.—The Fareham Urban District Council have decided upon an extension of the electric light works. The chairman formally moved the adoption of the report of the Council in committee, and said that, as was generally well known, the electric lighting undertaking had been progressing favourably, and at last the works had got to the extent of their capacity. In consequence the Council had had to deal with it as a commercial undertaking. After full and careful consideration of the whole subject the committee recommended that Messrs. May and Hawes be instructed to prepare the necessary plans, specifications, and estimates, and that application be made to the Local Government Board for sanction to borrow the sum of £10,000 to carry out the works. The resolution was carried unanimously.

Luton.—A deputation, representing traders in Wellington-street, have interviewed the Corporation Electricity Committee as to the erection of certain arc lamps in that thoroughfare. It was explained to the committee the Wellington-street shopkeepers' intention of advertising that street as a shopping centre by the erection, at their own expense, of five arc lamps between George-street and Stuart-street, suspended in the centre of the roadway by means of span wires, and their desire that the electrical engineer should carry out the installation and that the committee should charge a low rate for the current used by the arc lamps. It was resolved by the committee that the proposals of the deputation be acceded to, and that the price of current be at 2d. per unit, and to this the Council have agreed.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint special settling days in Mexican Light and Power Co.'s 1,500,000dol. 7 per cent. cumulative convertible preference shares of 100dol. each, and British Aluminium Co.'s 20,000 ordinary shares of £5 each, fully paid, Nos. 40,001 to 60,000, and 20,000 7 per cent. cumulative preference shares of £5 each, fully paid, Nos. 40,001 to £60,000. The committee has further been asked to allow the following securities to be quoted in the official list: Canadian General Electric Co.'s 2,000,000dol. cumulative preference stock in shares of 100dol. each, and County of London Electric Supply Co.'s provisional certificates for a further issue of 10,026 6 per cent. cumulative preference shares of £10 each, £4 paid, Nos. 120,001 to 130,026.

Gillingham.—A Local Government Board inquiry has been held into the application of the Town Council for sanction to the borrowing of £5,000 for extending the mains of the electric lighting undertaking. The town clerk gave the usual preliminary statistics. He stated that the population of the borough at the last census was 42,745, and the estimated population for 1908 was 48,000, while the area was 5,054 acres. The rateable value was £144,791, and the rateable value of Government property, in addition, was £39,619. The assessable value was £135,336. 5s., Government property, £33,247. A penny rate produced about £650. The total indebtedness of the borough was £143,321, and the present application was for £5,000, the repayment of which was to cover a period of 20 years. After a great deal of evidence for and against, the inspector intimated that he would report in due course.

Monmouth.—An inquiry was held on the 19th inst. by Mr. J. Frederick Willis, Local Government Board inspector. The Corporation had borrowed £10,000 from a local bank, on the security of a local nobleman, for electric lighting works, and the Local Government Board objected to the rates being used for payment of the interest. The Corporation now applied for a provisional order to remove this debt from the other debts of the Corporation, thus extending their borrowing powers, as a way out of the difficulty. The total indebtedness to the bank is £10,533. There are a few assets available, which would reduce that sum to about £9,000. Mr. Tweedy, borough treasurer, asked advice from the inspector as to the necessary increase in the rates this year. Mr. Willis replied that it would be safe for him to take one-twentieth of £9,000 as a basis to make the rate. The inquiry then closed.

Institution of Electrical Engineers.—The last meeting of the session of the Glasgow Students' Section of the Institution of Electrical Engineers was held on the 20th inst. at the Technical College, Prof. Magnus Maclean presiding. Mr. Norman Young read a paper on "Water Resistances." He dealt with the absorption of power generated by electrical machines under test, and showed how such varying conditions as area of plates, density of solution, temperature of fluid, and distance apart of the plates affected the electrical resistance. Mr Young described a form of resistance employed at the works he was connected with, and showed its advantages over the ordinary long tank type. A hearty vote of thanks was accorded to Mr. Young for his interesting paper. Prof. Magnus Maclean was re-elected chairman of the Students' Section, and Messrs. J. S. Nicholson, B.Sc., and R. B Mitchell were reappointed vice chairmen, while Messrs. James Miller and Fred. H. Downie, B.Sc., were elected to fill the vacancies on the committee, and Mr. James W. Campbell, B.Sc., was re-elected hon. secretary.

Wimbledon.—At a Local Government Board inquiry held this week at the town hall, Wimbledon, into an application by the Corporation

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to borrow £17,600 for machinery to increase the output at the electricity works, and also the installation of a new switchboard to cost £3,600, there was a good deal of opposition. Mr. H. J. Crickmay contended that the loan for the switchboard ought to be regarded as a renewal rather than in the light of original requirements. If this concern was carried on at a large profit, the expenditure ought to come out of the reserve fund. Mr. A. Steele Sheldon, town clerk, pointed out that by the terms of the order the Corporation was not allowed to use the reserve fund for the purchase of new machinery. That fund was intended to meet unforeseen contingencies. In connection with the £14,000 loan for machinery, Mr. Crickmay contended that the Corporation was asking for the money to enable it to provide electric light to an outside district. The town clerk refuted this, and said that the Corporation's supply to Merton was very small. The inquiry was then closed.

Swansea Docks.—Details of a proposal for the establishment of a new electrical station at the Swansea Docks have been supplied to the trustees, from which it would appear that the general manager and the chief engineer hold different views respecting control. Mr. Law (the general manager) favours the creation of a separate electrical department in charge of an engineer, at a salary of about £250, responsible to the general manager, with a proviso that, if necessary, an expert should be called in to advise upon new works of construction. Mr. Schenk (the chief engineer), on the other hand, disputes the necessity for the creation of a separate department, and contends that if such a department be created the engineer appointed must be responsible to him. Mr. Schenk further opposes the proposed equipment of the King's Dock with electricity, submitting that hydraulic power would prove cheaper and more efficient. Mr. Schenk supports his contention that he should have control of any electrical engineer who may be appointed by stating that this is the case on the Mersey and the Clyde, and at Bristol, the Wear, Hull, and Dublin.

Port Glasgow.—A special meeting of Port Glasgow Town Council was held on the 23rd inst. to consider the question of a public supply of electricity for Port Glasgow. The minutes bore that the Electricity Committee reported that the Greenock Corporation was prepared to give a supply to the burgh on certain conditions. The Greenock Town Council propose to lay the necessary high-tension transmission cables to Port Glasgow, and establish a low-tension supply throughout the burgh—the whole expenditure to be borne by Greenock, except in those cases where a consumer's demand is of an exceptional nature, when the supply shall be the subject of a special agreement. Port Glasgow to have the option to purchase the whole undertaking at the expiry of 28 years. The Electricity Committee recommended the Council to approve generally of the proposed agreement with the following additions—viz: (1) the rate of supply to be the same as charged to Greenock consumers; (2) any deficit to be met by Greenock; (3) that Greenock Corporation have no power to assess in Port Glasgow for any deficit. On the motion of the provost the minutes were approved of.

Wrexham.—In recommending that a rate of 3s. 3d. be levied for the ensuing year, a reduction of 6d. in the £ on the past years, Mr. Councillor Sauvage said that he thought that with a continuance of the care exercised by the officials and of the devotion to duty shown by the Council they could see their way clear, unless something unforeseen happened, to manage with a rate of 3s. 3d. for some years to come. This year for the first time the electric light had gone off the rates, the child was beginning to walk, and it was estimated that next year the undertaking would show a credit balance equal to a 1d. rate. This department was the property of the ratepayers, and whatever profit was made went in liquidation of the rate. All they asked for the enterprise was a fair field and no favours, and he believed that in time it would bring a good deal of credit to the ratepayers. He, in replying to a vote of thanks, claimed that Wrexham was as cheap a place as anyone could come to start new factories. They wanted new industries in the town, and the present rate and bright prospects for the future should act as an inducement for people to come here. They could easily be accommodated, and, if necessary, the Council would, no doubt, help them to start by placing the large warehouse at the depôt at their disposal, while the electricity department would be ready and willing to supply them with any amount of cheap power.—We are, indeed, glad to notice that the electricity department is now on a profit-earning basis, which is surely an indication that it is clearing its way out of the depression it has been under from the beginning. All credit for this achievement is due to Mr. Wm. G. Pickvance, the borough electrical engineer, and his able staff. With the development of Wrexham as an industrial centre there should be much further scope for the electricity department.

TRACTION.

Llandudno.—The Urban District Council have declined to accede to a request of the Great Orme Tramway Co. for permission to run cars on Sundays.

Geneva Tramways Co. (1906).—The traffic receipts for the month of February, 1908, amounted to 173,497fr., being an increase on 1907 of 19,986fr.

Rangoon Electric Tramway and Supply Co.—The total tramway receipts of the company for February were £4,177, an increase over February, 1907, of £1,465, the total increase from Jan. 1 being £2,905.

Rochdale.—The Corporation have been successful in obtaining a further reduction of over £1,600 in the assessment of their tramways undertaking for poor-rate purposes, and the appeal to quarter sessions will not now be prosecuted.

Madras Electric Tramways Co.—The directors recommend a dividend of 4½ per cent. per annum (2s. 3d. per share) on the preferred ordinary shares for the past half-year, to place £1,500 to depreciation and renewal fund, and to carry forward £221.

Yardley.—At the last meeting of the District Council the chairman of the Tramways and Electric Lighting Committee reported that arrangements for the conclusion of the agreement with the British Electric Traction Co. were well advanced, and he might promise a report at the next meeting.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending March 18, 1908, converted to gold, were £3,879; corresponding week last year £3,971—decrease, £92. Aggregates from Jan. 1, 1908, £41,180; aggregates from Jan. 1, 1907, £40,640—increase, £540.

Edinburgh.—The Dean of Faculty, arbiter under the lease between the Edinburgh Town Council and the tramway company in regard to the question involving the Marchmont-road circular route, and who recently decided that the tramway company were bound under the lease to run cars round the circular routes, has issued his award on the second hearing. Mr. Campbell has confirmed his previous finding on the ground that no reason has been shown why he should change his former decision.

Glasgow.—The Corporation Tramways Committee at their last meeting had before them the question of extending the lines to Burnside, Rutherglen, and to Rouken Glen by way of Thorniebank. It was agreed to continue consideration of the subject until the general policy with regard to tramway extensions is defined. A sub-committee afterwards discussed the proposed establishment of a complete through service between the east and west ends of the city. It was resolved to continue the present arrangements.

London United Tramways Co.—Gross receipts for the year 1907 amounted to £345 570, and expenses to £214,672, leaving a net revenue of £131,747. After meeting prior charges and preference dividend, there is a disposable balance of £10,260. The interim dividend at the rate of 2 per cent. per annum paid in August required £8,973, leaving £1,287 to be carried forward. The Board state that, owing to the exceptionally cold and wet summer season, receipts for the second half of the year's working have proved disappointing.

Kalgoorlie (Western Australia).—The Kalgoorlie Electric Power Corporation has increased its plant to the extent of 1,600 h.p. The company's general manager has recently been in England, and while there purchased the new machinery. The gross receipts from the tramways for the month of December, 1907, were £4,108. 18s. 8d., an average of £200. 8s. 8d per mile for the 20½ miles open. The estimated working expenses were £2,595. 9s. 9l., and net revenue £1,512. 8s. 11d. The aggregate gross receipts from Jan. 1, 1907, to the end of December totalled £47,822. 6s. 9d.

Aberdeen.—The average receipts per car mile of the Corporation tramways last week worked out at 9·51., as against 9·2d. last year. 273,571 passengers were carried over 26,783·6 miles, as against 261,506 passengers and 28,476·2 miles in the same week of March, 1907. The expenditure per car mile was: electricity, 1·27 units; traffic wages, 2·2d.; and repair wages ·3d., as against 1·25 units, 2 2d. traffic wages, and ·5d. repair wages last year. There were 478 luggage tickets issued and 151 parcels delivered, and the Suburban Tramway Co. earned £33. 12s. 9d., as against £33. 9s. 8d. last year.

Clay Cross.—An effort is to be made at Clay Cross to connect the town with the Midland Railway Station, which is distant some mile and a half, the proposal being to construct a light railway. The project is stated to be in the hands of certain gentlemen, and if the preliminaries turn out satisfactory and the railway becomes an accomplished fact, it will prove a great boon to the inhabitants. The present station is reached by means of a switchback footpath, the alternate route used by vehicles being nearly a mile further round. Numerous efforts have been made to obtain increased railway facilities, and deputation after deputation have waited on the Midland Railway Co., but so far without success.

Tramways to Loch Lomond.—Work in connection with the laying of the tramway track from Dalmuir to Balloch was prosecuted with vigour during last week. The contractors, Messrs. J. G. White and Co., London, while having now completed the track practically of half of the section from Dumbarton to Balloch, are making substantial progress on that from the county town to Dalmuir. The firm work on a system calculated to accomplish a mile of finished track per week, and they now will be attaining this remarkable rate of progress. It was anticipated that the Dumbarton-to-Alexandria section of the line would be opened for traffic during April, but the recent unfavourable weather has rendered this impossible.

Tramways over Kew Bridge.—The Standing Orders Committee of the House of Lords had under consideration on the 25th inst. an application to dispense with the Standing Orders in the case of the London United Tramways Bill. The Earl of Onslow presided. Mr. Cripps, for the promoters, explained that the Bill proposed the construction of tramways over Kew Bridge. The application was made because they had not obtained the consent of the County Councils of Surrey and Middlesex. Four years ago the County Councils passed a resolution, to which they still adhered, that they would give their consent if the tramways company agreed to pay a rent of £2,000 a year. This was equivalent to £5,700 per mile. He submitted that the Councils had no right under the Standing Orders to withhold their consent on condition that such terms were entered into. A bargain such as that ought to be considered by a Select Committee. After hearing arguments on behalf of the County Councils, the committee decided that the case was one in which the Standing Orders ought to be dispensed with, and the Bill will accordingly go forward in the ordinary way.

Greenwich.—The Borough Council have decided to intimate to the London County Council that if that body will undertake to construct a double line of electric tramway from the present terminus to either

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Church-lane, Charlton, or Charlton-lane, the Greenwich Council will be prepared to carry out the widening of the road to the point to which the tramway is to be carried according to the plans of the borough engineer, on condition that the London County Council will contribute two-thirds of the total cost of widening, including street works. Further, that if the London County Council have not at present the necessary powers to construct such tramway east of Rainton-road, the Council will agree to carry out such widening of the road, but only as far as Rainton-road, upon the same terms as to repayment by the London County Council upon that body undertaking in the next session of Parliament to seek the necessary powers for constructing the tramway to Church-lane or Charlton-lane, in which case the widening is also to be carried out upon the same terms, such proposals being subject to agreement of the necessary financial arrangements as to the time of repayment by the London County Council of their share of the cost of widening and agreement as to the date for the construction of such tramway and other matters.

Bury.—The gross receipts for the current year from April 1 to March 8 were £53,846. 3s. 9½d.; previous year, £47,248. 14s. 0½d., being an increase for the 49 weeks of £6,597. 9s. 9d. The total receipts on the Bury sections for the current year (49 weeks) were £37,082. 14s. 4½d.; previous year, £31,791. 0s. 0½d.; total increase, £5,291. 14s. 4d.; average per week since April 1, current year, £756. 15s. 9d.; previous year, £646. 18s. 3d.; increase per week, £109. 17s. 6d. Number of passengers carried per week has been: ordinary, 102,717; workpeople, 24,352—total, 127,069. During the last four weeks 768 parcels have been carried, for the carriage and delivery of which £6. 19s. 11d. has been received. The total receipts on the Radcliffe sections for the current year (49 weeks) were £8,853. 9s. 4d.; previous year, £7,838. 10s. 9½d.; total increase, £1,014. 18s. 6½d.; average per week since April 1, current year, £180. 13s. 8d.; previous year, £159. 10s. 1d.; increase per week, £21. 3s. 7d. The average number of passengers per week has been as follows: ordinary, 38,260; workpeople, 12,040 — total, 50,300. The total receipts on the Heywood sections for the current year (49 weeks) were £7,172. 9s. 1d.; previous year, £6,912. 5s. 10½d.; total increase, £260. 3s. 2½d.; average per week since April 1, current year, £146. 7s. 6d.; previous year, £140. 13s. 2l.; increase per week, £5. 14s. 4d. The average number of passengers carried per week has been as follows: ordinary, 21,606; workpeople, 7,356—total, 28,962.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Queensland.—The Postmaster-General invites tenders for the supply of lead-covered cables. Tenders by April 20.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Bremen.—Tenders are invited by the Municipality for electrically-driven pumps for the sewage pumping station. Tenders by March 30.

Madrid.—Tenders are invited by the Public Works Department for the construction of electric tramways in Bilbao. Tenders by April 30.

Kattowitz.—The Prussian Government Railways invite tenders for telegraph cable and telegraph construction material. Tenders by April 22.

Madrid.—Tenders are invited by the Post and Telegraph Department for the supply of 100,000 porcelain insulators. Tenders by April 11.

Edinburgh.—Tenders are invited for the installation of electrical fittings at the Midlothian and Peebles District Asylum. Tenders by March 30.

Buenos Ayres.—Tenders are invited for the construction and working of two sections of the underground electric railway. Tenders by May 1.

Madrid.—The Public Works Department invite tenders for the construction and working of an electric tramway at Sevilla. Tenders by April 4.

Madrid.—The Post and Telegraph Department invite tenders for laying, etc., telegraph cable between Chefarinas and Argelia. Tenders by March 30.

Madrid.—The Post and Telegraph Department invite tenders for the construction and exploitation of the interurban telephone service. Tenders by April 2.

Czernovitz.—In connection with the water station on the Pruth river, tenders are invited for electrical machinery for driving purposes. Tenders by April 21.

Leeds.—Tenders are invited for the supply of steam coal for the power station. Particulars from Mr. H. Dickinson, engineer. Tenders by March 31.

Bray.—The Urban District Council invite tenders for the annual supply of stores to the electricity department. Particulars from the Clerk. Tenders by April 7.

Brazil.—The Amazonas Provincial Government invite tenders for electric lighting, power supply, and tramways for the Mañaos Municipality. Tenders by April 4.

Leek.—The Urban District Council invite tenders for gas-producer plant and one gas-driven generator. Tenders to the Chairman of the Electricity Committee by April 11.

Hobart.—Tenders are invited by the Postmaster-General for 200 wall telephones, 800 telephone recorders, and extension of common-battery switchboard. Tenders by May 11.

Yarmouth.—The Corporation invite tenders for the supply of clothing for the tramway employés. Particulars from Mr. F. L. Turner, general manager. Tenders by April 7.

Sunderland.—Tenders are invited by the Corporation for the annual supply of stores to the tramways department. Particulars from the General Manager. Tenders by April 9.

Poplar.—The Electricity Committee invite tenders for the supply of switchboards and gear. Particulars from the Borough Electrical Engineer. Tenders by April 29. See advertisement

Melbourne.—The City Council invite tenders for hard-drawn copper cables. Particulars from Messrs. Ilwraith, McEacharn, and Co., Billiter-square-buildings, E.C. Tenders by April 7.

Tasmania.—The Postmaster-General invites tenders for material for extension of common battery and switchboard, 200 wall telephones, and 800 telephone recorders and cords. Tenders by May 11.

Weymouth.—The Weymouth and Melcombe Regis Corporation invite tenders for the supply of a 300-kw. steam-turbine and extension switchboard panel. Tenders to the Town Clerk by April 18.

Salford.—The Town Council invite tenders for the annual supply of stores to the electricity department. Particulars from Mr. V. H. McOowen, borough electrical engineer. Tenders by March 30.

Madrid.—The Post and Telegraph Department invite tenders for galvanised iron, or steel wire and bronze wire. Particulars from Direccion-General de Correos y Telegrafos. Tenders by April 10.

Dewsbury.—The Electricity Committee invite tenders for the supply of a surface condenser and the erection of a cooling tower. Tenders to the Chairman of the Electricity Committee by March 30.

Glasgow.—The Corporation invite tenders for works in connection with the Haggs road sub station. Particulars from Mr. W. W. Lackie, the electrical engineer. Tenders to the Town Clerk by April 6.

Edinburgh.—Tenders are invited for the supply of stores to the electricity department for one year, commencing May 16. Tenders to Mr. F. A. Newington, engineer, by March 30. See advertisement in last issue.

Bradford.—The Corporation invite tenders for the supply of 1,100 tons of steel girder rails (British Standard Section No. 4), 25 tons of fishplates, and 20 tons of joint pieces. Tenders to the Town Clerk by April 4.

Wallasey.—The Urban District Council invite tenders for the supply of automatic overload and reverse-current single-pole circuit breakers. Tenders to the Clerk, Council Offices, Egremont, Cheshire, by April 15.

Huddersfield.—The Corporation invite tenders for annual supplies to the tramways department, including overhead line materials, cables, traction lamps, etc. Particulars from the General Manager. Tenders by March 31.

Bristol.—The Electrical Committee invite tenders for a 12 months' supply of arc lamp carbons and joint and junction boxes. Tenders to Mr. H. Faraday Proctor, city electrical engineer, by April 7. See advertisement.

Poplar.—The Electricity Committee invite tenders for the erection of a sub-station building at Millwall. Particulars from the Borough Electrical Engineer, Glaucus-street, Bromley-by-Bow. Tenders to the Town Clerk by April 29.

Malvern.—The Electricity Committee invite tenders for the annual supply of stores. Particulars from Mr. W. J. Rendell Baker, engineer and manager, Council Offices, Malvern. Tenders to Mr. H. L. Whatley, clerk, by April 4.

Partick.—The Town Council invite tenders for the supply of stores to the electricity department, including arc lamp carbons, cables, engine-room stores, etc. Particulars from the Burgh Electrical Engineer. Tenders by April 4.

New South Wales.—Tenders are invited by the Postmaster-General for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators, best white porcelain, large. Tenders by May 20.

Sydney.—The Government Railway Department invite tenders fo the supply and installation of about 4½ miles of three-core, high-tension, paper-insulated, lead-covered feeder cable. Particulars from the Electrical Engineer, 51, Phillips-street, Sydney. Tenders by May 4.

Newcastle-on-Tyne.—Tenders are invited for (Contract No. 1) supply and delivery of 400 tons steel railway rails and fishplates; also (2) for the necessary points, crossings, and manganese rails for turnouts, for the Quayside improvement and extension. Tenders to the City Engineer by March 30.

Leeds.—The Corporation invite tenders for the annual supply of stores to the electricity department, including electric lamps, fittings, and the sundries; indiarubber-covered cables, mains, boxes, and fittings and jointing and insulating materials, etc. Particulars from Mr. Dickinson, engineer. Tenders by March 31.

Madrid.—The Post and Telegraph Department invite tenders for the construction and working of submarine telegraph cable from Cadiz to Teneriffe and Las Palmas, also for installation and exploitation of wireless telegraphy service. Particulars from Direccion-General de Correos y Telegrafos, 10, Carretas. Tenders by April 3.

Melbourne (Australia).—The Postmaster-General invites tenders for the construction and laying complete of two submarine telegraph cables between the State of Victoria and the State of Tasmania. Tenders must be accompanied by a deposit of £1,000. Tenders to the Secretary, Postmaster-General's Department, 51, Spring-street, Melbourne, by April 14.

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Copenhagen.—The Commercial Intelligence Branch of the Board of Trade have received from his Majesty's Consul at Copenhagen copies of the conditions and specification relating to a call for tenders for the supply of cables for electric lighting purposes. Tenders should be marked "Tilbud paa Vekselstroms-kabeler," and should reach Direktoren for Kobenhavns Belysningsvaesen, Copenhagen, by March 31.

Glasgow.—The Corporation invite tenders for the supply of stores for one year from June 1, 1908, including chilled iron brake blocks, car wheels, etc.; carbon brushes; vulcanised indiarubber cables; cast-iron castings; malleable iron castings; cast-steel castings; india-rubber and asbestos goods; springs; tiebars; galvanised wires; and fuel for Pinkston power station. Particulars from the General Tramways Manager. Tenders to the Town Clerk by April 6.

Manchester.—The Lancashire and Yorkshire Railway Co. invite tenders for the supply of stores during 12 months ending April 30, 1909, including signal and telegraph fittings; signal, telegraph, and electric light wires; steel springs (spiral); steel cotters and pins; steel plates (Siemens); steel sheets, etc.; steel tubes for boilers; steel tubing (cold-drawn weldless); tinned and zinc sheets, etc.; wire; wire rope, etc. Particulars from Mr. Waring, Stores Department, Osborne-street, Manchester, and tenders to Mr. R. C. Irwin, secretary, Hunt's Bank, Manchester, by March 30.

RESULTS OF TENDERS.

Manchester.—The Corporation have placed an order with Johnson and Phillips for supply and erection of three-phase transformers for one of their sub-stations.

Hucknall Colliery.—An order has been placed with Johnson and Phillips for the supply and erection of three-phase high-tension overhead transmission line.

Bristol Docks.—The Docks Committee has placed an order with Johnson and Phillips for complete installation of cable, switchgear, arc lamps, etc., for Avonmouth Dock.

Hastings.—The Town Council have accepted the tender of Messrs. Bradbury, Son, and Co., London, for the supply of coal at the electricity works during the six months from April 1.

Victoria.—The tender of Messrs. A. Roberts and Son has been accepted for the supply of two five-head batteries at £195 each, and that of Messrs. Johns and Waygood for two five-head batteries at £195 each.

Beckenham.—The Urban District Council have accepted the following tenders for annual supplies: H. R. Mansfield, cable troughs; C. C. Wakefield and Co., engine oil and cylinder oil; Englebert and Co., crank-chamber oil.

Hammersmith.—The Electricity and Lighting Committee recommend the acceptance of the tender of Messrs. Babcock and Wilcox for £1,285 and the tender of the Stirling Boiler Co. for £1,671, in connection with the electricity works extensions.

Australia.—The D.P. Battery Co. have received an order for a battery for telegraph work from the Commonwealth Government of Australia, and a repeat order for additional cells for their battery from the Bunbury Electric Light and Power Co. of Western Australia.

London, N.—The Islington Borough Council have accepted the tender of Messrs. Babcock and Wilcox for boilers for the extension at the electric lighting station for £10,694, and that of Messrs. Willans and Robinson for the supply of a turbo-generator and Willans alternator for £8,968.

Huddersfield.—The Council have accepted the tenders of Messrs. W. H. Roy and Co., of Manchester, for the construction of a cooling pond; the British Thomson-Houston Co. for transformers, etc., for extension to Messrs. Whiteley's premises; the British Westinghouse Electric and Manufacturing Co. for transformers for supply to Longroyd Mills; and Ferranti, Limited, for switchgear.

Queensland.—The following tenders have been accepted for supplies to the Postmaster-General's department: W. T. Henley's Telegraph Works, 880 yards lead-covered cable 208 pair 12½lb. conductor £630 per mile, 2,860 104 pair 12½lb. £360, 320 78 20lb. £380, 3,941 52 20lb. £285, 140 39 20lb. £245, 880 26 20lb. £180, 440 13 20lb. £115, 880 2 20lb. £25; Zwicker, Tod, and Co., Melbourne, 4,000 small cordeau insulators, 3d. each; A. Sargeant and Co., Brisbane, 2,000 black iron Y spindles, 2s. 1½d. each; 10cwt. soft-drawn copper wire, 50lb. per mile, £88 per ton.

OPENINGS FOR CONTRACTORS.

ABERBARGOED—School, Rhymney Valley, Group of Managers, Monmouthshire Section.

ABERDEEN—Electricity undertaking (£6,644), Town Council.

ABERDEEN—Two dwelling-houses, Devanha-gardens, Messrs. T. Wood and Lees; dwelling-house, Balnagask-road, Messrs. Freeland Bros.; pavilion, University-road, Aberdeen University Court—Messrs. A. Marshall Mackenzie and Son, architects; additions, premises, Fraser-road, Messrs. Edgar and Crerar; store, timber-drying shed, etc., Justice Mill-lane, Messrs. R. Beattie and Son.

ABERYSTWYTH—Four houses, North-road, Messrs. Jones and Lewis.

ACOCK'S GREEN—Elementary school (£18,000), Worcester County Council.

ADDINGHAM—Alterations, High Provided School (£524), West Riding Education Committee.

ALDGATE, E.—New branch post office (£2,521).

ALLOA—Illuminating hospital by electricity (£419), Council.

ANSLOW—Council school to accommodate 138 scholars, Staffs Education Committee.

ANNFIELD PLAIN—Two houses, Greencroft Estate, Messrs. Wilkinson and Crowley; three houses, Mary-street, Mr. W. G. Fawcett; four dwelling-houses, Neale-street, Mr. S. Ledger; four houses, South Medomsley, Mr. G. T. Wilson.

ASTON—Music hall, Potter's-lane, Newtown (£10,000), Mr. H. F. Stirling.

BALBY—Enlargement, St. John's Parish Church (£3,000), Churchwardens.

BALLYSHANNON—Housing scheme, Rural District Council.

BARGOED—Vicarage, Rev. T. Richards.

BARN ELMS—Extensions, boiler-house (£100), Metropolitan Water Board.

BARNOLDSWICK — Extensions, elementary schools, West Riding Education Committee.

BARNSLEY—Alterations and additions, residence. Mr. E. W. Dyson, architect.

BARROWFIELD—Warehouse, Holmfield Mills Co.; 12 houses, Fife-street, Mr. Lonsdale Nutter.

BEDFORD—Three houses, Elstow-road, Messrs. Jacobs and Burton; four houses, Short-street, Mr. C. Bushby; two houses, Devon-road, Mr. A. Prossier; three houses, Churchville-road, Messrs. B. Litchfield and Son; eight houses, Campbell-road, Messrs. Jacobs and Burton.

BELPER—Extensions to Sunday schools connected with church (£300), Wesleyans.

BEVERLEY—Public-house, Church-lane, Messrs. Moor and Robson; shop, Swinemoor-lane, Messrs. Wright and Hoggard; house, Trinity-lane, Mr. C. Bulmer; six houses, Swinemoor-lane, Mr. Crossland.

BEXHILL—Electric lighting (£2,860), Town Council.

BLACKBURN—Y.M.C.A. hall, Limbrick. Mr. F. J. Parkinson, architect.

BLACKHEATH—New post office (£7,390).

BLAIRGOWRIE—Motor garage, Commercial-street, Mr. W. Crockart.

BLOOMSBURY, W.C.—Alterations, County Court (£1,060); extensions, main buildings.

BLYTH—Premises (£2,000), Blyth Constitutional Club.

BOURNEMOUTH—Public conveniences (£3,250), Town Council.

BRANDON—Enlargement of concert hall (£1,000).

BRIDGWATER—Bandstand, Blake Gardens (£150), Town Council.

BRIGHOUSE—Secondary school, Governors.

BRIGHTON—Pavilion, municipal golf links (£4,000).

BRIGHTON—Church hall, Lewes-road (£1,100), Mr. T. Garrett.

BRISTOL—Arc lamp carbons, etc., City Electrical Engineer.

BROMLEY—Two houses, Langdon-road, Mr. H. R. Latter; house, Elmstead-lane, Messrs. Thorne and Norman; house, Edward-road, Mr. C. Quinnell; five houses, Gilbert-road, Kinnaird Park Estate Co.; house, Park-avenue, Mr. E. Pawley; two shops, Widmore-road, Mr. P. Coad.

BROMPTON, W.—Extensions, County Court buildings (£9,250).

BRYNCOCH—Elementary school, Glamorgan County Council.

BURMA—Courthouse, Amherst (£2,200), Government.

BURNLEY — Club premises, Parker-street. Messrs. Hitchin and Pritchard, architects.

BURY—Council school, Education Authority.

BURY—Extensions to works, Messrs. C. Walmsley and Co.

BUXTON—Electric lighting purposes, Urban District Council.

CAKEMORE—Police buildings (£2,600), Worcester County Council.

CAMBORNE—Two houses, Cross-street, Mr. Trounson; house and shop, Trelowarren-street, Messrs. Blewitt and Bunney; two houses, Enys-road, Mr. A. Parsons.

CAMBRIDGE—Mission room and house, Romsey-terrace, Messrs. Lewis and Gibson; additions, Jesus College, Governors.

CAMBRIDGE—Elementary school, Town Council.

CANTERBURY—Electricity undertaking (£4 000), City Council.

CARDIFF—School buildings, Nazareth House (£6,000), Mr. E. Corbett.

CARDIFF — Parish hall, Lewis-street. Messrs. Veall and Sant, architects.

CARLISLE—Electricity undertaking (£5,000), Town Council.

CARSHALTON—Offices for Urban District Council—Mr. W. W. Gale, surveyor; development, Westmead estate, Messrs. Dartnell and Banks.

CASHEL—Housing scheme (£56,428), Rural District Council.

CASTLEBAR—Housing scheme (£10,630), Rural District Council.

CHATHAM—Villa, Maidstone-road, Mr. R. W. Sayer; alterations, Prince of Wales Hotel, Railway-street, Truman, Hanbury, and Co.; stores at High-street, Messrs. S. J. Hart and Son; bungalow, Walderslade, and bungalow, Robin Hood-lane, Mr. H. W. Brake.

CHEADLE HULME—Council school, County Education Committee.

CHELMSFORD—Buildings and alteration, Brentwood grammar school.

CHERITON—Station near Risboro'-lane, Railway Authorities.

CHESELBORNE—Elementary school, Dorset Education Committee.

CHISWICK—Public conveniences (£1,250), Urban District Council.

CLAPHAM, S.W.—Five houses, Old Town, Mr. A. P. Lambert.

CLAPHAM (YORKS)—Elementary school, West Riding Education Committee.

CLEATOR MOOR—Catholic hall (£2,000), Parish Priest.

CLECKHEATON—Secondary schools, Education Committee.

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CLEETHORPES—Elementary school, Elliston-street, Lindsey County Council.
CLONES—Workmen's dwellings (£21,229), Rural District Council.
COLERAINE—Housing scheme (£18,497), Rural District Council.
CONSETT—Elementary school, Malton Colliery, Durham County Education Committee.
COUNDON—House, Trustees of the Shildon Primitive Methodist Circuit.
CRICKLEWOOD—Workshops, etc. (£1,000), Metropolitan Water Board.
CROMPTON—Mortuary, Council.
CUPAR—Extensions, school (£3,000), School Board.
DARLINGTON—Boiler, electricity works (£1,030), Town Council.
DARTMOUTH—Two houses, Coleman-court, Town Council.
DARTMOUTH—Alterations and additions, public convenience, Bayard's Cove, Corporation.
DARTON—Nurses' house. Messrs. R. and W. Dixon, architects.
DEAN BANK—Baptist Sunday school, Trustees.
DENVER—Additions to Non-Provided school. Messrs. Lacey and Upcher, architects.
DERBY—Day schools in connection with St. Joseph's Roman Catholic Church (£5,000).
DEWSBURY—Three houses, Westtown. Messrs. J. Firth and Son, architects.
DILTON MARCH—Workmen's dwellings (£1,800), Urban District Council.
DODDINGTON—House, Mr. Harding.
DORKING—Electric lighting (£11,600), Urban District Council.
DUDLEY—Enlargement, post office (£3,000).
DUNDEE—Erection and equipment of a laboratory, University College Authorities.
DUNDEE—Additions, house, Bernard-street, Mr. James Knight; villas, Blackness-road, Mr. J. G. Gilchrist; alterations, Royal Orphan Institution, Broughty Ferry-road, Directors; alterations, house, Crichton-street, Trustees of the late David Pirie; workshops, East Henderson's-wynd, Messrs. M'Culloch and Jamieson; motor garage, etc., Hazel Hall-drive, Mr. H. T. Walker; workshop, Larch-street, Mr. George Kilgour; motor-house, Farrington-street, Mr. J. Watson; alterations, house, Murraygate, Mather's Trustees.
DUNFERMLINE—Alterations, etc., City Arms Hotel, Messrs. Fraser and Carmichael; shop and dwelling-house, Chalmers-street, Mr. A. Fraser.
DURHAM—Elementary school, Chilton-buildings, Durham Education Committee.
DURHAM—Additions, St. John's Church, Neville's Cross, Rev. H. Robinson; branch store, Neville's Cross, Durham Co-operative Society.
EARBY—Elementary school, West Riding Education Committee.
EASINGTON—Two houses, Seaton, Messrs. Clark; 13 houses, New Seaham, Mr. Curry; seven houses New Seaham, Mr. Jackson; six houses, New Seaham, Messrs. Wilkinson and Turnbull; alterations, Haswell Tavern, Messrs Nimmo.
EASTBOURNE—Mission church, Hampton Park, Trustees.
EAST HAM—Eight houses, Grosvenor-gardens, Mr. F. Hamlett; shop and house, Mitcham-road, Mr. W. Allerton; house, Romford-road, Mr. F. Farquhar.
EAST HARDWICK—Elementary school, Board of Education.
EBBW VALE—Twenty-seven houses near Old Shop Row, Mr. F. Fudge.
ECCLES—Elementary school, Beech-street, Education Authority.
ENNISCORTHY—Housing scheme (£94,891), Rural District Council.
FAIRFIELD—Restoration, Fairfield Moravian Church (£1,700).
FELIXSTOWE—Pavilion, Hamilton-terrace Cliffs, Felixstowe and Walton Urban District Council.
FERRYHILL—Eleven houses, Broom-road, Mr. Walton
FLEETWOOD—Six houses, Oak-street, Councillor Whittaker.
FROME—Electric lighting (£11,100), Urban District Council.
GAINSBOROUGH—Hospital, Urban District Council.
GLENTIES—Workmen's dwellings (£7,518), Rural District Council.
GRANGE—Additions, Victoria Hall, Urban District Council.
GREENWICH—Alterations, superintendent's lodge, Greenwich Park.
GUILDFORD—Additions and alterations, baths, Castle-street, Town Council.
HACKNEY, N.E.—Shops, Mare-street, owner, 1, Victoria Park-road.
HALIFAX—Enlargement, post office (£1,500).
HAMMERSMITH, W.—Engine and boiler houses (£1,000), Metropolitan Water Board.
HAMMERSMITH, W—Houses, Dunraven-road, Mr. W. G. Ingram
HAMMERSMITH, W.—Six blocks of flats, Mr. F. W. Hingston.
HAMPSTEAD WAY—Development of estate, Messrs. Parker and Unwin.
HARDINGHAM—Chapel, Wymondham Circuit.
HARPENDEN—Laundry, etc., Harpenden-rise, Messrs. Messer and Co.; additions, Salisbury Villa, Milton-road, Mr. Ordish; nine houses, Holybush-lane, Mr. E. C. Jarvis.
HARWICH—Secondary school, County Education Committee.
HASTINGS—Drill hall, Bexhill-road, Messrs. Boulton and Paul; two houses, Bexhill-road, Mr. P. R. Papillion; two houses, Middle-road, Mr. Sellens.
HEALING—Elementary school, Lindsey County Council.
HENDON—Additions, factory, The Hyde, Messrs. A. Garston and Co.
HENDON—Seventeen houses, Mr. E. Evans.
HEREFORD—Workmen's dwellings (£3,800), City Council.
HEYSIDE—Vicarage to church (£700), Ecclesiastical Commissioners.
HEYWOOD—Extensions, electricity works (£9,000).
HINCKLEY—Public baths (£2,610), Urban District Council.
HOLBORN, W.C.—Additions, sub-station, Charing Cross, West End, and City Electricity Supply Co.
HOLLOWAY, N.—Extension, post office sorting department (£2,080).
HORNSEY—Extension, sorting office (£2,200).
HUDDERSFIELD—Manager's house, etc., sewage works, Deighton, Town Council.
ILFORD—Extension, premises, Seven Kings-road, Messrs. Ward and Ward; six houses, Messrs. Rawlins and Co.
ISLE OF MAN—Hospital (£20,000), Governors of the Isle of Man Hospital.
JARROW—Houses, Grange-road, Mr. B. Hall; additions, business premises, High-street, Mr. Hall.
KELSO—Two villas, Messrs. W. Simpson and Son; workmen's dwellings, Maxton, Messrs. R. and J. Grieve.
KEMPTON PARK—Workshops, etc. (£3,000), Metropolitan Water Board.
KENSINGTON, W.—Erection, tea-house, etc., Hyde Park (£1,500).
KEW—Alterations, Cambridge Cottage, Royal Botanical Gardens.
KEW—Extensions, fitting shops (£150), Metropolitan Water Board.
KIDDERMINSTER—House, Shrubbery-street, Mr. T. L. Brain; mission church, Broadwaters, Rev. W. G. Melville; additional storeroom, workhouse, Board of Guardians.
KILMALLOCK—Housing scheme (£80,250), Rural District Council.
KINGSTON-ON-THAMES—Extensive alterations, Royal County Theatre, Mr. P. Davy, proprietor.
KIRKWALL—Enlargement of Post Office, H.M. Commissioners of Works.
LAKHSAR—Police station (£2,233).
LANGHOLM—Post office, High-street, Town Council.
LEAMINGTON—Enlargement, post office (£3,000).
LEEK—Electricity works extensions, Urban District Council.
LEEK—Club building, Compton, Messrs. Wardell and Co.
LEPTON—Mill buildings, Messrs. Brierley and Wall.
LEWES—Council school, Education Committee.
LEWISHAM, S.E.—Eleven shops, Muirkirk-road, Messrs. Norfolk and Prior; 14 houses, Bankwell road, Messrs. Hatch and Hatch.
LEYTON—Extension, sorting office (£2,000).
LINTHWAITE—Houses and shops, Causeway-side, Mr. B. Whiteley; six houses, Smithriding, Mr. W. Hayes; shop, Smithriding, Mr. H. S. Heppenstall.
LISBURN—Housing scheme (£20,180), Rural District Council.
LIVERSEDGE—Three houses, Robert Town. Mr. Lister Coates, architect.
LLANDAFF—Elementary school, Dinas Powis, Glamorgan County Council.
LLANTRISANT—Elementary school, Talbot, Glamorgan County Council.
LONDONDERRY—Workmen's dwellings (£30,834), Derry No. 2 Council.
LONGTON—New post office (£2,000).
LOTHERSDALE—Improvements, school buildings (£238), West Riding Education Committee
LOWESTOFT—Extension, post office (£750).
LUMLEY—Alterations, Council school, Durham County Council.
LUTON—Eight houses, Dorden's-road, Leagrave, Mr. R. Melcombe.
MACHEN—Alterations and additions, Baptist chapel. Mr. J. H. Phillips, architect.
MADRAS—Municipal market (£1,110), Negapatam, Government.
MAGHERAFELT—Housing scheme (£37,790), Rural District Council.
MANCHESTER—Shops, offices, and stockrooms, Market-street, Messrs. Beaumont and Sons.
MARGATE—New post office (£1,000).
MARKET BOSWORTH—Eighteen houses, Desford Colliery Co.
MARYLEBONE, W.—Depôt for carts, etc., Grove-road, Mr. J. P. Waddington.
MELTON MOWBRAY—Two houses, Victoria-street, Mr. Watts; house, Craven-street, Mr. Denman.
MIDDLETON—Secondary school, Education Authority.
MIDSOMER NORTON—Factory, South View-road, Mr. G. Prior; shop, Radstock-road, Mr. F. Wines.
MITCHELSTOWN—Housing scheme (£35,190), Rural District Council.
MOGERHANGER—Elementary school, Beds Education Committee.
NEATH—Housing scheme (£28,028), Rural District Council.
NEATH—Additional workhouse accommodation (£4,600), Board of Guardians.
NETHERTON—Drapery stores, Netherton Co-operative Trading Society.
NEWCASTLE-ON-TYNE—Extension, post office (£5,000).
NEWTOWNARDS—Workmen's dwellings (£37,000), Urban District Council.
NEWTOWNCUNNINGHAM—Schools, Committee of Newtowncunningham Presbyterian Church.

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NORTH BROOMHILL—School-chapel, Primitive Methodist Trustees.
NORWICH — United Methodist church, Rodeberry-road, St. Clement Hill (£2,600), Trustees.
NORWOOD—Fifty-eight houses, Trinity-road, Herne Hill, Mr. H. D. Wood.
OBAN—New post office (£6,000).
OLD DEER—Rectory, Managers of St. Drostane's Episcopal Church
OLDHAM—Sunday school for parish of St. Ambrose, Prince Charlie-street (£3,500).
OSWESTRY—Secondary school (£6,000), Salop County Council.
PAISLEY—Two houses, Ralston, Mr. A. Urie, architect; tenement of shops and dwelling-houses, Broomlands, Mr. T. F. Reid.
PENGE—Congregational church, Royston's Estate, Beckenham-road.
POKESDOWN — Church, parish of St. James, Ecclesiastical Commissioners.
POLSTEAD—Alterations, Council school and teacher's house, West Suffolk Education Committee.
PORTSMOUTH—Out-patients' department (£4,000), Management Committee of the Royal Portsmouth Hospital.
PRESTBURY — House. Messrs. Prothero, Phillott, and Barnard, Cheltenham, architects.
PRESTON—Two houses, Ribchester, Mr. J. Barton; three houses, Longton, Mr. Tyson; two houses, Howick, Mr. J. Pitchford.
PRESTWICK—Parish church (£6,000). Mr. P. M. Chalmers, architect.
RAMMEY MARSH—Engine-house (£400), Metropolitan Water Board.
RAMSGATE—Secondary schools (£13,269), Town Council.
RANELAGH—Roman Catholic church (£10,000).
RICHMOND—Gate lodge, East Sheen entrance, Richmond Park (£600).
RICHMOND—Conveniences, Terrace Gardens, Town Council.
RISHTON—Additions, Victoria Mills, Managers.
ROLLESTON—Council school to accommodate 132 scholars, Staffs Education Committee.
ROTHERHAM—Elementary school, Cranworth-road, Education Committee.
ROTHERHITHE, S.E.—House, Silver-street, Mr. E. J. Bennett.
RUGBY—Alterations, premises, Market-place, Mr. A. G. Chamberlain.
SAFFRON WALDEN—Three pairs villas, Debden-road, Mr. A. R. Dix.
SALFORD—Secondary school and extensions to the present school (£25,000), Education Authority.
SALTERFORTH—Elementary school, West Riding Education Committee.
SCUNTHORPE—Arcade of shops. Plans passed by Urban District Council.
SEAHAM—Alterations, Londonderry Hotel, Messrs. Millburn; house, Maureen-terrace, Mr. Milburn; school, Emily-street, East Durham County Council; two houses, Alfred-street, Mr. Marriner.
SELHURST—Boiler-house (£500), Metropolitan Water Board.
SHIPTON—Elementary school, West Riding Education Committee.
SHREWSBURY—Two secondary schools (£18,000), Salop County Council.
SILSDEN—Extensions, elementary schools, West Riding Education Committee.
SILVERSTONE—Elementary school, Education Committee.
SKETTY—Elementary school, Glamorgan County Council.
SKIPTON—Restoration, parish church (£1,800). Messrs. Austin and Paley, architects.
SMETHWICK—Alterations, chapels and lodge, Uplands Cemetery.
SOOTHILL—Three houses, Sykes-lane, Mr. J. H. Ward.
SOUTHGATE—Sorting office, G.P.O. (£2,880).
SOUTH KENSINGTON—Branch post office (£6,000); western district parcel office enlargement (£13,000).
SOUTH KENSINGTON, S.W.—Metereological office (£4,500).
SOUTHMOLTON — Minister's residence. Messrs. W. C. Oliver and Son, architects.
STIRLING — House, California. Mr. E. Jack; house, Airdrie, Dr. Gemmell; house, Greenbank, Mr. W. Gillespie.
STOCKTON—Extension, post office (£1,000).
STOKE—Extension, post office (£500).
STOKE—Shops, bakery, and stables, Shelton New-road, Silverdale Co operative Society; four houses, Riseley-road, Hartshill, Mr. G. Evans; rebuilding Old Swan Inn, High-street, Mr. E. Williams.
STOPSLEY—Elementary school, Beds Education Committee.
STRAND, W.C.—Beer stores, stables, cask stores, etc., Broad-street, Messrs Huggins and Co.
STRATFORD—Alterations, Essex Arms, Leytonstone-road, Mr. R. B. Pritchard.
STREATHAM, S.W.—Twenty-six houses, Wyatt Park-road, Mr. W. L. Verran; 16 houses, Wavertree-road, Mr. F. Selby.
STIRLING — Four houses, Wallace-street, Mr. T. Ferguson; villa, Alexandra-place, Messrs. J Ronald and Sons.
TAUNTON—Extensions, sorting office (£1,000).
THIRLMERE—Two houses, Legberthwaite, Waterworks Committee.
THORNTON HEATH—Extensions, workhouse, Mayfair-road (£16,000), Croydon Guardians.
THORNTON-IN-CRAVEN — School (£1,050), West Riding County Council.
THRAPSTON—Elementary school, Northamptonshire County Council Education Committee.
TOTTENHAM—Extension of factory, Mr. S. C. Tee.
TOTTENHAM—Sub-transformer station, North Metropolitan Electric Supply Co.
TOW LAW—Two dwelling-houses, Mr. Rawes.
TRALEE—Housing scheme (£129,080), Rural District Council.
TREMAIN—House. Mr. L. Lewis, architect.
TRIMDON—Curate's house, and 16 houses, Trimdon Grange, Mr. Walter Scott.
TUAM—Housing scheme (£21,825), Rural District Council.
TUTBURY—Council school to accommodate 328 scholars, Staffs Education Committee.
TWICKENHAM—Public conveniences, Urban District Council.
TWFORD—Enlargement, parish church (£2,000).
UPTON—Hospital (£1,000), Rural District Council.
UXBRIDGE—New post office (£2,000).
WAKEFIELD—Board-room, committee rooms, etc., in connection with workhouse (£1,400).
WALTON—Boiler-house (£6,000), Metropolitan Water Board.
WELLINGTON—Secondary school (£9 000), Salop County Council.
WEST PELTON—Elementary schools, Durham County Education Committee.
WHITECHAPEL, E.—Factory, Great Alie-street, Mr. T. A. Mason.
WHITSTABLE—Two houses, Cromwell-road, Messrs. Harrison and Uden; two houses, Clare-road, Mr. F. S. Gann.
WICKFORD—Repairs, etc., Wickford parish church (£100).
WIGGENHALL—Restoration, St. Mary Magdalen Church (£3,500), Ecclesiastical Commissioners.
WILLESDEN, N.W.—Two shops, Mr. H. Shaw; development of estate, Church-road, Messrs Done, Hunter, and Co.; two houses, Mount Pleasant-road, Messrs. Trant, Brown, and Humphries.
WINCHESTER—Enlargement, post office (£2,800).
WINTON—Elementary schools, Beech-street, Eccles Education Committee
WISBECH—Storeroom, Golding-street, Mr E. J. Gray.
WOLVERHAMPTON—Enlargement of post office, H.M. Commissioners of Works.
WOLVERHAMPTON — Hotel, Queen-street Mr. A. E. Dempster, architect.
WOOLWICH—New station S.E. and C.R., Westmount-road, Eltham.
WOMBRIDGE—Elementary school, Salop County Council.
WORTHING—Electric lighting (£1,710), Town Council.
WRABNESS—Chapel, Trustees.
YARDLEY — Elementary school, Church-road (£20,000), Worcester County Council.

COMPANIES' MEETINGS AND REPORTS.

LLANDUDNO AND DISTRICT ELECTRIC TRAMWAY CONSTRUCTION.

At the annual meeting of the Company, Mr. Stephen Sellon congratulated the shareholders upon the success which had attended the Llandudno to Rhos section of the line since it was open for public traffic on Oct. 19. The receipts had averaged over 8d. per mile, and this might be considered very satisfactory, having regard to the season and the fact that the entire line had not yet been completed to the important terminus of Colwyn Bay. Considerable delay had taken place on the Colwyn Bay section owing to difference of opinion with the local authority as to the material to be used for paving, but through the medium of the Board of Trade this had now been satisfactorily settled. The work of construction had been commenced, and it was hoped would be completed in time for the holiday traffic. The proposed extension to Old Colwyn had been adjourned *sine die* to enable the Urban Council and the county authority to formulate a scheme of road improvement. A loan of £25,000 had been negotiated in Liverpool and Manchester to provide funds for the completion of the works which had been authorised under the deviation and the amendment order of 1907.

The report was adopted.

YORK TRAMWAYS.

At the half-yearly ordinary general meeting of the shareholders of the City of York Tramways Co., Mr. W. H. Thackwray, who presided, referred briefly to the company's agreement with the Corporation. The Light Railway Commissioners had held an inquiry into the Corporation's application to electrify the present system. The application had been approved, and in the ordinary way the powers asked for by the Corporation would be granted in the course of the next two or three months, in which case the Corporation would, under their agreement, purchase the company's undertaking within three calendar months after obtaining such powers.

GUILDFORD ELECTRIC SUPPLY.

The directors of the above Company in their annual report for the past year state that the gross receipts have been £6,466. 19s. 5d., as compared with £5,975. 7s. for the year 1906. There was a balance on the revenue account of £3,082. 9s. 8d. after crediting depreciation

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fund account with £1,000. A dividend of 5 per cent. on the ordinary shares is recommended. The total capital expenditure up to Dec. 31 last amounted to £53,271. 9s. 2d., and the total capital receipts were £49,386. There was, therefore, a balance over-expended of £3,885. 9s. 2d. The directors are very desirous of issuing further ordinary and preference shares, and also the balance of the debentures.

LONDON UNITED TRAMWAYS.

The report of the directors of the London United Tramways for the year ended Dec. 31 last states that the operation of the Company's undertaking during that period resulted in gross receipts amounting to £345,570, and the working and general expenses, maintenance, and repairs to £214,672, leaving, with the balance brought forward, a net revenue of £131,747. After payment of interest on debenture stock and loans and the dividend on the 5 per cent. preference shares for the year, and providing for income tax, there is a balance of £10,260. The gross receipts show an increase of £17,674, and the total number of passengers carried was 58,725,980, an increase of 3,370,699. The managing director's report states that the rolling stock, plant, etc., have been efficiently maintained out of revenue; but the directors regret that the profits have not permitted of any appropriation to the renewal fund, which it is their desire to augment year by year. The section of the Company's system in Surrey—from Raynes Park to Wimbledon and Tooting, about 6½ miles of tramway—was completed and opened for public traffic in June last. The tramway mileage now in operation consists of 55¼ miles. The Company's powers in respect of certain uncompleted lines expire in August next, and application is at present before Parliament for a further extension of time and also for powers to lay a line across Kew Bridge, forming a connection between the Company's main lines and Richmond. The London County Council connection with the Wimbledon lines at Tooting has not yet been effected, and the question of through running over the respective systems still remains the subject of negotiation.

WOKING ELECTRIC SUPPLY.

In their report the directors of the Woking Electric Supply Co. state that the total revenue for the year ended Dec. 31, 1907, was £14,135. 15s. 2d.; expenditure connected with the generation and distribution of electricity and management, £7,095. 16s. 1d.; leaving a balance on the year's working of £7,039. 19s. 1d., to which has to be added £504. 16s. 4d., the amount brought forward from last year, making a total of £7,544. 15s. 5d. After payment of dividends on the debentures and preference shares, 5 per cent. on the ordinary shares, £1,500 to depreciation fund, and other smaller charges, a sum of £566 is carried forward to the profit and loss account.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION.

The report of the South Wales Electrical Power Distribution Co. for the 12 months ended Dec. 31, 1907, to be submitted at the meeting in Cardiff on the 31st inst., states that, as intimated in the report, submitted to the shareholders at the meeting on July 27, 1907, the late directors resigned their seats on the Board at that meeting, and the present directors were duly elected in their stead, and have since that date administered the affairs of the Company. The working arrangement with the Treforest Electrical Consumers' Co., which was submitted to and approved by the shareholders at the last general meeting, has been put in operation, and the working of the Treforest generating station and the area supplied from that station was taken over by the Treforest Co. on Sept. 1, 1907. That company has already placed orders for about £2£,000 for new and modern plant, which will materially reduce the cost of production. Negotiations are proceeding, and it is hoped will shortly be completed, for the formation of a similar consumers' company in the Cwmbran area to take over and work the Cwmbran generating station. The directors report that creditors in respect of the heavy liabilities appearing in the last balance-sheet have met the Company in the most friendly manner by agreeing to accept preference shares in settlement of their claims, and liabilities for upwards of £78,000 have been settled in this way.

NEW COMPANIES REGISTERED.

United Sumatra Rubber Estates, Limited. — Registered March 10. Capital, £85,000 in £1 shares. Objects: to acquire, work, and develop the rubber estate in Sumatra known as the Bangoen Poerba Estate. Registered office: 30, Mincing-lane, E C.

Liens Registered.

Maxim Electrical Co., Limited (London).—A charge on the company's book debts, present and future, dated March 9, 1908, to secure not more than £1,000, has been registered. Holders: Barclay and Co.

Appliances and General Engineering Co., Limited (London).—Issue on Feb. 19 of £500 7½ per cent. second debentures, part of series created Sept. 18, 1907, to secure £2,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £1,300.

Coatbridge and Airdrie Electric Supply Co., Limited.—A mortgage or charge on the company's undertaking and property, present and future, including uncalled capital and the Coatbridge and Airdrie undertakings, dated March 5, 1908, to secure £14,338. 9s. 11d., has been registered. Holders: County of London Electric Supply Co., Moorgate-court, E.C.

De Mello Brazilian Rubber Co., Limited.—Particulars of £150,000 debentures created by resolution of Dec. 18, 1907, and secured by a trust deed dated March 4, 1908, have been filed pursuant to Section 14 (4) of the Companies' Act, 1900, a debenture of recent date having been produced to registrar. Trustees: G. Faure, 35, Rue de Berigne, Paris, and C. Steel, Glasfryn, New Barnet.

LEGAL INTELLIGENCE.

MEXICO ELECTRIC TRAMWAYS.

On Wednesday, the 18th inst, the hearing was concluded of a motion by the plaintiff in the action of Mr. Alfred Parrish *v.* the Mexico Electric Tramways and others. The motion came before Mr. Justice Eve in the Chancery Division of the High Court, and asked for the appointment of a receiver of the assets and undertaking of the defendant company. Plaintiff's complaint was that the defendant company had granted a lease of all their tramways to a Canadian company, the Mexican Consolidated Electric Co., which would have the effect of "freezing out" plaintiff and other shareholders who dissented from a scheme under which the Canadian company acquired all the shares of the defendant company held by Messrs. Wernher, Beit, and Co. It was alleged by plaintiff that the transactions in question amounted to a misfeasance.

Mr. MARTELLI, K.C., said the plaintiff's case was that the lease to the Canadian company was a mere device by the majority in the defendant company to secure for themselves the whole of the profits of the company in excess of 5 per cent. on the ordinary shares. Having regard to the regulations of the company as to the way the profits had to be divided, counsel said that was a fraud by the majority on the minority which the Court could not set aside at the suit of the minority in an action commenced by one of the shareholders on behalf of the minority.

Mr. ISAACS, K.C., said the only undertaking he could give was not to do anything with the lease pending the trial of the action.

Mr. MARTELLI said that did not go far enough. Plaintiff wanted to stop further distribution of the profits, and he also wanted a speedy trial. Counsel added that if he could not have a receiver he should press for an injunction restraining the defendant English company from parting with, and the Canadian company from receiving, any of the net profits of the former company, or any money due from the English company in respect of advances, pending the action. He submitted he had made out a *prima facie* case for interim relief.

Mr. ISAACS said his learned friend had not met the main point—namely, that if defendants were stopped in this way, who was to go on finding advances to enable the tramways of Mexico to be carried on. This was a form of pressure put on the defendants which was wholly unreasonable.

After a short consultation, Mr. ISAACS said his learned friend would accept what he offered—namely, that there should be no determination of the lease pending the trial of the action—and then they would proceed to a speedy trial.

There was no order accordingly, except that the costs of the motion be costs in the action.

NORTH METROPOLITAN TRAMWAYS CO.

On Monday, in the matter of the Arbitration Act, 1889, and in the matter of an arbitration between the North Metropolitan Tramways Co. and the Leyton Urban District Council, the Court of Appeal, consisting of the Lord Chief Justice, Sir Gorell Barnes, and Lord Justice Farwell, had before them the appeal of the North Metropolitan Tramway Co. from the order of Mr. Justice Phillimore and Mr. Justice Walton, sitting as a Divisional Court, dismissing an appeal against an award.

Mr. DANCKWERTS, in support of the appeal, said the question arose in connection with an award made by Mr. Graham Harris under the Metropolitan Tramways Co.'s Act of 1870 in regard to the part of their undertaking within the district of the Leyton Urban District Council, which had been compulsorily taken under the local Act. The question was whether Mr. Harris had dealt rightly in connection with certain car works and land. The Court had to decide whether or not the local authority could be compelled to take and pay for the car works. At present the decision was against him, but he submitted on the authority of a case in the House of Lords that where the car works were suitable and within the district the local authority was bound to pay for them. A second point for the appellants was that the arbitrator had given the local authority the permanent way of the tramway, including the entrance gates which were off the street, and had awarded nothing for the value of the land.

Mr. C. A. RUSSELL, K.C., argued the case for the respondents.

The LORD CHIEF JUSTICE, in his judgment, said he was satisfied there was substantial justice done by the award.

The other Lords Justices concurred, and the appeal was accordingly dismissed, with costs.

REPAIRING FLEET STREET.—IMPORTANT CASE.

In the City of London Court, on Friday, the French Asphalt Co., Suffolk House, Lawrence Pountney-hill, sued the City of London Electric Lighting Co., Great Winchester-street, for £3. 8s. for making good the footway paving round eight electric lighting boxes with 1in. of compressed asphalt and 4in. of concrete. The secretary of the plaintiff company said that the action was one of much public

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importance. His company was under a contract with the City Corporation to keep in repair many of the streets of the City with asphalt, and amongst them was Fleet-street. When they reinstated the pavement recently eight electric lighting boxes were left in a sunken condition, and the plaintiffs had to raise them under their contract with the City authorities. A grave public danger would have been caused if the work had not been done by them. They often had to do similar work for various public bodies, such as water companies, hydraulic companies, etc., and they had never known their claim to be questioned. The footways of Fleet-street were going to be relaid in sections extending over a period of four years. Defendants raised their boxes, and the asphalting now sued for was absolutely necessary. Mr. Wertheimer, counsel for the defendants, said he agreed that the case was one of great public importance, and the Postmaster-General was involved in the same way as the defendant company. The whole thing had arisen because the plaintiffs did not give defendants notice that the work was going to be done. The boxes were the defendants by parliamentary authority. Plaintiffs' duty was to give defendants notice before they started the work, so that defendants could have the boxes raised and tell plaintiffs how high they should be raised. Plaintiffs did their work in the night. Defendants never gave plaintiffs instructions to do the work sued for. Plaintiffs' secretary said that they would not know what levels the boxes ought to come to. It was impossible to take the same level all through the pavements. Plaintiffs were rendering important public work for the defendants, and they should be paid for it. Judge Rentoul, K.C., said that the case might be one of general public importance when the facts were proved. Defendants did not seem to have ordered the work. At present he did not see how the plaintiffs could recover. There were so many legal intricacies in the matter that plaintiffs' secretary and the directors acting with him could not deal with. They must take legal advice, and if they decided not to go on the defendant company would have their costs.

ACTION FOR THE HIRE OF A GENERATING SET.

On Friday last, in the King's Bench Division, Mr. Justice Darling and a special jury had before them an action by Messrs. Williams and Sons against the Beckenham Urban District Council to recover the sum of £780, the balance of an account delivered for goods sold and delivered, and the hire of generating sets for six months from October, 1906, to April, 1907, at £125 a month. Defendants had an option to purchase, but did not exercise that option.

Defendants said that the machinery did not produce the electricity necessary for the defendants' purposes, and they counterclaimed for £417.

Ultimately the case was settled, a verdict being entered for the plaintiff for £500 and costs.

PROVISIONAL PATENTS, 1908.

MARCH 13.

5628. Improvements in and relating to the control and transmission of electric energy. Richard Philip Myers and Edward Archibald Gedge, 5, Corporation-street, Birmingham.

5634. Improvements in and relating to devices for mechanically and electrically actuating counters. William Hampson, and Checkogram (1908), Limited, 290, Dashwood House, London.

5640. Improvements in or connected with electric motor-driven apparatus. Mavor and Coulson, Limited, and Samuel Miller Mavor, 58, St. Vincent-street, Glasgow.

5655. Improvements in electricity meters. Edward Jesse Piper, Iridge, Hurst Green, Sussex.

5679. Improvements in and relating to alternating electric current compensators or transforming devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

5680. Improvements in the reduction of metal compounds and apparatus therefor. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

5681. Improvements in and connected with electric light fittings. Francis Maddison Long, 77, Chancery-lane, London.

5686. Improvements in current-collecting devices for electric railway vehicles. Edward Alan Christian, 6, Lord-street, Liverpool.

5691. Improvements in dynamo-electric machines for the production of continuous and alternating currents. Jakob Schuerch and Gottlob Himmel, 6, Lord-street, Liverpool. (Complete specification.)

5698. Improvements in and relating to block apparatus or the like for railways. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

MARCH 14.

5708. Improvements in means for adjustably carrying shades for electric and gas lamps. Edwin Alfred Showell and Ernest Holtom Harris, Prudential-buildings, Corporation-street, Birmingham.

5719. Improvements in swing-out electric lamp carriers. Thomas Laidlaw Scott, 51, Broomfield-avenue, Palmers Green, London.

5748. Improvements in electric lamp connections. Henry Charles Gover, Charles William Zoephel, and George Basil Joseph Barham, Birkbeck Bank-chambers, Southampton-buildings, London.

5781. Improvements in or relating to aerial and other electrical conductors. Gerald William Partridge and Philip Dawson, 46, Lincoln's-inn-fields, London.

5783. Improvements in and relating to incandescent electric lamps. John White Howell, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, March 16, 1907, being date of application in United States.) (Complete specification.)

MARCH 16.

5829. Improvements in electric arc lamps. Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London.

5859. Improvements relating to alternating electric current relays. John Daniels Taylor, 2, Norfolk-street, Strand, London. (Date applied for under Section 91 of the Act, April 18, 1907, being date of application in United States.) (Complete specification.)

5860. Improvements in and connected with electric transformer switches. Joseph Peter Annacker, 55, Chancery-lane London.

5879. Improved automatic electrical switch. Oscar Gerhardt, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 18, 1907, being date of application in Germany.) (Complete specification.)

MARCH 17.

5916. Improvements in or relating to securing windings in the grooves of electric machines. Otto Titus Bláthy, 111, Hatton-garden, London. (Complete specification.)

5950. Improvements in the means of coupling electrical conduits. Barton and Sons, Limited, Alfred Barton, and Arthur James Harper, 77, Colmore-row, Birmingham. (Complete specification.)

5972. Electric lantern for cycles, motor cycles, and the like. Alexander Wiigh, 322, High Holborn, London.

5974. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

MARCH 18.

5996. Improvements in brackets for supporting electric light globes and the like. Joseph Pinson and Philip Henry Bibby, 5, Corporation-street, Birmingham.

6003. Improvements in electric meters. Albert Horstmann and the Horstmann Gear Company, Limited, 13, Union-street, Bath.

6029. Improvements in and relating to the refining of steel in electric furnaces. Company Bismarckhütte, 73, Cheapside, London. (Date applied for under Section 91 of the Act, Sept. 16, 1907, being date of application in Germany.) (Complete specification.)

6050. Improved process for hardening tantalum. Siemens und Halske Aktiengesellschaft, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 26, 1907, being date of application in Germany.) (Complete specification.)

6051. Improved process for hardening tantalum. Siemens und Halske Aktiengesellschaft, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 26, 1907, being date of application in Germany.) (Complete specification.)

6054. Improvements in accumulator plate connections or bridges. Walter Vernum, Beechwood-gardens, Caterham Valley, Surrey.

6059. Improvements in or relating to suspension devices for electric lamps. Réné Baron, 111, Hatton-garden, London.

6065. Improvements in and relating to methods of working in power installations and apparatus for use in connection therewith. Sebastian Ziani de Ferranti, 18, Southampton-buildings, London.

MARCH 19.

6079. Improvements in electric fuses for blasting and like purposes. Albert John Jordan, 3, Brown-street, Manchester.

6082. Improvements connected with electric trolleys. John Brown, 4, Clayton-square, Liverpool.

6101. Teaching instrument for wireless and other telegraph operators. Frederick John Chambers, Christ College, Brecon, South Wales. (Complete specification.)

6105. Improved means for ozonising air. Siemens Bros. and Co., Limited, Queen Anne's-chambers, Broadway, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

6119. Improvements in dynamo-electric generators. Joseph Erpelding, 55, Chancery-lane, London.

6149. Improvements in electric switches. George Henry Sykes, 53, Chancery-lane, London. (Complete specification.)

6173. Improvements in telephone systems for fire hose Harry Groswith, 28, New Bridge-street, London. (Complete specification.)

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6157. Improvements in apparatus for the electric ignition of large internal-combustion engines. The firm Robert Bosch, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Sept. 16, 1907, being date of application in Germany.) (Complete specification.)

6170. Improvements in brush-holders for dynamo-electric machines. John Herbert St. Hill Mawdsley, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on April 2.)

1907.

5339. Quick-acting "make-and-break" electric switches. Leitner.

5508. Alternating electric current motors of the commutator type. Lamme. (Date applied for under International Convention, Aug. 2, 1906.)

5522. Electromagnetic separator drum for grain and similar conveyors. James Hawley, Limited, and Jones.

5561A. Concatenated control of alternating-current motors. Mershon. (Date applied for under Rule 13, March 7, 1907.)

5652. Alternate-current motors also capable of use as generators. Fynn.

5853. Wireless telephony. Skinacker and Plisnier.

5982. Vehicle with collapsible pole for radio-telegraphy. Solari.

6064. Bow trolleys or collectors for electric railways and tramways. Brecknell, Munro, and Rogers, Limited, and Munro.

6083. Electromagnets. Morris and Lister.

6224. Protective fuses for use on electrical circuits. Handcock, Dykes, and Smith.

6729. Electric telegraphy. Kitsee.

6288. Electric trembler coils and contact breakers. Metcalfe.

6409. Electric lighting of railway and other vehicles. Sir W. G. Armstrong, Whitworth, and Co., and Honner.

6417. Electrical ignition apparatus. Torrens.

6847. Dynamo-electric machines. Johnson-Lundell Electric Traction Company. (Lundell.)

6869. Automatic time controller for targets, cameras, electric signs, and the like. Burnup and Kirk.

7933. Electric transmission of power from a prime mover for automobiles and other purposes. Archibald.

8764. Controlling devices for electric motors. British Thomson-Houston Company. (General Electric Company.)

9652. Electric switches. Watson.

9683. Voltage regulators. Storer.

9962. Electrically-operated signals. British Thomson-Houston Company. (General Electric Company.)

10440. Microphones for telephones. Browne.

11594. Control of electric motors for driving rolling mills. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, May 21, 1906.)

12529. Inductive telegraphy and telephony. Maiche. (Date applied for under International Convention, May 30, 1906.)

15505. Folding electric light bath cabinet. Holmquist.

15636. Automatically-operated station indicators for electric railways. Daley and Daley.

17690. Space telegraphy. Stone. (Date applied for under International Convention, Aug. 3, 1906.)

19274. Receivers for wireless telegraphy. Eisenstein.

21173. Automatic switches for use in electric circuits. Siemens Bros. Dynamo Works, Limited. (Siemens-Schuckertwerke Ges.)

23037. Alternating electric current motors. Conrad. (Date applied for under International Convention, Nov. 3, 1907.)

23098. Manufacture of electric incandescent lamps. Schott und Carl-Zeiss-Stiftung. (Date applied for under International Convention, Nov. 5, 1906.)

23225. Arc lamps. Timar and Von Dreger. (Date applied for under International Convention, Sept. 6, 1907.)

26081. Electric meter for direct current having a permanent magnet and an armature oscillatory in the field thereof. Meyerling. (Date applied for under International Convention, Nov. 23, 1906.)

27232. Ampere-hour meter provided with an armature rotating in the field of a permanent magnet. Meyerling. (Date applied for under International Convention, April 19, 1907.)

28425. Electric measuring instruments. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Jan. 2, 1907.)

28542. Electrical induction furnace. Hiorth. (Date applied for under International Convention, Jan. 4, 1907.)

1908.

660. Multiple-rate electricity meters. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Jan. 11, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-⅝
—— Ord., 1,125,000	1	..	½-⅝
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	11/ 6-3/16
—— Ordinary, Nos. 1 125,000	1	..	3/16 5/16
British Aluminium Co., Ordinary, 2 001-40,000	5	..	3⅝-4¼
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4⅜ 4⅝
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4¼-4⅜
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3⅝ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100 103
—— 5½ per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	97 100
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6⅞ 7¼
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅝ 6¼
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	86 91
British Westinghouse Elec and Manuf. 10 per cent Pref., 275 001-475 000	3	..	½-⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	3/16-7/16
—— 4½ per cent 1st Debenture Stock	100	..	77-80
—— 4½ per cent. 2nd Debenture Stock	100	..	63-66
Callender's Cable, Debentures	100	..	106-108
—— Ordinary	5	..	1 ⅜ 1 ½
—— 5 per cent. Pref.	5	..	5⅜-5¼
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	5	..	1¾-2
—— 5 per cent Debentures	100	..	94-96
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1 1/16-1 5/16
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Edison and Swan United, "A" Shares, 1-39 261	5	..	¾-1
—— "A" Shares, 01-017,139	5	..	1¼-2¼
—— 5 per cent. Debentures	100	..	87-90
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112,100	2	..	¼-½
—— 7 per cent. Cumulative Pref.	2	..	1¼-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100	..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅞-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	89-92
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½ xd
—— 4½ per cent. Preference	5	..	4⅜-½
—— 4½ per cent. Debentures	100	..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10	..	15⅛-15⅝
—— 4 per cent. Debentures	100	..	99-101
National Electric Construction Co., 1-170,000	1	..	7/16-11/16
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	31-33
—— 4 per cent. Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4⅝ 5¼
Bournemouth and Poole, Ordinary	10	..	11¼-12¼
—— 4½ per cent. Cum. Pref., 7 501-15 000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15 001-22,500	10	..	10-10⅜
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Bromley (Kent) Electric Light and Power Co.	5	..	4⅜-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-99
Brompton and Kensington, Ordinary	5	..	7¼-7½ xd
—— 7 per cent. Preference	5	..	6⅞-7⅛ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6⅞ 7¼
—— Nos. 80,000-100,000	5	..	6⅞ 7⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	93 97
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	4-4¼ xd
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	4¼-4⅜
—— 4 per cent. Debenture Stock, Red.	100	..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4¼-4⅜
—— ditto (1903) 40,001-80,000	5	..	4¼-4⅜
Chelsea Electricity Supply	5	..	3¼-3⅜ xd
—— 4½ per cent. Debentures	100	..	103-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	11½-12¼
—— 5 per cent. Debenture Stock	100	..	122-125
—— 4½ per cent 2nd Deb. Stk., Red.	100	..	101-104
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Coriolot Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-93
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3-3⅜ xd
—— 5 per cent Preference, 1-50,000	5	..	4¼-4⅜ xd
County of London Elec. Supply, Ordinary	10	..	7⅞-8¼
—— 6 per cent. Cum Pref.	10	..	11-11½
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	104-109
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	97-100
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	⅛-¼
—— 6 per cent. Cum Pref.	5	..	⅛-¼
—— 4½ per cent. First Mort. Deb.	100	..	60-70
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	72½-75½ p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm Pf., 1-30,000	5	..	2½-2⅝
—— 5 per cent Debenture Stock, Red.	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	91-94
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4⅜-½
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100	..	91-97
Hove Electric Lighting, Ord., 1-13,000	5	..	6¼-6⅝
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	97-100
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	⅜-½
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	..	7¼-8⅜ xd
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	99-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1½-1⅝ xd
—— 6 per cent. Pref.	5 ..	4½-5 xd
—— 4 per cent 1st Mortgage Debenture Stock, Red....	100 ..	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	92-95
Metropolitan Ordinary, 100,001-.00,000	5 ..	5-5½ xd
—— 4½ per cent. First Mortgage Debenture Stock.....	100 ..	107-111
—— 4½ per cent. Cum. Pref.	5 ..	4⅝-5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1 4,400 ,$1 000	— ..	75½-7⅞ p.c.
Mexican Light and Power Co., Capital Stock	$100 ..	51½-53½
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	84-86
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	5⅛-5¼ xd
—— do., 57,010-75,000	5 ..	5⅛-5⅛ xd
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5 ..	5¼-5⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5¼-5⅜ xd
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)....	5 ..	5¼-5⅜ xd
Notting Hill Electric Lighting	10 ..	11½-12½
—— 4 per cent. First Mort. Deb. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅜ 6¼ xd
—— 4 per cent. Debenture Stock	100 ..	93-96
River Plate Electricity Co, Ord., 1 119 687 & 120,501-120 507	1 ..	13/16-15/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red	100 ..	96 98
Rosario Electric Co 6 per cent Cum Pref., 1-20 000	5 ..	4⅜ 5⅛
—— 6 per cent Cum 2nd Pref., 1-15 000	5 ..	4⅜ 5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co, 5 p.c. Cons 1st Mt. Bds.	— ..	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	½-1½
—— 4 per cent. Debenture Stock	100 ..	70-74
South London Ordinary	5 ..	2⅜-2⅝
South Metropolitan Electric Light and Power, Ord.	1 ..	⅝-¾
—— 7 per cent Cum Pref.	1 ..	1⅛-1⅜
—— 4½ per cent 1st Mort. Deb.	100 ..	101 104
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7½-8½
—— 7 per cent. Pref.	5 ..	6½-7
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1½-2¼
—— 5 per cent. Cumulative Preference, 50 001 80,000....	5 ..	2-2½
Westminster, Ordinary	5 ..	7½-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 .	5-5½

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260 00'	5 ..	6-6¼
—— 10 per cent. Non-Cum 2nd Pref., 260,008-280 007 ..	5 ..	8-8¼
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	129-132
Auckland Elec Trams, 5 p.c. 1st Mor. Deb. Stk, Red.	100 ..	104-107
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1-10 000	10 ..	—
—— 5 per cent Deb., Red., 1 000	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-100,000	1 ..	⅛-¼
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1 ..	13/16-15/16
Birmingham and Midland Trams., 4½ p.c 1st Db. Stk, Red.	100 ..	93-96
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent Cum. Pref.	10 ..	9⅜-10¼
—— 4½ per cent. Deb. Stock, Red.	100 ..	96-97
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3¾-4⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜ 5
—— 4½ per cent Deb. Stk, Red., Prov Certs. all pd ..	100 ..	97-101
British Columbia Electric Railway Co., Old Def.	100 ..	127-130
—— Ord. Pref.	100 ..	108-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	105 109
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	101-104
—— 4½ per cent. Vancouver Power Deb.	100 ..	100-103
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10 ..	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	4-4¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	97-100
—— 4½ per cent 2nd Deb. Stock	100 ..	72-76
Bueno Ayres and Belgrano Trams	5 ..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27 500	5 ..	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110-116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	96-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100 104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	100-104
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	92 95
Calcutta Tramways, Ord., Nos 1-137,610	5 ..	6⅜-7⅛
—— 5 per cent. Cum. Pref., Nos. 1 50 000	5 ..	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	101-105
Cape Electric Tramways, Nos. 1-480,000	1 ..	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4⅜-7⅛
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	98-101
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5 ..	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red 1985	100 ..	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	89-93
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60 000	10 ..	12¼-13¼
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red..	100 ..	97-100
Havana Electric Railway Consolidated Mort 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	80 85
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-50,000	5 ..	⅝-1⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref....	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296 500 2nd Mort. Deb. Stock	— ..	—
—— £83,'30 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188....	1 ..	⅛-¼
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 ..	⅛-¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100 ..	81-85
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.....	100	96-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635 ....$1,000 ..		86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436 25 000	5 ..	4⅛ 5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-98
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1 ..	1/16 3/16
—— 5 per cent. Cum. Pref., 500,001-1,000 000	1	⅜-⅝
—— 4½ per cent. Deb. Stock, Red.	100 ..	96-98
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	82¼-84½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926, 1-5,500 and 7,001-8,000 .....$1,000 ..		103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 501-2,000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	½-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8½-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	⅛-¼
—— 5 per cent. Cum. Pref., 300,001-545 000	1 ..	7/16-11/16
—— 4½ per cent Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4½-5
—— 6 per cent. Cum. Pref., 1-10,000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-20,000	5 ..	5-5⅛
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	96-98
Sao Paulo Tramway, Light, and Power Co. .....$100 ..		121-126
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000 ...$500 ..		95-97 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.....	1 ..	⅞-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100 ..	78 82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100 ..	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5 ..	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3-3¼
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	65-68
—— 4 per cent. Pref.	100 ..	82-84
—— " " deferred	100 ..	42-45
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid) ..	100 ..	100-103
City and South London, Consolidated Ordinary	100 ..	37-39
—— 4 per cent Debenture Stock	100 ..	101-104
—— 5 per cent. Pref. Stock '91	100 ..	113-116
—— " " " '96	100 ..	112-115
—— " " " '01	100 ..	110 113
—— " " " '05	100 ..	106-109
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10¼
—— Ordinary, 1-50,000	10 ..	3⅜-4⅜
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	— ..	40-44
—— Deposit Receipts	— ..	40-44

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000 .....$1 000 ..		85 87
Anglo-American Telegraph Co., Ordinary	100 ..	54-57
—— 6 per cent. Preferred Ordinary	100 ..	97-99
—— Deferred Ordinary	100 ..	13⅜-13⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	98½-101½
Chili Telephone Co., 1-44 000	5 ..	7-7½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red..	100 ..	87-90
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	7-8
—— 10 per cent Preference, 1-6 000	10 ..	16-17
Direct Spanish Telegraph Co., Ordinary	5 ..	3⅛-3⅜
—— 10 per cent. Cum. Preference	5 ..	8½-9½
—— 4½ per cent. Debs., 1 000	50 ..	99½-102½
Direct United States Cable Co.	20 ..	13⅜-14⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	98-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	99-101
Eastern Extension, Australasia and China, 1-300,000	10 ..	12⅜-13¼
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	99-102
Eastern Telegraph Co., Ordinary Stock	100 ..	130-135
—— 3½ per cent. Preference Stock	100 ..	83-86
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-103
Great Northern Telegraph Co. (of Copenhagen)	10 ..	31-33
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs., within 1-1,200, Red.	100 ..	93-101
Indo-European Telegraph Co.	25 ..	54-57
Marconi's Wireless Telegraph Co., Nos. 256,128-284,180.....	1 ..	7/16-9/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	..15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	— ..	⅛-¼
National Telephone, Preferred	100 ..	106-108
—— Deferred Stock	100 ..	107¼-108½
—— 6 per cent. Cum. First Pref.	10 ..	10-12
—— 6 per cent Cum. Second Pref.	10 ..	10-12
—— 5 per cent. Non Cum. Third Pref.	5 ..	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-99
—— 4 per cent. Deb. Stock, Red.	100 ..	101-103
Oriental Telephone and Electric Company	1 ..	1 3/16-1 5/16
—— 6 per cent. Cum. Pref.	1 ..	1 3 32-1 7/32
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6-6½
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅜-5⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10¼
West Coast of America, 1-30 000 and 53,001-53,008	2½ ..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph ..	100 ..	98-101
West India and Panama Telegraph Co., Ordinary	10 ..	⅛-¼
—— 6 per cent. Cum. 1st Preference	10 ..	8-8½
—— 6 per cent. Cum 2nd Preference	10 ..	8-8½
—— 5 per cent. Debs., Red., 1-800	100 ..	100-103
Western Telegraph Co., 1-207,930	10 ..	13⅛-13⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	98½-101½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Mar. 18	1,154	1,163	- 29	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 21	178	179	- 1	—	8	8	,, 15	15,283	3,603,789	378,834	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 21	3,025	2,220	+ 805	+ 8,794	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 22	955	954	- 19	+ 502	23·53	23·53	March 31	55,408	11,686,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 14	6,336	5,442	+ 894	—	56½	56½	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 18	976	887	+ 89	+ 3,783	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 12	378	366	+ 12	- 1,142	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct. 26	311	279	+ 32	- 1,139	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	Mar. 22	2,065	2,139	- 74	+ 6,624	42	42	March 31	111,294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 18	1,429	1,351	+ 78	+ 2,379	29¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 14	4,188	3,993	+ 195	+ 5,559	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 22	659	758	- 99	- 3,345	17·191	17·191	,, 31	50,652	10,759,310	1,798,505	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 20	4,324	4,683	- 359	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 21	1,107	1,128	- 21	—	19¾	19¾	,, 31	62,699	11,967,498	1,205,830	1·31	12 48	5,825	8·21
Burton Corporation	,, 22	225	254	- 29	- 696	9⅞	8½	,, 31	15,576	3,383,527	421,317	1 07	8·87	1,768	6·14
Cardiff Corporation	,, 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	,, 21	133	148	- 15	+ 68	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 21	6,033	6,129	- 96	- 2,963	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,357	55·22a
Charing X, Euston, & Hamp. Ry.	,, 21	3,160	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway.	,, 22	3,297	2 728	+ 569	+ 4,089	9	6½	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	Feb. 26	160	151	+ 9	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	Mar. 19	415	448	- 33	- 269	15¼	15¼	Dec. 31	25,032	5,966,364	891,998	—	6·74	—	4·78
Croydon Corporation	,, 20	1,199	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 20	217	235	- 18	- 83	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1,124	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	Mar. 20	111	101	+ 10	+ 35h	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 20	5,034	4, 97	+ 36	+ 2,079	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 18	1,046	—	—	—	22	22	May 15	57,672	15,554 905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	,, 21	822	871	- 49	+ 347	14	14	March 31	47,140	15,049,240	1,062,151	·74	10·49	3,636	7·14
Glasgow Corporation	,, 21	16,750	17, 00	- 350	+18,034h	177½	169	May 31	887,381	224,063,088	20,350,367	95	10·47	5,035	5·21
Gloucester Corporation	,, 13	203	211	- 9	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 21	5,430	3,885	+1,545	+19,421	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,996	18,899,242	1,624 275	—	11·52	—	8·65
Huddersfield Corporation	,, 21	1,443	1,471	- 28	+ 3 269	35½	35	,, 31	81,196	15.252,150	1.804.745	1·22	10 79	2,770	5·92
Hull Corporation	,, 21	2 350	2,353	- 3	+ 6,847	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 14	391	414	- 23	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 18	121	124	- 3	+ 427	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	Feb. 26	251	228	+ 23	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1,723	4 95
Lancashire United Tramways	Mar. 18	1,098	1,113	- 14	+ 992	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 14	6 090	5,952	+ 138	+12,959	96½	96½	March 31	327,794	73,024,853	7,358,185	1 06	10·69	3,352	5 58
Leicester Corporation	,, 21	1,990	2,090	- 100	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 14	10,354	10,498	- 144	+ 687	104	104	Dec. 31	563,793	122,094,528	12.115,934	1 108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 22	1,393	1,371	+ 28	+ 48h	9·25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 7	29,954	27,731	+2,223	+237,004	98	98	March 31	1378,014	314,227,090	30 130 297	1·05	10 98	—	8 56
Lowestoft Corporation	,, 21	130	132	- 2	+ 161	3½	—	Sept. 30	11,009	2,622,922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 19	141	96	+ 45	—	3¼	2	March 31	5,913	1.186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 21	13,652	13.552	+ 100	+744,024	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 21	8,777	7,858	+ 919	+10 957	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 22	15,001	14,491	+ 510	+ 1,9.6	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 21	126	127	- 1	- 45	2¾	2¾	March 31	7,309	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation.	,, 21	3,569	3,966	+ 391	- 22	59⅛	57½	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 21	568	618	- 50	+ 2.035	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10 01	1,525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·259
Portsmouth Corporation	Jan. 18	1,470	1,416	+ 54	—	28½	28½	,, 31	98,911	20,668,825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,661	8,130,179	918,825	·96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10·45	2,691	7·38
Salford Corporation	Mar. 16	4,185	4,238	- 53	+ 6,859	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7·01
Sheffield Corporation	,, 22	5,118	5,487	- 369	+11,232	65¼	65¾	March 25	276,907	73,966,299	6,804,656	·898	9 767	4,174	5·94
Southampton Corporation	,, 18	854	822	+ 32	+ 3,342	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 18	263	257	+ 6	+ 227	9	9	,, 31	20,076	4,431,728	390,578	1 07	12·33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9·464	—	4·849
Sunderland Corporation	,, 22	1,067	1,318	- 291	- 3.156	20	20	,, 31	72,396	17.483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 19	180	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 21	699	825	- 124	+ 654	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965,296	429 785	—	10·724	1,989	6·95
West Ham Corporation	,, 12	2,116	2,087	+ 29	+ 2,161	14·7	14·7	,, [31	122,881	35,502,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 18	739	779	- 40	+ 569	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·095

* 1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE

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All communications intended for the Editor should be addressed C. H. W BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE INSTITUTION OF CIVIL ENGINEERS.

In our correspondence columns this week there is a letter signed by two corporate members of the Institution of Civil Engineers calling attention to a proposed alteration of Clause 6 in Section 5 of the by-laws. This alteration is to be discussed, and perhaps approved or rejected, at the special general meeting of corporate members of the institution to be held to-day. The existing buildings of the institution, which are comparatively new, occupy a site which is required by the Government for the extension of the Government offices in Whitehall. Hence the first business before Friday's meeting will be in the form of a resolution to authorise the council to enter into an agreement for the sale of the institution premises to H.M. Government. It is proposed to erect new buildings for the institution on an adjacent site, and we gather that the sum to be paid by the Government will be insufficient to cover the cost of these new buildings. The alteration of the by-law referred to above has for its object the increase of the entrance fees to all full members of the institution; new members elected will, if the by-law is amended, have to pay twenty guineas entrance fee instead of ten. Again, associate members, on being transferred to full membership, will have to pay a further sum of ten guineas. The Institution of Civil Engineers is without doubt the most influential association of engineers in existence. Formed early in last century by Thos. Telford, its object was then stated to be "for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in Nature for the use and convenience of man." This it has achieved, and its success is due to the fact that all civil engineers who have qualified by work and experience have been freely admitted to membership. The move made some years ago by which new associate members have to qualify by examination as well as by practical experience, restricted the membership by keeping out a large number of practical men who cannot find time to qualify by examination. The alteration in the by-laws now proposed will again tend to reduce the membership, as twenty guineas is a heavy entrance fee. We think that the council of the institution would be better advised if they raise the necessary building fund by voluntary subscriptions in the same way that the Institution of Electrical Engineers have done, otherwise the impression will spread that the Institution of Civil Engineers seeks to confine the advantages of membership and to form a close corporation. Such an important change in the by-laws might well be discussed only at the meeting held to-day, and the voting on it deferred till the country members have had more opportunity of considering the matter.

THE ELECTRICAL ENGINEERS.

The new army regulations which came into force this week, and which have resulted in some alteration in the designation, the status, and the duties of the Volunteer—or, as they are now known, the Territorial forces—have likewise effected some change in the Electrical Engineers' Corps commanded by Colonel R. E. B. Crompton. Henceforth this corps will simply be known as "The Electrical Engineers," and the additional duties which have been allotted to it include coast defence work, ballooning, cable and wireless telegraphy. The usefulness of this efficient corps in actual warfare, as demonstrated in the Boer War and in other directions, has been officially recognised, and it is not to be wondered, therefore, that the War Office

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authorities should seek to still further increase the sphere of its usefulness. In future we are likely to witness divisional corps of the Electrical Engineers in most of the important provincial centres, and to Birmingham belongs the honour of being the first district to take practical steps for the establishment of such a corps under the new regulations. As will be seen from an announcement in another column, the County Association of Warwick is co-operating with the Birmingham Local Section of the Institution of Electrical Engineers to give effect to this scheme, and we would like to draw the attention of our readers in the Birmingham district to the arrangements proposed, which might also serve as a stimulus and guide to other local sections. Those who wish to have their names submitted as possible candidates for commissions, or for service in non-commissioned ranks, should communicate without delay with Mr. H. B. Matthews, the hon. local secretary, Winchester House, Victoria-square, Birmingham, who will give much fuller particulars respecting the conditions of service, etc., than we can possibly give here. The Birmingham Local Section is to be congratulated on being the first to take active steps in the formation of a division of the Territorial Army. We believe that the Manchester Local Section has had the matter of the formation of a division in its district under consideration for some time, and we should like to hear that actual steps are being taken, not only in the Manchester district, but in every district which boasts a local section of the Institution of Electrical Engineers.

PRODIGIOUS.

It is not held by connoisseurs of what good conduct ought to be to give a flat contradiction to any statement made in good faith. The latest marvel, however, causes us to say with a celebrated character in fiction—prod*ee*gious, with the Scottish pronunciation. We are never astounded as to what we are told electricity is to do, but it makes us gasp to read that a Scotchman has discovered or invented a gun, actuated electrically, by which a 2,000lb. projectile is given an initial velocity of 50,000ft. a second. Inventors claim many things. They do not intentionally mislead, but give free rein to their imaginations, and their imaginations play pranks. Colonel Maude, however, is a military writer of some repute, and, we presume, has some connection and some knowledge of the elementary problems of mechanics. Assume for a moment that this wise inventor can do what it is said he can do, although till we know more about the method we beg leave to remain unbelievers. Still, assume the initial velocity, we are told there is nothing to prevent these weapons from throwing shells from London to Paris and *vice versâ*. Will Colonel Maude, or the inventor, or someone who knows tell us how far an aerolitic projectile of the substances ordinarily used would pass through the air at the velocity named before being dissipated in molten drops. It is hardly scientific to assume that when the resisting medium is increased four hundred times the heating will not be affected. Tell us, Colonel Maude, what is the rise in temperature of a projectile with a velocity of 2,500ft. per second through air? Then he will know the temperature at twenty times the rate with the resistance four hundred times greater. Electricity is a wonderful thing, but it cannot do everything that the mind of an imaginative man imagines.

ALL-BRITISH CABLES.

The Board of Trade of Ottawa, which celebrates its jubilee this year, is signalising the event by a further effort to bring about the completion of the scheme for a complete system of British-owned cables to connect, telegraphically, the several groups of self-governing British communities in Europe, America, Australasia, Asia, and Africa. The proposals include the laying of a cable from Cape Town to the United Kingdom, *vid* Ascension, the West Indies, and Bermuda, with a branch to Canada. This cable will form the fourth of four divisions of this "electric bond of Empire," the others being: (1) the United Kingdom to the Pacific, embracing a cable across the Atlantic and land lines through Canada; (2) across the Pacific from Canada to New Zealand and Australia, with land lines through Australia to the Indian Ocean; and (3) Australia across the Indian Ocean to South Africa, with a branch from Cocos Island to India. Of these the first has been regarded with much favour in Canada, the second is already an established fact, having been successfully carried out under a partnership arrangement between six British Governments—viz., the Home Government, the Canadian Government, the Governments of New Zealand, New South Wales, Victoria, and Queensland. In reply to an address on the subject presented to him by the Ottawa Board of Trade, Earl Grey, Governor-General of Canada, said that he was one of those who believed that the establishment of a State-owned "all-red" line would be a service of hardly less importance to the Empire than the establishment of the all-red route.

NEW ALTERNATE-CURRENT INSTRUMENTS.*

BY W. E. SUMPNER, D.SC., AND J. W. RECORD.

(Continued from page 438.)

INSTRUMENTS FOR PHASE MEASUREMENT.

Idle-Current Ammeter.—For constant-voltage circuits the wattmeter can be used as an idle-current ammeter. For single-phase circuits all that is necessary is to substitute for the quadrature transformer a non-inductive strip resistance, to which the moving coil is suitably shunted; or, alternately, an *ordinary* current transformer with a secondary coil of many turns short-circuited by the moving coil. For three-phase circuits it is only a matter of changing the connections of the potential leads; this is shown in Figs. 14 and 15. Fig. 14 shows the instrument as normally joined up to the mains, through a quadrature transformer, so as to read the watts of the circuit. By

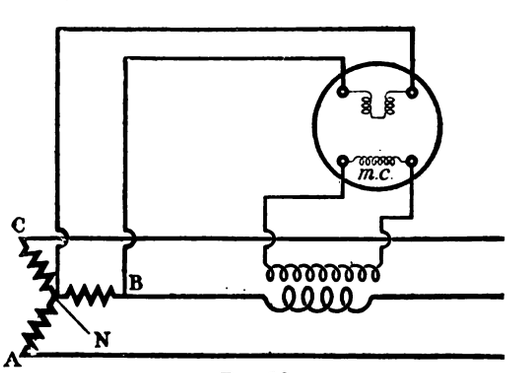

FIG. 14.

disconnecting the volt coil from N B and joining the lead to the points C A, the applied voltage is turned through 90deg. relative to the current, and for unity power factor loads the meter will read zero. For lower power factors the instrument will indicate V A sin ϕ, and may be calibrated to read the wattless current for the line voltage used.

Iron-Cored Phasemeters.—Phasemeters are instruments analogous with ohmmeters, and the theory of their working is similar and almost as simple. An ohmmeter contains a moving system, consisting of a magnetic needle, N, and a fixed system of two coils traversed by currents, A_1 and A_2, whose ratio is represented by the position of the pointer;

* Paper read before the Institution of Electrical Engineers.

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this deflection can thus be calibrated to indicate ohms or megohms. The currents, A_1 A_2, produce two magnetic fields, O F_1 and O F_2, usually, but not necessarily, at right angles, and the needle takes up the position corresponding with the resultant field, indicated by the pointer, O P (see Fig. 16). The calibration of the scale depends on the structure and winding of the coils, but for any given instrument is solely determined by the ratio of the currents,

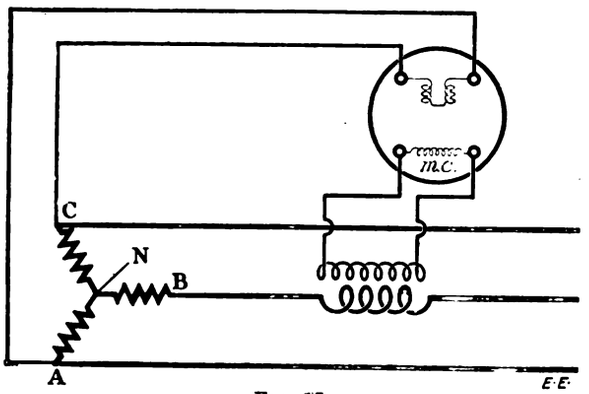

FIG. 15.

A_1 and A_2. If the currents are alternating and the strength of the needle, N, is also alternating, the position taken up will depend on the ratio of the two mean products, A_1 N and A_2 N, and this ratio will merely depend on the phase differences between A_1 A_2 and N, if the ratio of the R.M.S. values of A_1 and A_2 is constant, as is necessarily the case in a balanced multiphase system of currents. The phasemeter is merely an ohmmeter, having, in effect, an alternating magnetic needle, N, due to the flux caused by

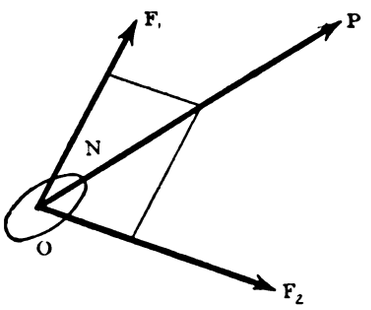

FIG. 16.

an alternating current traversing a moving coil, and having two alternating magnetic fields, O F_1, O F_2, in fixed directions (but not in in the same phase) due to the cyclic currents through its fixed coils. Usually a phasemeter consists of a fixed and moving system of coils, one system containing two coils, and the other only one. As regards the theory, it is immaterial whether the fixed or moving system is actuated by the main currents, provided the other system is actuated by the voltages; and it does not

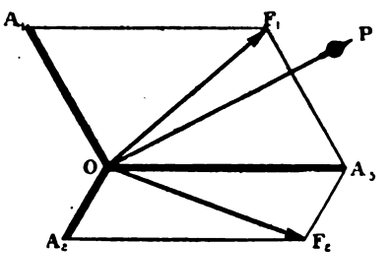

FIG. 17.

matter, in the case of either coil system, whether this system consists of one, two, or three coils, provided three or more coils in all are used for the two systems. The instruments here described have only one coil in the moving system, but contain three coils, C_1, C_2, C_3, in the fixed system, the latter being traversed by currents representing A_1, A_2, and A_3, the three currents of the three-phase mains. But these currents are necessarily such that one of them, say A_3, can always be regarded as the sum of the other two, so that the three coils, C_1, C_2, and C_3, just mentioned can really be regarded as only two coils, having a portion, C_3, in common, one of these coils being traversed by a current representing A_1 and producing the field O F_1, while the other is traversed by a current representing A_2 and producing the field O F_2. The directions O F_1 and O F_2 are approximately 90deg. apart, and this accounts for the total deflection of about 180deg. (90 for leading and 90 for lagging) to be found in

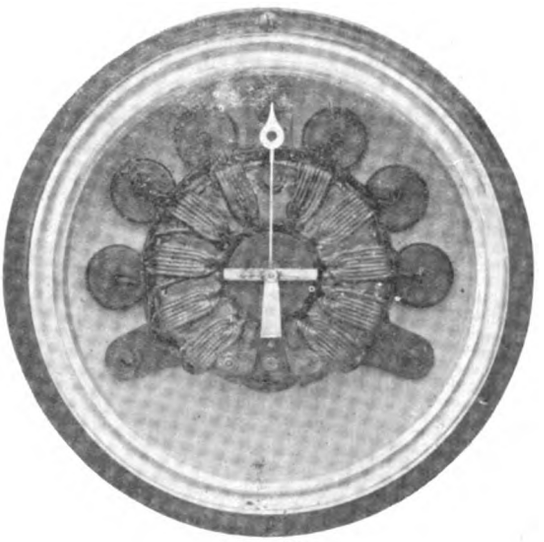

FIG. 18.

most phasemeters. The three fields due to a unit current in each of the fixed coils are fixed in direction, as shown by O A_1, O A_2, and O A_3 in Fig. 17. The lengths of these lines denote the strength of the field due to a unit current in each case, this strength being determined by the winding of the corresponding coil. O F_1 is the resultant of O A_1 and O A_3, while O F_2 is that of O A_2 and O A_3. The currents A_1, A_2, and A_3, which actually flow through the coils, can be regarded as two currents only. One of them, A_1, traverses the first and third coils, and produces a field always along O F_1, while the other, A_2, traverses the second and third coils, and produces a field always along O F_2. The analogy between the ohmmeter and the phasemeter will now be apparent. As is shown later, the fact that the reading of a phasemeter indicates a ratio can be advantageously used

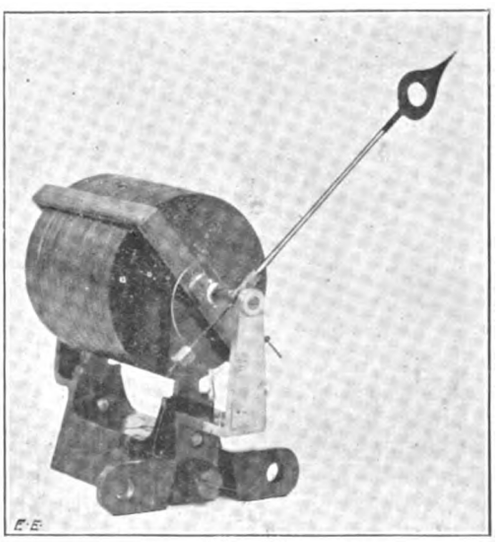

FIG. 19.

in the calibration of these instruments. The introduction of the iron-cored phasemeter is a new departure in power-factor meters, and its construction will be somewhat closely entered into. A view of the interior can be seen in Fig. 18. The field magnet resembles the stator of a three-phase generator built up with a number of iron laminæ, and wound as shown in Fig. 20. Instead of the rotor there is a fixed laminated iron core (Fig. 19). This core forms one circular boundary of an annular air-gap, about $\frac{1}{8}$in. across, between itself and the outer stator. In this

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air-gap swings a moving coil (Fig. 19), which is balanced and controlled by no other forces except those due to the interaction of the currents. The stator is wound for current, and for convenience is supplied from two series transformers, the primaries of which are traversed by two of the line currents. The moving coil has a high non-inductive resistance in series with it, and is placed in shunt across the mains. One mode of connection suitable for a three-phase circuit is shown in Fig. 21. Various arrangements of transformers, analogous to those stated in connection with the wattmeter, may be used with the phasemeter, but owing to the number of circuits in the instrument, and to the fact that resistances, transformers, or condensers may each be used with them, the number of possible combinations is so great that a mere summary

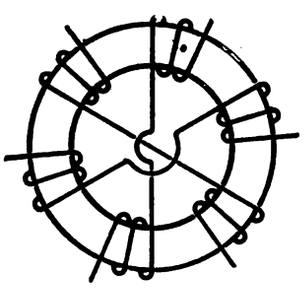

FIG. 20.

of them would take too long. Fig. 22 shows an arrangement for a power-factor meter suitable for connection to a constant frequency single-phase circuit. It will be noticed that the indicator itself is identical with that of the multiphase instrument. The stator has the same distribution of coils, but, in order to supply these coils with currents in suitable phase relation, a special transformer is necessary. This transformer, T (Fig. 22), is of the ordinary current type, with a connection, C, taken from the middle point of the secondary winding, A, C, B. C is joined to C of the phasemeter, and A and B are each joined to the corresponding terminals of the instrument, A through a non-inductive resistance, R, and B through an inductive resistance, I. The moving coil is joined through a suitable resistance either direct to the mains or to the secondary of a potential transformer whose primary is in shunt to the mains.

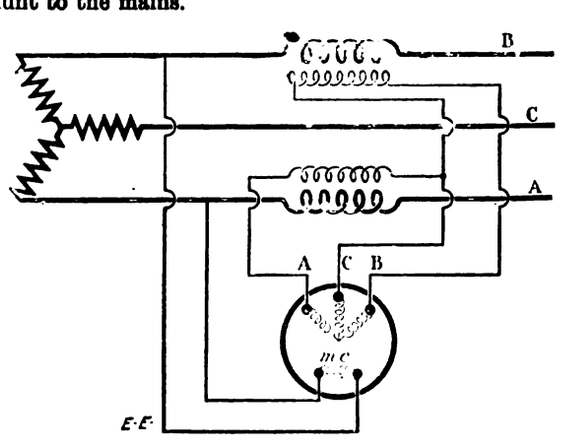

FIG. 21.

Voltage-Wound Phasemeters and Synchronisers.—A form of phasemeter is being developed having its stator coils wound for voltage and its moving coils for current, the latter being supplied either from a shunt or from a current transformer. Experiments are also being carried out on an instrument of the above type, which has been so constructed that the moving coil is free to revolve continuously in either direction. When these forms are fully developed it will be a simple matter, with the aid of a voltmeter switch, to quickly change the instrument from one alternator to another in a similar manner to that used for the wattmeter shown in Fig. 10; also by connecting the voltage windings to the 'bus bars, and the moving coil to the terminals of an incoming machine, the phasemeter will be converted into a synchroniser. It will indicate if the incoming machine is "too fast" or "too slow" by revolving either clockwise or anti-clockwise. When the pointer comes to rest the speed will be right, and by further regulation the pointer will turn and become stationary in the normal position, and this will indicate the correct moment for switching in.

CALIBRATION AND ACCURACY.

Wattmeters and Voltmeters.—A simple direct-current test is used to determine the wattmeter scale. The same method may be used for the voltmeter, since the scale markings in the latter case are proportional to the square root of the corresponding scale markings in the case of the wattmeter (see Fig. 13) The instruments are afterwards adjusted on an alternate-current circuit against a standard instrument; for a wattmeter by an adjustment of the resistance of the moving-coil circuit, and for a voltmeter by the choice of a suitable condenser, followed by a final adjustment of the spring. The scales prepared in this way have been found quite accurate for alternate-current circuits. The error of an instrument in actual working is frequently more due to extraneous influences, such as friction or disturbing fields, than to incorrect electrical action on the moving system. From such disturbing influences the present instruments are well guarded, owing to the strong controlling springs used and to the natural shielding due to the iron employed in their construction. Moreover, the deflection cannot be influenced by eddy currents, which may be induced in the iron case

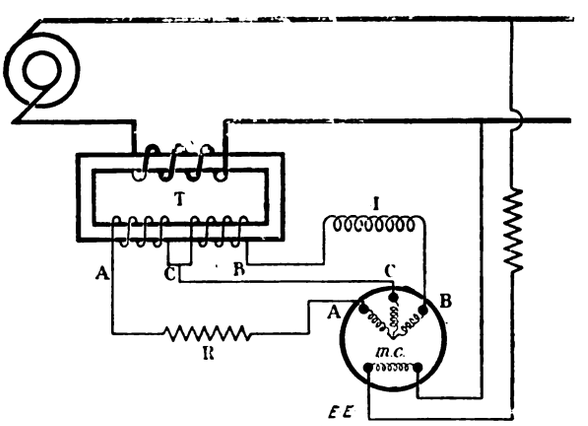

FIG. 22.

or other metal parts near the moving coil. Numerous experiments already published in the *Journal* have shown that the present instruments act correctly for changes in voltage, current, or frequency, and that the error for variations of power factor obeys the law applicable to all wattmeters, the error as a fraction of the true reading being given by $\theta \tan \phi$ where θ is a quantity characteristic of the instrument, and which may be conveniently called its *phase error*. In Table I. below the wattmeter error for a phase error of 1 per cent. of a radian ($\theta = 0{\cdot}01$) is expressed in three ways for loads of different power factors.

TABLE I.—Wattmeter Error for a Phase Error θ of 1 per cent.

Power factor, $\cos \phi$.	Per cent. of true watts, $100\,\theta \tan \phi$.	Per cent. of volt-amperes, $100\,\theta \sin \phi$.	Millimetres on scale.
1·0	0	0	0
0·9	0·48	0·43	0·55
0·7	1·02	0·71	0·90
0·5	1·73	0·87	1·10

In the second column the error is expressed as a percentage of the true watts. The third column shows the error as a percentage of the volt-amperes, or of the watts associated with the same current and voltage on a non-inductive load. The last column expresses the error as a shift of the pointer in millimetres on the scale, assuming that a deflection measuring 5in., or 127mm, denotes a power in watts numerically equal to the volt-amperes. For commercial purposes the error is sufficiently small if kept within a small fraction of the full deflection, and is always negligible if the corresponding shift of the pointer is within the error of reading under working conditions. In normal working full deflection is only attained for the circuit voltage at full-load current when the power factor is unity. The above table shows that if the

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phase error is 1 per cent., the error in the deflection is always less than 1 per cent. of the full deflection, however low the power factor, and that in nearly all cases it is less than 1mm. measured along the scale. The accuracy secured in the new instrument can be precisely indicated by the value of the phase error. In one of the portable standard instruments this value was only 0·0077 for 50-~ circuits, so that the corresponding errors are given by the numbers in Table I. when multiplied by 0·77. In one of the switchboard instruments θ was found to be 0·012 for 50-~ circuits, corresponding with the figures in Table I. when multiplied by 1·2. The error of the electromagnet is due to the phase error represented by the ratio of resistance to impedance of the field coil. This ratio is about 0·4 per cent. for 50-~ circuits. Two distinct ways have been found to precisely compensate the total phase error of the instrument for circuits of a fixed frequency. These methods have been amply tested and verified, bu they have not yet been embodied in the commercial instruments. The voltmeter is naturally less subject to error than the wattmeter, since the voltmeter is essentially the same as a wattmeter used on circuits of fixed power factor equal to unity. The deflection for a given voltage for a range of frequency of 3 to 1 does not vary as much as 0 5 per cent. In confirmation of the above statements the tests indicated in Table II. are given. They relate to a comparison of one of the iron-cored wattmeter, I.C.W., with a standard Mather-Duddell instrument, M.D.W. The current, A, was passed through (1) the current coil of the M.D.W., (2) the quadrature transformer of the I.C.W, and (3) a non-inductance load of lamps. It was obtained from a pair of slip-rings of a small rotary converter run from the direct-current side, the voltage, V_1, being approximately in phase with A. Another pair of slip-rings gave a voltage approximately in quadrature with V_1. These were joined to the primary of an equal ratio transformer, the secondary voltage, V_2, of which was about equal to V_1 in magnitude and also approximately in quadrature with it. Since the voltages V_1 and V_2 were electrically separate, they could be joined in series to produce a voltage, V, differing in phase from A by about 45deg. By means of a reversing switch V could be made either the vector sum or the vector difference of V_1 and V_2. In the former case the voltage V was leading and in the latter case was lagging in reference to A. The pressure coils of the two wattmeters were put across mains at voltage V. The wattmeters were read carefully, and observations were taken alternately for leading and lagging voltages. The watts were obtained from the readings of the M.D.W. which had been previously standardised on a non-inductive load, using the same ammeter and voltmeter as were afterwards employed for the tests in Table II.; the power factor cos ϕ being obtained from the readings of the same instruments. The frequency of the circuit was 51 ~.

TABLE II.

Voltage.	V.	A.	M.D.W.	I.C.W.	Watts.	Cos ϕ.	Tan ϕ.
V_1+V_2	120	19 8	66·6	65·4	1,550	0·652	—
V_1-V_2	119	18 8	65·2	65 0	1,515	0·676	—
V_1+V_2	122	19·4	66·3	65 0	1,540	0 650	—
V_1-V_2	121	18·7	65 2	65·2	1,515	0 670	—
V_1+V_2	—	—	66·45	65·2	—	0 651	+1·167
V_1-V_2	—	—	65·20	65·1	—	0·673	−1·099

The numbers given in the last two lines are the means of the tests for leading and lagging voltages. From these it appears that the readings of the M.D.W. corresponding with a reading of 65·2 of the I.C W. in the two cases are 66·45 and 65·30. Hence, if the phase error is θ, we have

$$\frac{66{\cdot}45}{65{\cdot}30} = \frac{1+1{\cdot}167\ \theta}{1-1{\cdot}099\ \theta},$$

and the value of θ works out to be 0·77 per cent. Such value compares well with that calculated from the data of the wattmeter. The ratio of the resistance of the electromagnet winding to its impedance was measured as 0·385 per cent. at 50 ~ or 0·378 per cent. at 51 ~. The self-induction of the secondary of the quadrature transformer was 0·882 millihenry and the resistance of the moving-coil circuit 82 8 ohms, so that the ratio of reactance to resistance at 51 ~ works out to be 0·34 per cent. The sum of 0·378 and 0·34 is 0·72, comparing well with 0·77, the number measured. The quadrature transformer used was ironless, so that no allowance has to be made for any phase error due to hysteresis.

Phasemeters.—The theory and modes of calibration of phasemeters have been already discussed by one of the present writers (*Phil Mag.*, January, 1906, and it has been shown that the phasemeters in general are much more accurate instruments on balanced loads than they are usually credited with being; in fact, phasemeters for multiphase circuits, if properly calibrated, are all alike in normal action, and differ only in liability to disturbances. Various makes differ, not in electrical, but in mechanical properties. The actual errors arising in working are due to causes extraneous from the electrical action of the instrument, being due to friction when the deflecting forces are weak, or to the influence of stray fields, or to the want of balance of the circuit currents. In the instruments here described the moving coil is perfectly shielded by the iron, and if this coil is out of proper position the rectifying forces brought into action are strong, so that errors due to the first two causes do not arise. All phasemeters are equally subject to error when used on unbalanced loads. A similar error arises in measuring the power of a three-phase circuit by the single-wattmeter method. The error which arises from such want of balance is determined simply by the ratios of the three currents in the mains, and is not dependent on the instrument employed.

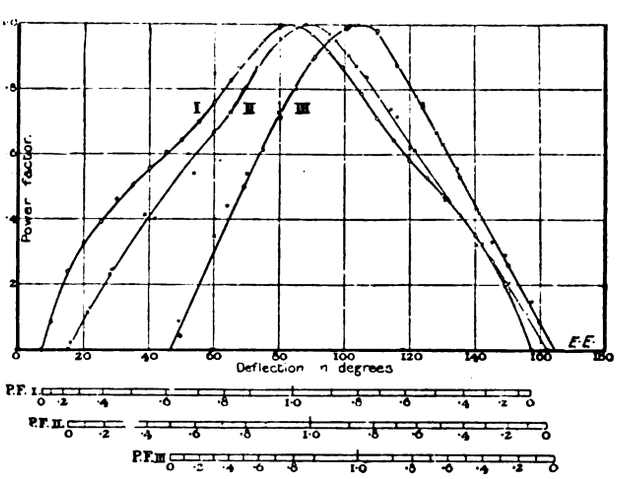

FIG. 23.

It is the same for all wattmeters and for all phasemeters, however good or however bad they may individually be. It is not serious except for low power factors and for badly balanced loads. In the design of the phasemeters here described a great deal of attention has been devoted to the production of suitable scales. Special difficulties arise in these instruments owing to the irregularities in the magnetic field due to the slots in the stampings bounding the air-gap. That these difficulties have been successfully overcome is shown in the curves of Fig. 23, connecting the deflection of the instrument (in degrees) with the corresponding value of the power factor. Three curves are shown for the same instrument for different modes of connection with the mains. In order clearly to separate the curves, these have been arbitrarily shifted along the scale of degrees. The shift of zero corresponding with Curves 1 and 2 is not known, because the scale of degrees was changed between the two calibrations, but as regards Curves 2 and 3 a reading of 140deg. for Curve 3 denotes the same position of the pointer and moving coil as one of 120deg. for Curve 2. The first two curves were obtained by the direct-current method, and the third by alternate-current tests. The field coils were the same, and were star connected in all three cases, but the most important of the three coils was joined up in one direction for Curve 1 and in the opposite direction for Curves 2 and 3. The calibration for Curves 1 and 2 was determined from measurements on the currents actually flowing through the instrument coils. Curve 3 represents

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the action of the instrument when the coil currents were produced from the secondary circuits of two very small experimental transformers, the primaries of which were traversed by two currents representing those in the main. The three scales of power factor, PF_1, PF_2, and PF_3, are shown at the bottom of the figure, and it will be seen that the scale markings corresponding with Curves 2 and 3 are regularly spaced. Numerous tests made at different times have proved that the alternate-current and direct-current modes of calibrating these instruments yield the same result. The tests shown by Fig. 23 are not given as any confirmation of this. The curves apply to the same instrument when connected to the mains in different ways. The tests for Curve 3 consisted of two sets of observations taken at frequencies of 80 and 50 cycles per second. These two sets of tests are distinguished by using different signs on Curve 3, and incidentally show that the action of the phasemeter is independent of frequency.

If reference be made to the paper on the "Theory of Phasemeters" (*Phil. Mag.*, January, 1906), it will be seen (from equations 3, 4, and 5 on pp. 84, 85), that if $\mathbf{A}_1$ and $\mathbf{A}_2$ are two of the currents through the windings of one system of coils of the phasemeter, and if $\mathbf{V}$ be the current through the coil of the other system, the forces on the moving system will be balanced for a deflection x when

$$\frac{\text{Mean product of } \mathbf{V}\,\mathbf{A}_1}{\text{Mean product of } \mathbf{V}\,\mathbf{A}_2} = \frac{\overline{\mathbf{V}\,\mathbf{A}_1}}{\overline{\mathbf{V}\,\mathbf{A}_2}} = \rho,$$

where ρ is a quantity which for any particular instrument depends solely upon the deflection x of the moving coil.

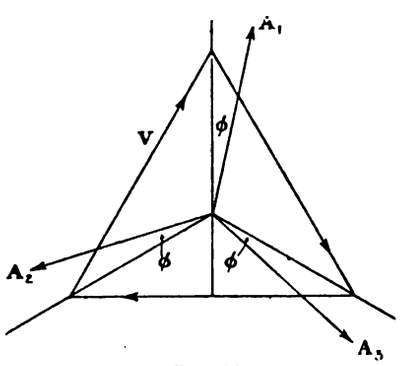

FIG. 24.

Thus the deflection of the pointer depends simply upon the ratio of the two watt products, $\overline{\mathbf{V}\,\mathbf{A}_1}$ and $\overline{\mathbf{V}\,\mathbf{A}_2}$. The phasemeter indicates power factor indirectly, but always measures by a single deflection the ratio of two watt products such as those frequently observed for the measurement of power factor from the readings of two wattmeters, or from successive readings of one such instrument. If there is any error in estimating the power factor from such a ratio, such an error will be common to all these methods, which are essentially the same except in the matter of relative convenience. Phasemeters, like ohmmeters, are instruments which really measure a ratio. So far as theory and calibration are concerned, it does not matter whether the main currents are those actually used in the instrument coils, or whether the latter are produced by the former through the operation of suitable transformers. If the transformers act correctly, there will always be a particular deflection for each value of the ratio $\overline{\mathbf{A}_1\,\mathbf{V}}$ to $\overline{\mathbf{A}_2\,\mathbf{V}}$; so that if the instrument circuits are connected up in the special way in which they are to be used in practice, the currents $\mathbf{A}_1$, $\mathbf{A}_2$ and the voltage $\mathbf{V}$ used for calibration purposes may be produced in any convenient manner for determining the scale. The most convenient method in practice is to take the currents $\mathbf{A}_1$ and $\mathbf{A}_2$ from two independent secondaries of a transformer whose primary is subjected to the voltage $\mathbf{V}$. It is easy to arrange for $\mathbf{A}_1$, $\mathbf{A}_2$, and $\mathbf{V}$ to be in essentially the same phase, and the ratio ρ is then simply that of the currents $\mathbf{A}_1$ and $\mathbf{A}_2$ as read by two ammeters. It only then remains to mark the deflection with the numerical value of the power factor corresponding with the ratio ρ observed. This value will be cos ϕ where ϕ is such an angle of lag in actual working that the line currents $\mathbf{A}_1$ and $\mathbf{A}_2$ and the moving-coil current due to the line voltage will correspond with the same value of ρ as that observed in the calibration tests.

The real calibration of the instrument consists in determining by any convenient method the ratio ρ corresponding with each deflection, x. The scale marking then depends on the interpretation to be given to ρ, and this interpretation will vary with the instrument connections, to the multiphase circuit, governing the magnitude and phase relations of the currents $\mathbf{A}_1$, $\mathbf{A}_2$, and the moving-coil current $\mathbf{V}$ in actual working. As an example, if $\mathbf{A}_1$ and $\mathbf{A}_2$ are the currents in two of the mains of a three-phase system, and if $\mathbf{V}$ is the voltage across these two mains applied through a high resistance to the moving coil of the phasemeter, then for balanced loads of power factor cos ϕ it will be seen from Fig. 24 that the ratio of $\overline{\mathbf{A}_1\,\mathbf{V}}$ to $\overline{\mathbf{A}_2\,\mathbf{V}}$ will be numerically that of cos $(30-\phi)$ to cos $(30+\phi)$ but opposite in sign. We shall thus have

$$-\frac{\text{Cos } (30-\phi_1)}{\text{Cos } (30+\phi_1)} = \rho_1,$$

where ρ_1 is the value of the ratio observed in the calibration test for the deflection x which is to be marked cos ϕ_1.

Again, if the above case be varied by applying the voltage $\mathbf{V}$ to the moving coil through a condenser instead of through a non-inductive resistance, the moving-coil current will be in quadrature with the voltage $\mathbf{V}$, and a little consideration will show that we then have

$$+\frac{\text{Cos } (60+\phi_2)}{\text{Cos } (60-\phi_2)} = \rho_2,$$

and the deflection x to be marked cos ϕ_2, is that corresponding with ρ_2 as given by this formula. From each such formula it is easy to plot a curve connecting cos ϕ with ρ, and this curve can be conveniently used in the calibration tests. In most of the cases likely to arise it will be found that one or other of the above two formulæ (with proper sign for ρ) is applicable to the calibration tests. Inverting the value of ρ merely amounts to changing the sign of ϕ, so that it is convenient to always make ρ less than unity by dividing the smaller by the greater of the two quantities, the ratio of which is ρ. It is always necessary to know when ρ is to be taken positive and when negative, and this can only be predicted from a careful consideration of the vector diagram in each case; but in actual calibration no difficulty arises, for unless the proper sign be attributed to ρ the values of cos ϕ read off from the curve are evidently wrong. The numbers given in Table III. below enable the curves connecting ρ with cos ϕ to be readily plotted for each of the above two formulæ. The curve for ρ_1 is well known, and is often used for the determination of power factor by the two-wattmeter method.

TABLE III.

±	Value of cos ϕ_1		Value of cos ϕ_2	
	For ρ_1 ±	For ρ_1 ∓	For ρ_2 ±	For ρ_2 ∓
0·0	0·500	0·500	0·866	0·866
0·1	0·577	0·431	0·904	0·817
0·2	0·654	0·358	0·933	0·756
0·3	0·731	0·297	0·954	0·682
0·4	0·802	0·241	0·971	0·596
0·5	0·866	0·189	0·982	0·500
0·6	0·918	0·143	0·989	0·404
0·7	0·951	0·101	0·994	0·292
0·8	0·982	0·064	0·998	0·188
0·9	0·996	0·030	0·999	0·008
1·0	1·000	0·000	1·000	0·000

(To be continued.)

THE CARE OF DYNAMOS DRIVEN BY ENCLOSED GAS-ENGINES.

It has been noticed in a number of suction gas installations which include dynamos that the difficulty of working the latter is considerably enhanced by the gases and dust present. Extreme care in running the machines must, therefore, be exercised, especially as regards the commutator. It is advantageous in some cases to treat the commutator with a dilute solution of sal ammoniac.—*Elektrotechnik und Maschinenbau.*

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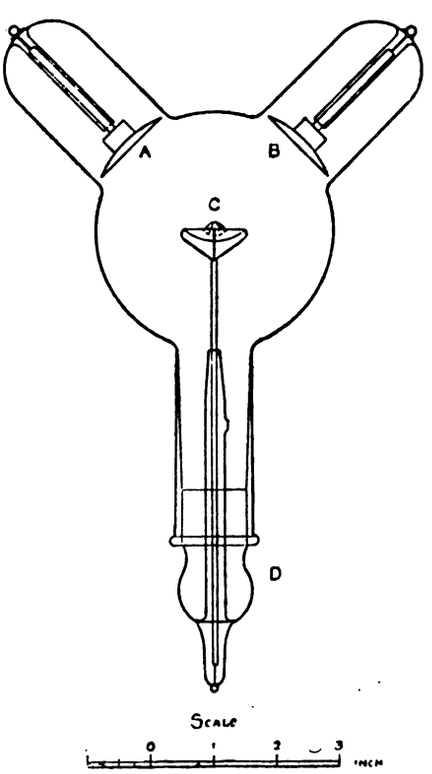
THE CONVERSION OF DIAMOND INTO COKE IN HIGH VACUUM BY CATHODE RAYS.*

BY THE HON. CHARLES A. PARSONS, C.B., F.R.S., AND ALAN A. CAMPBELL SWINTON.

The objects of the experiment were three-fold: firstly, to ascertain whether a diamond could be entirely converted into coke or graphite by heating in a vacuum by cathode rays; secondly, in the event of this being found practicable, to make a determination by Féry's optical pyrometer of the temperature at which the conversion takes place; thirdly, to endeavour to ascertain if, during the conversion, any gas was emitted or absorbed by the carbon.

The vacuum tube employed is shown in the illustration, where A and B are the two aluminium electrodes, C the diamond, and D an airtight ground-glass stopper joint, through which the diamonds were introduced. Alternating current was employed, each of A and B acting as cathode and anode in turn, while their concave curvature was such as to accurately focus the cathode rays on to the diamond. The latter was supported on a plate of iridium, which, in turn, rested in a platinum cup, this arrangement being designed to prevent any stray cathode rays which might



miss the diamond from striking the glass walls of the tube and melting the latter. During the experiment the tube was connected to two mercury pumps of the Toepler type, and in connection with the tube there were also attached two spectrum analysis discharge tubes for the purpose of collecting and examining some of the residual gas in the tube, both before and after the conversion of the diamond into coke.

The alternating current from the mains, which was of 85 periods per second, was passed through the primary of a 10in. Rhumkorff coil, with the contact breaker and condenser disconnected, with an adjustable choking coil in series in the primary circuit, so that the secondary voltage could be varied from about 5,000 to 12,000 volts. A reflecting milliampere-meter was employed to read the current through the tube, while the volts across the tube's terminals were measured by an electrostatic voltmeter.

Two diamonds, each about 0·2in. in diameter, were experimented with. The first was entirely converted into coke without difficulty, while in the case of the second the process was stopped when most of it had been so converted, the residue being black throughout its mass. As the proper degree of vacuum was reached by working the mercury pumps, and as the volts were raised, the diamond in each case became red, and then intensely white hot, till with about 8,000 volts and 44 milliamperes (352 watts) passing through the tube the diamond began to throw off small sparks. On the volts being increased to 9,600, and the current rising to 45·5 milliamperes (436 watts), the sparks thrown off became more numerous and the diamond commenced to become black. Finally, with 11,200 volts and 48 milliamperes (537 watts) a rapid disintegration of the diamond took place, with considerable increase in volume, the residue having much the appearance and consistency of coke. The temperature of the diamond, as given by the pyrometer, during disintegration was 1,890deg. C.

During the heating up of the diamond and of the tube, large amounts of gas were driven off and had to be pumped out, but there was nothing to indicate that any of this gas originated from the diamond rather than from the metal parts and glass walls of the tube. Two experiments were made, and in the latter there was distinct indication of a rise in vacuum just about the time of the conversion. These rises in vacuum are, however, not unusual in tubes in which there is highly-heated metal, and it was impossible to decide whether any of the absorption of gas took place in the diamond.

In the experiment in question one of the spectrum discharge tubes was sealed off just before the conversion, when the diamond was commencing to blacken on the surface, while the other was sealed off after the diamond had been converted into coke. These two tubes, therefore, respectively contained samples of the residual gas before and after the conversion. Their spectra have been photographed alongside of one another, but though they are not altogether the same, the differences do not appear sufficiently marked to determine with exactitude any variation in the nature of the gases present.

The experiments were arranged and carried out by Mr. Swinton at his laboratory in London.

* Paper read before the Royal Society.

THE RELATION BETWEEN THE CONDUCTIVITY AND THE ILLUMINATION OF SELENIUM.

Numerous attempts have been made to determine the relation between the resistance and the illumination of selenium cells, and various empirical equations have been developed. Thus Hopius found that the relation was given by the formula:

$$\frac{1}{W} = a\sqrt[3]{i},$$

where W is the resistance of the cell, i the illumination on it, and a a constant.

Heschus has given the formula:

$$i = a(b^m - 1),$$

where m is the conductivity and a and b are constants.

A recent investigation by G. Athanasiadis failed to confirm either of the above results and points to an equation of the form:

$$i = m(m - a)b,$$

where i is the illumination, $m = \frac{10^5}{W}$ = the conductivity, and a and b are constants. This formula was found to apply fairly well to light of all colours, each colour, however, having its own constants, a and b. The selenium was most sensitive to red light. The numerical values of a and b depend on the original resistance (with the cell in the dark), and this resistance varies with the temperature, the time of previous exposure to the light, and the mechanical shocks to which the cell has been subjected. A cell, for instance, which had a resistance in the dark of 39,750 ohms at first was reduced to 30,490 ohms by a severe knock.

With regard to the time lag of the resistance change behind the change of illumination, it was found that immediately after the removal of the illumination the resistance rose very rapidly at first and then more slowly. The original resistance is regained after 50 to 60 seconds.—*Elektrotechnik und Maschinenbau.*

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THE SANDYCROFT FOUNDRY COMPANY, LIMITED, CHESTER.

In these days of over-competition and cut prices it is gratifying to find an electrical firm here and there which is able to flourish without resorting to the manufacture of motorcars or golfers' requisites to boost up profits. The Sandycroft Foundry Company, Limited, are among the

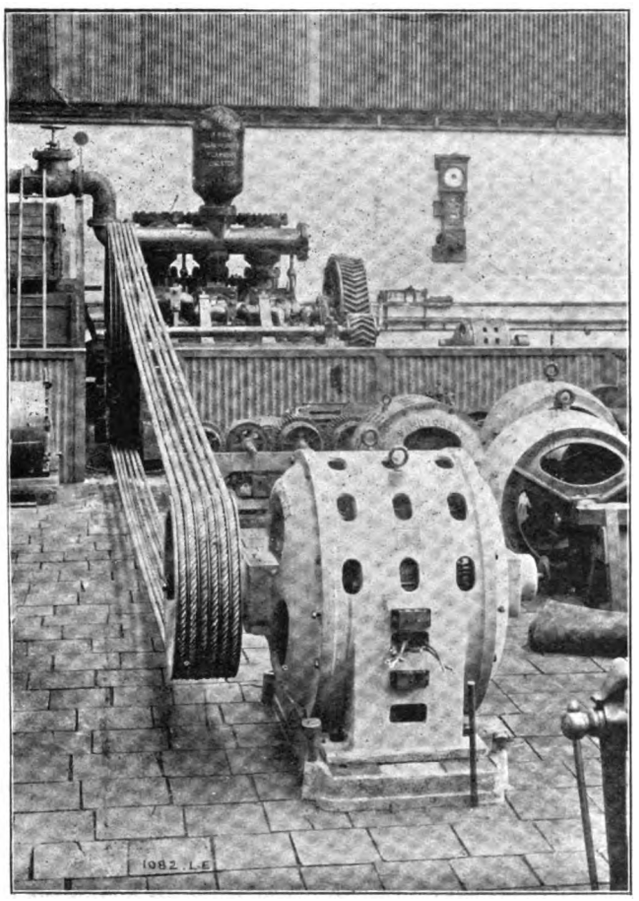

FIG. 1.—A Sandycroft 100-b h.p. "Cascade" Motor driving a Three-Throw Mining Pump.

select few, and in their case we have witnessed the rapid development of what was a purely mechanical engineering business into an electrical concern of first-class importance—rather an isolated phenomenon in recent history. If we look for the reasons for this unusual success, we shall discover that good management and specialisation of a high order are chief among them. But successful specialisation is simply the reflection of intimate knowledge and that measure of skill necessary to meet given conditions.

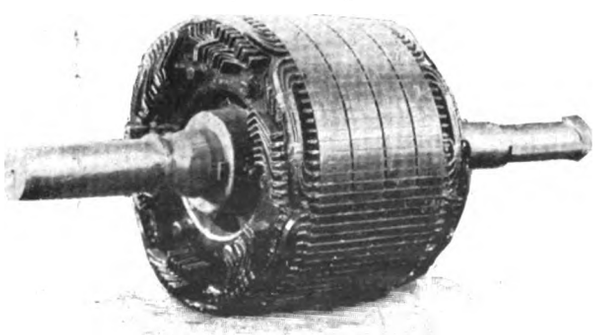

FIG. 2.—Rotor of the 100-b.h.p. "Cascade" Machine.

The foundry is in an isolated position about six miles from Chester. It is probably due to this fact that more light has not been shed on the good work accomplished or in progress at Sandycroft. The consignment of the chief products to remote mines also tells against publicity. Then some allowance must be made for the reliability factor; had this been lower we should doubtless have heard more about Sandycroft plant. Where there is no trouble there is little talk, and repeat orders flow in. It is not intended for the present to describe the works or their up-to-date equipment. Dimensions of shops may look impressive on paper, especially when accompanied by interior views which fade away into the dim haze of distance, but we assume that the vast majority of our readers will be interested rather in the products of the works. Let us, therefore, proceed straightway to the main erecting shop, paying but passing attention to the foundry proper, which turns out the whole of the castings required for the company's electrical and other manufactures. Having regard to precedent, we ought to pass in with a fresh batch of rough castings or core plates, and follow them through the various machining, assembling, and winding processes to the test-bed for finished machines. But time is limited and return trains few, so we elect to start with the test bay and

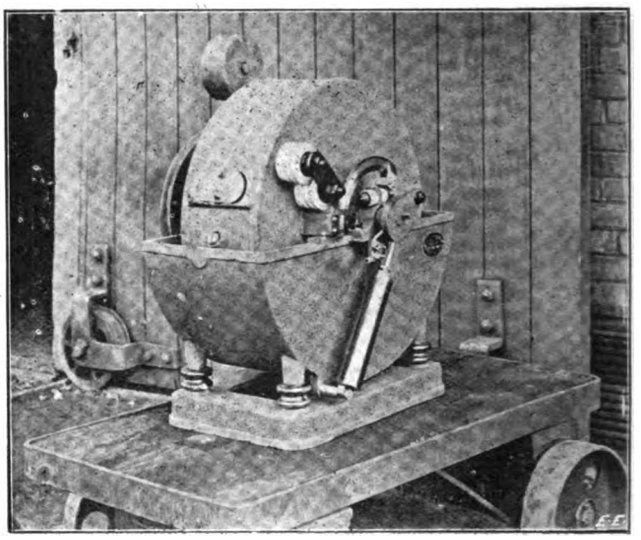

FIG. 3.—Water-Cooled Automatic Liquid Switch, actuated by means of a cord and weight or float.

so make sure of the most interesting items which happen to be in hand at the moment. Thus it is that a three-throw horizontal pump destined for a Cornish mine first claims our attention. The duty of this pump is to raise 750 gallons of water per minute under a vertical head of 300ft. It has 12in. plungers, cased with gunmetal, and a 15in. stroke, the general construction being of the heavy type adapted for mining work. However, it is the drive rather than the pump itself which interests us here. Referring to the accompanying illustra-

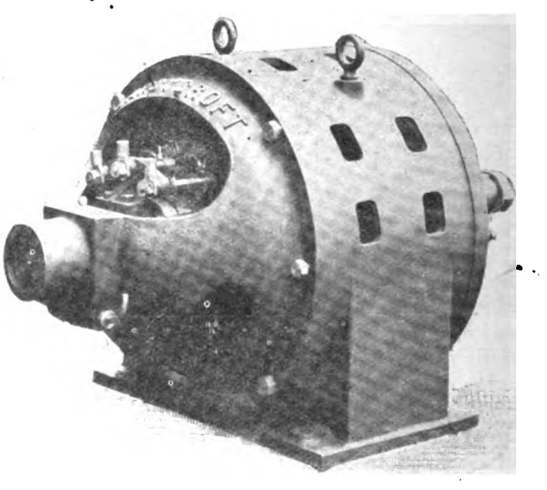

FIG. 4.—Three-Phase Slip Ring Motor.

tion (Fig. 1), it will be seen that this drive is transmitted by means of ropes from a 100-b.h.p. electric motor. Now this motor possesses several noteworthy features. It is of the firm's new "Cascade" induction type (Hunt's patent), being arranged to start the pump under its full head. The absence of rubbing contacts gives the type a peculiar value for situations where absolute freedom from sparking is desirable. The rotor windings (Fig. 2) are short-circuited on

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themselves, the torque and speed being controlled by means of a two-phase starting switch connected to tappings taken from symmetrical points in the parallel "star" or "mesh" windings of the stator. The starting switch is of the firm's liquid type (Fig. 3), and is connected to one phase

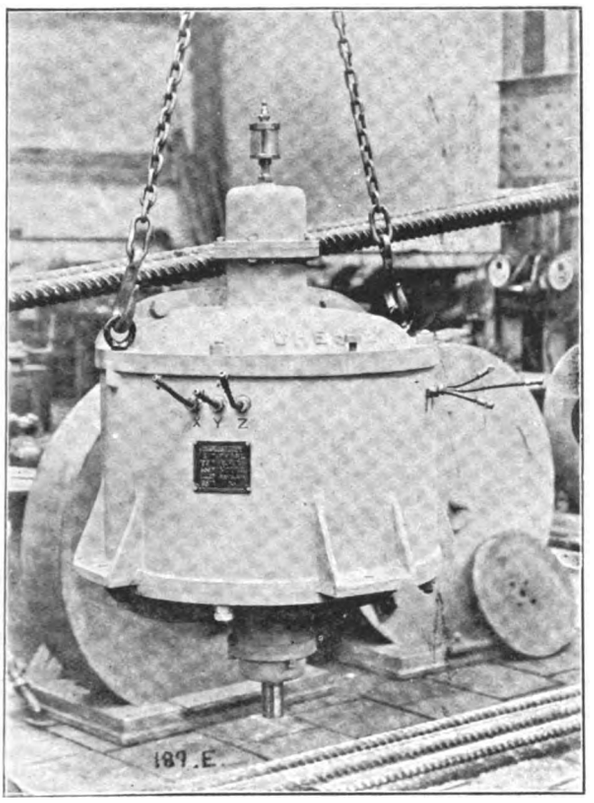

FIG. 5.—Vertical Spindle Three-Phase Motor for driving Centrifugal Pump

of the stator windings, the secondary currents during starting being in quadrature. The machine starts with full-load torque, taking full-load current. After it has reached normal speed the short-circuiting switch mounted on the casing is closed. The secondary currents, under these conditions, are six-phase, and circulate in the whole of the

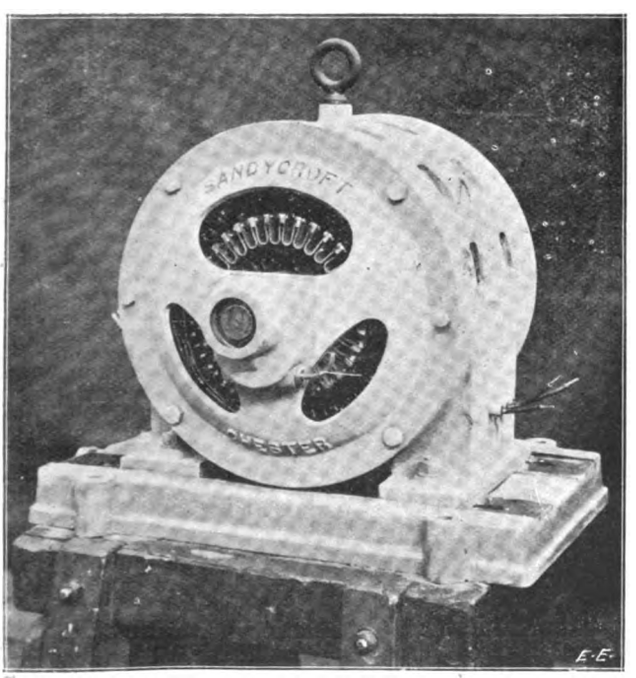

FIG. 6.—A Sandycroft Patent "X" Type Motor with High-Resistance Rotor Loops.

stator windings. With further regard to the rotor windings, it may be explained here that they consist of a series of coils of 12 pole pitch interconnected with a series of eight-pole pitch coils. The effect of this arrangement is to make the windings equivalent to eight-pole and four-pole windings, producing fields rotating in opposite directions. This causes the machine to act as if it consisted of two motors connected in cascade, the control being effected by regulating the currents induced in the stator windings by the four-pole rotor field. With the arrangement described considerably less copper is required for the rotor windings than would be the case if separate eight-pole and four-pole windings were employed. At the same time the efficiency is increased, due to the reduced amount of copper, while the power factor is improved owing principally to the shortening of the inter-connections. The particular motor in question is designed to run at a normal speed of 494 r.p.m. on 400-500 volts, 50 ~.

A noteworthy characteristic of motors of this type is their small slip. In the machine described it amounts to about 1·2 per cent. Thus the motors are eminently adapted for driving textile machinery, where the importance of steady running is very great, especially in the case of silk looms. We understand it is possible to build 50-b.h.p. motors of the type with a slip of only 1 per cent.

After a brief survey of various other machines, of less individual interest, under test, we pass on to a plant which in every detail is to be an exact replica of that just

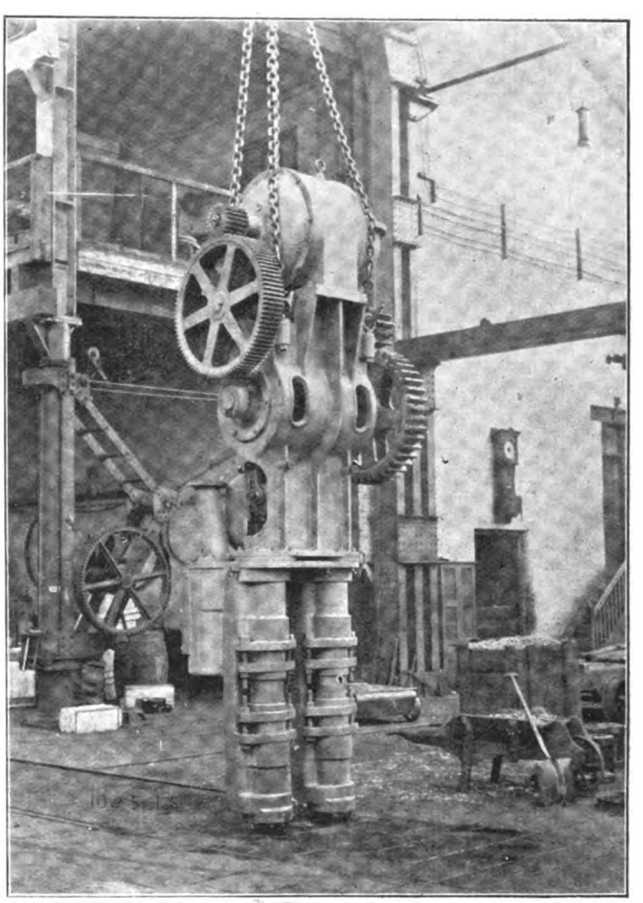

FIG. 7.—Mine Sinking Pump driven by Three-Phase Motor.

described, but has not attained to the same state of completion. Our next halt is made opposite a 350-b.h.p. three-phase slip-ring motor, fitted with a combined brush-lifting and short-circuiting gear. This machine is nearly ready for its test, having made note of which fact we proceed to a 150-b.h.p. vertical-spindle three-phase induction motor (Fig. 5), whose destiny is to drive a centrifugal pump for mine drainage. It is wound for 50 ~, 440 500 volts, and looks a thoroughly suitable machine for its purpose. Not far distant our attention is called to a 180-b.h.p. motor of similar design. It may be remarked here that the pumps for coupling to these motors are also being constructed on the spot.

At this stage we are confronted with a machine which calls for more than passing notice—viz., a Sandycroft "X" type induction motor. This motor (Fig. 6), whilst possessing all the good features of the ordinary "squirrel-cage" design, is free from its disadvantages. Moreover, as no starting transformer or resistance is required, it is simpler to handle. The rotor is of the short-circuited type

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without any rubbing contacts, and the machine will develop twice the full load torque, taking 3 to 3·6 times full-load current. With full-load current it will start against 55 to 60 per cent. of full-load torque, and will develop full-load starting effort, requiring 1·8 times full-load current, the actual value being dependent upon the number of poles. A very important feature of this machine is the high power factor when starting, being 2 or 3 per cent. higher than when it is running normally, and developing the same torque. Hence difficulties with voltage regulation due to excessive lagging currents do not occur. The rotor is provided with a high-resistance squirrel-cage winding, to the short-circuiting rings of which are attached low-resistance cross-connections. By changing the number of stator poles the rotor currents can be caused to flow either through the high-resistance short-circuiting rings (the condition for starting) or through the low-resistance connections, in parallel with the squirrel-cage short-circuiting rings (the condition when running normally). The short-circuiting rings are formed of a special high-resistance metal, and owing to the overlapping of the currents in them, the fan action of the cross-connections, and the cooling effect of the bars and cross-connections themselves, the rings even for large motors are of quite small cross-section. It will be seen, too, that with this construction the inductance of the rotor at starting is less than when running, and this helps the power factor and increases the maximum starting torque obtainable. When running, the short-circuiting rings are in parallel with the cross-connections, and increase the radiating surface of the rotor; and this, together with the fan action of the cross connections, permits the use of a smaller, and consequently cheaper, machine for a given output than is possible where a wound rotor is provided. As the starting is independent of the resistance of the bars themselves, or of the low-resistance cross-connections, these can have a very low resistance, whence it follows that "X" type induction motors have a higher efficiency than machines of either the wound or squirrel-cage types. The stator windings are of the firm's patented type, giving alternative numbers of poles. The connections are mesh for normal running and parallel star for starting, a simple oil-break change-over switch serving to effect the change. It remains to add that special attention is paid to the cross-connections to enable them to withstand the heat generated in the short-circuiting rings. The low-resistance connections are riveted and sweated to the rotor bars, while the loops of high-resistance metal are bolted and sweated. Six terminals are provided, three on each side of the machines. In the further course of our inspection of the work in hand we come across several examples of this motor in various sizes for different purposes, but, as the features outlined above are characteristic of the whole, the one reference will suffice.

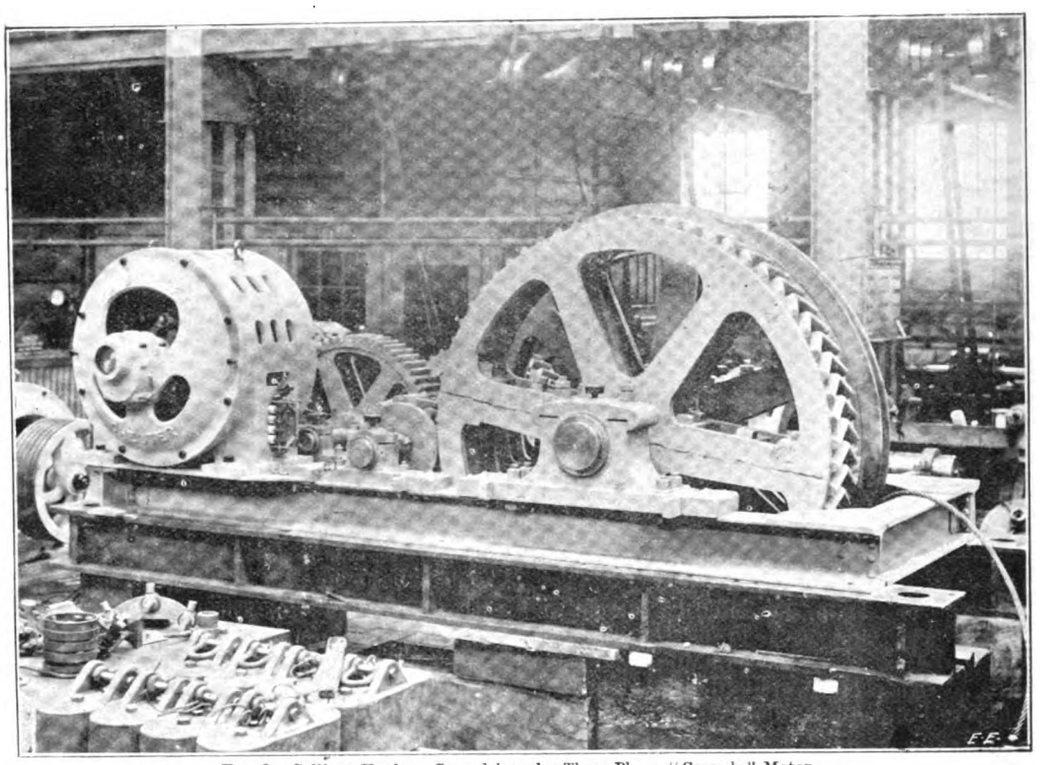

FIG. 8.—Colliery Haulage Gear driven by Three-Phase "Cascade" Motor.

Stepping aside to allow the passage of a heavy casting, we pause before parts of a 125-b.h.p. three-phase "Cascade" induction motor destined to drive a winding engine in a gold mine on the West Coast of Africa. The designed speed is 495 r.p.m. on 400 volts, 50 ~. A little further on are two motors of similar type for driving centrifugal turbo-pumps at 1,450 r.p.m. with the same voltage and frequency, and in the same part of the world. Con-

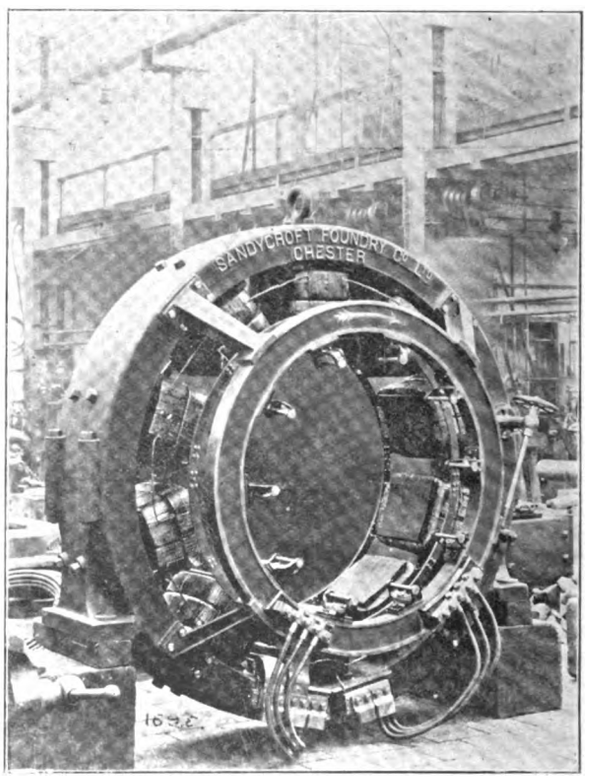

FIG. 9.—Magnet Frame of Ten-Pole 200-kw. Gas-Engine Driven Generator.

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tributory evidence of a reputation for Sandycroft specialities extending outside the home market is afforded by some 40-b.h.p. "Cascade" induction motors for driving ore crushers and aerial ropeways in Rhodesian gold mines. These are designed to run at 592 r.p.m. on 500 volts. We also notice some plants for India, Japan, and other remote parts of the globe. Then, in turn, a duplex mine sinking pump (Fig. 7), driven by a totally-enclosed waterproof

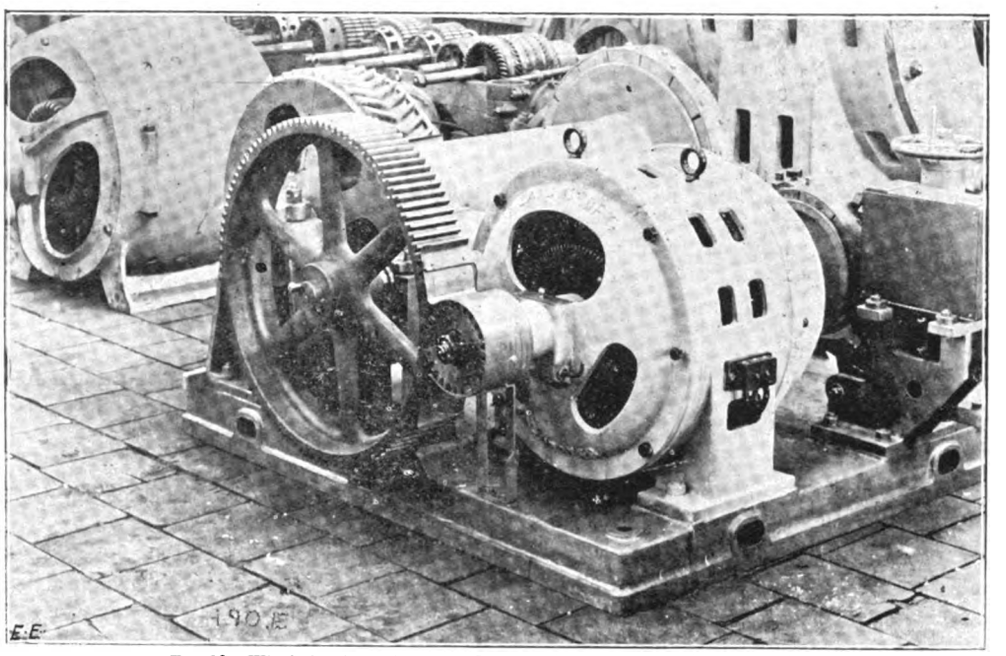

FIG. 10.—Winch for Actuating Scrap-Breaking Ball driven by Three Phase Motor.

three-phase induction motor giving 50 b.h.p. at 725 r.p.m., and the endless-rope haulage gear (Fig. 8) for a colliery in North Wales. This gear is provided with three reductions, that from the driving motor having machine-cut teeth, while the remaining two are of the double helical type, and give highly satisfactory results in combination. The "Cascade" driving motor yields a continuous output of 60 b.h.p. at 494 r.p.m. on 440 volts 50 ~, the rope speed being two miles per hour. It is fitted with a short-circuited

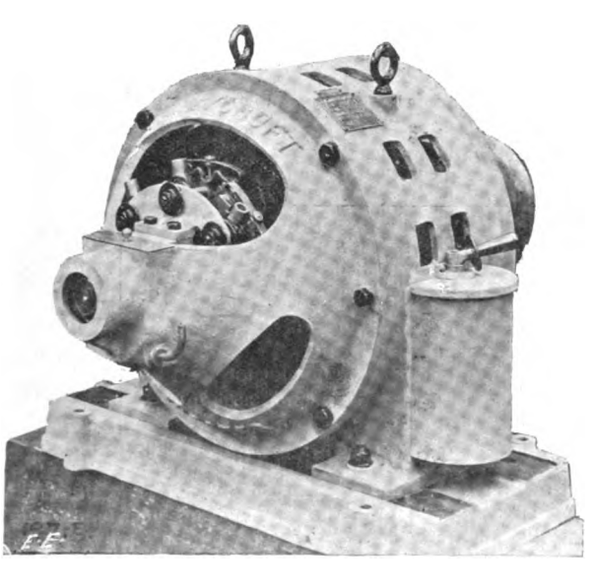

FIG. 11.—A Sandycroft Patent Two-Speed "Cascade" Motor, with the Two-Speed Switch Mounted on Side.

rotor, and arranged for controlling through a starting switch connected in the stator windings. A continuous-current generator designed for an output of 200 kw. at 210 volts when running at 120 r.p.m. next claims brief attention. This machine is to be installed with three facsimiles, representing previous orders, in the power-house of a local steelworks, and will be driven independently, like its companions, by a Crossley gas-engine. The 10-pole magnet frame is shown in Fig. 9.

Quite a contrast in size to the last-mentioned machine is a continuous-current motor for driving a Reavell air-compressor in a South Wales copper works. It is provided, we notice, with commutating poles, being required to give 50 b.h.p. at any speed between 200 r.p.m. and 400 r.p.m. without sparking at the brushes. The winch (Fig. 10) for actuating a scrap-breaking ball in a steelworks next attracts us. It is driven by a three-phase 42-~ motor giving 45 b.h.p. at 810 r.p.m. The double-reduction cut-steel gearing is provided with a solenoid brake, control being effected through a liquid starting switch of the Sandycroft standard type.

Proceeding a few paces we are diverted by another interesting speciality, this time a "Cascade" motor designed for two speeds—viz., 610 r.p.m. and 410 r.p.m. At the higher speed the machine is to develop 15 b.h.p., we are told, and at the lower speed 10 b.h.p. It is to be used for driving a mortar mill, and will run normally at the top speed, while the lower speed provides for the removal of the mortar as required. In order to effect the reduction, the three slip-ring are open-circuited and a short-circuiting switch mounted on the side of the motor (as shown in Fig. 11) closed. This switch short-circuits the stator tappings and causes the motor to run as a "Cascade" machine. Thus the necessity for change-over switchgear is obviated. At the higher speed the number of poles is eight and at the lower 12. A similar motor wound for 50 ~, but designed for three speeds—namely, 333 r.p.m., 500 r.p.m., and 1,000 r.p.m.—is under construction in another part of the shop. This machine is required for driving a ventilating fan, and will develop 30 b.h.p. at the top speed.

Another brief halt is made to inspect some motors for driving coal-cutters. They are, we find, of the "Cascade" three-phase induction type without slip-rings, and represent a new departure. Each motor is wound for 500 volts 50 ~, and develops 25 b.h.p. at 490 r.p.m. It will start at full-load torque when taking full-load current, high starting efficiency being a characteristic of the type. Being three-phase motors without any current-collecting gear, absolute freedom from sparking is ensured, and it is further claimed that no more attention is required than for the squirrel-cage type of motor.

Our time is almost up as we repass in rapid succession alternating-current generators, dynamos, and other plant, besides that specifically mentioned above, in various stages of manufacture, on our way to the coil-winding and insulating department, which occupies a side bay. Here we note the extraordinary care taken with the insulation of stator or armature windings. After being served with a special insulating compound, the coils are dried in a vacuum oven, and then dipped in an insulating varnish which fills up all the interstices in the insulating material and renders the

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coils water and oil proof. They are next carefully taped, and having been dried again are dipped, dried, redipped, then subjected to a severe test, and, finally, placed in position. Former-wound coils in open slots are used in the case of induction motors to enable the best results to be obtained in regard to insulation. They are each tested under water with 500 volts. The high insulation of a field coil selected at random is demonstrated in our presence by subjecting the insulation to a stress of 5,000 volts under water—nothing happens. We need not dwell upon the importance of such effective insulation, especially where mining plant is concerned. It is the practice of the company to put motors of the induction type through in batches up to the 40-b.h.p. size, and they observe the same rule in the case of continuous-current motors up to the 100-b.h.p. size. Hence, although much of their work is to order, they can generally supply standard sizes from stock. Three-phase plant constitutes quite 75 per cent. of the output of the electrical department. We know of no other English firm which has specialised this type of plant to the same extent.

Crossing from the coil-winding bay to the opposite side of the main erecting shop, we enter a bay in which a considerable number of liquid starting switches are under construction, but we have no time to linger over them. Our visit, though of necessity hurried, has been interesting, and for this we have to thank Mr. Hunt, M.I.E.E., the head of the electrical department. All we have seen has but confirmed our early impression that the Sandycroft Foundry Company, Limited, turn out a first-class article, and the business done proves that they have secured a firm market for the same.

THE EXPERIMENTAL SECTION OF THE NEW BERLIN HANGING RAILWAY.

In order to enable them to decide on the suitability of a railway of the hanging (or Barmen-Elberfeld) type for the suggested new line in the eastern portion of the city, the Berlin traffic authorities have recently had a short experimental section erected in the Brunnenstrasse, which forms the narrowest part of the proposed route. Considerable modifications have been introduced since the construction of the Elberfeld line, as will be seen from Figs. 1 and 2, which show the elevation and plan of the design selected for the trial section. The line is supported by girders measuring 32in. by 26in. at the ground level, and spaced about 50ft. apart. These girders are grouted firmly into the roadway midway between the existing up and down

The upper surface of the structure, with the exception of two narrow wood-covered side tracks used for inspection purposes, is uncovered, and gives a distinctly light and airy

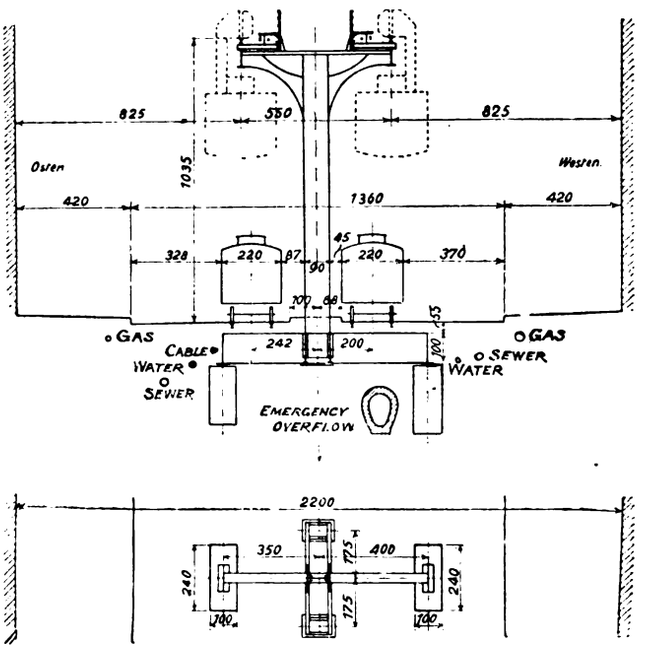

FIG. 1.

appearance to the line. This is accentuated by the fact that even in this narrowest street on the route the whole stretch of the structure is only about one-quarter of the

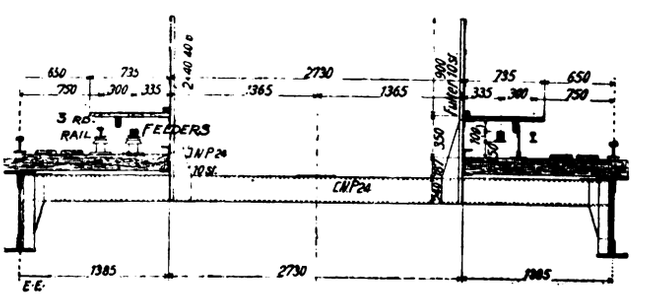

FIG. 2.

road span. The running rails are carried on wooden sleepers so as to deaden the noise. The current is collected from a third rail mounted on insulators, and feeder cables,

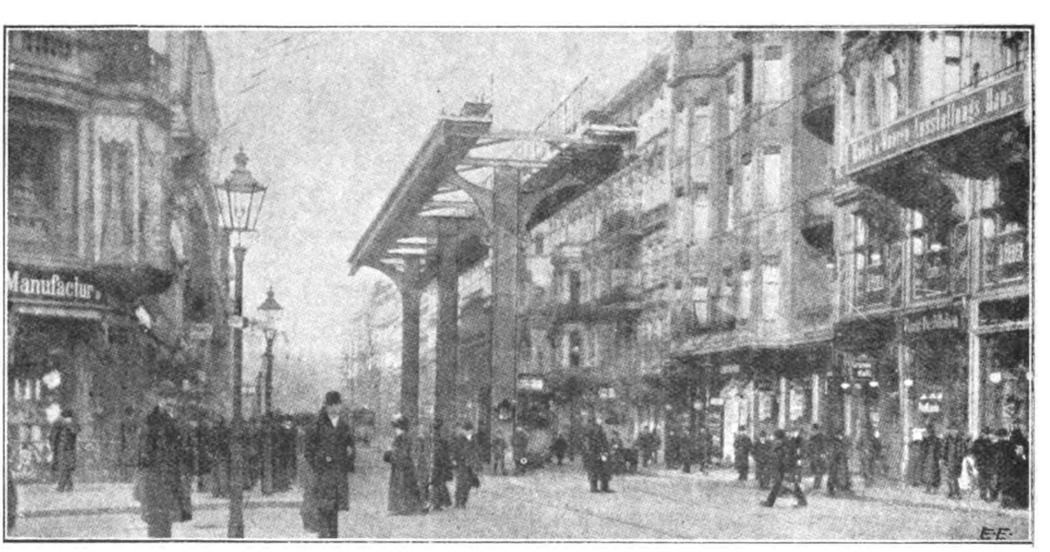

FIG. 3.

tramlines, which have been specially separated to the necessary extent. The running rails and the current supply rails are carried by cross-arms branching out of the upright girders. Three designs for these cross-arms have been included in the trial section, as is shown in Fig. 3.

also mounted on insulators, run beside the third rail, as shown in Fig. 2. The light and attractive appearance of the trial section has considerably reduced the previously existing opposition to the scheme, so that it may be proceeded with shortly.—*Elektrische Kraftbetriebe und Bahnen.*

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ARTIFICIAL LOAD FOR TESTING ELECTRICAL GENERATORS.*

BY R. K. MORCOM AND D. K. MORRIS, MEMBERS.

(*Concluded from page 456.*)

Power Factor.—Referring again to the example of a 10-kw. transformer, the copper loss in the windings might be 3½ per cent., or 350 watts. At these high flux densities the core loss may be as much as 1,100 watts. Thus the total loss is 1,450 watts, and the power factor of the current taken is accordingly 1·45/80 = 0·018. This is an

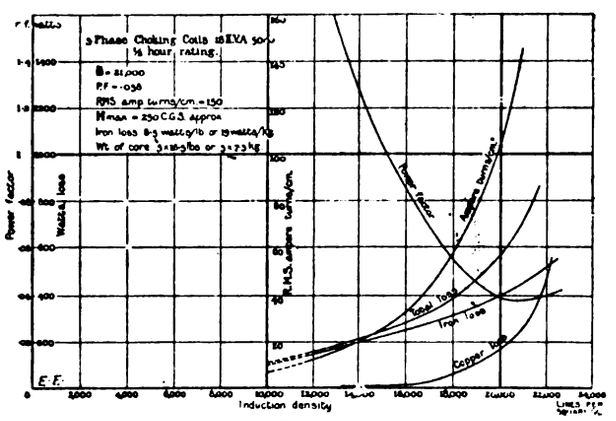

FIG. 7.—Characteristics of Three-Phase 18-Kilovolt-Ampere Choking Coil at 50~.

exceedingly low power factor, and corresponds to the lowest that can be obtained with a choking coil of the ordinary construction, even when very liberally designed. It represents a lag of nearly 89deg. The lower the power factor the less the energy which has to be got rid of in the inductive coils, and consequently the higher the figure at which such coils may be rated. The minimum power factors obtainable with different sizes of these coils are found by the makers to be as shown in the accompanying table. The manner in which power factor varies with the

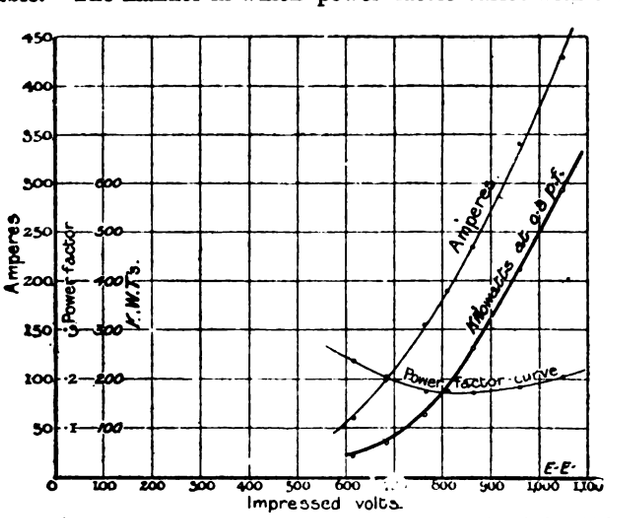

FIG. 8.—Characteristics of Single-Phase Choking Coil Wound with Iron Strip.

voltage or flux density is clearly shown in the curves (Figs. 7 and 8). The data given in Fig. 7 relate to the condition of working which gives the least power factor. Curves showing the various losses are also given.

Continuous rating with special cooling of the core if necessary. Kilovolt-amperes.	Minimum power factor.	Phase displacement of current. Degrees.
0·25	0·090	84·5
0·80	0·060	86·5
2·00	0·035	88·0
10·00	0·030	88·3
40·00	0·020	88·8
120·00	0·015	89·1
340·00	0·012	89·2

Characteristic of Closed-Core Choking Coils.—The relation between impressed terminal voltage and current (R.M.S.) taken by the coils depends upon the magnetisation curve of the iron used in the core, as well as on the wave-form of the current itself. At high flux densities a relatively small drop in voltage reduces the current almost to nothing. It is characteristic, therefore, of these choking coils that while they work well over a wide range of current, yet their range of voltage is small.

Regulation of Voltage and Current.—It is not practicable to have special inductive loads made for every voltage and current of the machines which may have to be tested. It is, therefore, of the greatest importance to provide means whereby the voltage as well as the current of an inductive load may be regulated while the power factor is maintained at a specified value of, say, 0·8. The most satisfactory method of arranging for such regulation is by means of water resistance arranged in such a manner that the

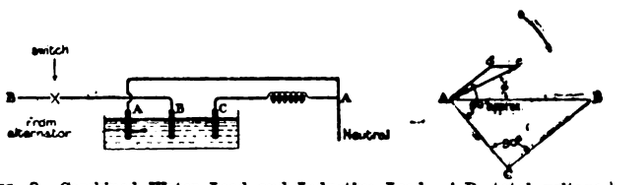

FIG. 9.—Combined Water Load and Inductive Load. A B, total voltage to neutral; A C, voltage across choking coil; B C, voltage across series resistance; A *d*, current in choking coil and series resistance; *d e*, current in shunt resistance; A *e*, total current.

inductive coil current is shunted by an in-phase component of current in a water load, while, at the same time, resistance may be put in series with the choking coil (see Fig. 9). By shifting the plate B towards A or C, the double adjustment may be conveniently effected at one time. Adjustment is also obtained by raising or lowering one or more of the plates. The inductive coil may be either immersed in the tank, or may be in a separate place according to the method used.

Further variations of voltage and current may be obtained by the well-known methods of paralleling the coils, or changing from star to mesh connection or both, used always in conjunction with the above combination of water loads (Fig. 10). Since the change from star to mesh coupling reduces the voltage for which the inductive set is suitable and increases the current by $\sqrt{3}$, it is convenient to make the next step down in voltage correspond to the paralleling of three equal sections of the winding, since this will again give a step = $\sqrt{3}$. The next step, again, would then be by changing from star to mesh, the coils remaining still in parallel. In this way an extreme range of voltage of as much as 9 : 1 may be obtained with a three-phase set, each of whose

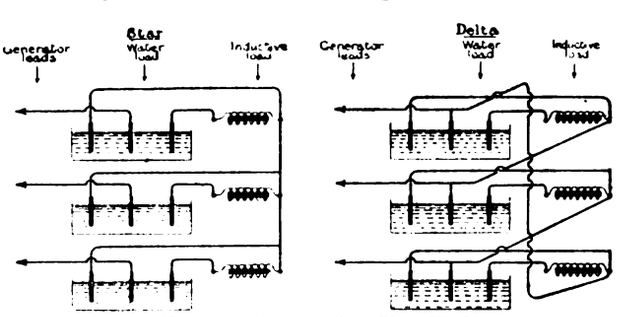

FIG. 10.—Connections for Three-Phase Working.

windings is sub-divided into three parts only, while throughout this range the set can be worked, if required, at constant kilovolt-amperes and core flux density. For testing at reduced loads the correspondingly smaller kilovolt-amperes are obtained by working the cores slightly at lower flux density.

For economy in design it is best to use choking coils wound for the lowest voltage which will satisfy the purpose for which the coils are required. If they are wanted for testing three-phase generators at a moderate power factor, it will be found that the necessary coil voltage is not more than one-third to one-half of the terminal voltage of the machine under test. For example, let it be required (see Fig. 11) to test a generator of 1,000 kw. at 6,000 volts and 50~, the test to be carried out at 0·75 power factor. Using Y connections, this means in each branch a voltage of 3,460 and a current of 128 amperes, being the resultant of an in-phase current of 96 amperes and an out-of-phase

* Paper read before the Institution of Electrical Engineers.

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current of 84·7 amperes. Each branch of the circuit requires, therefore, a choking coil designed for 84·7 amperes and 3,460 volts, shunted by a water resistance taking 96 amperes at the same voltage. No water resistance whatever would be used in series with the coils. It is possible, however, to obtain the same result using choking coils wound for lower voltage and correspondingly higher current. The coils can each be wound for the full current—128 amperes—and resistance can be arranged in series only with the coils. If the coils are so designed that, when taking this current, the voltage across each coil is 2,290 volts, while the drop across each water resistance in series with a coil is 2,600, then, since these two voltages are practically in quadrature, the full-phase voltage of 3,460 volts will be maintained as before, and the current will be 128 amperes at 0·75 power factor, also as before. Thus, to carry out a 0·75 power-factor test on a 1,000-kw. 6,000-volt generator requires three coils each for 128 amperes at 2,290 volts only; while the combined kilovolt-amperes of the coils is $3 \times 128 \times 2{,}290$, or 880 k.v.a., as compared with the 1,333 k.v.a. of the generator. Similarly, if the test had been required at 0·85 power factor the coil voltage would have been 1,820 volts, and the combined kilovolt-amperes of the coils 620, the generator kilovolt-amperes being now 1,130.

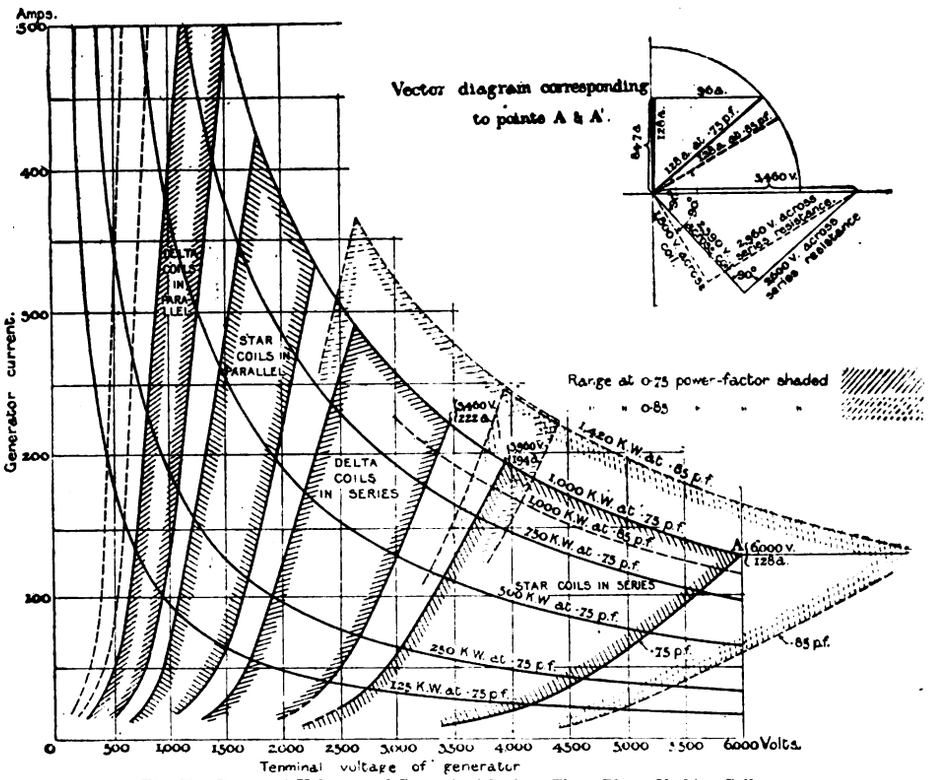
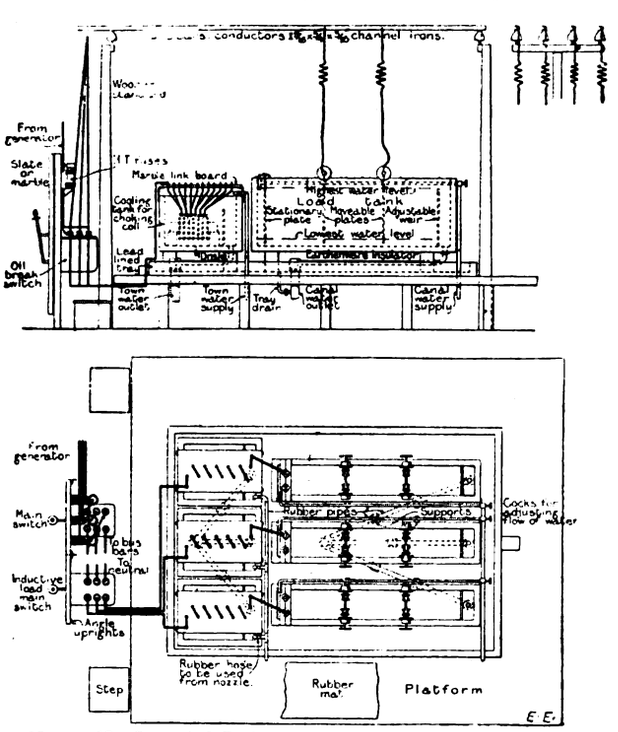


FIG. 11.—Range of Voltage and Current with given Three-Phase Choking Coils.

Generally, if E_g = terminal volts of three-phase generator;
W = output in kilowatts; and
$\cos \phi$ = required power factor during test;
then the three choking coils needed should be wound each for a current of

$$I = \frac{W}{(\sqrt{3} \cdot E_g \cdot \cos \phi)},$$

and a voltage of $E_c = \frac{E_g \cdot \sin \phi}{\sqrt{3}}$.



FIGS. 12 AND 13.—Suggested Design for Artificial Load Inductive and Non-Inductive, suitable for 1,000 kw. at 1,000 to 6,000 volts. Also at 500 volts with Heavier Switchgear and Leads and with Extra Plates for Water Load.

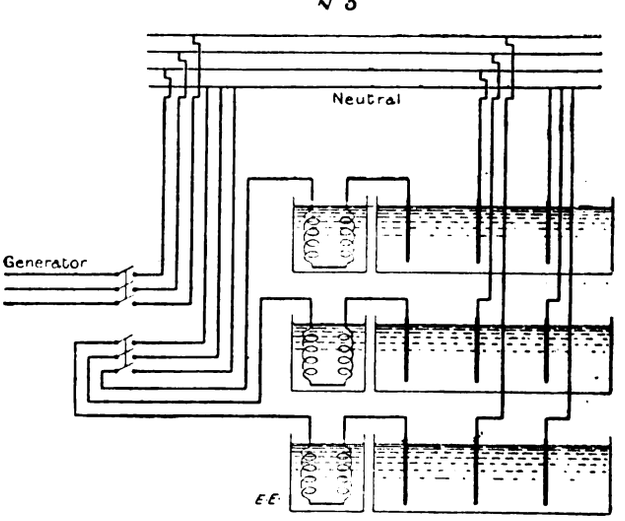


FIG. 14.—Diagram of Connections on Figs. 12 and 13.

The maximum combined kilovolt-amperes of the three coils is therefore = W tan ϕ. It will be plain from the above that the combination of inductive coils and water resistances described in the paper is capable of dealing with a given number of kilowatts at a specified power factor over a range of voltage extending from $E_g \sqrt{3}$ down to sin ϕ times this amount, where cos ϕ is the power factor.

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The range of current is correspondingly as sin ϕ : 1. Throughout this range both voltage and current of each choking coil is that for which they have been assumed to have been designed. When the coil voltage is reduced the current will fall off rapidly after the manner shown in Figs. 7 and 8. By using similar arguments to those given already, it is seen that a combined inductive and water load as described can deal with the range of voltage, current, and power as well at a given power factor. Such a range is shown by the shaded area on the right-hand side of the figure (Fig. 11) worked out for 0·75 power factor and 1,000 kw. or less.

To extend the range of the set the sections of the combined load may be coupled in mesh or delta connection. In this way the current capacity is increased as 1 : $\sqrt{3}$, while the voltage limits are correspondingly reduced. On referring again to Fig. 11, it will be noticed that this covers another large range of voltage, current, and power which will overlap the former range only when sin ϕ is equal to or less than $1/\sqrt{3}$, or 0·578, which means that the power factor of the test must not be less than 0·816. Above this power factor the ranges covered overlap, below it there are certain currents and voltages which cannot be dealt with. To deal with yet lower voltages and higher currents it is convenient to subdivide the windings on the coils each into three sections as described above. These, when paralleled and star-coupled, give a set of volt ranges one-third of those first available, and consequently reduced as $\sqrt{3}$: 1 from the second arrangement in which the apparatus was delta-connected and all the windings on each core were in series. Lower voltages still can, of course, be obtained by delta-coupling the third arrangement; and, if advisable, by further sub-division of the coils into nine sections each. In each of the arrangements the range of power which can be dealt with at a given power factor is the same—namely, 1,000 kw. and less for tests at 0·75 power factor, and from 1,420 kw. and less for tests at 0·85 power factor.

The combination of coils and water loads described here is thus of a very flexible nature and well suited to deal with the variety of generators which may have to be tested commercially. The kilovolt-amperes of an inductive load being fixed, the winding must be so chosen that the following conditions are satisfied: (*a*) it must carry the required current without undue heating continuously, or, in special cases, for a given short period; (*b*) its number of turns must be such that, when carrying this current, a back E.M.F. equal to the required terminal voltage is obtained; and (*c*) there must at the same time be enough ampere-turns operating on the coil's magnetic circuit that the requisite high flux density is obtained. If the coil is above a very small size, and not required for short-time rating only, the core must be cooled. The use of these coils worked at such high flux densities gives rise to a current wave whose peak is about 10 per cent. higher than that of an equivalent sine wave of current. That is, in calculating the ampere-turns available for producing the maximum of flux density the R.M.S. ampere-turns must be multiplied by about 1·56, so that the value of H is about 1·96 × the R.M.S. ampere-turns. The approximate field is, therefore, roughly obtained by doubling the R.M.S. ampere-turns. The distortion of wave-form is, however, not very great owing to the very high flux density, and, therefore, uniformly low permeability which occurs.

Approximate data relating to Sankey's Lohys and Stalloy irons at these high flux densities, based partly on the author's experiments, are given below:

B	H		Loss per lb. at 50 periods.	
Lines per sq. cm.	Lohys. C.G.S. units.	Stalloy. C.G.S. units.	Lohys. Watts.	Stalloy. Watts.
18,000	100	132	5	4·0
30,000	220	275	8	7·5
22 000	360	440	11	10·0
24,000	500	600	14	12·5

The most suitable design of choking coil is in many cases that giving the *least power factor*. This factor is the ratio of copper and iron losses to the total kilovolt-amperes of the choking coil. The losses depend on the square of the current, and on some similar function of a not widely varying flux density, while the kilovolt-amperes are proportional to current and flux density. Thus there will be a point at which the power factor is a minimum which occurs at a higher flux density the larger the coil. This is illustrated in the curves already given in Figs. 7 and 8.

It is difficult to generalise as to the best method of combining the details, but the authors append a suggestion for a working plant on lines which have been found very satisfactory in practice over a large range of conditions (see Figs. 12 and 13). The diagram of connections for this arrangement is given in Fig. 14. The inductive coils here shown are cooled by immersion in suitable tanks in which water is circulated, as also in the main load tanks by a system of pipes clearly indicated.

STANDARDISATION APPLIED TO ELECTRICITY.

The second of two lectures by Dr. R. T. Glazebrook, F.R.S., on "Standardisation in Various Aspects" before the Royal Institution of Great Britain was delivered on the 26th ult. In his first lecture, in dealing with mechanical measurements, Dr. Glazebrook referred to the work of the Engineering Standards Committee. That work has included electrical science also. Committees and sub-committees have been formed to deal with electrical plant, generators, motors, and transformers, copper conductors, meters of all kinds, incandescent lamps, etc. The problems discussed have given rise to two or three investigations of great interest. He then referred briefly to the results of some of these.

In an electric machine, a dynamo, a motor or a transformer, heat is generated both by the passage of the current through the copper and by the magnetisation of the iron. If the temperature rises too high, the insulation on the copper perishes and the machine breaks down. What rise of temperature is permissible, and how may it be measured? A thermometer placed on the coils outside does not measure the temperature of the wire. Means exist by measuring its resistance to get with accuracy the average temperature of a coil, but what is needed as a security against breakdown is a knowledge not merely of the average, but of the maximum temperature of the coil. Mr. Rayner's experiments have gone far to answer these questions, and have shown us how in many cases the maximum temperature can be inferred from quantities which can be measured, while in another series of researches he has examined the effect of keeping the insulating materials in general use at high temperatures for prolonged periods. This work is to be extended, but meanwhile the results have allowed the Standards Committee to draw up rules for temperature limits, etc., of great value, given in their report.

Dealing with the standardisation of electric lamps, Dr. Glazebrook said: We buy and pay for electric energy. What we want is light, and we take but little care to see that the lamps we use are as efficient as they may be. The committee have drawn up a specification for lamps which, if acted on, will add greatly to the satisfactory results obtained from carbon lamps. This is based in great measure on Mr. Paterson's work. The main outcome of the work is to show the necessity for life tests on specimens of lamps. Five per cent. of the lamps in a consignment are selected for preliminary tests of candle-power, watts per candle, and of these 5 per cent.—*i.e.*, 2·5 lamps per 1,000—are selected for life test. These lamps are run for 400 hours at the rated efficiency and their candle-power measured at intervals. From these measurements the candle-power hours of the lamp are determined, and hence its value as a source of light. In America millions of lamps are sold annually to a specification based on the results of such tests, and the National Physical Laboratory is now engaged in equipping itself for similar work in England. Similarly, the committee has issued numerous other electrical specifications of very great value.

Continuing, he said standardisation in electric matters has spread outside our island. The International Electrical Commission had its origin in the work of the Engineering Standards Committee which was brought by Colonel

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Crompton before the International Electrical Congress at St. Louis, and I am indebted to the very efficient secretary of the commission (Mr. LeMaistre) for accurate information as to the present position. As a result the following resolution was adopted: "That steps should be taken to secure the co-operation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardisation of nomenclature and ratings of electrical apparatus and machinery." The English delegates were asked to bring the matter forward in Europe, and an executive committee was appointed under the chairmanship of Mr. Alexander Siemens. A preliminary meeting was held in June, 1906, and rules which now await confirmation by the authorities appointing the delegates were agreed to. Lord Kelvin was appointed president. The rules require the appointment of electrotechnical committees in the countries co-operating. These committees have been appointed in Austria, Belgium, Denmark, England, France, Germany, Hungary, Mexico, Spain, Sweden, and the U.S.A., and the matter is being considered by Australia, Canada, Japan, Russia, South Africa, and Switzerland. The British committee have commenced on nomenclature by appointing a sub-committee under the chairmanship of Mr. A. P. Trotter. A list of terms used in the electrical industry, with the meaning of each, is being drawn up, and will, when it has been considered by the British committee, be circulated to the other committees. It is hoped that the meetings of the council will be held in London this autumn.

Now all this has been possible because electricity in quite early days established itself as a science of measurement, a science in which standards were possible. The history of our subject does not take us so far back as was the case in mechanical engineering. Electricity is a modern science, and its founders—Coulomb, Cavendish, Oersted, Ampère, Ohm, and Faraday—all lived within the last 150 years. From the earliest days it has been a science of measurement. Standardisation has been possible. Coulomb verified the law of the inverse square by his observations on the torsion balance, and the absolute measurement of a quantity of electricity followed as a consequence. Cavendish's experiments put the law on a more secure basis. Coulomb's work also standardised a quantity of magnetism, and Oersted's discovery of the force which an electric current exerts on a magnet was quickly followed by Ampère's classical investigations, in which he reduced to law the forces between a circuit carrying a current and a magnet, or between two circuits. Ohm, in the law which bears his name, stated the relation between a current and the E.M.F.'s producing it; while Faraday, by his idea of lines of force and his discovery of electromagnetic induction, enabled these forces in any electric circuit to be expressed in terms of the changes in the lines of magnetic force linked with it. Joule stated the relation between E.M.F. and a circuit on the one hand and the heat generated in the conductor on the other, and thus indicated one way in which electrical and mechanical units can be directly connected together.

The fundamental units we deal with in mechanics are those of mass, length, and time, the standards of weight and measures, and in terms of these other mechanical units, such as force or energy, can be expressed. When a quantity is determined in terms of these fundamental units it is said to be determined in absolute measure, and the electrical laws discovered by the workers I have mentioned allow the fundamental quantities met with in electrical science to be so measured. This is the first step to standardisation, and it was soon taken. Thus an electric current can be measured either by the force of attraction between two coils of wire through which it passes or by the force which it exerts on a magnet; the E.M.F. in a circuit is measured by the heat generated wherewith current traverses the circuit and the ratio of these two—E.M.F. to current—is found to be constant for a given conductor in a given physical state and measures the resistance of the conductor.

This last quantity, measuring as it does a definite property of a conductor—a piece of wire, for instance—was early fixed upon as one which ought to be standardised absolutely, and Wilhelm Weber attempted the task. He and Gauss recognised very fully the value to electrical science of a definite standard system of units, and he was the first to issue wire standards of resistance supposed to be of some definite absolute value. Previous to that time, and, indeed, for some years after, the units used in various countries, as Fleeming Jenkin pointed out in a well-known report to the Royal Society, had been most miscellaneous. Leng, in 1833, had taken 1ft. of No. 11 copper wire as his unit. Wheatstone (1843) suggested 1ft. of copper wire weighing 100 grains, while later in England the unit was one mile of No. 16 copper wire, in Germany one mile of No. 8 iron wire, in France a kilometre of iron wire 4mm. in diameter, until, finally, we reach Werner von Siemens's mercury unit—a column of mercury 1m. long, one square millimetre in section—to which in our recent legislation we have so nearly returned.

At this time the British Association Committee on Electrical Standards began its work. Appointed at the Manchester meeting in 1861, its history is the history of the standardisation of electrical units in England, and that history is closely bound up with the lifework of the great electrician whom England rightly honoured on that memorable occasion in Westminster Abbey a few months ago. William Thomson (Lord Kelvin) was a member of the British Association Committee for over 46 years, its leader all the time and the man who inspired its work.

The first report of the committee presented at Cambridge in October, 1862, by Williamson, Wheatstone, W. Thomson, Miller Mallhussen, and Fleeming Jenkin deals chiefly with the unit of resistance, and incidentally establishes the absolute system of electrical measurements in these words: "A battery or this motor of unit E.M.F. will generate a current of unit strength in a circuit of unit resistance and in the unit of time will convey a unit quantity of electricity through this circuit and do a unit of work or its equivalent." But before these units could be realised a choice must be made of the units of length and mass and time in terms of which they would be measured. Various systems were considered as the advice of men of science throughout the world obtained. Thus at an early date letters were received from Prof. Edlund, Fechner, Henry, Jacobi, Kirchhoff, Mallenci, Neumann, Poggendorff, Pouille, Weber, and from Dr. Wernher Siemens. In the end it was decided to take the centimetre as the unit of length, the gramme as that of mass, and the second as the unit of time—and thus was born the C G.S. system of units. The units of E.M F. and resistance on this system were both too small for practical use; the E.M.F. of the cells thus ordinarily used contains about 108 C.G.S. units, and this quantity was taken as a practical unit, and later it was called a volt. Siemens's unit of resistance contains approximately 109 C.G.S. units of resistance. This multiple of the C.G.S. unit, then, was taken as the practical unit of resistance and called an ohm, and the practical unit of current, called an ampere, being the current which one volt gives rise to in one ohm, is in C.G.S. units $10^8/10^9$ or 10^{-1}.

The first steps towards standardisation were to realise then the ohm, the ampere, and the volt in a form in which they can be utilised as standards, and the committee first dealt with the ohm. In their report (1862) they refer to Prof. Weber's work, and after explaining that they propose to make a new determination they state that: "If Prof Weber's results accord within 1 per cent. with these new determinations it is proposed that provisional standards shall be made in German silver in the usual way, and that they should be at once issued to all interested in the subject without waiting for the construction of the final material standard. At present we are striving to multiply this accuracy 1,000 times."

Dr. Glazebrook then referred to the various methods adopted for the determination of the absolute standards and to the result. He said: For the ohm Weber suggested several methods. (*a*) By the use of the earth inductor—A coil of mean radius a and n turns of wire is turned 180deg. about a vertical axis. The total change in the number of lines of force due to the earth's horizontal field, H, is $2\,n\,\pi\,a^2$ H, and if the ends of the coils are connected to a ballistic galvanometer of constant G, and R be the resist-

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ance of the circuit, the quantity of electricity which traverses the circuit is $2\,n\,\pi\,a^2\,H/R$. But if B be the first throw of the needle of the galvanometer and T its time of swing, this quantity is measured also by $H'\,T \sin \frac{1}{2} B/\pi G$, where H′ is the earth's field at the centre of the galvanometer coil. Moreover, if A be the mean radius of this coil and N the number of its turns, then approximately $G = 2\,N/A$.

Hence $$\frac{2\,n\,\pi\,a^2\,H'}{R} = \frac{H'\,T\,A \sin \frac{1}{2} B}{2\,\pi^2\,N}.$$

Hence $$R = 4\,\pi^3\,N\,n\,\frac{a^2}{A\,T} \cdot \frac{H}{H'} \cdot \frac{1}{\sin \frac{1}{2} B}.$$

Now the ratio H/H′ can be found with considerable accuracy; indeed, if the site and arrangements are properly chosen it is unity. Sin ½ B is a known number depending on the observed throw, and we have R, the resistance, determined in terms of the length, *a* and A, and the time of swing, T. It is thus found in absolute measure.

Another method due to Kirchhoff has also been used. If a current of strength *i* is reversed in the primary of a pair of coils in which the mutual induction is M, the total flow of electricity round a secondary circuit of resistance, R, is $2\,M\,i/R$. If this circuit contains a ballistic galvanometer of constant G, this quantity is $H'T \sin \frac{1}{2} B/\pi G'$, and if *i* is measured by a tangent galvanometer of constant G placed in a position when the field is H^a, then $i = H \tan \theta/G$, θ being the deflection.

Hence $$\frac{2\,M\,H \tan \theta}{G\,R} = \frac{H'\,T \sin \frac{1}{2} B}{\pi\,G'}.$$

Thus $$R = \frac{2\,\pi\,M}{T} \frac{H}{H'} \frac{G'}{G} \frac{\tan = \theta}{\sin \frac{1}{2} B}.$$

R is given in terms of quantities which can be measured.

The British Association Committee used a modification of the first method due to Thomson. The coil is made to rotate continuously at a uniform rate, being short-circuited at the time. An alternating current is set up in the coil, and is measured by the deflection of a magnet suspended at its centre. In the Lorenz method a disc is spun in a field, M *i*, due to a current, *i*, in a coil. If the disc make *n* turns a second, the E.M.F. round its centre and its edge is $M\,n\,i$, and this is balanced potentiometer fashion against the E.M.F., R *i*, due to the same current, *i*, flowing through a resistance, R, when the speed is that required for the balance, $R\,i = M\,n\,i$, and we have $R = M\,n$. The last method is the one from which the greatest accuracy is to be expected. The result is conveniently expressed in terms of the length of the column of mercury, one square millimetre in section, which at a temperature of 0 degree C. has a resistance of one ohm.

Turning to the ampere and the volt, Dr. Glazebrook said: The first is determined by measuring the attraction between two coils carrying a current, and the arrangements fall into two groups. (*a*) Electro-dynamometers: If two circular coils are placed with the coils at right angles and the axis coincident, the one being fixed and the other free to move about a diameter common to the two, then when a current traverses the coils the movable one tends to set itself with its plane parallel to the fixed coil. By measuring the couple which resists this we have a measure of currents. Or, again, (*b*) Current weighers: Consider a fixed coil with its plane horizontal, and imagine another coil suspended from one arm of a balance above this, the axes of the two being coincident and the planes, therefore, parallel. If a current passes through the coils there is attraction (or repulsion) between them, and by balancing this by weights in the other pan of the balance the absolute value of the current can be found. This value, it should be noted, will involve *g*, the acceleration due to gravity. Both methods have been used; the latter, suggested originally by Joule, in the hands of Lord Rayleigh, and later of Ayrton, Mather, and Smith, has given extremely exact results.

But a unit current cannot be carried about as a material object like a standard ohm. We must make use of some other property of the current to recover it. One of these is the deposition of a metal, say silver, from an electrolytic solution such as silver nitrate. Now, it has been found that an ampere as measured on the balance passing under defined conditions through a pure solution of silver nitrate deposits ·111827 grm. of silver per second, and hence we arrive at the international unit of current—that current which deposits silver at this rate. Again, when a current of an ampere passes through a resistance of one ohm, the E.M.F. between the ends of the resistance is one volt, and careful research has shown that cells can be prepared which, when set up according to proper direction, have a definite E.M.F. measured in volts. Such a cell is the Clark cell composed of zinc, zinc sulphate, mercurous sulphate, and mercury with an E.M.F. at 15deg. C. of 1·4328, or the Weston cell of cadmium, cadmium sulphate, mercurous sulphate, and mercury, with an E.M.F. at 20deg. of 1·0183 volts. These various units of resistance, current, and E.M.F. have been adopted by the different countries of the world as the outcome of the discussion at various international electrical meetings, the last being that of Chicago, held in 1893, which practically adopted the definitions arrived at the previous year at the Edinburgh meeting of the British Association Committee.

The definitions, however, of the various nations on which which legislation has been based are not identical. Moreover, recent research has been able to specify more exactly the conditions to be adhered to in making a silver deposit or setting up a standard cell, and, indeed, we have shown that the value generally accepted in the year 1893 for the value of the E.M.F. of the Clark cell needs revision. Hence it is generally agreed that the time has come for a further congress to revise the definitions and specifications in the light of modern knowledge and practice, which requires a higher degree of accuracy than was thought necessary 20 years ago. Such a conference is to be held this autumn in London, and we may hope will carry the standardisation of electric units one step further.

TRANSATLANTIC CABLE JUBILEE.

Aug. 17 will be the fiftieth anniversary of sending the first cable message across the Atlantic Ocean. In August of 1857 the first attempt to lay a cable was made, but about 300 miles from the Irish coast a strain caused by a sudden dipping of the sea bottom caused the cable to part, and the attempt was for the time abandoned. A message of 90 words from Queen Victoria to President Buchanan, which took 67 minutes to transmit, was sent through the 1858 cable, but after a few following short messages it ceased to transmit signals. One of the electricians on the U.S.S. "Niagara," which, together with the British war vessel "Agamemnon," laid this cable, always maintained that no message was ever sent, and that the message to Buchanan from Queen Victoria was "cooked up" for commercial purposes, his ground being that the cable had ceased to test out long before reaching the Newfoundland coast, and that on several occasions in paying it out accidents had occurred that had destroyed the insulation of the cable. In 1865 another unsuccessful attempt was made to lay an Atlantic cable, and the first operative cable was not laid until 1866.

HIGH-TENSION ELECTROSTATIC VOLTMETER.

Considerable difficulty has been encountered in measuring very high pressures, although many types of instruments are utilised which give satisfactory results for E.M.F. up to 25,000 volts. Accurate readings can be obtained by using a transformer, if all leakage is prevented, and non-inductive resistances may be utilised to advantage as multipliers. Other high-tension instruments have been designed with condensers in series, employed as multipliers. But difficulties have been encountered due to the various frequencies employed, it being hardly possible to construct an instrument with the same dielectric coefficient as the condenser.

The voltmeter described below has given excellent results. It is of the electrostatic type, and was recently designed by

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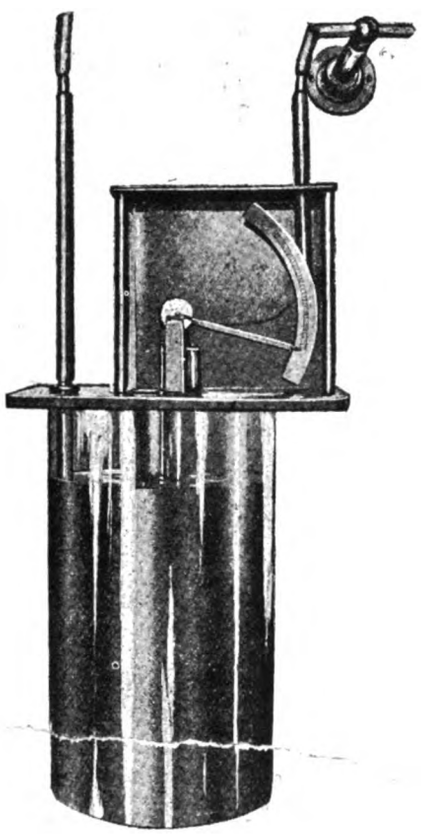
Prof. August Grau, of Vienna, Austria, for measuring E.M.F. not exceeding 90,000 volts. The apparatus consists of a glass jar filled with oil, which is used as a dielectric, with a glass plate resting on three supports at the bottom. A metallic cylinder is supported on this plate, forming one plate of the voltmeter, the connections being made to this cylinder, which is 5⅜in. high and 8in. in diameter, by a wire placed in a porcelain tube passing through the oil. A smaller cylinder, 4⅜in. long and 1⅛in. in diameter, is placed concentric with the larger cylinder suspended by a copper wire surrounded by a glass tube. A thin plate is attached to the lower end of this small cylinder with a lead weight of 200 grm. under the plate. A glass rod projects from the weight to hold the movable system, which is concentric with the large fixed cylinder. There is also a fine wire passing over a pulley connected with a counterweight, the pulley having the pointer attached to it and multiplying the suction of the cylinder, which travels up and down, the proper reading being indicated on the scale. The other side of the high-tension circuit is connected to the movable system, the conductor passing to the pulley through a



porcelain tube, while in order to damp the motion of the cylinder a plate is fastened to the lower end of it. There are three friction rollers fastened to the glass plate which holds the glass rod in position, the latter passing through an opening in the plate.

There should be a wide field of usefulness for this electrostatic voltmeter in measuring the E.M.F. of high-tension energy transmission lines and apparatus.—*Electrical World.*

THE FRAUDULENT USE OF ELECTRICITY FROM THREE-PHASE MAINS.

It is a common practice when supplying customers with current for power and lighting purposes from three-phase mains to give a proper three-phase three-wire supply for the motors and a separate two-wire supply for the lamps—each supply being separately metered. M. C. Herz, in *La Lumière Electrique*, points out that under the circumstances it is possible, with certain conditions, for the power meter to fail to act and the light meter to run in the reverse direction. The action is the result of the motors taking a heavy lagging current, and is analogous to the well-known difference in amount of power registered by the two meters used in the ordinary way for metering a three-phase supply by the two-wattmeter method.

ELECTRICITY FROM PEAT GAS.

The Dublin and Central Ireland Power Bill Fails.

A committee of the House of Commons presided over by Mr. Luke White has been considering the past few days the Dublin and Central Ireland Electric Power Bill. The Bill was opposed by the Dublin County Council, the Corporation of Dublin, the Pembroke and Rathmines Urban District Councils, the Dublin United Tramways Company, and the Alliance and Dublin Consumers' Gas Company.

Mr. FREEMAN, K.C., in opening for the promoters, stated that a company was to be incorporated for the purpose of supplying electric power to an area which comprised portions of the counties of Dublin, Kildare, King's County, and Queen's County, with a generating station in, approximately, the middle of the area. The electricity was to be generated by gas engines using peat gas by a process which had not yet become familiar in this country, but was very familiar in other countries, and by which electricity could be supplied at a very much cheaper rate than if coal or other means of providing generation had to be depended on. It was proposed to buy 500 acres of the peat bogs nearest the generating station. The depth of bog would furnish a supply for a great number of years, even on the most favourable assumption of business likely to be procured, and there was a sufficient supply of peat in the district for future requirements. Electricity would be generated at, it was estimated, a cost of ·05d., as compared with ·19d. in Salford and ·13d. in Newcastle, where the generation was by means of coal. It was also intended to produce sulphate of ammonia, which would be recovered in the process with a financial result that would about pay for the cost of the peat. Other by-products could also be obtained. The capital proposed was £450,000 in shares and £150,000 borrowing powers.

Evidence in support of the measure was given by Mr. JOHN STURGEON and Captain H. RIALL SANKEY.

The objectors contended that the scheme was speculative, experimental, and immature, and the finance of the scheme was severely criticised.

Mr. FREEMAN replied that the establishment of this particular scheme would attract a considerable number of manufactories and industries requiring power to the area of supply. As to finance, he frankly admitted that until they were able to launch the scheme they could not say exactly what financial support would be forthcoming, but they believed that it would be quite sufficient to enable them to start the undertaking.

On Wednesday, after the committee had deliberated for some time in private, the CHAIRMAN announced they had come to the unanimous decision that the preamble of the Bill was not proved.

BIRMINGHAM DIVISION OF ELECTRICAL ENGINEERS.

The County Association of Warwick has authorised Mr. J. F. Lister to raise in the Birmingham district three telegraph companies for the Territorial Army, and the assistance of the Institution of Electrical Engineers, through its local sections, has been solicited in the matter. The companies will consist of one wireless telegraph company, consisting of three officers and 66 men; one cable telegraph company, consisting of six officers and 150 men; one air-line telegraph company, consisting of seven officers and 282 men.

The training will consist of about 20 drills, and at least eight days' annual training, which will probably take place at such a time as to include August Bank Holiday week. All officers and a good proportion of non-commissioned officers and men are mounted. The County Association provides the mounts.

The minimum period of service is four years. The necessary outfit for an officer will cost about £40. If an officer wishes to purchase a complete outfit, including full dress, etc., the cost will probably be £60 or £70. Part of this expense is met by a Government grant of £20 on appointment. In addition officers and men during training in camp will receive pay at army rates. For officers this rate would be from 10s. per day, according to rank. The County Association will provide necessary uniform, equipment, etc., for non-commissioned officers and men.

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FORTHCOMING EVENTS.

FRIDAY, APRIL 3.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., meeting at the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne.

SATURDAY, APRIL 4.

Royal Institution.—At 3 p.m., "Electrical Discharges through Gases," by Prof. J. J. Thomson. (Lecture V.)

Manchester Students' Section.—At 2.30 p.m., visit to works of Messrs. Browett, Lindley, and Co., Patricroft.

MONDAY, APRIL 6.

Institution of Electrical Engineers (Newcastle Local Section).—At 7.30 p.m., at Armstrong College, "High-Speed Electrical Machinery," by Mr. G. Stoney and Mr. A. H. Law.

Dick-Kerr Engineering Society.—At 8 p.m., at the works, Preston, "Elevators," by Mr. R. V. Morse.

TUESDAY, APRIL 7.

Institution of Electrical Engineers (Manchester Students' Section).—At 7 p.m., business meeting; at 8 p.m., discussion on "General Testing," at the Municipal School of Technology.

Optical Society.—At 8 p.m., at 20, Hanover-square, W., "Colour Vision," by Prof. Bursch.

Institution of Civil Engineers.—At 8 p.m., meeting.

Liverpool Engineering Society.—At 8 p.m., discussion on "Electrical Incandescent Lamps" at Hackins Hey.

Junior Institution of Engineers.—At 8 p.m., at Royal Service Institution, Whitehall, "Purification of Water," by Mr. T. H. Hughes.

WEDNESDAY, APRIL 8.

Institution of Electrical Engineers (Birmingham Local Section). At 7.30 p.m., at the Technical School, Suffolk-street, "New Alternate-Current Instruments," by Dr. W. E. Sumpner and Mr. J. W. Record.

Royal Society of Arts.—At 8 p.m., "Technical Education in America," by Sir William H. Preece.

Association of Engineers-in-Charge.—At 7.30 p.m., at St. Bride's Institute, Fleet-street, "Indicators and Indicator Diagrams," by Mr. W. A. Tookey.

FRIDAY, APRIL 10.

Physical Society.—At 8 p.m., at the Royal College of Science, South Kensington, papers by Prof. Bragg and Mr. Madsen, and Mr. W. Duddell.

Royal Institution of Great Britain.—At 9 p.m., "The Carriers of Positive Electricity," by Prof. J. J. Thomson.

SATURDAY, APRIL 11.

Institution of Electrical Engineers (Students' Section).—Visit to the electric lighting station of the London and North-Western Railway, Chalk Farm.

Royal Institution.—At 3 p.m., "Electrical Discharges through Gases," by Prof. J. J. Thomson.

Birmingham and District Electric Club.—At 7 p.m., at the Colonnade Hotel, New-street, "Electric Train Lighting," by Mr. T. H. Bridcutt.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE FUTURE OF THE TELEPHONE SERVICE.

SIR,—Mr. Webb says that I am mistaken with regard to his relations with the National Telephone Company, but the *Newcastle Chronicle* of March 10 states definitely that he is chief of that company's contract department, and this accords well with what has been generally known for a long time, although his official designation may be different. Under cross-examination at the last Brighton inquiry, where he had given evidence as an independent witness, he admitted that he was in the employ of the company. It is, therefore, too late in the day to pose otherwise than as a paid advocate. As such, and in that guise, he is, no doubt, entitled to a hearing and to have his views considered. But he comes forward as an unbiassed commentator, and I decline to discuss telephone matters with him on that basis or to meet his statements about Glasgow or the other municipal telephone systems otherwise than by a direct denial of their truth. The municipal telephone authorities have long pressed for a Select Committee to inquire into their affairs. This, Mr. Webb—*i.e.*, the National Telephone Company—and the Post Office are, above all things, anxious to avoid, because they know that the increased tariffs are artificial and incapable of justification. The position is that the municipal telephone systems court inquiry while their traducers shirk it. Let the telephone-using community adjust their views accordingly.—Yours, etc.,

A. R. BENNETT.

INSTITUTION OF CIVIL ENGINEERS.

SIR,—We have to-day received a communication from the secretary of the Institution of Civil Engineers notifying us of a special general meeting of corporate members of the institution to be held on Friday next, April 3:

(1) To authorise the council to enter into an agreement for the sale of the institution premises to H.M. Government; and

(2) To consider, and, if approved, to adopt, the following alteration of the by-laws of the institution:—Section V., Clause 6, to be altered by the omission of the words in brackets and the addition of the words printed in italics. Every new member *shall, on admission to the institution, pay a fee of 20 guineas, and every* associate member and associate shall, on admission to the institution, pay a fee of 10 guineas; [but no payment, other than the increased annual subscription, shall be due from an *associate* member on his transfer to membership], *and every associate member on his transfer to membership shall pay a fee of 10 guineas. All such fees paid on transfer and one half of the fees paid on election to full membership shall be treated as revenue unless otherwise directed by the council.*

The letter further asked for a reply on a post card enclosed expressing agreement with or dissent from the proposal before March 31.

We venture to think, Sir, that the proposals deserve more time for consideration and discussion amongst the members than can possibly be given under the circumstances indicated above, and that before members can express their opinions as asked for on the post card they are entitled to further information.

The existing premises must presumably have been taken over by the Government at a fair price, and one fails at first sight to see the necessity for (*a*) a special building fund, (*b*) additional revenue derived from transfer and entrance fees. Surely it is putting the cart before the horse to ask for an expression of opinion before the meeting, when, presumably, information will be given.

We venture, further, to think that the vote on the proposal to alter the by-laws should be taken, not at this meeting called at only a week's notice, but at a further meeting at a later date, when those members who may be prevented from attending on April 3 have had an opportunity of considering the matter in the light of the printed report of the explanatory meeting.

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Many members are disposed to think that the erection of the new buildings provides an opportunity for making the premises of much greater convenience to the general body of the members than has been the case in the past.

It is true that engineers have at the ordinary evening meetings opportunities of meeting brother engineers from the provinces and abroad, but it appears to us that the institution might in a much greater degree than hitherto constitute a rallying point and meeting place for the members generally, and a place where informal discussion and conversations could be carried on.

The present building, stately as it is, does not contain a single cosy corner where two engineers can talk, much less smoke a friendly cigar together.

This is, however, neither the time nor place for consideration of such details, and we merely beg the hospitality of your columns to enable us to make an appeal to fellow corporate members who may think with us to ask for further time in which to come to a decision, and to communicate their views in writing to the secretary and to attend the meeting on April 3.—Yours, etc.,

(Signed) H. W. HANDCOCK.
A. H. DYKES.

Associate-members of the Institution of Civil Engineers.

March 27, 1908.

TRAMWAY STAFF PASSES.

SIR,—Referring to an article in last week's issue on the subject of "Staff Travelling Privileges," I entirely disagree with the writer that the "token system" as adopted by the London County Council tramways is by any means an ideal one. The elaborate and cumbrous machinery which such a system entails is absolutely not worth the candle. The underlying idea seems to be that each employé has the deliberate intention to rob the Council by an unauthorised use of the travelling privilege. Each journey has to be entered upon a special form giving details of letter, number of ticket, value of tokens used, date, and number of tokens used. This form, together with tickets, received has to be sent in each week to be checked. Previous to the issuing of tokens application forms, etc., have to be filled up. When one considers the number of employés, such a system must be very costly to administer, and the complexity involved in the application is so cumbrous as to defeat the object. The cost must be far and above the "limited pass" system, and the administration simply an absolute waste of time and money. These pedantic methods do not reflect much credit upon the authors of the system, for it is commercially indefensible.—Yours, etc., JUNIUS.

THE TESTING OF ONE DIRECT-CURRENT MACHINE.

SIR,—It is not my intention to enter into any lengthy correspondence with regard to the letter I published in your correspondence columns of March 20, 1908, describing two methods I had worked out for testing a single direct-current machine under full-load conditions by merely supplying the losses, as I prefer to await experimental results.

I shall be glad, however, if you will permit me to make the following remarks in reply to Dr. Lulofs's letter which appeared in your issue of March 27, 1908.

In the first place, I should like to point out that my methods are only intended to be used commercially, and not in the laboratory, consequently the use of an auxiliary machine and of low exciting pressures are not matters to which any very great objection can be raised. In a test house where all ranges of pressure, etc., are at hand, my tests will not present much difficulty, whilst connecting up an auxiliary machine involves nothing more than what is necessary for taking the magnetisation curve.

Whether my methods involve any more complicated schemes of connections than those which Dr. Lulofs suggests I am unable to say, but he also describes a method (in his letter to the *Electrical Engineer* for March 13, 1908) whereby an auxiliary machine is needed.

Further, with regard to the armature heating, I do not say this will be the same as under actual conditions, but, as far as I have been able to ascertain from tests up to the present, I have found the core losses practically equal to the actual; and here, again, I might point out that Dr. Lulofs mentions an error of 6 per cent. in one of his tests.

As far as I am concerned, however, the core heating does not interest me nearly so much as the sparking, and in this case also I venture to say the conditions will not be found very different from those which obtain in practice.

Lastly, I might just mention that Dr. Lulofs is wrong when he says I do not state in my second test that the poles must be given their proper polarity. Possibly he did not read my paper carefully, but if he refers to it again he will find I said: "Throughout the test the machine is run at full speed, and excited normally as for full load."—Yours, etc., STANLEY P. SMITH.

March 31, 1908.

THE ELECTRICAL PROPERTIES OF PORCELAIN.

The electrical properties of porcelain have been investigated by H. Haworth using porcelain plates 205mm. in diameter and 5·5mm. thick coated on both sides by sheets of tinfoil. In order to determine the amount of charge as a function of the time two such plates were connected in parallel to a source of voltage for a given time, and then discharged through a galvanometer. It was found that 90 per cent. of the charge was taken up within two seconds, while the full charge was completed within one minute. The charge was always proportional to the voltage, except due to temperature variation. The temperature had a marked effect on the capacity, as shown by the following figures:

Temperature degrees C.—									
·38	6	16·5	20	28	44	56	65	80	99
Capacity in thousandths of a microfarad—									
1·12	1·16	1·33	1·38	1·67	2·39	3·27	4·12	6·03	9·82

The increase in capacity between 0deg. and 30deg. C. was much less (54 per cent.) than that between 70deg. and 100deg. C. (108 per cent.).

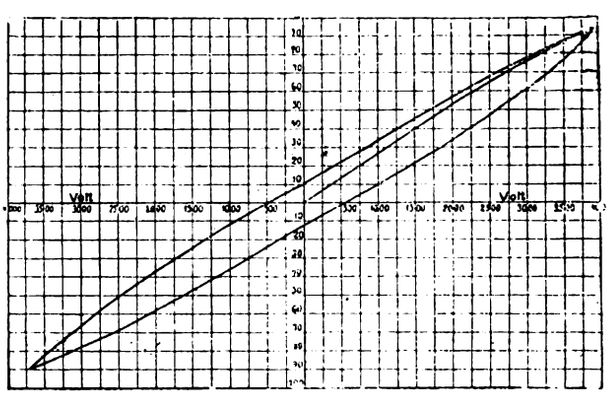

FIG. 1.

At 20deg. C. the specific inductive capacity of the porcelain was 8·95. In a further set of experiments the conductivity of the porcelain under a cyclic variation in voltage was studied. These showed that a polarisation effect is present, so that a dielectric hysteresis loop is formed as shown in Fig. 1. The energy so expended is proportional to the maximum value of the voltage. The conductivity falls with a long continued application of the voltage.—*Elektrotechnik und Maschinenbau.*

NOBLE ELECTRIC IRON SMELTER.

The new experimental furnace at the Noble electric iron smelter, at Heroult, on Pitt River, near Redding, Cal., has been run continuously for several days, turning out 2,400lb. of pig iron every 24 hours. The new furnace is the design of Prof. Dorsey Lyon, of Stanford University, who superintended its construction and is directing its operation. The recent test run was very satisfactory, the furnace being tapped regularly every four hours. The Lyon furnace differs from the Heroult electric furnace in that it is operated by a single-phase current, the other being of the three-phase type. After a month's thorough test of the Lyon furnace a larger one will be constructed so as to make a thorough test on a commercial basis of the process.

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EXHIBITIONS.

Commercial Motors at Olympia.

The second exhibition held at Olympia by the Society of Motor Manufacturers and Traders for commercial motor vehicles and motor boats was opened on Friday last by the Lord Mayor of London, and it may be said at once that this exhibition is, in point of quality, even better than the successful exhibition held in March, 1907, and it fully justifies the policy of continuing this series of exhibitions. In the main hall are the commercial motor vehicles, the display of which comprises considerably over 200 exhibits, including every system, and embracing everything from a small carrier with a capacity of 3cwt. to the heavy wagon to carry six tons, or the double-decked omnibus; also a small but comprehensive display of working machinery and stationary motors. In the annexe are displayed motor boats, of which there are over 30, ranging from an 8ft. yacht's tender to a 40ft. cruising launch with its 100-h.p. engines, etc. The usual extensive display of tyres, wheels, components, accessories, is to be found in the gallery.

A representative display of the application of electricity to motor vehicles is provided for visitors to Olympia, who may see electric vehicles, from the motor tricycle, delivery van, and wagon to the omnibus and the ambulance. Chief among the stands at which electrically-driven vehicles are to be seen is the Electric Vehicle Company, Limited, 1, Earl-street, Westminster, S.W. The exhibits at this stand include a 2-h.p. electric carrier motor tricycle, direct driven, having a carrying capacity of 3cwt., suitable for express delivery. There is also a 15cwt. to 1-ton electric light delivery van, driven by a single motor through a Cardan shaft drive, and fitted with special control, four speeds forward and two reverse, having a speed of 20 miles per hour and mileage range of 50 miles. Next will be seen a two-ton electric wagon, with two motors, chain drive, fitted with special control, four speeds forward, two reverse, capable of a speed of 12 miles per hour and a mileage range of 40 miles. In view of the interest aroused by the successful commercial operation of electrically-driven motor omnibuses, special attention should be given to the complete electric double-deck omnibus shown at this stand, built to order for the London Electrobus Company, Limited. The twin motors dispense with differential and all gear and chain drive. It is fitted with special check stop controllers, five speeds forward and three reverse, speed 12 miles per hour, mileage range 45 miles with full complement of passengers (34) under actual service conditions. The same company is also exhibiting an emergency repair wagon suitable for fire brigade, tramway work, electric motor services, and an electric ambulance fully equipped with all latest appliances and stretcher.

Adjoining this stand is that of Messrs. Greenwood and Batley, Limited, Albion Works, Armley-road, Leeds, who are showing a 35-h.p. standard double-deck omnibus chassis, the feature of which is the adoption of an improved form of electric transmission in conjunction with the petrol engine in place of clutch and change-speed gear. A 35-h.p. petrol motor is coupled direct to the electric generator supplying continuous current to a double-armature electric motor. The latter drives a live rear axle by worm gear without a differential. The speed of the car in relation to that of the engine is varied by an electric controller using no external resistance. The controller is operated by a handle below the steering wheel, and gives four forward speeds and a reverse. The method adopted is a combination of series-parallel and field control. The generator is connected to the crankshaft of the engine by a short flexible coupling. The motor is a four-pole enclosed series-wound, having two separate armatures within the same yoke running on ball bearings. It is carried on a trunnion and connected to the rear axle by a large central radius tube. There are two separate gears driven by the two armatures. As to wiring, insulated cables are carried in rubber and canvas pipes terminating in watertight unions at the controller, generator, and motor. No accumulators are used.

Another stand at which a petrol-electric arrangement is to be seen is at that of Messrs. J. and E. Hall, Limited, Dartford Ironworks, Dartford, Kent, who are showing a 30-38-h.p. three-ton "Hallford" petrol-electric omnibus chassis, 1908 pattern, with petrol-electric transmission gear under S.B.S. Syndicate and Stevens's patents. The chief feature of this system is in the situation of the electric motors outside the frame, rendering these, together with the worm gears, through which they drive the back wheels, quite accessible. A number of these 'buses are now in service in the South of London.

Other exhibits show the various uses to which electricity and electrical apparatus are put on motor 'buses. Messrs. Clarkson, Limited, of Moulsham Works, Chelmsford, are showing one of their public service steam omnibuses, the interior of which is lighted by electricity, as are also the usual outside regulation lamps, supplied from a generator, driven by the engine. A "Hesse" patent reversing gear driven by an electric motor is on view at the stand of the Teddington Motorcar and Launch Works. Messrs. D. Stewart and Co. (1902), Limited, Bridgeton, Glasgow, have a 70-b.h.p. three-cylinder vertical gas-engine (Stewart "Improved Otto"), direct-coupled to 40-kw. "Morris-Hawkins" dynamo, erected on antivibrator (Jolivet) system.

Several small petrol-electric light sets are shown by Messrs. Dixon Bros. and Hutchinson, Limited, of Woolston, Southampton.

At many of the stands are to be seen an interesting variety of electrical accessories. Messrs. C. A. Vandervell and Co., Worple Way, Acton, W., have on view some new designs in "C. A. V." electric side, tail, and head lights, roof lamps, dashboard indicators, and communicators; also special lighting sets suitable for private carriages, cabs, and 'buses. Various types of the "Lodge" ignition coil are on view at the stand of Messrs. Lodge Bros, Birmingham. Messrs. Boulton and Paul, Limited, Norwich, have a selection of "Norvic" whistles, which are worked from the ignition accumulator. Messrs. W. H. Willcox and Co., Limited, Southwark-street, London, S.E., are exhibiting oils, greases, injectors, rotary pumps, head and tail lamps, and general requisites, while an interesting display of castings distinguishes the stand of Messrs. Willans and Robinson, Limited, Victoria Works, Rugby.

Franco-British Exhibition.

We are pleased to announce that a definite movement is now being made in regard to making a thoroughly representative and effective demonstration of electricity. We understand that the committee have acquired a space of 7,000 square feet, on which will be erected four fireproof pavilions, in and around which will be shown electrical apparatus of every description in general use. At a meeting held on the 27th ult. some 15 or 20 of the largest electrical manufacturing firms made formal application for space, and a circular and plan of the exhibition stands is being prepared to send out to those firms who have already expressed their intention of taking part in the exhibit but were prevented from being present. Any other firms who are desirous of taking part in this movement should communicate at once with Mr. C. S. Northcote, 2, Queen Anne's-gate, Westminster, S.W., as space being limited, applications for same are dealt with in rotation, and very nearly half has been allotted. It is anticipated that within the next week or 10 days there will not be room for any further exhibitors. The committee of conference of the chief officials of the London supply companies have donated a substantial sum of money towards the cost of making this electrical advertisement, and although this is the first co-operative exhibit arranged for the electrical industry, its success seems likely to be undoubted, and the cost to individual exhibitors is, by means of combining all interests, quite nominal. We might add that the committee are desirous of obtaining offers from manufacturers of incandescent lamps or cooking apparatus which may be exhibited to arrange for demonstrations of lampmaking, heating, and cooking.

Manchester Electrical Exhibition.

The general committee organising the electrical exhibition, October, 1908, to be held in Manchester, held a meeting on the 24th ult., when the executive committee reported fully as to their proceedings up to date, and it was unanimously resolved to confirm the recommendations

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of that committee and to proceed with the final details in connection with the exhibition. The secretary (Mr. W. Davenport) was instructed to enter into a contract with the Manchester Corporation for the use of Platt Fields Park, Fallowfield, as the site, and to accept the lowest tender for the necessary buildings, the plans of which have been passed by the city architect, and the buildings have been licensed by the Manchester Corporation for one year. Since our last article appeared on the scheme the management have received numerous applications and inquiries for space. The secretary was instructed also to enter into the necessary contract with the Manchester Corporation Electricity Committee for a full supply of electrical energy. The current available will be continuous, at 200 volts for lighting and 400 volts for power, alternating, three-phase 400 volts. A preliminary prospectus or circular has been approved, and will be circulated forthwith, and rules and regulations, with a plan of the floor space available, are in course of preparation.

It has been decided that the exhibition should be opened on Saturday, Oct. 3, and close on the 31st of that month. The committee appointed Mr. S. G. Castle Russell, M.I.E.E., as honorary consulting electrical engineer, and Mr. Albert Jennison, Deansgate-arcade, Manchester, consulting architect. The activity which all members of the committee are displaying in the movement, together with the interest being evinced in all branches of the trade allied to the electrical industry, confirms the opinion which has already been formed, that the exhibition will be an unqualified success.

The First Municipal Exhibition.

What is actually the first Municipal and Public Health Exhibition will be held at the Royal Agricultural Hall from May 1 to 12, and we are informed that excellent progress is being made, and that the exhibition promises to be the marking of a new departure in this branch of enterprise. It is the aim of the organisers, Messrs. Smith and Bridges, to depict as comprehensively as possible the development and progress which has been made in the different branches of municipal work. In connection with lighting, some very interesting and instructive demonstrations are to be given, under the direction of Mr. Leon Gaster, showing the methods in vogue for the measurement of the illuminating power of different illuminants now in use Promises have been received from the Union Electric Company, the General Electric Company, Messrs. Robertson's, the Acetylene Corporation, etc., to provide lamps for this purpose, while a number of photometers in use in this country and abroad will also be loaned. This is a new departure in exhibitions, and should certainly attract a considerable amount of interest among municipal people, especially as there has been so much controversy recently on the respective merits of different forms of illumination. One or two papers will also be read at the conference on the subject by well-known lighting men. A special conference is being organised in connection with the exhibition, and it is hoped to arrange for municipal officials, councillors, etc., to visit places of interest on certain days. The work of technical schools is to be illustrated, and the excellent idea has been adopted of offering three or more diplomas in each branch of practical work done at the various schools by students during the last two sessions. This should result in a highly interesting and instructive section of the exhibition. The honorary advisory council of the exhibition will be glad if those who happen to have specimens of old appliances of photos, prints, etc., showing methods in vogue at early dates, models of new appliances, and improvements, etc., in any branch of work will communicate with the organising managers with a view of adding these to the loan section. The council also holds the opinion that there exists a large number of new ideas which have been embodied in patents for improvements of methods and appliances in different branches of municipal work which have not been commercially applied. In order to bring these under the notice of public officials, therefore, a special inventors' section will be organised, particulars of which may be obtained from the organising managers of the exhibition, Balfour House, Finsbury-pavement, London, E.C.

International Rubber and Allied Trades' Exhibition.

This exhibition was to have been held at the Royal Horticultural Society's Hall, Westminster, in September, but by the middle of March the whole space had been taken and applications continue to pour in. The committee have, therefore, been obliged to secure Olympia, in order that the various rubber-producing countries, traders, and manufacturers may be fully represented. The exhibition will open for two weeks, from Sept. 14 to 26.

TWO NEW FREQUENCY-CONVERTER PATENTS.

J. E. Noerggerath has recently taken out a patent for a frequency converter consisting of two rotary converters mounted on the same spindle. The current to be converted is sent into the slip-rings of one of the machines and the direct current produced is then sent into the commutator of the second machine (having a different number of poles), which finally delivers the alternating current of altered frequency. Both machines can be compounded by the direct current produced. Such a converter requires no separate exciter, as does the more ordinary arrangement consisting of a synchronous motor driving an ordinary alternator. Further, the armature reaction and heating are low in both machines, owing to the partial neutralisation of the direct and alternating currents, as in the case of the ordinary rotary converter.

The General Electric Company, of New York, employ a multiphase induction motor as a frequency converter. Both the stator and the rotor are provided with two separate windings of two different numbers of poles. One of the stator windings works together with the (short circuited) rotor winding of the same number of poles as an ordinary driving motor, whilst the second stator winding works with the second (slip-ring) rotor winding of like poles as a transformer. The motoring stator winding is arranged for reversal, so that the motor rotating field, and with it the rotor, can be made to revolve in either direction. If the rotor is run in the same direction as that of the rotating field due to the transformer stator winding the combination will act as a frequency reducer, whilst if the rotor revolves in the opposite direction relatively to the transformer field the frequency will be raised.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE

The thirteenth annual dinner of the Association of Engineers-in-Charge was held on Saturday, March 28, in the Holborn Restaurant. The growth of this useful association has often been referred to, and the association has sufficiently progressed to make its influence felt in engineering circles in this country. But it is only on occasions afforded by last Saturday's event, or by attending the monthly meetings at St. Bride's Institute, that one can have truly impressed upon one's mind the precise extent of the development of the association. The dinner was held in the largest hall of the Holborn Restaurant—the King's Hall—which was filled by the 300 odd guests who sat down to a sumptuous repast. Mr. W. H. Patchell, the president of the association, was in the chair, and was supported by many distinguished visitors, including his Honour Judge Rentoul, LL.D., K.C., Prof. Henry Adams, Mr. H. Percy Boulnois, M.I.C.E., Mr. Alexander Ritchie, J.P., Mr. W. T. Hatch (past president), Mr. E. B. Ellington (vice-president of the Institution of Mechanical Engineers), Captain H. Riall Sankey, R.E., Mr. Kenelm Edgcumbe, M.I.E.E., Mr. E. G. Rivers, I.S.O., M.I.C.E. (vice-president), Mr. A. Davey (chairman of the association), Mr. A. E. Penn (vice-chairman of the association), Mr. H. Swann (hon. treasurer), Mr. H. Capsey (hon. secretary), and others. The after-dinner oratory was, on the whole, pleasant, and was relieved by many bright flashes of humour. An excellent musical programme was provided by Mr. George Hardy, and a very pleasant and enjoyable evening was spent by all present at the dinner.

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THE MAGNETIC ACTION OF CATHODE RAYS.

It is now generally admitted that cathode rays convey a negative charge with them. This is evidenced by the fact that the rays are deflected by a magnet in the same way as a flexible conductor carrying a negative electrical stream would be deflected. Experiment has shown that an electric charge set in rapid motion produces a magnetic field proportional to the speed of motion and to the amount of the charge. The production of a magnetic field by the cathode rays might, therefore, be reasonably expected, and experiments have been made in this direction by Hertz and others, but with entirely negative results—probably due to want of sensitiveness in the apparatus used and to the numerous sources of error. E. Klupathy has recently repeated the experiment with a very sensitive magnetometer, and has succeeded in proving that the cathode-ray stream from a cathode tube sets up a magnetic field corresponding to a negative current from the cathode. By replacing the tube by a straight wire and passing a sufficient current to produce the same effect on the magnetometer, it was found that this current was equal to 4×10^{-6} amperes. Experiments with stronger bundles of cathode rays—such as occurs in the Wehnelt tubes—showed no magnetic effect. This somewhat surprising result is apparently due to the speed being too slow in the case of these rays. This is confirmed by the fact that even with the ordinary cathode tubes, "hard" tubes—*i.e.*, tubes with high-speed rays—gave much better results than "soft" tubes with their slower speeds.—*Elektrotechnik und Maschinenbau.*

TELEPHONE RATES.

The Postmaster-General was asked in the House of Commons on Wednesday whether he was prepared to make any statement as to the future policy of the Post Office on the subject of telephone rates, and especially in regard to the financial basis on which he proposed that the Post Office telephone system should be conducted.

Mr. BUXTON replied as follows: I am glad to have an opportunity of stating my views on the question of the future policy of the Post Office in regard to telephone rates. I consider that the Post Office telephone system should be conducted on a sound business basis; that is to say, that the revenue should be sufficient to provide for current expenditure of all kinds, for the maintenance and adequate renewal of plant, and for interest at 3 per cent. on capital expenditure, together with a moderate but not excessive margin of profit. In order to ascertain whether the rates are fixed at a level sufficient to satisfy these conditions, and to put the telephone service on a business footing, it is necessary that there should be a clear separation between the revenue and expenditure of the telephone service and the revenue and expenditure of other branches of the Post Office, especially of the telegraphists. It is in this way alone that the telephone system can be made to stand on its own basis, unaffected by the profit and loss made on other Post Office services. The various branches of Post Office work are, in practice, frequently conducted in the same building, sometimes by means of the same plant and under the supervision of the same persons. The separation of the cost is consequently a matter of some difficulty. Last autumn, therefore, I appointed an expert committee, including the president of the Institute of Chartered Accountants, to investigate this question and to advise me as to the best method to be adopted for separating the accounts. The committee has not yet finished its work, but, as a first result of its investigation, the estimates for 1908-9 have been presented to the House in such a manner as to separate the expenditure on telegraphs and telephones, and the telephone revenue will be shown separately.

The new telephone rates must to some extent be regarded as experimental. Longer experience is required before it is possible to say what what may be the permanent cost of operating a fully-developed system, or to ascertain with any accuracy the life of the varying descriptions of telephone plant, having regard especially to probabilities of obsolescence and the consequent necessity of replacing plant before it is worn out. Moreover, the conditions under which the Post Office service is conducted will be considerably modified when the system of the National Telephone Company is taken over by the Post Office at the beginning of 1912.

Although it is not possible for me to pledge my successors, I should anticipate that the principles which I have stated above as those which should determine the rates will be accepted by them, and the rates will doubtless be from time to time modified in accordance with those principles.

BRUCE PEEBLES AND CO.

A meeting of the creditors of this company was held in London on Friday last, Mr. A. W. Tait (one of the liquidators) presiding.

The chairman submitted the following balance-sheet, made up from the books at Feb. 14, 1908:

Liabilities.

	£	s.	d.
Share capital—30,000 preference shares of £5 each, fully paid, £150,000; and 28,381 ordinary shares of £5 each, fully paid, £141,905	291,905	0	0
Debentures, £75,000; and interest accrued, £1,352. 18s. 9d.	76 352	18	9
Debts due by the company, including loans and amounts due to sub-contractors	169,150	10	8
Overdraft at bank	41,614	1	6
Special reserve fund	11,556	14	4
General reserve account	27,000	0	0
	£617,579	5	3

Assets.

	£	s.	d.
Land and buildings	49,000	0	0
Plant, machinery, tools, and fixtures	80,540	4	7
Trade marks, patents, and goodwill	23.557	10	2
Stock, stores, work in progress, and finished work	79,780	7	8
Debts due to the company, including balances on current contracts	87,134	9	10
Cash on hand and in bank	1,498	7	8
Shares and debentures in power and traction companies	119,744	7	0
Endowment policies	1,300	0	0
Special reserve fund investments	11,937	2	0
Profit and loss balance	163,086	16	4
	£617,579	5	3

Mr. Tait explained that the losses had been due to a variety of causes, but they all hinged upon the fact that the company had been seriously in want of working capital for some time past. The year 1907 was a very difficult one for all manufacturing concerns, and for the electrical industry in particular. There had been an abnormal rise in raw materials, while the price of the finished article had steadily decreased. Summarising the causes which had led to the present crisis, he said their difficulties were due to losses on contracts, following upon the high price of raw materials, to insufficient reserves for contingencies, to losses due on the realisation of securities, to an insufficiency of working capital, and to the heavy expenses in connection with the administration of the business. If there were a forced realisation, the assets, he calculated, would realise only about 6s. 6d. in the £, and even this could not be distributed among the creditors for a considerable time—probably two years. If the business were reconstructed on a reasonable footing, notwithstanding the dull times in the electrical world, reasonable profits should accrue to the concern if it were properly administered by a Board having knowledge of the business. He detailed the following scheme: that the debentures should be extended for 10 years; that the interest should remain, at at present, 5 per cent., with a sinking fund of 2 per cent. per annum; and that the trade creditors should accept 7s. 6d. in the £ in a debenture which would be redeemed by the proceeds of the sale of securities and the collection of contract balances. This 7s. 6d. he considered should be paid in a short time. Thus they would receive probably more in cash under the scheme than by a forced liquidation. The other 12s. 6d. would be given to the creditors in the shape of a cumulative 6 per cent. preference shares in the new undertaking. Altogether 120,000 cumulative preference shares would be issued, of which 30,000 would be offered at par to the shareholders for subscription, and that would provide £30,000 for working capital and for redeeming debentures—the second debentures the creditors were asked to take.

Eventually a committee representing English and Scotch creditors was appointed to go into the matters detailed by the chairman, such committee to report the result of their labours to the creditors.

PERSONAL.

Mr. S. Hann, electrical superintendent to the Stoke Newington Borough Council, has had his salary increased from £150 to £175 per annum.

We are informed that Mr. William Embleton-Fox, of Northorpe Hall, Lincoln, has joined the Board of Messrs. Robey and Co., engineers, Lincoln.

Mr. P. F. Brittain, 110, Cannon-street, London, E.C., has been appointed sole selling agent in England, Ireland, and Wales for the Universal Electrical Manufacturing Co.

Mr. E. C. Amos, 22, Walbrook, London, E.C., has been appointed sole agent for London and district for Messrs. Wright and Wood, of Halifax, for motors, dynamos, and other specialities.

Mr. P. W. Beatty, chief electrical engineer of the Pacific Railway, has left for England, in connection with the tenders for the new

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power-house which is to be erected at Bahia Blanca at a total cost of £250,000.

Mr. J. Cornish, chief engineer to the six associated companies of the Grand National group, has been appointed chief engineer to the City of Santos Improvements Co., carrying on the business of electrical traction, lighting, gas and water service.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Cuba Submarine Telegraph Co.—The directors recommend a dividend at the rate of 6 per cent. per annum for the past half-year.

St. Marylebone.—The London County Council have decided to lend the sum of £31,306 to the Borough Council for electric lighting purposes.

Colchester.—The output of electricity from the Corporation works during February totalled for lighting 86,141 units and for traction 39,064 units.

Chatham.—The Medway Board of Guardians have asked the Laundry Committee to consider a proposal to install electric light throughout the workhouse.

Acton.—The District Council have decided to engage the services of an expert electrical engineer at a fee of 100 guineas to report as to the electrical undertaking of the Council.

Wrexham.—The Town Council have decided to apply to the Local Government Board for sanction to the borrowing of £6,850 for the purpose of extending the electricity works.

Aston Manor.—The Local Government Board will hold an inquiry on April 7 into the application of the Council for sanction to borrow £25,213 for purposes of their electricity undertaking.

Notice of Dividend.—The *London Gazette* states that a first and final dividend of 1s. 11½d. in the £ has been declared in the estate of the British Electric Equipment Co., 265, Strand, London.

South Metropolitan Electric Light and Power Co.—The warrants for payment of interest due April 1 on the 4½ per cent. first mortgage debenture stock of this company have been posted.

Liverpool.—The Electricity, etc., Committee are recommending the Council to apply for sanction to the borrowing of £3,000 for the purchase of a site for the North-end sub-station in Beaumaris-street.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the four weeks ended Feb. 28, 1908, were 298,976, compared with 271,037 units in the corresponding four weeks of 1907.

Frome.—On Tuesday Mr. H. Ross Hooper, one of the inspectors of the Local Government Board, resumed his inquiry into the Frome Urban District Council's application to borrow the sum of £10,000 for purposes of electricity.

Derby.—The Electric Lighting Committee estimate that £7,500 will be required for capital expenditure during the year, and are asking the Council to make application to the Local Government Board for sanction to the same being raised by loan.

Release of Trustee.—According to the *London Gazette*, Mr. F. Gimblet, 7, Adam-street, Adelphi, Strand, W.C., has been released from trusteeship in the estate of Mr. F. Beville de Foe Paynter, electrical engineer, 2, Faversham-road, Catford, Kent.

Glasgow.—The Corporation have agreed to accept the offer of the electricity department, amounting to £30. 17s. 8d., to install the electric power at Dixon Hall necessary for cinematograph entertainments. The competing price from a contractor was £31.

Birkenhead.—The Electricity Committee have passed a resolution for the laying of feeder mains at a cost of £4,114 in Craven-street, Park-road North, and Laird-street to Mallaby-street, and from the end of Conway-street down Vittoria-street to Cleveland-street.

Leek.—The Urban District Council have decided to invite tenders for the erection of the building and the supply of the necessary plant required in the extension of the works, the acceptance of tenders to be subject to the consent of the Local Government Board being given to the loan required for the works.

Stoke-on-Trent.—During the month of February there were supplied from the Corporation works 42,900 units, an increase on the corresponding period of last year of 90 per cent., the number of consumers on the books being 352, representing a total of 15,290 32-watt lamps for lighting and heating, and 582½ h.p. in motors.

Clones (co. Monaghan).—At a meeting of the Urban District Council the subject of the electrical lighting of the town was discussed, and a communication from a Birmingham firm was read. The Council was disposed to obtain a provisional order, but decided to adjourn the matter pending further information as to the probable cost.

British Electric Transformer Co.—The company report that the net trading profits for the past year were £6,247. Deducting the adverse balance of £3,998 brought forward, £2,249 remains. It is proposed to add £1,300 to the depreciation reserve, and to pay the preference dividend at the rate of 6 per cent. per annum for the six months ended Dec. 31, 1906, carrying forward £34.

Hanwell.—The Works Committee of the Council have had under consideration the report of Mr. H. S. Russell on the alternative proposals of the Metropolitan Electric Supply Co. and the Corporation of Ealing with regard to the Council's electric lighting order, and have resolved to recommend the Council to make arrangements with the Metropolitan Electric Supply Co. for the taking over of the order.

York.—The return for the month of February from the Corporation works included the following statistics: units generated, 154,882; approximate units sold, 127,451. Horse-power of motors connected during February, 17; total horse-power of motors connected to date, 1,010½; 8-c.p. lamps connected during February, 197; total 8-c.p. lamps connected to date, 60,198; equivalent 8-c.p. lamps connected total 84,455.

British Westinghouse Electric and Manufacturing Co.—The company announce an issue of £250,000 (part of a total authorised issue of £300,000) 6 per cent. prior lien debentures in 2,500 debentures of £100 each to bearer. Any debentures not previously redeemed will be repayable at par on Jan. 1, 1933. The price of issue is £98 per debenture, and applications should be lodged with the company's bankers on or before April 8.

Liquidations.—The *London Gazette* announces that a general meeting of the members of the Chatham, Rochester, and District Electric Lighting Co. will be held at 4 p.m. on May 21, at 22, High-street, Chatham, for the purpose of receiving the liquidator's report. A general meeting of the members of the York Electrical Co. will be held at 2 p.m. on April 29 at Yorkshire Bank-chambers, Nessgate, for the same purpose.

Mansfield.—At the last meeting of the Town Council it was reported that during the month 809 8-c.p. lamps had been connected. It was stated that in 1904 the output of electricity was equivalent to about nine million cubic feet of gas, but in 1907 the electricity output was equivalent to 70 million cubic feet of gas. The increase was being maintained, and there was no doubt that in a short time an extension to the works would be necessary.

Southampton.—The Town Council have agreed to charge a flat rate of 1d. per unit for the supply of current in places where the electric light is already installed for heating and cooking purposes, also to reduce the charges to £2 per lamp in the annual charge for the public arc lighting, and to make ¼d. reduction in the charge for current in respect to the metered lamps. For power purposes a reduction of ½d. is to be made to the Tramway Committee.

Trafford Park.—We learn that one of the largest firms on this estate is offering at cost price about 50 acres of its freehold not required for extensions. This firm was one of the original buyers, so that, considering the great improvements since made at Trafford Park for facilitating all sorts of industrial operations, the chance of picking up a bargain in land should not be missed, especially as our Continental friends, urged by the new Patent and Designs Act, are now actively bidding for lots everywhere.

Oriental Telephone and Electric Co.—The directors of this company are recommending the shareholders, subject to final audit of the accounts, the payment of the following dividends: at the rate of 6 per cent. per annum on the preference shares for the half-year ended Dec. 31 last, less income tax; a final dividend of 5 per cent. on the ordinary shares issued, free of income tax, making a total of 8 per cent. for the year. The share transfer books of the company will be closed from April 17 to 29, both days inclusive.

Ashton.—The Ashton Board of Guardians have been informed that their application to the Local Government Board for permission to borrow £2,000 for the provision of plant for the electric lighting of the new hospital and workhouse has been refused. The reason given for the refusal was that the Guardians would not be able to generate electricity at a less cost than 3d. per unit, and that they could buy it more cheaply from the Corporation. The Guardians have claimed that the cost of their scheme would be only 2d. per unit.

Secret Commissions and Bribery Prevention.—The Secret Commissions and Bribery Prevention League has now received its certificate of incorporation, and a public meeting in furtherance of the objects of the league will shortly be held in the city of London. The league (of which Sir Edward Fry is president, and the Archbishop of Canterbury, Earl Fortescue, Sir William Holland, Bart., M.P., Sir Albert Spicer, Bart, M.P., Sir William Mather, and Mr. David Howard are vice-presidents) has now upwards of 200 members.

Aberdeen.—A decided improvement has been effected in the lighting of the Albert Basin by the erection of electric lamps on the extremities of the pontoon dock. Hitherto the pontoon has been a menace to incoming vessels, and it is indeed surprising that no collisions between them and the construction have taken place. The lights were in use for the first time on the 25th ult., and the crews of incoming vessels expressed themselves highly pleased with the new departure, and they found much less difficulty in getting their ships berthed at the market side. The lights illuminate almost the whole of the upper part of the dock.

Haslingden.—In seeking terms for the supply of electricity to the workhouse buildings the Board of Guardians have received a reply from the Rawtenstall Corporation, stating that they would be prepared to supply the Board with electricity for lighting the house and the new infirmary at the rate of 4½d. per unit. The committee have, however, deferred the further consideration of this matter until a report has been received from their own electrical expert, but they have decided to ask Rawtenstall if the terms quoted included the cost of laying the cable and if the terms are the lowest possible. Terms from other boroughs are also to be obtained.

Stock Exchange.—The Stock Exchange Committee has appointed April 9 a special settling day in British Aluminium Co.'s 20,000 ordinary shares of £5 each, fully paid, Nos. 40,001 to 60,000, and 20,000 7 per cent. cumulative preference shares of £5 each, fully paid, Nos. 40,001 to 60,000, and Nigeria Bitumen Corporation's further issue of 1,793 shares of £1 each, fully paid, Nos. 183,408 to 185,200; and April 10 in Vickers, Sons, and Maxim's scrip (fully and partly paid) for £1,000,000 5 per cent. third mortgage debentures of £100 each. The committee has also ordered Mexico Tramways Co.'s 200 000dol. additional general consolidated first mortgage 5 per cent. gold bonds of 500dol. each, Nos. B 13,201 to B 13,600, and Vickers,

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Sons, and Maxim's scrip (partly paid) for £1,000,000 5 per cent. third mortgage debentures of £100 each to be quoted in the official list.

Morley.—At a special meeting of the Town Council a communication was read from the Yorkshire Electric Power Co., stating the terms and conditions upon which they were prepared to supply electric current in the bulk for the purpose of the tramways in Morley and district. Plans prepared by the borough electrical engineer for providing the power for the tramways were also examined and discussed. It was resolved that the Corporation provide additional plant required to supply the power for the tramways, and that the plans and specifications submitted by the borough electrical engineer be approved, and that application be made to the Local Government Board for authority to borrow the sum of £7,942 to carry out the work, also that application be made to the Local Government Board for authority to borrow the sum of £5,000 for new electric cables.

Electrical Engineers on the s.s. "Lusitania."—On March 28, by the kind permission of the Cunard Steamship Co., the members and friends of the Liverpool and District Electrical Association paid a visit to the s.s. "Lusitania," which was lying in the River Mersey on her return from New York. A party of about 150, including many ladies, took part in the excursion, and were conveyed to and from the Liverpool landing stage by the tender "Skirmisher." Mr. J. J. Richardson, vice-president of the association, and Mr. S. Frith, hon. secretary, were with the party, and also a large number of gentlemen connected with electrical and mechanical engineering. The visitors were shown over the large steamer and enjoyed themselves greatly, the ladies admiring the beautiful fittings of the saloons, staterooms, etc., whilst the gentlemen were more particularly interested in the engine-room. The visit, in fact, was both educational and interesting.

Leeds.—At last month's meeting a deputation waited upon the Council and asked that the charges for electricity for power and heating purposes might be revised. Since then the Tramway and Electricity Committee have had the matter under consideration, with the result that a reduced scale will be recommended to the Council for adoption. When the quantity consumed is less than 250,000 units a charge, based upon the number of units consumed per kilowatt of the consumer's maximum load, is proposed to be made according to a graduated scale as follows: less than 300 units per kilowatt per quarter, 1¾d. per unit; from 300 to 450, 1½d.; 450 to 600, 1¼d.; 600 to 720, 1¼d.; 720 to 850, 1d.; 850 to 1,000, 0·95d.; 1,000 and upwards, 0·9d. When the units consumed are 375,000 or upwards but less than 500,000 the charge will be ·85d., and for a consumption per quarter of 500,000 or upwards, the charge will be ·80d. This, if adopted, will take effect as from April 1, when the cost of current for cooking purposes, etc., will be at the rate of 1½d. per unit.

TRACTION.

Madras Electric Tramways (1904).—The receipts for the fortnight ended March 31, 1908, totalled Rs.19,446, being a decrease of 5·8 per cent. over the corresponding period of 1907.

Brisbane Electric Tramways Investment Co.—The directors recommend a dividend of 4s. per share, free of income tax, on the ordinary shares, being at the rate of 4 per cent. per annum, and that £2,130 be carried forward.

Blackburn.—The traffic returns of the Corporation tramways for the week ending March 18 show that during that period 190,388 passengers were carried, the receipts amounting to £976. 14s. 3d., an increase of 13,432 passengers and £88. 19s. 5d.

Buenos Ayres and Belgrano Electric Tramways Co.—The receipts for the week ending March 25 were £3,782, as against £3,837 in the corresponding period last year—decrease, £55. Aggregates from Jan. 1, 1908, £44,962; aggregates from Jan. 1, 1907, £44,477—increase, £485.

Bristol.—It was stated at a committee meeting last week that the difficulties with which the Bristol Electric Tramway Co. had previously to contend with preliminary to running the electric cars to Westbury had been surmounted, and that within a few months a commencement would be made with the laying down of the lines.

Battersea.—The London County Council have, on the recommendation of the Highways Committee, resolved to communicate with the Board of Trade and the road authorities concerned, with a view to the adoption of the underground conduit system of electric traction upon the existing tramways from Lavender-hill, *via* Queen's-road, to Chelsea Bridge, at an estimated cost for track work, cables, etc., of £53,013.

Dundee.—A conference has been held between the Tramways and Electricity Committees of Dundee Town Council with reference to the price of the current supplied for tramway purposes. The present charge is 1¼d. per unit, and the Joint Committee agreed to recommend that for the year beginning in May it should be reduced to 1¼d., and that if the consumption reached 2½ million units and everything was favourable it should in the following year be 1d. per unit.

Blackpool.—From April 1, 1906, to March 19, 1907, the total receipts on the Blackpool Corporation tramways were £51,745, a decrease of £1,156 as compared with the preceding year. The promenade line showed a falling off of £1,261, while the Marton line took £1,162 more. The passengers showed a decrease of 17,693, while the cars ran 11,084 fewer miles. The total figures for the year ending this month will compare favourably with the original estimate.

Derby.—The receipts of the Corporation tramways for the four weeks ending March 21 were £3,052. 3s. 5d., being an increase of £275. 9s. 7d. compared with the corresponding period of 1907. The tender for men's uniform, amounting to £270, of Messrs. J. Smith and Co., of Derby, has been accepted. The Council is asked to sanction the extension of the tramways to the borough boundary on the Burton road at a cost of £6,500, and that Mr. G. F. Tomlinson be employed to carry out the work.

London County Council Tramways.—The traffic receipts on the tramways owned and worked by the London County Council for the week ended March 21 last were £30,045, against £29,023 in the corresponding period of last year, the number of passengers carried being 6,960,997, against 6,738,037 in the previous year. The total traffic receipts from April 1, 1907, the beginning of the financial year, to March 21 last were £1,580,849, against £1,339,016 in the corresponding period of last year.

Anglo-Argentine Tramways Co.—The company report that, including the Buenos Ayres and Belgrano system, from July 1 the gross receipts for the past year were £1,009,568; working expenses (which include £65,000 carried to depreciation renewals funds, in addition to ordinary maintenance) were £654,076. Adding £10,081 brought forward, there is an available sum of £365,573. A dividend of 4s. per share (8 per cent.), free of income tax, is proposed on the new ordinary shares, leaving £16,734 to be carried forward.

London United Tramways Co.—Mr. C. Cater Scott, who presided over the meeting of this company on the 27th ult., said the time had now come when they must allow their system to consolidate and develop. All they would do for some time to come would be to electrify the Kew and Richmond line, and effect the construction of two furlongs over Kew Bridge. Their total mileage was now 55½. Traffic receipts in 1907 were £345,570, an increase of £16,697; and they had carried 58,725,980 passengers, an increase of 6 per cent., the average receipt per passenger being slightly less.

Aberdeen.—At a meeting of the Tramways Committee of the Town Council there was a long discussion on the question of the renewal of the agreement between the Corporation and the Aberdeen Suburban Tramways Co. for the supply of electric power to the company. It was resolved to recommend that a suggestion be made to the company that the question as to the price to be charged for the current under the agreement be submitted to an arbiter to be chosen by the Board of Trade. The electric engineer's monthly statement showed that in February 554,368 units of electricity were generated, compared with 481,443 units in February last year.

Bradford.—The financial year of the Bradford Corporation Tramway Committee ended on the 31st ult., and although the figures will not be available for a day or two there is every reason to believe that the receipts of the department will show a substantial increase on the takings of the previous 12 months, and so create a new record. Last year the total received was £232,499, and this figure had been passed on Saturday last, when the takings, including fares and parcels, amounted to £236,131. Adding to this a sum of £1,565 as the probable receipts of Tuesday last, the year's total thus reaches £237,696, or an increase on the previous year of over £5,000.

Birmingham.—Six persons were injured at Birmingham on Saturday afternoon by a tramway accident on a line operated by the cable system of traction communicating with Handsworth. The car was completing its journey into the centre of the city with about 20 passengers, and the stopping lever failed to act when the driver attempted to apply it. The conductor hastened to put on the slipper brake, but there was a violent impact as the car rushed against the underground stop blocks at the end of the track. The tram was not overturned, however. The outside passengers saved themselves from being flung over by clinging to the sides, but six inside passengers were injured and conveyed to the hospital.

Ashton.—On the night of the 25th ult. an alarming tramcar accident occurred at Denton. A car belonging to the Oldham, Ashton, and Hyde Electric Tramway Co. was going down Broomstarr Brow, a steep incline in the direction of Hyde, when it suddenly left the metals, and rushing at a terrific speed ran into a boundary wall across the road. The car overturned and fell into a yard below the level of the road. The driver, a man named John Wilson, was thrown out, but escaped unhurt. There were several passengers in the car at the time, but none of them were seriously injured, all escaping with a severe shaking. The car had to be left all night in the place where it had fallen. It is not definitely known what was the cause of the accident, but it is supposed that the brake chain snapped.

Newcastle.—At the meeting of the Corporation Tramways Committee a discussion took place concerning the falling off in the receipts due to the strikes. The chairman, vice-chairman, and manager had been appointed to see what could be done in the matter. The chairman explained that they had decided to curtail the service in many of the districts, giving a five minutes' service, except in the Spital Tongues and Fenham districts, which have a 20 minutes' service. A car leaves Fenham at the hour and Spital Tongues at 10 minutes past the hour, thus giving at the bottom of Brighton-grove a 10 minutes' service. By this arrangement, instead of extending the holidays of the motormen and conductors from April to September, it has been arranged to let them go in batches of 50 and 60 a week, and this will obviate the necessity of dismissing any men, the suspension being in place of the summer holidays, for which the men are paid.

Liverpool.—The annual report of the traffic manager, Mr. C. W. Mallins, regarding the working of the Liverpool Corporation tramways is, as usual, very interesting reading. After detailing the routes, stages, fares, and services opened or extended during the year, he mentions that 27 persons were knocked down or fell in front of the cars in the course of the year, but they were pushed clear of the metals by the plough lifeguard without sustaining any serious injuries. The ratio of fatalities to passengers carried was 1 in 12,404,324. Ten persons met their deaths in the course of the year, five being pedestrians, two passengers, one a cyclist, and two carters. The number of cars in stock is stated to be 515, and an ordinary day's service consists of 398 cars. The passengers carried during 1907

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numbered 124,043,239, the receipts amounted to £572,822, and the mileage to 12,231,799. The increases over 1906 were: passengers, 1,948,711, equal to 1·59 per cent.; receipts, £9,045, equal to 1·60 per cent.; and mileage, 115,865, equal to ·95 per cent. The average earnings per car mile were 11·24d., as against 11·17d. in 1906, an increase of ·07d. per car mile. The traffic receipts and car mile earnings, together with the number of passengers carried, are the highest recorded in connection with the Liverpool electric tramways. The receipts exceeded those of 1905 by £22,738.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Dundee.—The Town Council invite tenders for the supply of stores to the electricity department. Tenders by April 13.

Queensland.—The Postmaster-General invites tenders for the supply of lead-covered cables. Tenders by April 20.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Innsbruck.—Tenders are invited by the Austrian Government Railways for an electric pump. Tenders by April 15.

Portsmouth.—The Corporation invite tenders for electrically wiring and fitting the South-parade Pier. Tenders by April 9.

Brussels.—Tenders are invited for iron poles for overhead equipment for the Chemins de Fer Vicinaux. Tenders by April 8.

Hornsey.—The Town Council invite tenders for supply of cable, joint-boxes, and feeder pillar. Tenders to the Town Clerk by April 21.

Dublin.—Tenders are invited for a 12 months' supply of coal for the electricity works. Particulars from the Town Clerk. Tenders by April 8.

Aberdeen.—The Town Council invite tenders for six tramcar top-deck covers. Particulars from the General Manager. Tenders by April 9.

Dunkirk.—The Government Marine Service Department invite tenders for the erection of a wireless telegraphy station. Tenders by April 15.

Madrid.—The Post and Telegraph Department invite tenders for the installation and working of telephones in Villagarcia. Tenders by April 13.

Madrid.—Tenders are invited by the Public Works Department for the construction of electric tramways in Bilbao. Tenders by April 30.

Kattowitz.—The Prussian Government Railways invite tenders for telegraph cable and telegraph construction material. Tenders by April 22.

Madrid.—Tenders are invited by the Post and Telegraph Department for the supply of 100,000 porcelain insulators. Tenders by April 11.

Buenos Ayres.—Tenders are invited for the construction and working of two sections of the underground electric railway. Tenders by May 1.

Madrid.—The Public Works Department invite tenders for the construction and working of an electric tramway at Sevilla. Tenders by April 4.

Exeter.—Tenders are invited for supply of clothing for the Exeter tramway staff. Tenders to Mr. H. Lloyd Parry, town clerk, Exeter, by April 8.

Czernovitz.—In connection with the water station on the Pruth river, tenders are invited for electrical machinery for driving purposes. Tenders by April 21.

Bray.—The Urban District Council invite tenders for the annual supply of stores to the electricity department. Particulars from the Clerk. Tenders by April 7.

Limerick.—Tenders are invited for the annual supply of stores to the electricity department. Particulars from the Borough Electrical Engineer. Tenders by April 10.

Brazil.—The Amazonas Provincial Government invite tenders for electric lighting, power supply, and tramways for the Mañaos Municipality. Tenders by April 4.

Leek.—The Urban District Council invite tenders for gas-producer plant and one gas-driven generator. Tenders to the Chairman of the Electricity Committee by April 11.

Hobart.—Tenders are invited by the Postmaster-General for 200 wall telephones, 800 telephone recorders, and extension of common-battery switchboard. Tenders by May 11.

Madrid.—Tenders are invited by the Public Works Department for the construction of electric tramways from Calle de Segovia to Glorietta del Puento. Tenders by April 15.

Yarmouth.—The Corporation invite tenders for the supply of clothing for the tramway employés. Particulars from Mr. F. L. Turner, general manager. Tenders by April 7.

Sunderland.—Tenders are invited by the Corporation for the annual supply of stores to the tramways department. Particulars from the General Manager. Tenders by April 9.

South Shields.—The Corporation invite tenders for annual supplies of duplicate parts for overhead equipment, engineers' tools, etc., for the tramways department. Tenders by April 11.

Melbourne.—The City Council invite tenders for hard-drawn copper cables. Particulars from Messrs. Ilwraith, McEacharn, and Co., Billiter-square-buildings, E.C. Tenders by April 7.

Tasmania.—The Postmaster-General invites tenders for material for extension of common battery and switchboard, 200 wall telephones, and 800 telephone recorders and cords. Tenders by May 11.

Madrid.—The Post and Telegraph Department invite tenders for galvanised iron, or steel wire and bronze wire. Particulars from Direccion-General de Correos y Telegrafos. Tenders by April 10.

Poplar.—The Electricity Committee invite tenders for the supply of switchboards and gear. Particulars from the Borough Eelectrical Engineer. Tenders by April 29. See advertisement in last issue

Rotherham.—The Corporation invite tenders for supply of one 500-kw. direct-current steam turbo-generator and surface-condensing plant. Tenders to the Town Clerk by April 16. See advertisement.

Glasgow.—The Corporation invite tenders for works in connection with the Haggs road sub station. Particulars from Mr. W. W. Lackie, the electrical engineer. Tenders to the Town Clerk by April 6.

Bradford.—The Corporation invite tenders for the supply of 1,100 tons of steel girder rails (British Standard Section No 4), 25 tons of fishplates, and 20 tons of joint pieces. Tenders to the Town Clerk by April 4.

Wallasey.—The Urban District Council invite tenders for the supply of automatic overload and reverse-current single-pole circuit breakers. Tenders to the Clerk. Council Offices, Egremont, Cheshire, by April 15.

Weymouth.—The Weymouth and Melcombe Regis Corporation invite tenders for the supply of a 300-kw. steam-turbine and extension switchboard panel. Tenders to the Town Clerk by April 18. See advertisement.

Colchester.—The Tramways Committee invite tenders for the supply of clothing for the tramways employés during 12 months ending March 21, 1909. Tenders to Mr. R. C. Bullough, Car Depot, Colchester, by April 10.

Poplar.—The Electricity Committee invite tenders for the erection of a sub station building at Millwall. Particulars from the Borough Electrical Engineer, Glaucus-street, Bromley-by-Bow. Tenders to the Town Clerk by April 29.

Bristol.—The Electrical Committee invite tenders for a 12 months' supply of arc lamp carbons and joint and junction boxes. Tenders to Mr. H. Faraday Proctor, city electrical engineer, by April 7. See advertisement in last issue.

Malvern.—The Electricity Committee invite tenders for the annual supply of stores. Particulars from Mr. W. J. Rendell Baker, engineer and manager, Council Offices, Malvern. Tenders to Mr. H. L. Whatley, clerk, by April 4.

Felixstowe.—The Felixstowe and Walton Urban District Council invite tenders for erection of an accumulator house at their electricity generating station at Felixstowe. Particulars from Mr. F. B. Jennings, clerk. Tenders by April 7.

Partick.—The Town Council invite tenders for the supply of stores to the electricity department, including arc lamp carbons, cables, engine-room stores, etc. Particulars from the Burgh Electrical Engineer. Tenders by April 4.

Madrid.—The Post and Telegraph Department invite tenders for the installation and working of telephones between Las Palmas and Aurucas. Particulars from Direccion General de Correos y Telegrafos, 10, Carretas. Tenders by April 14.

Hull.—The Electric Lighting Committee invite tenders for the supply of coal to the electricity works. Particulars from the Electrical Engineer. Tenders to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by April 8.

New South Wales.—Tenders are invited by the Postmaster-General for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators, best white porcelain, large. Tenders by May 20.

Leek.—The Urban District Council invite tenders for engine, dynamo, and other foundations and extensions to their generating station buildings in Station-street, Leek. Tenders to the Chairman of the Electricity Committee by April 10.

Stockport.—The Tramway Committee invite tenders for the erection of new tramway offices in Mersey-square. Particulars from Mr. Robert Hyde, town clerk, Town Hall, Stockport. Tenders to the Chairman of the Tramways Committee by April 13.

London, S.W.—The Metropolitan Asylums Board invite tenders for the installation of electric lighting at the South-Western Hospital and Ambulance Station, Landor-road, Stockwell, S.W. Tenders to Mr. T. Duncombe Mann, clerk, by April 15.

Rhyl (Wales).—The Urban District Council invite tenders for the wiring, etc., for electric lighting of the new promenade gardens. Specification, etc., from the engineer, Mr. E. H. Wright, Electricity Works, Rhyl. Tenders to Mr. Arthur Rowlands, clerk, by April 9.

Sydney.—The Government Railway Department invite tenders for the supply and installation of about 4½ miles of three-core, high-tension, paper-insulated, lead-covered feeder cable. Particulars from the Electrical Engineer, 51, Phillips-street, Sydney. Tenders by May 4.

Cardiff.—Tenders are invited for the wiring, etc., of the Ty-Clydd Mental Hospital, Whitchurch, Cardiff, for the Visiting Committee. Particulars from Mr. Arthur Ellis, city electrical engineer and manager, Central Offices, The Hayes, Cardiff. Tenders by April 6.

Melbourne (Australia).—The Postmaster-General invites tenders for the construction and laying complete of two submarine telegraph cables between the State of Victoria and the State of Tasmania. Tenders must be accompanied by a deposit of £1,000. Tenders to the Secretary, Postmaster-General's Department, 51, Spring-street, Melbourne, by April 14.

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Christiania.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Christiania that tenders are invited by the Norwegian State Telegraphs for the supply of insulators, iron wire, bronze wire, bronze thread, steel cable, battery, zinc, and canal cable. Tenders are to be delivered at Telegrafstyrelsens Tekniske Avdeling, 3, Hasselgaarden, Christiania, by noon on April 13.

Glasgow.—The Corporation invite tenders for the supply of stores for one year from June 1, 1908, including chilled iron brake blocks, car wheels, etc.; carbon brushes; vulcanised indiarubber cables; cast-iron castings; malleable iron castings; cast-steel castings; india-rubber and asbestos goods; springs; tiebars; galvanised wires; and fuel for Pinkston power station. Particulars from the General Tramways Manager. Tenders to the Town Clerk by April 6.

RESULTS OF TENDERS.

Chiswick.—The Urban District Council have accepted the tender of Mr. F. Evans, Hounslow, for the maintenance of fire-alarms and telephones for one year.

Sunderland.—The Education Committee have accepted the tender of Mr. Davison Taylor for alterations to the electric light installation at Cowan terrace School.

Buxton.—The Urban District Council have accepted the tender of Drake and Gorham for a switchboard, at £46, for the electricity department, and that of Williams and Co. for a 250-kw. dynamo.

Ashton-under-Lyne.—The Corporation have accepted the tender of Parmiter, Hope, and Sugden, Hulme Electrical Works, Manchester, for the supply of motor-starting switches for 12 months from April 1, 1908.

Battersea.—The Council have accepted the tender of Appleby's, Limited, for converting overhead travelling crane at electric lighting station so as to enable it to be driven by electricity instead of by hand as at present for the sum of £124. 10s.

Finchley.—The Urban District Council have accepted the tender of Messrs. Browett, Lindley, and Co., Manchester, for the supply and erection of one 700-kw. high-speed engine and dynamo combined, together with spare parts, for the sum of £4,528.

Briton Ferry.—The tender of Wellman-Seaver and Head (Electrical Department) has been accepted for the new generating station for the Briton Ferry Steel Co., comprising two steam generators, switchboard, overhead traveller, and wiring through the works.

Grimsby.—The Corporation have accepted the following tenders for annual supplies: Ferranti, Limited, and Venner and Co., meters; Sloan Electrical Co., London, arc lamp carbons; H. O. Brown and Co., Hull, lubricating oils; United Asbestos Co., Hull, engine-room stores.

Westminster.—The Improvements Committee of the London County Council have approved the acceptance by the City Council of the tender of the Westminster Electric Supply Corporation for the installation of five flame arc lamps in connection with the Marble Arch improvement.

Cardiff.—The contract for the extensive electrical installation of the new University College of South Wales and Monmouthshire, which is being constructed at Cardiff, has been given to R. Alger and Sons, Newport. This firm has also in hand an important colliery installation, as well as several large heating works.

Heywood.—The Electricity Committee have accepted the following tenders in connection with the electricity works extensions: T. Hill and Sons, Heywood, boilers, etc.; Browett, Lindley, and Co., Patricroft, engines, condensers, etc.; Whipp and Bourne, Castleton, switchboard; British Insulated and Helsby Cables, Liverpool, cables.

Wrexham.—The following tenders have been accepted for the supply of stores to the electricity department for the year ending March 31, 1909: T. Hayes, tools and ironmongery; General Electric Co., rubber cable; British Insulated and Helsby Cables, ordinary service cut-outs; Venner and Co. and Ferranti Limited, meters; Sloan Electrical Co., arc lamp carbons; Wynnstay Colliery Co. and Barton and Co., coal; S. Rogers, wood troughing; Lee, Howl, and Co., boiler solution.

London.—The London County Council have received the following tenders for the supply of steam, exhaust, feed, drain, and condenser piping, and valves, water-tanks, etc., required for the second portion of the Greenwich electricity generating station:

J. Spencer, Limited, Wednesbury*	£10,910 13 10
J. Oakes and Co., Alfreton	11,265 5 5
S. Russell and Sons, Leicester	11,737 4 0
Babcock and Wilcox, London, E.C.	12,453 0 0
Jones and Co., London, E.C.	12,589 18 6
Railway and General Engineering Co., Nottingham	12,918 19 0
Stewarts and Lloyds, Glasgow	13,175 17 9
J. Wilson and Co., London	13,443 1 1

* Recommended for acceptance.

London.—The following tenders have been received by the London County Council for roadwork, etc., in connection with reconstruction of tramways from Brixton to Camberwell:

W. Manders, Leyton*	£19,276 8 0
R. W. Blackwell and Co., Westminster, S.W.	20,339 12 2
W. Underwood and Bro., Dukinfield	20,382 17 8
G. Law, London and Kidderminster	20,511 19 1
Dick, Kerr, and Co., London, E.C.	20 869 19 0
J. Mowlem and Co., Westminster, S.W.	21,520 2 2
Fry Bros., Greenwich	21,795 3 7
W. Muirhead and Co., London, E.C.	22,308 7 6
R. C. Brebner and Co., Edinburgh	22,879 1 7
W. Griffiths and Co., London, E.C.	23,341 5 9
T. Doney, Plymouth	25,923 19 6

* Recommended for acceptance.

Liverpool.—The Tramways and Electric Power and Lighting Committee recommend the acceptance of the tenders of the British Westinghouse Electric and Manufacturing Co. for the supply of five 500-kw. motor-generators and two 200-kw. motor-generators. The tender of E. Wilson and Co., Collingwood-street, Liverpool, for the supply of 7in. by 2¾in. gutter bends, 18in. radius, 9in. long, to the electric supply department for the 12 months ending March 31, 1909, is also recommended for acceptance.

London.—The London County Council have received the following tenders for the manufacture, delivery, and laying of high-tension electric cables and low-tension electric cables and telephone cables for the tramways:

High-tension electric cables, etc.

British Insulated and Helsby Cables, Prescot*	£32,000 3 11
Siemens Bros. and Co., Westminster, S.W.	32,487 4 10
Western Electric Co., North Woolwich	32,580 14 8
Callender's Cable and Construction Co., London, E.C.	32,918 16 2
W. T. Henley's Telegraph Works Co., London, E.C.	33 292 13 0
W. T. Glover and Co., Manchester	33 648 15 7
Johnson and Phillips, Charlton	33,922 10 8

Low-tension electric cables and telephone cables, etc.

W. T. Henley's Telegraph Works Co.*	35,101 4 7
Union Cable Co., London and Berlin	36,085 2 2
British Insulated and Helsby Cables	36,349 9 10
Siemens Bros. and Co.	36 918 11 1
Johnson and Phillips	36,955 11 8
Western Electric Co.	37,050 0 0
W. T. Glover and Sons	38,546 13 6
Callender's Cable and Construction Co.	38,745 11 3

* Recommended for acceptance.

Hertford.—The Corporation have received the following tender for alterations, heating, and electric lighting at the Corn Exchange:

Alterations.

Rayment and Sons	£489 0 0
A. Scales	513 0 0
H. Norris and Son	490 0 0
E. R. Kemp	604 5 0
Ekins and Co. (accepted)	483 0 0

Heating.

Rayment and Sons	59 0 0
A. Scales	58 0 0
H. Norris and Son	59 18 0
J. Cooper and Sons	61 18 0
E. R. Kemp	94 18 0
Ekins and Co. (accepted)	75 0 0
Burroughs and Sons, London	80 0 0
Cannon and Sons, London	100 19 0
Moorwood and Sons, London	88 12 0
Vaughan and Cook, London	87 5 0
Dargue, Griffiths, and Co., Liverpool	122 0 0

Lighting.

Rayment and Sons	153 10 0
H. Norris and Son	147 10 0
J. Cooper and Sons	150 0 0
Ekins and Co. (accepted)	125 0 0
Burroughs and Sons	225 0 0
Cannon and Sons	112 11 3
Moorwood and Sons	170 10 0
Vaughan and Cook	198 0 0
Dargue, Griffiths, and Co.	250 0 0

Rest of Hertford.

OPENINGS FOR CONTRACTORS.

ABERAMAN—Alterations and additions, 63, Jubilee-road, Mr. W. L. Jones.

ABERDEEN—Abattoir, Hutcheon-street. Mr. J. Rust, architect.

ABOYNE—Post office, H.M. Commissioners of Public Works.

ABRAM—Two houses near Platt Bridge, Mr. T. Bennett.

ACTON—Elementary school, Education Committee.

AHMEDABAD—Additions, Civic Hospital, Governors.

ARMLEY—Eight houses. Mr. J. A. Webster, architect, Leeds.

ASHBURTON—Two villas, Lurgecombe Cross, Ashburton Building Co.

ASPULL—Council school, New Springs, local Education Committee.

ASTON MANOR—Electricity undertaking (£25,213).

ASTON SOMERVILLE—Restoration of parish church (£1,350).

AUDENSHAW—Nineteen dwelling-houses near Stamford-road, Audenshaw Building and Investment Co.

AUDLEY—Council school, Wood-lane, Staffs County Education Committee.

BALCARRIS—Housing scheme, North Dublin Rural District Council.

BALDOYLE—Housing scheme, North Dublin Rural District Council.

BALGRIFFIN—Housing scheme, North Dublin Rural District Council.

BALLANGLASS—Housing scheme, Urban District Council.

BALLYBOGGAN—Housing scheme, North Dublin Rural District Council.

BALLYMUN—Housing scheme, North Dublin Rural District Council.

BARGOED—Vicarage, Rev. T. Richards.

BARNOLDSWICK—Six houses, Essie-street, Mr. W. J. J. MacDonald.

BATTLE—Alterations and additions, infirmaries at union workhouse, Board of Guardians.

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BARNSLEY—House, Langdale-road, Messrs. Wade and Turner.
BELFAST—Additions, infirmary (£4,000), Guardians.
BIDEFORD—Alterations, grammar school (£600), Council.
BIRKENHEAD—Erection Hemingford-street school (£18,743), Education Committee.
BITTON—Elementary school, Gloucester Education Authority.
BLACKBURN—Elementary school, Sudell-road, Education Authority.
BLACKROCK—Artisans' dwellings (£4,300), Urban District Council.
BONNYBROOK—Housing scheme, North Dublin Rural District Council.
BONNYRIGG—Public library. Messrs. Greig and Fairbairn, Edinburgh, architects.
BORSTAL—Reconstruction of H.M. prison (£12,800), Home Office.
BOURNEMOUTH—Public conveniences (£3,250), Town Council.
BRADFORD—Conversion of warehouse into offices. Messrs. Adkin and Hill, architects.
BRIGHOUSE—Secondary school (£3,100), Education Committee.
BROADSTAIRS—Additions, Dane Court, Mr. Latham Tomlin; dwelling-house and garage, Osborne-road, Mr. J. Steed; alterations, golf clubhouse, George Hill-road, Mr. W. Capel-Slaughter.
BROCH—Court building (Rs.28,000), Bombay Government.
BROGHAN—Housing scheme, North Dublin Rural District Council.
BROMLEY—Public convenience (£300), Town Council.
BROUGHTY FERRY—Enlargement, Grove Academy (£6,000), School Board.
BULAWAYO—Establishment of tobacco warehouse, Mr. J. N. Motley, Danville, U.S.A.
BURRADON—Additions to Burradon and District Social Club. Messrs. White and Stephenson, Newcastle, architects.
CARDIFF—Electric wiring, etc., Ty-Clydd Mental Hospital, Whitchurch. Mr. A. Ellis, Central Offices, Cardiff.
CASTLE DONINGTON—Elementary school, Education Committee.
CATHERINGTON—Detached house, Hambledon-road, Waterloo, Mr. J. G. Miles.
CHATHAM — Elementary school, Rainham-road (£10,000), Kent Education Committee.
CHELTENHAM—Alteration, Holy Trinity Schools, Board of Education.
CHESTER—New works (£2,000), Town Council.
CHOPWELL—Shops, warehouse, etc. Mr. D. M. Spence, architect.
CHOPWELL—Alterations, school, Durham County Council.
CLACTON—Convalescent home, Holland-road, Governors of Great Northern Central Hospital.
CLIFTON—Wagon-building works, London and North-Western Railway Co.
CLONSHAGH—Housing scheme, North Dublin Rural District Council.
COLDWINTERS — Housing scheme, North Dublin Rural District Council.
COLERAINE—Housing scheme (£18,497), Rural District Council.
COULTRY—Labourers' dwellings, North Dublin Rural District Council.
COWIE—Two rows of houses, Alloa Coal Co.
CROMPTON—Twenty-two houses, George-street, Messrs. A. and A. Crompton; two houses, Messrs. Williams and Beaty.
CROOK—Additions, Crook Council School (£3,000), Council.
CUPAR FIFE—Enlargement, premises, Crossgate—architect, Mr. H. A. Newman; extensions, inspector of weights and measures offices, County Council—Mr. Henry, architect; additions, house, Well-street—Mr. Storrar, architect.
DARDISTOWN—Housing scheme, North Dublin Rural District Council.
DENVER (U.S.A.)—Improvements, lighting plant (50,000dol.), Electric Company.
DESBOROUGH—Baptist chapel (£320), Trustees.
DHARMSALA—Rebuilding Dak Bungalow (Rs.14,000), Punjab Government.
DISWELLSTOWN—Housing scheme, North Dublin Rural District Council.
DUBBER—Houses, North Dublin Rural District Council.
DUBMIRE—Council school, Education Authorities.
DUDLEY—Carnegie Library, Libraries Committee.
DUDLEY—New club premises. Mr. J. G. Crone, architect.
DUNSOGHLY—Housing scheme, North Dublin Rural District Council.
EAGLESCLIFFE—Organ chamber and vestry, church. Mr. C. Hodgson Fowler, architect.
EAST HAM—Roman Catholic school, Manor Park, Education Committee.
ENNISCORTHY—Housing scheme (£94,891), Rural District Council.
EXETER—Extensions to Hele's School buildings (£3,500), City Council.
FALMOUTH—Two semi-detached houses, Gyllyngdune, Mr. T. J. Pye; additions, house, Marlborough-road, Mr. Moss.
FAREHAM—Extensions, electric light works (£10,000), Urban District Council.
FELIXSTOWE—Accumulator house, electricity generating station, Felixstowe and Walton Urban District Council.
FINGLAS—Housing scheme, North Dublin Rural District Council.
GILLINGHAM—Extending mains, electric light undertaking (£5,000), Town Council.
GLASGOW—Alterations and extensions, market, Moore-street, Corporation.
GOLDTHORPE—Additions to institute. Mr. J. Fawcett, architect.
GOLCAR—Twenty-four houses, Scarhouse, Golcar Co-operative Society; three houses, Scar-lane, Messrs. Heap, Armitage, and Thornton; four houses, Botham Hall-road, Messrs. Beaumont Bros.; additions, house, Scartop, Mr. T. W. Thorne.
GRANGE—Housing scheme, North Dublin Rural District Council.
GREAT TORRINGTON—Cottage hospital. Mr. W. C. Medland, architect.
HADLEIGH—Elementary school, Essex Education Authority.
HALLOW—Police station (£400), Worcester Standing Joint Committee.
HANWELL—Cookery and manual training centres, St. Anne's Council School (£1,346).
HARRISTOWN—Housing scheme, North Dublin Rural District Council.
HARROGATE HILL—Elementary school, Darlington Education Committee.
HOCKLEY HEATH.—Alterations, Nag's Head Hotel, Messrs. Forsyth, Betterson, and Co.
HOPE (U.S.A.)—Power-house, City Council.
HORSFORTH—Alterations, public offices (£650).
HORSHAM—Rebuilding shops, West-street. Plans passed by Urban Council.
HULL—Offices, Albert Dock, North-Eastern Railway Co.
HULL—Public abattoir (£16,880), Corporation; offices, etc. (£8,000), Tramway Committee.
HULL—Eight houses, New-street, Mr. H. Hornsey; 14 houses, Rosmead-street, Mr. J. H. Needler; seven houses, Ventnor and Exmouth streets, Mr. J. Jacobs; four houses, Beverley-road, Mr. T. West; 26 houses, Southcoates and Holderness-avenue, Mr. J. T. Taylor; nine houses, Ventnor-street, Mr. J. Barnett; six houses, Kelvin-street, Mr. J. Ward; reconstruction of Myton Arms, Myton-street, Hull Brewery Co.; reconstruction, Robin Hood, Myton-street, Managers; 14 houses, Remsburg-street, Mr. E. Whitlock; 16 houses, Brecon-street, Mr. E. Russell; 19 houses, Garden City, Garden Village, Limited; five houses, Cottingham-road, etc., Mr. M. Garton; shop, Chanterlands-avenue, National Radiator Co.; extensions, Brook-street, Trustees, Royal Infirmary; schoolroom, Beverley-road, Trustees, Congregational Church; workshops, Villa-place, Mr. G. Hodge.
HUNCOAT—Church, St. Augustine's. Messrs. Grimshaw and Cunliffe, architects.
ILFORD—School in connection with High-road Baptist Church.
ISLE OF MAN—Hospital, Hills Estate (£20,000), Governors of Isle of Man Hospital.
ISLE OF WIGHT—Isolation hospital, Rural District Council.
KILBARRACK—Housing scheme, North Dublin Rural District Council.
KING'S NORTON—Temporary school, Education Committee.
KINGSTOWN—Housing scheme, North Dublin Rural District Council.
KINGSTOWN—Public baths (£1,000), Urban District Council.
LAUGHARNE—Additions, Town Hall, Council.
LAUGHTON-EN-LE-MORTHERN—Elementary school (£5,040), West Riding Education Committee.
LEEDS—Rearranging the education offices (£1,200), Education Committee.
LEEK—Theatre and club, Market-place, Leek Theatre Co.
LIMERICK—Theatre, Managers of the Syndicate.
LISBURN—Consumptive annexe at workhouse (£45), Board of Guardians.
LITCHFIELD—Council school, Staffs Education Committee.
LITTLEBOROUGH—Spinning mill (£80,000), New Mill estate, Featherstall.
LLANELLY—Eighteen houses and shops, Penallt-terrace, Messrs. B. Howell and Co.; additions, house, Bigyn-road, Mr. J. Charles; additions, premises, Stepney-street, Mr. E. M. Dickens; additions, premises, Campbell-street, Mr. E. J. Bees.
LOWER EDMONTON—Infirmary in connection with the workhouse of the City of London Union (£55,400).
LYDBROOK—Council school, Camomile Green, Gloucester Education Authority.
LYTHAM—Fairhaven Church, Woodlands-road (£6,000), Lytham and St. Annes Wesleyan Methodist Circuit.
MAESTEG—One hundred and seventy-two private residences, eight shops, rebuilding 17 houses, erection of a chapel and vestry, two day schools, temporary classrooms for day schools, drill hall, mining offices, storerooms, workshops, bakehouse, curing house, studio, stables and coach-houses. Plans passed by Council.
MALAHIDE—Carnegie Library. Mr. A. Scott, Dublin, architect.
MALTON—Additions to Malton, Norton, and District Cottage Hospital, Urban District Council.
MEAKSTOWN—Houses, North Dublin Rural District Council.
MELTON MOWBRAY—Two houses, Major Andrew Coats, Burrough.
MONMOUTH—Electric lighting purposes (£10,000), Corporation.
MORECAMBE—Technical school (£12,415), Corporation.
NAILSWORTH—Additions, Council school, Gloucester Education Authority.
NEWBURY—Elementary school (£8,380), Town Council.
NEWBURY—Dwelling-house, Essex-street, Mr. H. Rogers; additions Essex-street, Mr. Langford; dwelling-house, London-road, Mr. T. A. Field; two semi-detached villas, Pyle-hill, Messrs. Hodges Bros.; laundry and house, Kingsbridge, Mr. Bell.
NEW HOLLAND—Additions to Christ Church (£400).
NEWPORT—Cookery instruction rooms, caretaker's cottage, Orchard-street (£1,000), Education Authority.

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NEW PARK—Housing scheme, North Dublin Rural District Council.
NEWTOWN—Council school, Gloucester Education Authority.
NEWTOWN—Housing scheme, North Dublin Rural District Council.
NORTHALLERTON—Hospital, Urban District Council.
NORTHALLERTON—Police station, etc., Standing Joint Committee of North Riding County Council.
NORTON MALREWARD — Improvements, Holy Trinity Church. Messrs. Cottam and Samson, architects.
OMAGH—Labourers' dwellings (£35,100), Rural District Council.
OSWALDTWISTLE—Secondary school, Lancs. Education Committee.
PADIHAM—Council school (£8,150), Education Committee.
PAIGNTON—School of art and science (£925).
PANTYGRAIGWEN—Ten houses, G. W. Colliery Co.
PARADISE—Enlargement, Council school, Coventry Education Committee
PEMBRY—Restoration, parish church (£3,500), Ecclesiastical Commissioners.
PENKRIDGE—Elementary school, Staffs County Education Committee.
PENTIR—Alterations of Bryn Hyfrid, Calvinistic Methodists.
PHILADELPHIA (YORKS). — Two houses, Voltage-terrace, Messrs. Liddell Bros.; building development, Paddock Stile, Ecclesiastical Commissioners.
POPPINTREE—Housing scheme, North Dublin Rural District Council.
QUEENSBURY—Seven houses, Ford-hill. Messrs. J. Drake and Son.
RADCLIFFE—Restoring parish church and new clock installed, Churchwardens.
RANGOON—General hospital (£30,000).
RHYL—Wiring, etc., for electric lighting new promenade gardens, Rhyl Urban District Council.
ROCHESTER—Additions to police offices (£160).
ROCHFORD—Additions, children's home, Guardians.
SACRISTON—Council school, Durham County Council.
ST. DOUGHLOUGH—Houses, North Dublin Rural District Council.
ST. JUST—Villa at the Carn, Mr. J. Holman
SALFORD — Two extensions for higher education, etc. (£25,000), Education Committee.
SAMFORD—Enlargement, workhouse (£420), Board of Guardians.
SANDYHILL—Housing scheme, North Dublin Rural District Council.
SANTRY—Housing scheme, North Dublin Rural District Council.
SEAFORD—Baptist Chapel, Trustees.
SELLY OAK—Elementary school, Raddle Barn-lane (£15,000), King's Norton Education Committee.
SENGHENYDD—Alterations and additions to premises, Commercial-street, Senghenydd and Aber Valley Co-operative Society.
SHANGAN HILL—Housing scheme, North Dublin Rural District Council.
SHEERNESS—Elementary school (£7,800), Kent Education Committee.
SHEPSHED—Five houses and storeroom, Trustees, Lambert's Charity.
SHOTTON—Elementary school, Education Authority.
SHREWSBURY—Pavilion (£600), Old Shrewsbury Bowling Club.
SILKSWORTH—Six houses, Somerset-street, Mr. S. Watson; six houses, York-terrace, Messrs. J. and W. Hodgson.
SKELMANTHORPE—Additions and alterations, Pilling House. Mr. J. Berry, architect.
SKERRIES—Carnegie Library. Mr. A. Scott, architect.
SIALKOT—Wesleyan church, Trustees.
SIDLESHAM—Alterations and additions, Council school, West Sussex and Chichester Local Education Committee.
SLAITHWAITE—Two houses off Meal-hill. Mr. A. Shaw, architect.
SOLIHULL—Administrative block, workhouse (£5,130), Board of Guardians.
SOOTHILL—Elementary school, Mill lane, Hanging Heaton (£2,340), West Riding Education Committee.
SOUTHAMPTON—Enlargement of grammar school (£2,992), Governors of Trade Schools.
SOUTHCHURCH—Construction of a railway station, Managers.
SOUTH ELMSALL—Four dwelling-houses and shops. Mr. J. R Dodds, architect.
SOUTHEND—Extensions, Conservative club, Managers; two houses, Belle Vue-place, Mr. W. Bray; additions and alterations, The Esplanade Hotel, The Leas, Mr. T. H. W. Idris; house, Tintern-avenue, Mr. J. Knight; two houses, Grand-drive, Mr. R. S. Tomlin; house, Glen-road, Mr. F. S. Johnson; two houses, London-road, Messrs. Scott and Willerson; two houses, Ailsa-road, Mr. J. Poulton; house, Victoria-drive, Mr. H. Chance; schools, Chalkwell Hall, Leigh-road, Education Committee; offices, London-road, Mr. J. Sellar; additions, shop, Summer-court-road, Mr. J. Sears; shop, Sweyne-avenue, Mr. H. R. Wilkinson; two houses, Eastwood-road, Mr. J. Wyatt; bungalow, Eastwood-road, Mr. J. Snelling; four houses, Leigh-road and Southview-drive, Mr. W. G. Whitby; house, Highcliff-drive, Mr. H. Pearce; house, Crowstone-road, Mr. J. A King; house, Eastwood-road, Mr. H. W. Grainger; addition, Pijenot, Highcliff-drive, Mr. F. S. Oram; two houses, Fernleigh-drive, Mr. W. Annereau; bungalow, Fairfax-drive, Mr. W. Turner; two houses, Woodfield-road, Mr. E Edmunds; additions, 162, Station-road, Mr. J. E. Harding; two houses, Main London-road, Messrs. Scott and Willerson; house, Crowstone-road, Mr. J. A. King; laundry, Eastwood-road, Albany Laundry Co.; five houses, Glen-road, Mr. J. J. Blanch; 16 houses, Broadway Market, Mr. F. F. Ramuz.
SOUTHMINSTER—New station, London, Tilbury, and Southend Railway Co.
STAINLAND—Mill, Bank House Mills. Messrs. C. F. L. Horsfall and Son.
STIRCHLEY—Infants' school, Charlotte-road, Education Authority.
STOCKPORT—Tramway offices, Mersey-square, Tramways Committee.
STOCKWELL—Installation of electric lighting at the South-Western Hospital and Ambulance Station, Landor-road, S.W., Metropolitan Asylums Board.
STOKESLEY—Primitive Methodist Church, Stockton and Darlington District Committee.
STOWMARKET—Secondary school and special subjects centre, East Suffolk Education Committee.
SUNDERLAND—Alterations, technical college (£272), Education Committee.
SURLINGHAM—Elementary school, Norfolk Education Committee.
SWANSEA — Extensions, intermediate school (£6,000), Council; houses, Baptist Well Estate, Corporation.
TEWKESBURY—School, Gloucester Education Authority.
TOLKA—Housing scheme, North Dublin Rural District Council.
TONLAGEE—Housing scheme, North Dublin Education Committee.
TRALEE—Housing scheme (£129,080), Rural District Council.
TROEDYRHIW—Three houses. Mr. T. E. Rees.
TROWBRIDGE—Extension, market (£520), Urban District Council.
TURRIFF—Improvements, technical school (£240), School Board.
TWINAPIN—Housing scheme, North Dublin Rural District Council.
TWYFORD—Organ chamber, parish church, (£1,000), and extensions, etc., church, Ecclesiastical Commissioners.
WALTON-ON-THAMES—Elementary school, Sunbury-lane, Education Committee.
WARD—Housing scheme, North Dublin Rural Rural District Council
WARMINSTER—Hospital, Urban District Council.
WELWYN—House, Digswell, Messrs. Powell and Co.; house, High Welwyn, Mr. F. Newton.
WEST DEAN — Council school (£4,350), Gloucester Education Authority.
WEST HARTLEPOOL — Primitive Methodist Church, Stockton and Darlington District Committee.
WHITEHAVEN—Elementary school (£15,000), Education Committee.
WHITEHAVEN—Alterations to premises, Ice Co., Queen-street.
WHITTON PARK—Council school, Durham County Council.
WILLINGTON—Council school, Durham County Council.
WIMBLEDON—Electricity undertaking (£21,200).
WINDLESTONE—Primitive Methodist Church, Stockton and Darlington District Committee.
WINDSOR—Two houses, Clewer, New Town, Mr. Jamieson; slaughter-house, Jutland-lane, Mr. Peters.
WIRRAL—Improvements, workhouse, Board of Guardians.
WORKSOP—Additions, premises, Worksop Football Club; additions, motor garage, Carlton-road, Mr. T. Marris; four houses, Netherton-road, Mr. McCarrick.
WRITTLE—Houses (£1,640), Chelmsford Board of Guardians.
YOUGHAL—Housing scheme (£12,500), Rural District Council.

COMPANIES' MEETINGS AND REPORTS.

LONDON UNITED TRAMWAYS.

The sixth ordinary general meeting of the London United Tramways was held at Winchester House, Old Broad-street, E.C., on Friday last. Mr. C. J. Cater Scott, chairman of the directors, presided.

The CHAIRMAN, in moving the adoption of the report and accounts (*Electrical Engineer*, March 27), said they had now completed and opened the Surrey lines which were under construction a year ago, and had thus linked up their system with the important tramways of the London County Council in South London. Their policy now would be to let the undertaking consolidate and develop, and until that had taken place they did not propose to go on with further construction works. There was, however, one very small exception, for they would probably have to face the electrification of the Kew and Richmond line, and with that the construction of about two furlongs of tramways over Kew Bridge. For the power to cross Kew Bridge they were now going to Parliament, and he was glad to say that in spite of opposition they had passed Standing Orders in both Houses. They had been hampered during the past year by the fact that their lines in Wimbledon were not opened as soon as they might have been. The local authority had the power to say that no portion of the mileage should be open until the whole was completed, but it was never contemplated that they would arbitrarily exercise that power in the way they did, and in a way in which it had never been exercised anywhere else. The result was that for many weeks they were deprived of the revenue they might have received from the completed portion of the lines, and the residents were deprived of the facilities for transit which they might have enjoyed. Their gross takings for the year were £345,570, or an increase of £16,697 upon the previous year, while the number of passengers carried showed an increase of 6 per cent. To show how much they were affected by the weather, he stated that for the fine week ending July 19 their receipts were £8,473, while for the wet week ending July 5 their takings were £1,242 less. Traction expenses showed an increase of £5,087, which was not a serious item

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seeing the extra mileage they were working and the high prices that prevailed generally last year. Traffic expenses had increased £11,695, and a large proportion of that was amply justified by the increase of 12½ per cent. in the route mileage. The item of £12,144 for compensation and legal expenses they did not like, showing as it did an increase of £1,416, but he did not know how it could be avoided. It seemed to be generally assumed that a tramway company was fair game to be shot at, and under existing circumstances he believed it was the wisest policy to try and settle such cases out of court, although in many instances no blame really attached to the Company. They had earned enough to pay the interest on the debenture stock, 5 per cent. on the preference stock, and 1 per cent. on the ordinary stock. As to the future he saw no reason for despondency. Early in May the Franco-British Exhibition would be opened, and as their cars ran to the very doors he believed they should greatly benefit by it.

Sir CLIFTON ROBINSON, the managing director, formally seconded the motion, which was unanimously adopted.

BRITISH INSULATED AND HELSBY CABLES.

The twelfth ordinary general meeting of shareholders of the British Insulated and Helsby Cables was held on the 24th ult., Mr. E. K. Muspratt (the chairman) presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said the profit for the year was £135,619, as compared with £197,112 in the previous year. The latter, however, was exceptional, and the directors took the opportunity to write down the sum outstanding in the balance-sheet against patents and goodwill, which now stood at £150,000. Although during the year money had been spent in acquiring further patents, the cost had been charged against revenue. The reduction in profit was largely owing to the high price of copper in the early part of the year and the tightness of the money market, which led to a large decrease in orders, particularly for heavy cables. These conditions having now changed, the directors were looking forward to better times. The profit for 1907, nevertheless, showed an increase over that of 1905, the figure for that year having been £133,902, against the present figure of £135,619. Adding the balance from 1906, there was available for all purposes the sum of £172,332, out of which directors' fees had been paid, £22,000 had been placed to depreciation fund, £5,000 to redemption of debentures, £10,000 to reserve, while debenture interest, preference share dividend, and an interim dividend on the ordinary shares had been paid. The balance now available for distribution was £58,200, out of which the directors recommended a further dividend of 4 per cent., and a bonus of 2 per cent. on the ordinary shares, making a total distribution for the year of 10 per cent. and leaving a balance to carry forward of £28,300. With regard to investments, these now stood at £507,010, against £485,849 last year, the increase being mainly due to capital required for the Midland Electric Corporation for Power Distribution to pay for the necessary cables and connections to supply new customers. That company's sale of current had increased about 30 per cent., and there was a consequent increase of profits, and the company had earned last year £6,000, against £4,000 in the previous year, which went towards the payment of debenture interest. Up to Dec. 31, 1907, they had absolutely connected the equivalent of 7,470 h.p., as compared with 5,507 h.p. at the same date of the previous year, and since Jan. 1 last a further 768 h.p. had been connected. The substitution of electric energy for steam power was sure to increase, and it was more economical to take that energy from a central station than for users to generate electricity for themselves. The Electric Supply Co. of Victoria continued to make progress. Last year the profit in addition to being sufficient to pay the debenture interest and preference dividend left a balance more than sufficient to pay for the debenture sinking fund. Reverting to their own Company, the Chairman said the actual cash balance in 1906 was £60,987; in 1907 at the time of making up the balance-sheet it was £85 551, and at present it was £98,643, and this was in cash, and did not include any discounted bills. Although the results of the year's working were not so good as those of the previous year, the directors could not complain of the general trade, with the exception of the heavy cable department. If this department were short of work, as was the case during the first six months of the year, it affected the Company's profits adversely, but the directors were glad to say that orders had been better in the latter part of the year, and the present year would feel the benefit. The orders on the books on Jan. 1 last were very satisfactory, and they anticipated that the lower price of raw materials would lead to the issue of orders which had been deferred, of which no doubt the Company would get its share. Since 1897 the sum of £193,000 had been placed to depreciation, notwithstanding that the whole of the buildings and machinery had been maintained in thorough working order out of revenue.

Mr. J. S. HARMOOD BANNER, M.P., seconded the motion, which was carried unanimously.

METROPOLITAN ELECTRIC TRAMWAYS.

The annual meeting of the Metropolitan Electric Tramways Co. was held in London last week, Mr. E. Garcke presiding.

In moving the adoption of the report, the CHAIRMAN said their operations were not confined to the working of tramways and light railways, for they had an extensive business in electrical power supply and electric lighting. These operations were carried on by three companies—the Metropolitan Electric Tramways Co., the North Metropolitan Electric Power Supply Co, and the North Metropolitan Electric Power Distribution Co. All the shares of the power company were held by the tramways company, and all the shares of the distributing company were held by the power company. The output of electrical current had steadily increased from 2,000,000 units in 1904 to 11,000,000 in 1907, and the gross receipts from £10,000 to £60,000 in the same period. For the past year the power company had paid a dividend of 4 per cent. They were now working 40 miles of tramways and light railways, and their gross receipts for the past year were £277,000, against £215,000 in 1906. The gross profits were £75,000, against £68,000. They had carried 48 million passengers, which was an increase of 25 per cent. They were able to pay 4½ per cent. on the ordinary shares—being ½ per cent. more than last year—and to carry forward £5,700.

Sir E. SPENDER seconded the motion, which was unanimously adopted.

ELECTRIC LIGHTING AND TRACTION OF AUSTRALIA.

The report of the Electric Lighting and Traction Co. of Australia for the year ended Aug. 31, 1907, to be presented at the meeting in London on the 6th inst., states that during the year capital expenditure in Australia on buildings, plant, and mains has been incurred on the Melbourne undertaking £11,657 and on the Geelong undertaking £2,526, together £14,183. The profit and loss account shows that the gross profit from the Melbourne and Geelong undertakings was £16,354. Adding the dividend received on the Company's holding of ordinary shares in the Adelaide Electric Supply Co., together with interest, discounts, transfer fees, etc., the total gross profit for the year amounted to £19,741, which compares with £16,202 the previous year. Management and general expenses at the London head office absorbed £1,971, and interest on debenture stock and sundry loans amounted to £13,361. After payment of these charges there remains a balance to the credit of profit and loss account of £4,408, to which must be added £1,185 brought forward, making £5,594. Of this sum the directors have transferred £4,000 to reserve account, leaving £1,594 to be carried forward. The provision of the additional capital required to cope with the continued expansion of the Melbourne and Geelong undertakings is receiving the careful consideration of the directors, and they hope to be in a position to place before the shareholders at an early date a comprehensive scheme for effectually dealing with this question.

WILLANS AND ROBINSON.

The report of Willans and Robinson for the half-year ended Dec. 31, 1907, to be presented at the meeting on the 7th inst., states that as regards Rugby, after writing off £6,711 as depreciation, there is a profit of £22,945 as the result of the half-year's work. As regards Queen's Ferry, there is a net loss on the half-year's working (after contributing to debenture interest and to the directors' salaries) of £3,128. The net profit for the half-year is, therefore, £19,817, and the total amount available for distribution or otherwise, including £2,708 brought forward, is £22,526. The directors propose to pay a dividend at the rate of 6 per cent. per annum on the preference shares, to pay £874 interest upon funding certificates, to apply a like sum of £874 as arranged to the redemption of funding certificates, and to pay a dividend at the rate of 10 per cent. per annum on the ordinary shares. A balance of £7,443 remains to be carried forward. At Queen's Ferry there has been an increased output, with better profits, from the steelworks, and the result of the half-year's working would have been far from unsatisfactory (having in view the unfavourable conditions of working) were it not for certain failures in the motorcar trade, which have necessitated the reservation of a proportion of the Queen's Ferry earnings to meet bad debts either incurred or foreseen to be probable. The same cause has led to losses at Rugby, but there the proportion which the trade with motorcar builders bears to the whole business is very much less than at Queen's Ferry. The results obtained at Queen's Ferry, when considered with reference to the necessarily small scale of operations, and still more with reference to the limited and imperfect appliances at the disposal of the management, prove, in the directors' opinion, that the special products for which Queen's Ferry has now a high reputation (especially Vanadium steel) might form the basis of a sound and remunerative business in the hands of an organisation commanding adequate capital for the necessary extensions of plant. This is so evidently the case that the directors have strong hopes that a sale may be effected upon reasonable terms in the near future. The Board greatly regrets that Sir Gilbert Clayton East, whose important services to the Company are fully known to the shareholders, has definitely decided to retire. Sir Gilbert became a partner in 1883, and since that time he has been unwearied in devotion to the interests of the undertaking and in active participation in its management. To fill this vacancy the Board recommends unanimously (except as regards Sir Gilbert, who expresses no opinion) the election of Mr. George F. L. Clayton East, at present the general manager at Queen's Ferry, where, in the opinion of the Board, he has deserved well of the Company, and has acquired experience which will be of value to the Board. With the insufficient appliances at his disposal, already referred to (which the Company had not, and has not, the means to extend), it has been impossible that the work should be carried on at a profit. Mr. Clayton East has had only the ungrateful and difficult task of carrying it on (in the interest of its future disposal as a going concern) at as small a loss as possible. In this the directors consider that he has been highly successful. Mr. Clayton East holds 350 preference and 320 ordinary shares in the Company, and his holding and Sir Gilbert's together amount to 2 250 preference and 1,080 ordinary shares, besides £3,150 in debenture stock. The Board is of opinion that the office of general manager at Queen's Ferry can properly be held in conjunction with a seat on the Board. It is not proposed to give Mr. Clayton East any additional renumeration as a director so long as he fills the office of general manager at Queen's Ferry and receives for his duties there his present salary of £800 per annum. The proposed arrangement will, therefore, reduce the cost to the

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Company by the whole amount of the present salary of Sir Gilbert Clayton East. But as the Board looks forward to finally disposing of Queen's Ferry, when, of course, the office of general manager will come to an end, it is proposed to arrange that so soon as Mr. Clayton East shall give up the office he shall be remunerated by a salary, as director, of £550 per annum, he undertaking to give so much time to the affairs of the Company as shall enable him to carry out the work in connection with the accounts which has hitherto been carried out by Sir Gilbert Clayton East. Owing to rearrangement of the work among the directors it is not considered necessary that there should in future be more than two giving their whole time to the executive work of the Company. Under these circumstances Mr. Lazenby intimates that when his turn comes to retire (in a year's time) he will not seek re election; but, to further facilitate the new arrangements, Mr. Lazenby offers to retire at once if the Company will pay him £600, being one-half the amount of the salary to become due to him under his agreement for the coming year. This proposal meets with the approval of the Board, who recommend its acceptance by the shareholders. In that event the Board will not propose to fill the vacancy so created, but will recommend that the number of directors be reduced to four. The saving which would accrue from this reduction would be £600 for the coming 12 months, and £1,200 per annum thereafter.

EDWARDS AIR-PUMP.

The tenth annual report of the directors of the Edwards Air-Pump Syndicate with revenue accounts and balance-sheet at Dec. 31, 1907, states that the result of the past year's working has again been satisfactory, and the directors are pleased to be able to recommend a final dividend at the rate of 15 per cent. per annum, making with the interim dividend of 5 per cent. paid in June last a dividend for the year at the rate of 20 per cent. per annum. They also recommend placing a further sum of £2,500 to the reserve fund for redemption of patents, making it £15,000, and the shareholders will note with satisfaction that this fund now equals the amount originally paid for the patents. The reserve for dividend equalisation stands at £1,000, and the investment reserve account at £565. 2s. 4d. The total number of pumps booked during 1907 was 1,208, as compared with 1,221 during 1906. Of this number 737, or 61 per cent., were for land installations, and 471, or 39 per cent., for marine work. The royalty income for 1907 amounted to £10,440, of which total the sum of £2,408, or 23 per cent., was received from foreign countries. The ordinary expenditure for the year was £4,133. The Edwards pump maintains its position as the most efficient and reliable air-pump on the market, and has now been fitted to nearly 2,800 steamers and to more than 400 of the principal electric lighting and traction stations. Many of the largest turbo-generators in the United Kingdom and abroad have been fitted with the Edwards air-pump, and the number of repeat orders are the best proof of the highly satisfactory results obtained. The gross revenue for the year has been £11,555. 8s. 5d.; the working expenses have amounted to £4,262 3s. 6d., leaving a gross profit of £7,293. 4s. 11d.; the balance from 1906, after paying the dividend, etc., is, £63. 9s. 6d., leaving £7,356. 14s. 5d. Out of this sum an interim 5 per cent. dividend was paid in June, absorbing £1,067. 18s. 9d.; and there has been set aside for redemption of patents £2,500 and for depreciation written off £6. 16s., leaving £3,781. 19s. 8d. The directors propose paying a further dividend of 15 per cent., making, with the interim dividend, 20 per cent. for the year, absorbing £3,203. 16s. 3d., leaving to be carried forward £578. 3s. 5d.

GATESHEAD AND DISTRICT TRAMWAYS.

The annual report and statement of accounts of the directors of the Gateshead and District Tramways Co. for the year ended Dec. 31, 1907, states that the total revenue for the year amounted to £54,309. 18s. 6d., as against £52,622. 17s. 9d. for the previous year. After deducting all expenses chargeable to revenue, including repairs and maintenance and interest on mortgages, there remains a profit of £23,132. 15s. 4d., to which is added an amount of £623. 5s. 7d. brought forward from the previous account, making a total available for appropriation of £23,756. 0s. 11d., which the directors recommend should be applied as follows: To transfer to the credit of depreciation and renewals account, which would thus be increased to £15,392. 6s. 7d., £3,500; to write off depreciation of investments (Newcastle and Gateshead gas and water stock), £609; to sinking fund for redemption of mortgages, £1,701. 10s. 8d.; to provide for a dividend for the year on £12,610 6 per cent. preference shares, £756. 12s.; to provide for a dividend on the year on £120,000 5 per cent. preference shares, £6,000; to pay a dividend on the ordinary shares at the rate of 7 per cent. per annum, £9,450; and to carry forward to next account, £1,738. 18s. 3d. The expenditure chargeable to the capital account during the year amounted to £332. 13s. 4d., making the entire capital outlay of the Company in and upon the undertaking £311,977. 0s. 11d. Having regard to the bad weather experienced continuously throughout the year, and the serious depression in the shipbuilding industry on the North-East Coast, the directors consider that the result of the year's working is very satisfactory. The question of operating motor omnibuses from the terminus of the Company's lines over the high-level bridge to the terminus of the Newcastle tramways at the Central Station has been before the directors. As, however, the tolls which the North-Eastern Railway Co. are authorised to demand in respect of motors crossing the bridge would very materially increase the cost of working, the railway company were approached with a view to more favourable terms being arranged. We regret to say that the negotiations were unsuccessful, and, having regard to this, the directors are unable to recommend the inauguration of the service. The Company has been approached by the Urban District Council of Hebburn with a view to the extension of the Felling route into that district, but the directors cannot at present see a profitable return upon the increased capital which such extension would necessarily involve. An abandonment order has been obtained in respect of the powers for those extensions in Whickham which were authorised but not constructed, the directors, after careful consideration, being of opinion that the extensions if constructed could not be worked at a profit. This has entailed a payment to the Urban District Council of Whickham of £400, as provided in an agreement with that Council dated May 18, 1907, and this amount has been debited to profit and loss account, and is included in the accounts now presented. A further extension of time to Oct. 22, 1908, has been obtained for the completion of that portion of the Wrekenton Light Railway which lies beyond the colliery wagon rope which stretches across the road just below the present terminus. The Corporation of Gateshead are working in unison with a local committee of the residents of Wrekenton with a view to overcoming the difficulty. A clubroom for the employés has been built during the year over the men's mess-room, at a cost of £184, which has enabled the premises previously rented by the Company for their employés at £26 per annum to be given up. A parcels service was inaugurated in May last, and has proved successful, a net profit of £320 having been made in connection therewith during the nine months ending Dec. 31 last. The undertaking has in all respects been maintained, as in years past, in good order and repair. The Company has joined the British Electrical Federation, which is formed by various electric lighting and traction companies for the purposes of co-operation and joint action in matters of common interest. Mr. W. L. Madgen has been elected a director and deputy-chairman in place of the late Mr. W. J. Greer. The directors retiring by rotation are Mr. W. L. Madgen and Mr. H. S. Day, who, being eligible, offer themselves for re-election.

Mr. C. R. Greene, J.P., presided on Tuesday at the annual meeting of the Company held at Donington House, Norfolk-street, London, W.C. In moving the report, Mr. Greene called attention to the remarkable progress of the undertaking, and stated that the year 1907 had once more proved a record one in the annals of the Company. Total receipts at £54,309 were up £1,687 over 1906, while expenses had gone in the opposite direction, being £31,177, or £1,517 less than the expenses during 1906. A dividend of 7 per cent. per annum was declared on the ordinary shares (6 per cent. was paid in 1906), and a vote of thanks to the chairman terminated the proceedings.

SOUTH LONDON ELECTRIC SUPPLY.

The report of the South London Electric Supply Corporation, Ltd., and Reduced, for the year ended Dec. 31, 1907, to be submitted to the meeting on the 7th inst., states that the total receipts for the year amounted to £33,991 and the expenditure to £18,192, leaving, with the amount brought forward, the sum of £19,605 available for distribution. After allowing for depreciation and interest on debentures and loan from bankers, there remains a sum of £15,478 to be carried to the balance-sheet. The Board recommends a dividend at the rate of 4 per cent. per annum on the original capital as it existed on Dec. 31 last, carrying forward a balance of £2,478. At the end of 1907 there were connected to the Company's mains the equivalent of 162,230 8-c.p. lamps, showing the satisfactory increase for the year of 17,608 8-c.p. lamps. Applications were then also in hand for an additional 5,000 lamps. Although there has been, as, of course, was inevitable, a large decrease in the gross receipts from supply of current through the expiration of the temporary contract with the London County Council for supply to their tramways, the revenue from supply to the Corporation's other consumers has increased by £4,000 as compared with 1906 and the output by 551,641 units, being an increase of 27 per cent. The units sold for industrial purposes increased by over 46 per cent. In view of the high rates prevailing in the money market until quite recently, the Board has considered it desirable to defer the issue of debentures referred to 12 months ago until the present year, and arrangements have been made with the Company's bankers for a renewal of the temporary advance in the meantime. The directors have been successful in coming to a satisfactory settlement with the borough of Lambeth over the long-pending dust destructor litigation, and consequently the appeal to the House of Lords against the decision of the Court of Appeal was withdrawn. The special resolutions for reducing the share capital from £325,000 to £260,000, which were unanimously confirmed by the shareholders on Jan. 7 last, came before the Court on March 14, when they were duly confirmed by Mr. Justice Neville, and the readjustments of the various capital accounts rendered necessary by such reduction will be at once carried into effect, though, of course, they cannot appear in the current accounts. Mr. Algernon Turnor, C.B., and Captain E. Ironside Bax are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. Price, Waterhouse, and Co., also retire, and offer themselves for re-election.

GREENOCK AND PORT GLASGOW TRAMWAYS.

The report of the Greenock and Port Glasgow Tramways Co. for the year ended Dec. 31, 1907, states that the outlay on the electrical construction during the year amounted to £517, making the total expenditure thereon to Dec. 31 last £193,641. The total revenue for the year amounted to £34,358. The expenditure, including interest, rents, and other sums payable to corporations, cost of repairs and maintenance, and after providing £2,250 for renewals and depreciation, amounted to £25,592, leaving a balance of £8,766. To this has to be added £136, being the balance brought forward, making a total of £8,902. The directors recommend to carry to the reserve (sinking) fund the sum of £1,780, to pay a dividend at the rate of 3 per cent. per annum on the ordinary shares, leaving a balance to be carried

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forward of £172. The reserve (sinking) fund will then stand at £11,390. The receipts show a decrease of £640 compared with the previous year, due to the decline in the shipbuilding trade, but, on the other hand, the expenditure has been reduced by £817, making the net result of the year's working an increased profit of £177.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER.

The report of the Bromley (Kent) Electric Light and Power Co. for 1907 states that very satisfactory progress has been made by the Company during the year, the lamp connections having increased from 71,222 to 77,802. The sale of current increased from £13,997 to £15,237. The works have been maintained in good order and repair. During the year considerable extensions have been made to the generating plant to meet the increased demand, and an additional distributing station is being erected at Elmstead. The result of the year's trading, including £313 brought forward, shows a profit of £12,386, and after payment of debenture interest and trustees' fees, amounting to £3,202, and £250 for depreciation of stock, there is a balance of £8,933. An interim dividend at the rate of 4 per cent. per annum was paid for the half-year in October, and the directors now recommend the payment of a further dividend at the rate of 7 per cent. per annum, making a total dividend of 5½ per cent. for the year, and that £4,500 be placed to reserve account, leaving a balance of £308 to be carried forward.

WYCOMBE (BOROUGH) ELECTRIC LIGHT AND POWER.

The directors of the Wycombe (Borough) Electric Light and Power Co., in their annual report and statement of accounts for the year ended Dec. 31, 1907, state that further progress has been made by the Company during the year, the connections having risen from 46,048 to 47,941, being an increase of 1,893 equivalent 8-cp. lamps, the income from sale of current having increased from £6,835 to £7,337. The result of the year's trading, including a balance of £147. 9s. 8d. brought forward from the previous year, shows a profit to the credit of the net revenue account of £4,659. 15s. 7d., and, after paying interest on debentures and outstanding accounts, £3,074. 12s., and the balance of the cost of the exhibition, £95. 19s. 11d., and preliminary expenses, etc., £49. 16s. 2d., there remains a balance of £1,439. 7s. 6d. available for distribution. The directors recommend the payment of a dividend at the rate of 2 per cent. for the year, which will absorb £800, that £500 be placed to the reserve fund for depreciation of plant, and £100 to reserve for bad and doubtful debts, leaving a balance of £39. 7s. 6d. to be carried forward to next year's accounts. One of the directors, Mr. J. C. Wigham, retires by rotation, and being eligible, offers himself for re-election.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT.

The revenue account of the Brisbane Electric Tramways Investment Co. for the year 1907 shows, subject to final audit, and including £2,267 brought forward, an available balance of £54,180. The directors have dealt with this as follows: in payment of debenture stock interest, £19,237; in payment of preference dividend, £17,812, leaving £17,130. Out of this balance the directors recommend that a dividend of 4s per share, free of income tax, be paid on the ordinary shares, being at the rate of 4 per cent. per annum, and that the sum of £2,130 be carried forward. The appropriation of the available balance of the tramways company, of which this Company holds all the shares, includes an allocation to renewals fund of £15,000 and a carry forward of £296.

LIENS REGISTERED.

Llandudno and District Electric Tramway Construction Co., Limited.—Particulars of £50,000 debentures, created by resolution of March 6, 1908, have been filed pursuant to Section 14 (4) of the Companies' Act, 1900. Property charged: the company's undertaking and property, present and future, including uncalled and unpaid capital. No trustees.

Electrolytic Alkali Co., Limited, Middlewich.—Issue on Feb. 15 of £1,000 and on March 4 of £700 4½ per cent. first mortgage debentures, part of series created July 9, 1904, to secure £50,000. Charged on the company's undertaking and property, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., 6, Castle-street, Liverpool. Total amount previously issued of same series, £34,850.

Rhondda Tramways Electric Supply Co., Limited.—An assignment of leasehold redemption policies, dated March 16, 1908 (supplemental to a trust deed dated Aug. 8, 1907, securing £44,000), has been registered. Property charged: various policies in the Sun Life Assurance Society, Century Insurance Co., and Profits and Income Insurance Co., for a total sum of £44,000. Trustees: C. A. Scott-Murray (director of Sun Life Assurance Society), 63, Threadneedle-street, E.C.; and L. B. Schlesinger, 21, Cornhill, E.C.

Tasmanian Copper Co., Limited. — Particulars of £30,000 debentures, created by resolution of Jan. 23 and secured by a trust deed, dated March 4, 1908, have been filed pursuant to Section 14 (4) of the Companies Act, 1900. Property charged: Mines in South Australia and Tasmania, with the buildings and works connected therewith and the company's undertaking and property, present and future, including uncalled capital. Trustees: F. L. Cox, 118, Temple chambers, E.C., and J. White, LL.D., Bank-buildings, Ludgate-circus, E.C.

Lancashire Dynamo and Motor Co., Limited. — Issue on March 2 of £1,200 5 per cent. first mortgage debentures, part of series created by resolutions of March 4 and June 24, 1907, to secure £75,000. Charged on two plots of land in Trafford Park, Stretford, Lancs., containing about 10,946 and 5,300 square yards respectively, together with the works and erections thereon and fixed plant and machinery therein, and the company's undertaking and other assets, except uncalled capital. Trustees: E. F. Sheppard, 55, King-street, and A. Tongue, 86, King street, Manchester. Total amount previously issued of same series, £66,800.

Cape Electric Tramways, Limited.—Particulars of £140,000 5 per cent. debentures, created by resolutions of Nov. 17, 1897, and Aug. 30, 1898, and secured by trust deeds, dated March 9 and Aug. 30, 1898, have been filed, pursuant to Section 14 (4) of the Companies' Act, 1900, a debenture of recent date having been produced to the registrar. In certain events a bonus of 6 per cent. is secured to the holders. Property charged: the company's property, present and future, including £120,000 shares in the Port Elizabeth Tramways Co., and (*pari passu* with £315,000 6 per cent. debentures) upon the residue of the company's property, present and future, except £130,000 shares in the Metropolitan Tramways Co.; £45,000 shares in the Southern Suburbs of Cape Town Tramways Co.; £158,500 shares in the City Tramways Co.; upon which the present debentures rank as a second charge, subject to the said 6 per cent. debentures. Trustees: C. Rube and L. Breitmeyer, 120, Bishopsgate-street Within, E.C.

LEGAL INTELLIGENCE.

WIRELESS TELEGRAPHY.

Action against the Marconi Co.

Before Mr. Justice Bigham, in the King's Bench Division on Wednesday, an action was brought by the Buitenlandsche Bank of Amsterdam against the Marconi Wireless Telegraph Co. to recover damages for an alleged breach of contract in connection with the erection of a number of wireless telegraph stations in the Dutch East Indies, and the formation of a company to own and work the stations. Liability was denied by the defendants.

Mr. J. A. HAMILTON, K.C., who appeared for the plaintiffs, said that a year ago it occurred to some gentlemen who were well acquainted with the Dutch East Indies that the islands afforded a particularly good field for the operation of a wireless telegraph system, and they applied to the Dutch Government for a concession, and also put themselves into communication with the Marconi Telegraph Co. The result was that in November, 1906, it was agreed between the plaintiffs and the defendants that the bank should form a company under Dutch law, with a share capital of about £200,000, for the purpose of acquiring and working the stations. It was also agreed that the defendants should arrange for the erection of 48 stations and provide the necessary working capital of the new company up to £50,000. The shares of the company were to be pooled, and plaintiffs were to have a certain number for their services. The concession was granted on June 5, 1907, and, according to Dutch law, £1,000 had to be deposited and 10 per cent. of the amount of the subscribed capital of the new company had to be paid. In the previous January the Marconi Wireless Telegraph Co. had registered the Sanfil Co., and assigned to them any benefits they were entited to under the agreement. The sum of £1,000 required as a deposit was provided by a cheque of the Sanfil Co., but the Marconi Wireless Telegraph Co. lent the Sanfil Co. the money to meet the cheque. Mr. Smith, the secretary to Mr. Hall, of the Marconi Wireless Telegraph Co., and a director of the Sanfil Co. subscribed for 600 shares of 1,000 guilders each and gave a cheque for £5,000, being 10 per cent. on the share capital which had been subscribed. That was a cheque which could not be met unless the Marconi Wireless Telegraph Co. placed the amount at the disposal of the Sanfil Co. The Marconi Wireless Telegraph Co. did not provide the money, and the cheque was in consequence dishonoured. In the result the concession was cancelled and the company came to nothing. The defendants now said that they were not under any obligation to the plaintiffs until the Dutch East India Co. was formed and in a position to commence business. They further said that they were entitled to transfer their obligations and benefits under the agreement to any company, syndicate, or corporation which they might form to acquire the same, and that as they had transferred their benefits and obligations to the Sanfil Co. they were under no liability to the plaintiffs. Counsel submitted that the Marconi Wireless Telegraph Co. was not entitled to transfer its obligations without the consent of plaintiffs, and remarked that if they had carried out their obligations the plaintiffs might in four or five years have realised £14,000 or £15,000.

Evidence was given to the effect that in their opinion if the stations had been erected and worked, the company would have earned a profit of from 7 to 9½ per cent. on the capital invested.

The hearing was adjourned.

LONDON ELECTRON WORKS CO. v. WAGNER.

This case came before Mr. Justice Ridley and a special jury in the King's Bench Division last week, and was an action by the plaintiffs for an injunction to restrain the defendant from committing an alleged breach of an agreement and from threatening to break it. Defendant denied the breach of the agreement, and, further, said that the agreement was void in law.

Mr. MCCALL, K.C., in opening the plaintiffs' case, said the plaintiff company was formed by a few gentlemen for the purpose of working

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a secret process which might be described as "detinning," by which tin boxes or anything made of tin was put into an apparatus consisting of a tank filled with a certain chemical moisture and agitated by a powerful electric current, which succeeded in taking the tin off and keeping it pure. This small company had a capital of £40,000, and dealt with about 15,000 tons of tin metal each year, and out of that it got pure tin to the extent of about 2 per cent. Before 1897 this process had been tried in various ways. On Aug. 26, 19 5, the plaintiffs and the defendant, a foreigner, entered into negotiations for the purpose of the plaintiffs securing the defendant at their London works. After the terms of the proposed agreement were discussed, it was entered into. Plaintiffs told defendant that they wanted him to contract not to enter into a similar business in England, and then not to disclose any of the experience he had gained while with the plaintiffs. On those terms he entered the plaintiffs' employment, and the agreement was made on Nov. 20, 1905. That agreement provided that the defendant was not to enter into a competing business in England, and that he was not to disclose any of the processes or modes of business carried on by the plaintiffs. Defendant turned out to be a professional chemist, and probably in the course of 12 months defendant learned all that was to be learned about the plaintiffs' business, but he proved himself an insubordinate employé. In 1906 he told one of the plaintiffs' employés that he was in communication with a rival manufacturer (a German), and that coming to the plaintiffs' notice they gave the defendant three months' notice to terminate the agreement—the time provided for by the agreement. Defendant asked the plaintiffs to release him from the clauses in the agreement preventing him from going into a rival employment and from disclosing the plaintiffs' secret processes. Plaintiffs declined to release him, and then defendant began to threaten that the plaintiff company in the course of their business carried on certain wrong practices which he was prepared to disclose, and he finally said that, whether the plaintiffs agreed or no, he would not be bound by the covenants. Defendant left the plaintiffs on March 5, 1907. In April the directors of the plaintiff company were astonished to find in a German journal which concerned itself with electrical chemistry a description of the plaintiffs' process purporting to be written by a certain Dr. Mennike. He (counsel) would ask the jury to say that that article could not have been written except upon information supplied by the plaintiffs. If that was so, there had been a gross breach of the agreement which the plaintiffs had entered into. Although there was a penalty clause in the contract, the plaintiffs did not ask for damages against the defendant, but they would ask for an injunction if the defendant would not undertake not to disobey the provisions of the agreement. Plaintiffs would accept that.

His Lordship said that as plaintiffs did not ask for damages, but only for an injunction, he could not understand how it was that the defendant refused to give an undertaking which the plaintiffs expressed their willingness to accept.

In the result defendant, while denying that he had committed any breach of the undertaking, gave the undertaking plaintiffs asked for, and it was decided that each party should pay their own costs.

PROVISIONAL PATENTS, 1908.

March 20.

6187. Improvements in switches for electric lighting and other electrical purposes. Frederick Hodgson, 24, Queen Victoria-street, London.

6228. Method of producing a constant booster voltage with variable speed. Hugo Grob, 37, Essex-street, Strand, London. (Date applied for under Section 91 of the Act, March 20, 1907, being date of application in Germany.) (Complete specification.)

6229. Improvements in or relating to electric arc lamps for theatrical and other stages. Thomas Joseph Digby, 37, Essex-street, Strand, London. (Complete specification.)

6235. Improvements in and relating to electrically striking clock bells, gongs, and the like. The Hon. Stuart Pleydell Bouverie and Frank Hope-Jones, 7, Southampton-buildings, London.

6245. Improvements in metal-filament electric lamps. The Westinghouse Metal-Filament Lamp Company, Limited, Westinghouse Buildings, Norfolk-street, Strand, London. (Date applied for under Section 91 of the Act, March 27, 1907, being date of application in Germany.) (Complete specification.)

March 21.

6283. Improvements in variable gears for motorcars, motor cycles, electrical, and other machinery. Samuel Edward Eachus, 247, Shelley-road, Preston, Lancs.

6287. Improvements in clutches for the change-speed mechanism of motor vehicles, for electric motors, and for other purposes. Harold Cornelius Reading, trading as H. C. Reading and Co., 5, Corporation-street, Birmingham.

6295. Improvements relating to vehicle electric lamps with switch-plug combination. Wilhelm August Robert Cramme, 88, Long-lane, Aldersgate, London.

6323. Apparatus for electromagnetic treatment. Ferdinand Steinert and Heinrich Stein, 56, Myddelton-square, London. (Date applied for under Section 91 of the Act, March 21, 1907, being date of application in Germany.) (Complete specification.)

6292. Improvements in electric resistances. Walter Frederick Jones, 166, Wellington-road, Eccles.

6331. Improvements relating to metallic conduits as employed for electric wiring. John Richard Browne, 18, Southampton-buildings, London.

6338. Improvements in electric batteries or accumulators. Walker Moseley, 16, Love-walk, Denmark-hill, London.

6348. Electrical device for releasing and attaching levers, bolts, and the like. Charles Frank Vincent and William Dyson and Co., Limited, 33, Cannon-street, London.

6370. Improvements in electric starting switches. Haydn Thies Harrison, 46, Lincoln's-inn-fields, London.

March 23.

6384. Run-back automatic electric brake. Edwin Daley and Robert Roberts, 63, Tiverton-street, Picton-road, Liverpool.

6407. Improvements relating to means for absorbing vibration in electric filament lamps. Paul Druseidt, 20, High Holborn, London.

6409. Improvements relating to electric incandescent filament lamps. Charles Pauli, 20, High Holborn, London. (Application for patent of addition to No. 27541/07.) (Complete specification.)

6412. Improvements in electric sliding or other contacts. Victor Lowendahl, 65, Chancery-lane, London. (Complete specification.)

6421. Improvements in and relating to electric arc lamps. Crompton and Co., Limited, and Claude Crompton, Arc Works, Chelmsford.

6432. Improvements in electrical alarms for tramcars and the like. Thomas Robert Kinsella and Christopher William Hodgetts, Fife House, Kingston-on-Thames. (Date applied for under Section 91 of the Act, March 21, 1907, being date of application in the United States.) (Complete specification.)

6449. Process for the electrolytic production of aluminium oxide. Frank Walter Morris, 40, Chancery-lane, London. (Complete specification.)

6458. Improvements in thermostatic circuit closers. Jay Orr Woods and Joseph William Graham, 18, Southampton-buildings, London.

6461. Automatic electric control for fluid-compressing pumps for working mechanisms at variable capacities. Edward Charles Robert Marks, 18, Southampton-buildings, London. (Societa Anonima Italiana Gio Ansaldo, Armstrong and Co., Italy.) (Complete specification.)

6477. Improvements in apparatus for use in connection with electric cables. Charles James Beaver and Ernest Alexander Claremont, 4, Bloomsbury-square, London.

March 24.

6493. Concentric pinion-geared electric capstan. James Andrew Liddle, 23, Rutland-street, Edinburgh.

6501. Improvements in electric switch boxes. Emile Charles, 4, Corporation-street, Manchester.

6520. Improved telephone shield. Herbert Darnley, 57, Rectory-grove, Clapham, London.

6518. Improvements in connection with the generation of electric energy and apparatus therefor. William Spiers Simpson, 173, Fleet-street, London.

6562. Improvements in electric clock-winding mechanisms. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (George H. Rupley, United States.)

6568. Improvements in circuit breakers or makers. John Grice Statter, Norfolk House, Norfolk-street, Strand, London. (Application for patent of addition to No. 14577/06. (Complete specification.)

March 25.

6605. New or improved method of holding or clutching gas or electric globes or shades in their galleries. Alexander Morrison, 13, Randolph place, Edinburgh.

6638. Improvements in or connected with electric current converters. Christopher John Montgomery, 15, Water-street, Liverpool.

6644. Improvements in methods of generating electrical oscillations. William Henry Eccles and Alfred Jacques Makower, 37, Marcsfield-gardens, London.

6687. Improvements in and relating to incandescent electric lamps. The British Thomson-Houston Company, Limited, and Harry Hampton Needham, 83, Cannon-street, London.

6688. Improvements in elastic fluid turbine systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.) (Complete specification.)

March 26.

6726. Signalling key for use with high-tension electric currents. Maurice Child, 24, John-street, Bedford-row, London.

6737. Improvements in or relating to non-inductive resistances. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, March 25, 1907, being date of application in Germany.) (Complete specification.)

6751. Improvements in arc lamps. Arthur Holman, 44, West George-street, Glasgow.

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6750. Improvements in the combination of materials used for conveying lubricants to the journals of electric motors, railway and tramway axles, and the like. Cecil Hastings Stone and Ernest Sultan Quilliam, 121, Bensham Manor-road, Thornton Heath, Surrey.

6753. Improvements in connection with electric conductors and their fittings to prevent access of water or moisture thereto. Ernest Lower Berry and Frederick Harrison, 47, Lincoln's-inn-fields, London.

6757. Improvements in electric cables. Victor Pindter von Pindtershofen, 4, South-street, Finsbury, London. (Complete specification.)

6764. Improvements in electrically-controlled locks particularly applicable to carriages and like vehicles. Société Ch. Legrand et Cie, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 29, 1907, being date of application in France.) (Complete specification.)

6767. Monotelephone relay transformer. Société des Télégraphes Multiplex (Système E. Mercadier), Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 27, 1907, being date of application in France.) (Complete specification.)

6771. Improvements in electric contact breakers for induction coils. Herbert Charles Newton and Russell Stuart Wright, 3, Fleet-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on April 9.)

1907.

1373. Electric lighting of railway and other vehicles. Park and Mason.

6649. Compensated dynamo-electric machines of the commutator type. British Thomson-Houston Company. (General Electric Company.)

6854. Electromagnetically-operated switches particularly adapted for controlling electric motors. Schattner and Amberton.

6906. Alternating-current series commutator motors. Keith and Tuson.

6920. Apparatus for magneto-electric ignition for internal-combustion engines. Fuller and Fuller.

6943. Electric arc lamps. Davy.

7181. Electric motor-control systems for towing and the like systems. British Thomson-Houston Company. (General Electric Company.)

7737. Electric lifts or hoists. R. Waygood and Co. and Bone.

7742. Electric furnaces. Cowper-Coles.

8151. Means for adjustably supporting electric incandescent lamps and shades or reflectors therefor. Rawlings and Smith.

9010. Telautographs. Ritchie.

10091A. Electric telegraph apparatus. Sutcliffe. (Date applied for under Rule 13, May 1, 1907.)

11166. Method of generating high-tension direct electric currents. Highfield.

13172. Electrically-actuated fire-alarms. Tatlock and Horne.

13196. Electric insulators. British Thomson-Houston Company. (General Electric Company.)

13739. Electric reactances and the like. British Thomson-Houston Company. (General Electric Company.)

14876. Dynamo-electric machines. Noeggerath. (Date applied for under International Convention, June 30, 1906.)

16366. Starters for electric motors. Mayo and Houlehan. (Date applied for under International Convention, Feb. 11, 1907.)

16710. Dynamo-electric machines. Bruce Peebles and Co. and La Cour.

17695. Space telegraphy. Stone. (Date applied for under International Convention, Aug. 3, 1906.)

17769. Lightning conductors. Morris.

18849. Laying of underground electric conduits and laying conductors therein. Dussek and Dussek.

19875. Electric hot-water radiator for heating buildings or the like. Nobbs and Nobbs.

20670. Mercury interrupters for electric currents. Drault. (Date applied for under International Convention, Sept. 21, 1906.)

20932. Method of manufacturing moulds used in the electrolytic manufacture of so-called honeycomb radiators and apparatus connected therewith. Friedheim. (Date applied for under International Convention, Nov. 27, 1906.)

21670. Control of electric motors. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Oct. 1, 1906.)

27400. Electrical box couplings. Rawlings and Smith.

1908.

220. Selective electric signalling. Nicholson.

1333. Telephonic receivers. Nicholson.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price
	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	½-⅝
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125 000	1 ..	11/16-13/16
—— Ordinary, Nos. 1 125,000	1 ..	3/16 5/16
British Aluminium Co., Ordinary, 2 001-40,000	5 ..	3⅝-4½
—— 7 per cent. Cum. Pref., 1-40,000	5 ..	4⅛ 4⅞
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	4⅛-5⅛
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3⅞-4½
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100-103
—— 5½ per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-6⅝
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	88-92
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275,001-475 000	3 ..	½-¾
—— 4 per cent. Mortgage Debenture Stock	100 ..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2 ..	0-½
—— Non. Cum., 6 per cent., Pref.	2 ..	3/16-7/16
—— 4½ per cent 1st Debenture Stock	100 ..	77-80
—— 4½ per cent. 2nd Debenture Stock	100 ..	63-66
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10½ 1·½
—— 5 per cent. Pref.	5 ..	5⅜ 5¼
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3	1 11-16-1 15/16
—— 5 per cent Debentures	100 ..	92-95
Dick, Kerr and Co., Ordinary, 1 260 000	1 ..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼ xd
—— 4½ per cent. Debenture Stock, Red.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99 261	5 ..	2-1
—— "A" Shares, 01-017,133	5 ..	1½-2½
—— 5 per cent. Debentures	100 ..	85-87 xd
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112 100	2 ..	½-¾
—— 7 per cent. Cumulative Pref.	2 ..	1½-1⅝
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	61-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅜-8¼
—— 4 per cent. 1st Mort. Deb Stock	100 ..	87-90 xd
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	4¾- ¼
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-1⅝
—— 4 per cent. Debentures	100 ..	98-100 xd
National Electric Construction Co., 1-170,000	1 ..	7/16-11/16
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-30,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	31-33
—— 4 per cent. Bonds	100 ..	100-105
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9

Electric Lighting and Supply.—

Name.	Amount paid.	Last price
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅜-5¼
Bournemouth and Poole, Ordinary	10 ..	10¾-11¼ xd
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	10-11
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	10½-11
—— 4½ per cent. Debenture Stock, Red	100 ..	100-103
Bromley (Kent) Electric Light and Power Co	5 ..	4⅜-5⅛
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	96-99
Brompton and Kensington, Ordinary	5 ..	7¼-7½
—— 7 per cent. Preference	5 ..	6¾-7⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6⅞-7¼
—— Nos. 80,000-100,000	5 ..	6⅞-7¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	92-96 xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3¾ 4¼
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	4¼-4⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	4¼-4⅜
—— ditto (1905) 40,001-80 000	5 ..	4⅜-4⅝
Chelsea Electricity Supply	5 ..	3⅜ 3⅝
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	9¼-10⅜ xd
—— 6 per cent. Cumulative Pref.	10 ..	11¼-11¾ xd
—— 5 per cent. Debenture Stock	100 ..	123-126
—— 4½ per cent 2nd Deb. Stk., Red.	100 ..	101-104
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3-3⅜
—— 5 per cent Preference, 1-50,000	5 ..	4¼-4½
County of London Elec. Supply, Ordinary	10 ..	7⅜-7⅝
—— 6 per cent. Cum Pref.	10 ..	10⅜-11¼ xd
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	106-109
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	97-100
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅛-¼
—— 6 per cent. Cum Pref.	5 ..	¼-⅜
—— 4½ per cent. First Mort. Deb.	100 ..	58-63
Electrical Development Co. of Ontario. 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	— ..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-2⅜
—— 5 per cent Debenture Stock, Rd.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	91-94
Folkestone Electric Supply, Ord., Nos. 1-10 000	5 ..	4¼-5 xd
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	4¾-5⅛ xd
—— 4½ per cent. First Deb Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	6¼-6⅜ xd
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	96-99
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 .	⅛-¼
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	7¼-8¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100 ..	97-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼

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Name.	Amount paid.		Last price.
	£		£
London Electric, Ordinary	3	..	1½-1⅝
—— 6 per cent. Pref.	5	..	4½-5
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	..	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100	..	92-95
Metropolitan Ordinary, 100,001-.00,000	5	..	5-5½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	107-111
—— 4½ per cent. Cum. Pref.	5	..	4⅝-5½
—— 3½ per cent. Mortgage Debenture, Red.	100	..	£5 90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1 000 ($100), D 1-3,000 ($500), M 1 4,400 ($1,000	—	..	75-77 p.c.
Mexican Light and Power Co. Capital Stock	$100	..	50-52
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1 000)	—	..	84-86
Midland Electric Power Dist., 4½ p.c. 1st Mort. Deb.	—	..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	..	5⅞-6⅛
—— do, 57 010-75 000	5	..	5⅞-6⅛
—— do, 75,001-87 500 (issued at £2 prem., 16s. paid	5	..	6⅛-6⅜
—— 5 per cent., Pref., 1-57,009	5	..	5⅛-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	..	5⅛-5⅜ xd
Notting Hill Electric Lighting	10	..	11½-12½
—— 4 per cent. First Mort. Deb. Nos. 1 500 (Reg.)	100	..	95-97
Oxford Electric, Ordinary, 1-96 and 40 14,310	5	..	5⅞ 6½
—— 4 per cent. Debenture Stock	100	..	93-96
River Plate Electricity Co., Ord., 1 119 687 & 120,501-120 507	1	..	13/16 15/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red.	100	..	96 99
Rosario Electric Co 6 per cent. Cum Pref, 1-20 000	5	..	4⅞-5⅛ xd
—— 6 per cent Cum 2nd Pref., 1-15,000	5	..	4⅞-5⅛ xd
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	96 98
Shawinigan Water and Power Co, 5 p.c. Cons. 1st Mt. Bds.	—	..	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	..	½-1½
—— 4 per cent. Debenture Stock	100	..	70-74
South London Ordinary	5	..	2⅝-3⅛
South Metropolitan Electric Light and Power, Ord.	1	..	⅛-⅜
—— 7 per cent Cum Pref.	1	..	1½-1⅝
—— 4½ per cent 1st Mort. Deb.	100	..	99 102 xd
St. James's and Pall Mall, Ordinary, 101-20,000	5	..	7½-8½
—— 7 per cent. Pref.	5	..	6½-7
—— 3½ per cent. Deb.	100	..	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	1⅜-2⅛ xd
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	..	1⅜-2⅛ xd
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	..	87-90 xd
Westminster, Ordinary	5	..	7½-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	..	5-5½

Electric Tramways.—

Name.	Amount paid.		Last price.
	£		£
Anglo-Argentine, 6 per cent. Cum Pref., 1-200 00	5	..	6-6⅛
—— 10 per cent. Non-Cum. 2nd Pref., 2 0 008-280.007	5	..	8-8½
—— Permanent 6 per cent Debenture Stock, 1888	100	..	129-132
Auckland Elec Trams., 5 p.c. 1st Mor. Deb Stk, Red.	100	..	104-107
Barcelona Tramways, Ord, 1-20 000	10	..	—
—— 5 per cent. Cum. Pref. shares, 1 10 000	10	..	—
—— 5 per cent Deb., Red., 1-600	100	..	—
—— 4½ per cent. Red. Deb. Stock	100	..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001 1 0,006	1	..	⅛
—— 5 per cent. Cum. Pref. Shares, 1-75 000	1	..	13/16-15/16
Birmingham and Midland Trams., 4½ p.c 1st Deb. Stk, Red.	100	..	93-96
Blackpool and Fleetwood Tramroad	10	..	13⅜ 13⅝
Bombay Elec Supply and Trams Co., 6 per cent Cum. Pref	10	..	9⅜-10¼
—— 4½ per cent. Deb. Stock, Red.	100	..	94½ 95½
Brisbane Tramway Invest., Ord., 1-75,000	5	..	3¼-4⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4⅞ 5
—— 4½ per cent Deb. Stk, Red., Prov Certs. all pd	100	..	97-101
British Columbia Electric Railway Co., Ord Def	100	..	132-135
—— Ord. Pref.	100	..	108-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	105 109
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40	..	101-104
—— 4½ per cent. Vancouver Power Deb.	100	..	100-103
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10	..	1⅛- ⅝
—— 6 per cent. Cm Pf., 30 0001-60 000	10	..	4-4½
—— 5 per cent. Perpetual Debenture Stock	100	..	94½-97½ xd
—— 4½ per cent 2nd Deb. Stock	100	..	72-76
Bueno Ayres and Belgrano Trams	5	..	4⅝-4⅞
—— "A" 6 per cent. Cm. Pf., 1-4 000	5	..	4⅝ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27 500	5	..	4⅝ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	..	110-116
—— Prov. Cert., all paid	100	..	—
Buenos Ayres Electric Trams, 5 p.c Deb. Stk., Red.	100	..	95-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	100-104
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	92 95
Calcutta Tramways, Ord., Nos 1-137,610	5	..	6⅜-7⅛
—— 5 per cent. Cum. Pref., Nos. 1 20 000	5	..	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red	100	..	102-105
Cape Electric Tramways, Nos. 1-480,000	1	..	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	..	4⅜-7⅞
—— 4 per cent 1st Mortgage Deb, 1-3 000 (1917)	100	..	98-101
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5	..	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red. 1985	100	..	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	89-93
Cork Electric Tramway and Lighting Co, Ordinary	10	..	13-14
—— 6 per cent. Cum. Pref.	10	..	12⅜-13⅜
—— 4 per cent. Debentures	100	..	90-95
Dublin United Tramways (1896), Ord, Nos 1-60 000	10	..	12¼-13½
—— 6 per cent. Pref., Nos. within 1-60 000	10	..	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	..	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk., Red.	100	..	95-98 xd
Havana Electric Railway Consolidated Mort 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1 000		80 85
Imperial Tramways, Ordinary	all		18-19
—— 6 per cent. Cum. Pref.	all		13-13½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref, Nos. 30,001-60,000	5	..	⅜ 1⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100	..	87-91
—— 6 per cent. "B" Deb. Stock	100	..	71-75
Kidderminster and District Lighting and Traction, Pref.	5	..	10- 0½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100		91-94
—— £296 500 2nd Mort. Deb. Stock	—	..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	..	⅛-1⅛
—— 6 per cent Cum. Pref., Nos 1-425,553	1	..	⅛-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	90-95

Name.	Amount paid.		Last price.
	£		£
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	6-7
—— 4 per cent. 1st. Mt. Db. Stock, Red	100		81-85
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100		95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	86 90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436 25,000	5	..	4½ 5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	..	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1	..	1/16 3/16
—— 5 per cent. Cum Pref., 500,001-1,000,000	1		⅜ ⅝
—— 4½ per cent. Deb. Stock, Red.	100	..	86-89
Mexico Trams. Co, Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	82½-84½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 20-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	..	103-106
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000 1922	100	..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34 001-74 000	5	..	½-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	2
—— 5 per cent. Cum. Pref.	10	..	8½-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mit. Deb. Stk	100	..	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1	..	¼-⅜
—— 5 per cent Cum Pref., 300,001-545 000	1	..	7/16-11/16
—— 4½ per cent Debenture Stock	100	..	93-96
Provincial Tramways Co., Ordinary, 1-24,912	10	..	4½-5
—— 6 per cent. Cum. Pref., 1-10,000	10	..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-20,000	5	..	5⅛-5⅝
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	122-127 xd
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500	..	95 97 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	⅛-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100	..	78 82
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red. 1-1 600	100	..	73-78
Yorkshire (West Riding) Elec Tram. Co, Ord., 70,001-110,000	5	..	1-1½
—— 6 per cent Cum. Pref., 1-46,261	5	..	3 3½
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	84-87

Electric Railways.—

Name.	Amount paid		Last price.
	£		£
Central London, Ordinary	100	..	71-74
—— 4 per cent. Pref.	100	..	82-84
—— " " deferred	100	..	52-55
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	100-103
City and South London, Consolidated Ordinary	100	..	39-41
—— 4 per cent Debenture Stock	100	..	101-104
—— 5 per cent. Pref Stock '91	100	..	113-116
—— " " " '96	100	..	112-115
—— " " " '01	100	..	110 113
—— " " " '05	100	..	106-109
Liverpool Overhead, 5 per cent. Pref	10	..	10-10½
—— Ordinary, 1-50 000	10	..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red, 1-1 700	—	..	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	..	40-44
—— Deposit Receipts	—	..	40-44

Telegraphs and Telephones.—

Name.	Amount paid.		Last price.
	£		£
Amazon Telegraph Co., 1-25,000	10	..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	..	84-87
American Telephone and Telegraph Coll. Trust 4 per cent. Bonds, 1-28 000 and 53 001-78,000	$1 000	..	85 87
Anglo-American Telegraph Co., Ordinary	100	..	55-58
—— 6 per cent. Preferred Ordinary	100	..	98-100
—— Deferred Ordinary	100	..	13½-14
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	98½-101½
Chili Telephone Co, 1-44 000	5	..	7-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	..	86-89 xd
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	..	7-8
—— 10 per cent Preference, 1-6,000	10	..	16 17
Direct Spanish Telegraph Co., Ordinary	5	..	3¼-3⅜ xd
—— 10 per cent Cum. Preference	5	..	8¼-8½ xd
—— 4½ per cent Debs., 1-600	50	..	98½-102½
Direct United States Cable Co.	20	..	13⅜-14⅜
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	..	98 101
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000, 1913	25	..	99-101
Eastern Extension, Australasia and China, 1 300 000	10	..	12⅜-13⅜
—— 4 per cent. Mort. Deb. Stock. Perp	100	..	98-102
Eastern Telegraph Co., Ordinary stock	100	..	130-135
—— 3½ per cent. Preference Stock	100	..	84-87
—— 4 per cent. Mortgage Debenture Stock	100	..	101-104
Great Northern Telegraph Co. (of Copenhagen)	10	..	31-33
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100	..	99-101
Indo-European Telegraph Co.	£5	..	54-57
Marconi's Wireless Telegraph Co, Nos 255,128-284,190	1	..	7/16-9/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	—	..	⅛-1
National Telephone, Preferred	100	..	107-109
—— Deferred Stock	100	..	108-110
—— 6 per cent. Cum. First Pref.	10	..	10-12
—— 6 per cent Cum. Second Pref.	10	..	10-12
—— 5 per cent. Non. Cum. Third Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	..	97½-99½
—— 4 per cent Deb. Stock, Red.	100	..	101-103
Oriental Telephone and Electric Company	1	..	1 3/16-1 5/16
—— 6 per cent. Cum. Pref	1	..	1 3 32-1 7 32
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	..	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5	..	6-6½
—— 5 per cent Cum. Pref., 1-40,000	5	..	4⅜-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	..	99-102
West African Telegraph Co.	10	..	10-10½
West Coast of America, 1-30 000 and 53,001-53,008	2½	..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	..	98-101
West India and Panama Telegraph Co., Ordinary	10	..	⅛-⅜
—— 6 per cent. Cum. 1st Preference	10	..	8-8½
—— 6 per cent. Cum 2nd Preference	10	..	8-8½
—— 5 per cent. Debs., Red., 1-800	100	..	100-103
Western Telegraph Co., 1-207,930	10	..	13½-13⅝ xd
—— 4 per cent. Debenture Stock, Red.	100	..	99-102

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	Mar. 25	1,187	1,178	+ 9	— A	27½	27½	May 31	72,605	17,676,000	1,539,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 23	181	210	- 28	—	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 21	3 025	2,220	+ 805	+ 8,734	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 29	1,024	1,058	- 14	+ 5.0	23·53	23·53	March 31	55,408	11,696,691	1,384,743	—	—	—	6·1
Birmingham Corporation	,, 28	6 064	5,575	+ 59	—	56½	54½	,, 31	18 557	5,252,088	315.345	87	.6·2	9,228	—
Blackburn Corporation	,, 14	976	887	+ 89	+ 5,783	23·80	23·80	,, 25	51.951	10.09·,028	1,004 372	1 25	12 64	2,309	8·02
Blackpool Corporation	,, 26	358	500	- 142	1,217	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	Oct 26	311	273	+ 32	- 1,.39	16½	6½	Dec. 31	34,819	2 707,918	625,110	3 09	12 903	—	7·795
Bolton Corporation	Mar. 29	2,210	3,276	-1,0.5	- 5,558	42	42	March 31	111 294	24,410,690	2,411,909	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 25	1,3 6	1,455	59	+ 2 52.	24	24½	,, 31	85,665	13,503,.10	1,765,088	1 48	11·37	2,860	7·28
Bradford Corporation	,, 21	4 191	4 336	- 141	+ 5,317	'8	95	,, 31	232 427	46,728,977	5.167,26	1 195	10 79	2,421	—
Brighton Corporation	,, 2.	703	1,078	- 375	- 3,72.	17·191	17·191	,, 31	50,662	10,769,210	1 798,386	1 09	10·49	2,844	7·4
Bristol Tramway Company	,, 27	4 42.	5,257	835	—	51½	51½	,, 31	265,769	56,902,257	6 178,886	—	—	—	—
Burnley Corporation	,, 28	1,160	1,718	- 558	—	19½	19½	,, 31	62 69.	11,967,4 8	1,205,830	1 31	12 48	5,825	8·21
Burton Corporation	,, 29	242	303	- 61	- 7.6	9½	8½	,, 31	15 576	3,383,527	421,317	07	8 87	1,718	6·14
Cardiff Corporation	,, 7	1,86.	1,820	+ 40	-	32 62	†32·26	,, 31	106,550	24,438,.64	2,624,504	1 04	9·74	3,226	6
Carlisle Tramways Company	,, 30	171	169	+ 2	+ .0	8 5	8·5	Dec. 31	10 25.	2 790 689	350,417	—	—	—	7·96
Central London Railway	,, 28	5 287	5,.01	+ 685	- 2 23.	6	6	,, 31	349.298	43.067,997	1,279 t9Ca	1·85	62·29a	55,357	5·22a
Charing X, Euston, & Hamp. Ry	,, 21	3,.60	—	—	—	7½	6½	—	—	—	—	—	—	—	—
City and South London Railway	,, 28	3,279	2 408	+ 871	+ 4,960	9	6½	A June 30	82,456	10.048,780	—	—	—	—	—
Colchester Corporation	Feb. 26	160	151	+ 9	-	8	8	* March 3	10,588	2.457,653	220,788	·97	7 47	1,401	6·12
Cork E. T. and L. Company	Mar 26	78.	47.	- 8	352	15½	15½	Dec 31	25,03.	5.966 364	891.9·8	—	6·74	—	4·78
Croydon Corporation	,, 27	1,259	—	—	—	12 c	12 c	March 3	64,065	13,614,918	1, .2 408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 27	93.	318	- 87	- 171	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Dec. 28	181	169	+ 12	- 1.124	4½	4½	,, 31	12 468	3 178,063	328,406	·94	9·11	2,686	—
Dublin and Lucan Electric Ry.	Mar. 27	95	118	- 22	+ 13a	6½	6½	—	—	—	—	—	—	—	—
Dublin U.T.	,, 27	4 605	5,001	- 396	+ 1,754	54½	48½	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 25	1,073	1 051	+ 12	+ 2 257	22	22	May 1'	57 672	15 554 905	1,162 782	·878	1·9	4,358	7·3
East Ham Corporation	,, 28	826	1,046	- 220	+ 127	14	14	March 31	47,140	15,049,240	1 062 151	·74	0 49	3 636	7 14
Glasgow Corporation	,, 28	16 877	17.434	— 557	+17,.8A	177½	169	May 31	87.381	224,(63,0·8	20,350.367	95	0·47	5,035	5·21
Gloucester Corporation	,, 25	206	210	- 44	—	15	15	March 31	15,733	3,182,111	579,986	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	,, 21	5 430	3,885	+1,545	+19,421	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77 986	18,893,242	1,624 275	—	1·52	—	8·65
Huddersfield Corporation	,, 21	1,443	1,471	- 23	+ 3 269	35½	35	,, 31	8',196	15 252,150	1.804,745	1 52	0 79	2,770	5·92
Hull Corporation	,, 21	2 495	2,50.	- 13	. 6,831	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 14	39.	414	- 23	—	10½	10½	,, 31	26,499	6,586,754	616,117	89	9 58	2,225	6 5
Ilkeston Corporation	,, 25	126	130	- 4	+ 423	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 25	21.	27.	- 28	—	7½	7½	May 15	13,702	4,640,618	466,919	6·2	7·55	1 773	4 95
Lancashire United Tramways	,, 25	1,184	1 178	+ 5	+ 992	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 21	5 938	6 173	- 23.	+12,.23	96½	96½	March 3	327,794	73,024,253	7,358,185	1 06	10·69	3,352	5 58
Leicester Corporation	,, 28	2,099	2 3.6	- 207	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 21	9,921	11,207	-1,.86	- 1,973	104	104	Dec. 31	563.793	122.094,528	12 115,934	1·108	·1 17	5,421	7·75
Liverpool Overhead Railway	,, 29	1,3.6	1,429	- 43	+ 5A	9 25	6·66	June 30	77 568	10 957,148	1,102,809	—	—	—	—
London County Council	,, 14	30 .93	27,.90	+3.008	+240 812	98	98	March 31	1'78,014	314 227 090	30 130 987	1·05	10 98	—	8 56
Lowestoft Corporation	,, 28	130	180	- 50	+ 111	3½	—	sept. 30	11 039	2,6 2 982	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 26	151	99	+ 52	—	3½	2	March 31	5,913	1 186.566	157,050	1 14	8 6	2,956	6·2
Manchester Corporation	,, 21	13,652	13 552	+ 100	+741 021	172	161	,, 31	719,673	143 264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 21	8,777	7 818	+ 919	+10 957	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 29	15,08.	13,672	+1,411	+ 3,357	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 28	126	—	—	—	2⅜	2⅜	March 31	7,.69	2.035,300	303,303	86	8 64	1 892	8·69
Newcastle-on-Tyne Corporation	,, 28	3,717	4,229	- 512	+ 534	59⅛	57½	,, 31	2 0 491	45,5.6 468	4,263,174	1 11	11 85	3 560	6·14
Newport (Mon.) Corporation	,, 21	568	618	— 50	+ 2 035	14½	14½	,, 31	32,421	7.760 403	772 753	1 03	10 01	1 525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,.50	35½	35½	,, 25	94 948	18,647,731	1,818,444	1·19	12·53	2 603	7·2.9
Portsmouth Corporation	Jan 18	1,470	1 4 6	+ 54	—	28½	28½	,, 31	98,911	21 668 825	2 199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	653	+ 9	- 788	13½	13½	,, 31	32,661	8,130 179	918 825	96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	25,916	5 743,298	618,211	1 12	10 45	2,691	7·38
Salford Corporation	Mar. 23	4,2 2	4,387	- 175	+ 6 685	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78c	4 78c	Dec. 31	7,779	1.537 845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 22	5.118	5,497	- 379	+11.232	65½	65½	March 25	276.907	73 966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	,, 25	841	849	- 7	+ 3,535	18	18	,, 31	49,185	9 437,396	1,143,085	1·25	10·71	—	7 7
Southend-on-Sea Corporation	,, 25	267	287	- 20	+ 207	9	9	,, 31	20,07.	4,431,.28	380,538	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8 617,127	1,248 656	—	9 464	—	4·849
Sunderland Corporation	,, 29	1,062	1,472	- 410	- 3 566	20	20	,, 31	72,396	17.483 132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,.75.221	224,417	·8	9 94	1,968	7 79
Torquay Tramways	,, 26	198	—	—	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 28	791	962	- 170	+ 433	12 68	12·43	,, 31	43,607	7,995,451	862,123	1·26	12·14	3,439	7·6
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965 296	429 785	—	10 724	1,989	6·95
West Ham Corporation	,, 26	2,520	2,340	- 320	+ 1,678	14 7	14 7	,, 31	1 2,881	35,.02 836	2,556,854	789	10 96	4,907	6·79
Wolverhampton Corporation	,, 25	741	771	- 30	+ 540	20	20	,, 31	43,823	9 276,023	966,133	—	10 886	2,159	6·035

* 1905-6 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. A Half-year's figures

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ELECTRICAL UNDERTAKINGS.

"Garcke's Manual" for 1908 has just reached us, and shows by its increased bulk the increase in importance of the electrical industries. The magnitude of work involved in the preparation of this manual may be perfectly gauged by the amount of capital employed in the industry. This for the volume in question stands at £366,583,581. The editors of this volume have collected statistical information from the companies and municipal undertakings using the above capital. This information is supplied promptly in the great majority of cases, but there are always a few what we may term black sheep in the flock who decline for certain reasons to send in the returns. The stupendous work of dealing with the information sent in can only be fully appreciated by those who, like ourselves, have attempted to deal with one section only of the electrical industries. Besides the individual returns from each undertaking, the "Manual of Electrical Undertakings" collects in its preface statistics made up from these returns, and it is interesting to try to draw conclusions from these figures. Thus the total capital employed has increased by 6½ millions during the past year. The average return on the capital is, unfortunately, on the down grade, which has tended to restrict the introduction of new capital. This average return stood at 5·4 per cent. in 1901, and for the past year is 4·36 per cent. Comparing 1907 with 1906, there are decreases in telegraphs, electricity supply, and traction. The telephone proportion has gone up from 5·02 per cent. to 5·26 per cent.; and, curiously enough, the manufacturing and miscellaneous sections both show increases—the former from 5·09 per cent. to 5·43 per cent. and the latter from 3·86 per cent. to 4·22 per cent. These figures have, however, to be considered in relation to the fact that liquidations and writing down of capital may raise the average dividend without implying prosperity. It is a significant feature of the manufacturing section that the record is derived from 143 companies with £31,385,000 in capital, as compared with (in 1906) 110 companies with £31,353,000. That is to say, there are 33 more companies and only £32,000 more capital. A somewhat similar change is observable in the figures of miscellaneous companies. In 1906 there were 34 companies with £5,005,000 in capital; the 1907 figures are 42 companies with £5,196,000 in capital. The inference is that with these sections of the industry the day does not rest with large successful companies. In the electric supply section we find figures to show that some 40 millions have now been raised on loan by local authorities for the supply of electricity. This is a 6¼ per cent. increase on the previous year. The actual amount of money borrowed during the year for this purpose was about 2½ millions. The capacity of the plant employed is now about half a million kilowatts, so that the average expenditure per kilowatt installed stands at about £80. The number of units sold, however, has increased from 422,850,000 to 475,530,000. On the other hand, in spite of this addition of over 53,000,000 units to the output, the total receipts from sale of current are almost precisely the same—£4,118,629 for the past year and £4,118,510 for the previous year. Reductions in tariff and the effects of metallic-filament lamps no doubt combined, along with the increase in the motor load, to produce this result. In the company section of the supply division 95 undertakings are dealt with as against 88. The capacity has increased from 240,210 kw. to 271,724 kw. The number of units sold has risen from 211,467,000 to 248,133,000, and the revenue from

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£2,364,000 to £2,395,000. Going back to the 1906 volume, with 71 undertakings, we find that the rate of increase of output was substantially greater—45,000,000 units per annum, as against 37,000,000 units per annum—but the increase of revenue was much higher—£206,300 between 1906 and 1907, as against £31,000 between the 1907 and 1908 volumes. Thus companies show the effect of the same general causes as municipalities. Another significant point is that the capital expenditure of 95 supply companies in the current volume is £21,835,319, as compared with £20,231,325 for 88 companies in the 1907 volume, showing that little or no fresh capital has come into a business which should continue in rapid development. As far as the London companies are concerned these are responsible for a large proportion of the capital above referred to, and the delay of Parliament in coming to some definite decision on the bulk supply question seriously hampers their extension. In electric traction the manual shows that corporations have spent £41,735,000 and the companies £22,356,000. Thus the former have spent twice as much capital as the latter, and it is interesting to note that the first named carried during last year 1,808 million passengers against the companies' 646 million. In other words, the municipal tramways carried three times the passengers. The revenue of the corporations was £8,172,322 and that of the companies £3,677,000. The average fare on the corporation tramways was hence 1·08d. and on the company tramways 1·37d. The tendency of the editorial comment in the manual is to consider undertakings by the net revenue they produce. This neglects the consideration of the value of the services rendered, and the above figures show that the passengers on company tramways have to pay on an average 27 per cent. higher fares than those on corporation tramways. Hence the public may receive very great advantages from electrical undertakings which, when considered on their profit-earning basis, do not compare favourably with commercial undertakings, whose object it is to earn a large net revenue. Of course, the value of "Garcke's Manual" is not determined by the attitude of its editors in this respect. The figures given are equally valuable to all, and there are few electrical engineers who can afford to dispense with this guinea volume.

HERO WORSHIP—DAVY.

In the popular mind a hero is either a brave fighter or one who has performed physical deeds of an extraordinary character. That is just because the popular mind can appreciate physical strength, and it can appreciate little else. Not so the trained minds of a select few. They look upon pure animal strength and dexterity as something of a very ordinary character, and they select heroes from those who have shown extraordinary mental strength and dexterity rather than otherwise. Thus we select heroes of the arts, of the sciences, of the professions. Electricians have their heroes—living and dead. Prof. Thorpe, at the Royal Institution, has been speaking of one who is reckoned a hero in a twofold manner—Davy. Incidentally Prof. Thorpe told us something of the Royal Institution which is not generally known. It originated in a "proposal to deal with the question of the unemployed—namely, by forming in London by private subscription an establishment for feeding the poor and giving them useful employment . . . connected with an institution for introducing and bringing forward into general use new inventions and improvements, particularly such as relate to the management of heat and the saving of fuel, and to various other mechanical contrivances by which domestic comfort and economy may be produced." The ideas of eleemosynary aid to the unemployed necessarily came to naught. Charity never did, never will, and never can deal with unemployment. Then the institution became a grand centre for philosophical lectures and experimental work. It became a breeding ground for heroes of science, of whom Davy was the first Perhaps the halo of glory surrounding Davy pales somewhat before that of Faraday. Shall we mention Tyndall, that prince of lecturers, or shall we revel in the possession of Dewar, whose investigations into low temperatures and the liquefaction and solidification of gases, though not appealing to the exponent of physical culture, will place his name very high upon the list of heroes of science? Prof. Thorpe's lecture was mainly devoted to Davy's work in connection with the "isolation of the metals of the alkalis," the centenary of which was being celebrated. But Prof. Thorpe holds, and we agree with him, that "Davy's greatest claim as a philosopher to our admiration and gratitude is in the theories he advanced and the experimental results he obtained as to the chemical agencies of electricity." Continuing investigations with the voltaic battery, it was on Oct. 19, 1807, that he obtained his first decisive result in this isolation, his journal saying: 'A capital experiment, proving the decomposition of potash." A hundred years ago sodium and potassium were the new-born infants. To-day the Castner-Kellner process for the production of sodium is of world-wide repute, and "the yearly output amounts to about five thousand tons, though the plant already laid down is capable of producing at least twice that quantity." We need not do more than refer to the use of the sodium in the manufacture of sodium cyanide, and the large use of the latter in the extraction of gold. It is more to the purpose to show the progress of a century, at the birth of which a piece of sodium was a great scientific curiosity, at the end of which its cost was eightpence per pound, and, as we have said, its use measured by thousands of tons. Truly, Davy was a hero both from the scientific and from the practical point of view—and he was of the Royal Institution.

CAPITAL AND POLITICS IN AUSTRALIA.

Commerce and industry are so interwoven with politics that to set out to consider the broader aspects of these matters invariably leads one to the thorny paths of politics, whence the return is often much more difficult than is supposed. And however distasteful to the average business man may be the noise of partisan politics, and however much he may wish to turn his back upon the feuds of the parties, he cannot, nevertheless, remain indifferent to events that are transpiring, and must of necessity keep in close touch with them in order to prepare himself for the safeguarding of his interests. We may ignore the rantings of the apostles of Demos in this country, which, after all, do not concern us greatly, and note what are the effects of political interference with commercial and industrial enterprise in countries which pride themselves upon their advanced social politics. Australia forms an instructive example as showing how the trend of State and municipal labour politics in the colony affects British capital. The recent Colonial Conference is doubtless still within the recollection of our readers, who may remember that several gentlemen interested in Australian finance then met Mr. Deakin and some of the other premiers, and pointed out to them that the trend of politics in Australia had been in recent years unfavourable to British enterprise

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and British capital. Mr. R. P. Sellon referred to the matter at the meeting of the Electric Lighting and Traction Company of Australia on Monday, and at the same time pointed out that there was a growing feeling in this country that this trend was in a direction unfavourable to the development by the agency of private capital of the various enterprises with which they were connected. It was pointed out to Mr. Deakin and his colleagues in London last summer that if that

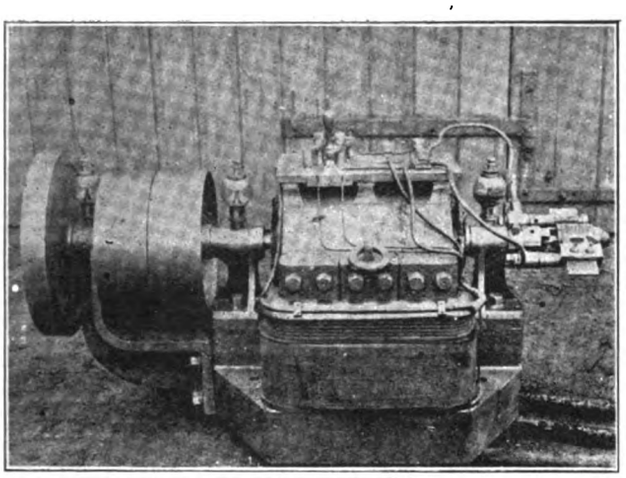

FIG. 1.—Type of Machine, 1879.

feeling really became settled in the city of London, the flow of British capital into Australian industrial enterprises would dry up. The premiers, we are glad to say, replied very frankly, and seemed clearly to realise the difficulties of the position. They gave very explicit assurances that not only was it not the intention of Australian statesmen, politicians, local authorities, or others in any way to hamper such industrial developments, but that they would also do their best, in case any such restrictions should be proved to exist, to have them removed. We hope, for the sake of the vast sums invested and likely to be invested in electrical enterprises in the Antipodes, that these assurances will be fulfilled.

TAUNTON.

The late Mr. F. M. Newton in the later part of the 1870 decade started electrical manufacturing works in Taunton,

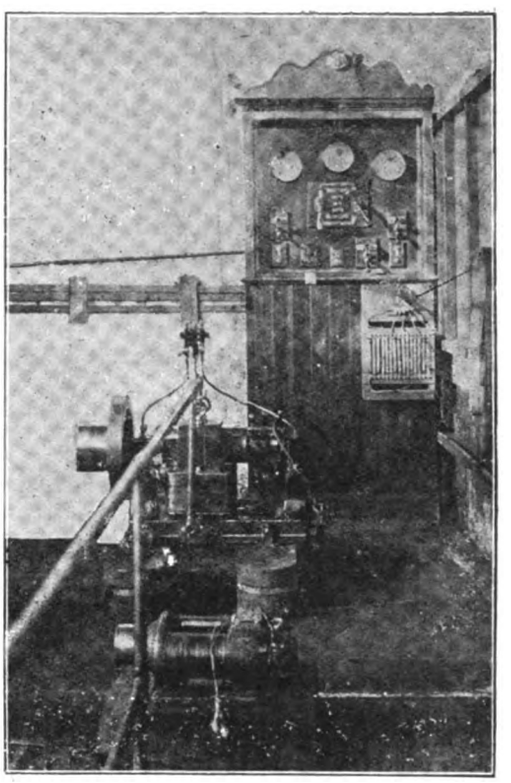

FIG. 2.—Machine and Switchboard for a Country House.

which were among the earliest of such works established in this country. It may be remembered that in 1878 was held an International Exhibition in Paris, and at that exhibition the Gramme dynamo and the Jablochkoff lamp were exhibits that interested the whole world, and set inventors going to discover what they saw was wanted—a method of dividing up such light as was given by an arc lamp. The inventors soon designed lamps of incandescent

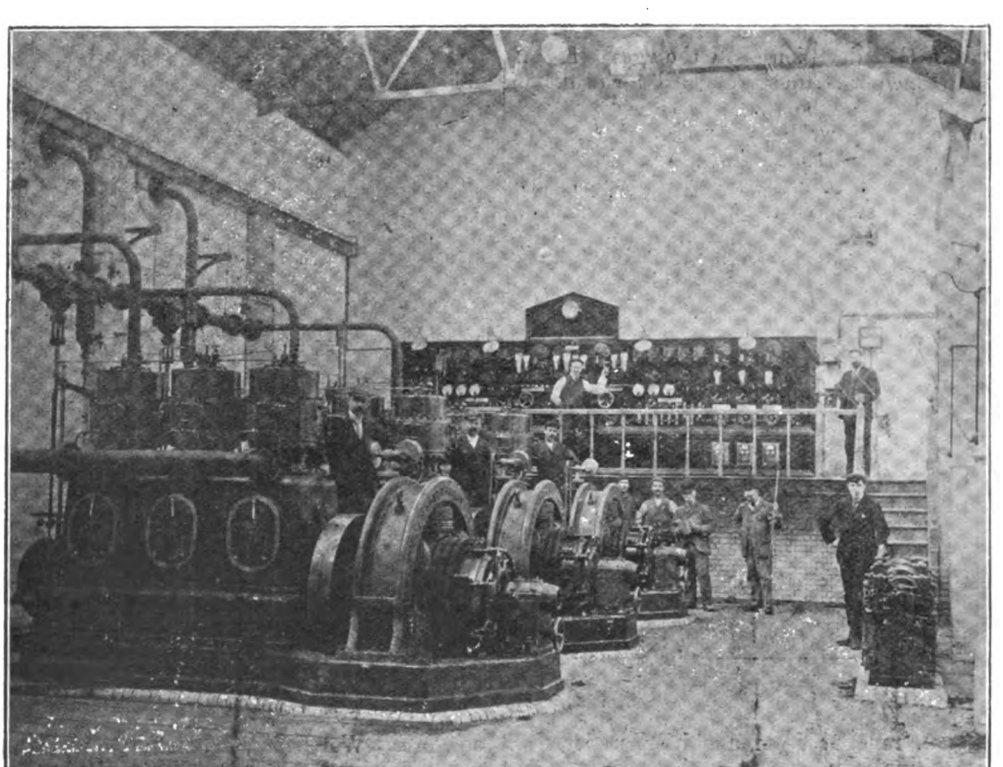

FIG. 3.—Interior of Barnstaple Station. Dynamos by Messrs. Newton.

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material, now universally used for interior lighting. Well, Mr. Newton started his works, and it is interesting to know that some of the earliest machines which have done good work have found a resting place for future workers to see—in the works at Taunton.

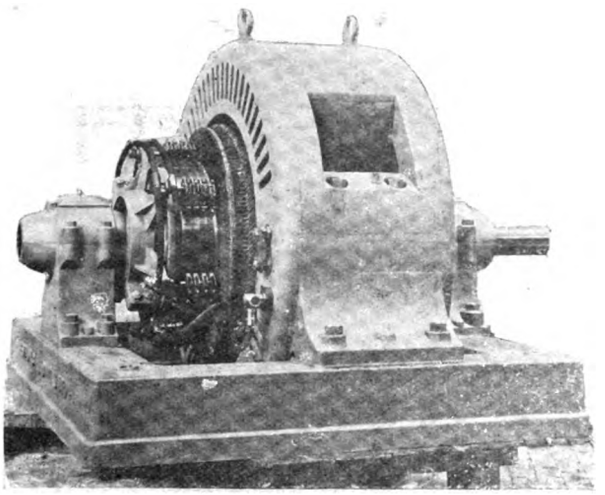

FIG. 4.—Multipolar Dynamo according to the Zone Patents.

Fig. 1 shows the type of machine made by the late Mr. F. M. Newton about the year 1879. This machine was in use for about 20 years, and did good work, when, however, it was superseded by a machine of more modern design. It is, perhaps, a pity that there is not a national mechanical museum wherein such relics of early designs could be collected for the education of all the ages. Fig. 2 shows another of these old machines, designed for country-house lighting, with the switchboard then in use.

Fig. 3 shows more modern work—the Barnstaple station, which commenced work in 1903. Here we get three Newton dynamos of 375 kw. capacity driven by engines by Messrs. Reavell, of Ipswich. When it is remembered that the demands on revenue from a station under the local authority is compulsory, and that the interest and charges at this station in 1903 were as much as £1,288, it will be thought good organisation to have in the second year of work a deficit of only £24, while the third year produced a profit of £269. Messrs. Newton do good work.

Fig. 4 shows one of the most recent designs of the Taunton works. It is made under the Zone patents. Writing of this dynamo in our issue of Jan. 11, 1907, we said: "It embodies a peculiar method of field winding by which distortion of the field is entirely prevented, and which serves the same purpose as commutating poles, but without complications. As a result, sparkless commutation at all loads is obtained with fixed brushes, and the general construction of the machine is simplified to a remarkable degree. Incidentally, we may point out that as cast steel is not used for the magnets the time required for manufacture is considerably lessened, while the absence of all complication renders these machines especially valuable where skilled attention is not available. Particular attention has been paid to the brush gear, and the carbon block can be removed from the holder without disturbing the neighbouring brushes. The brush is fitted with a hold-off catch, and is also provided with a stop to prevent the metalwork of the holder injuring the commutator when the carbon has worn down. Since their first appearance large numbers of these machines have been made and sold, including all sizes from ½-h.p. motors up to large generating plants direct-coupled to high-speed engines. The users now include the War Office, Admiralty, and Home Office, and a large number of central stations and private users at home and abroad. Two of these dynamos have lately been supplied to the Llandudno Pier Company."

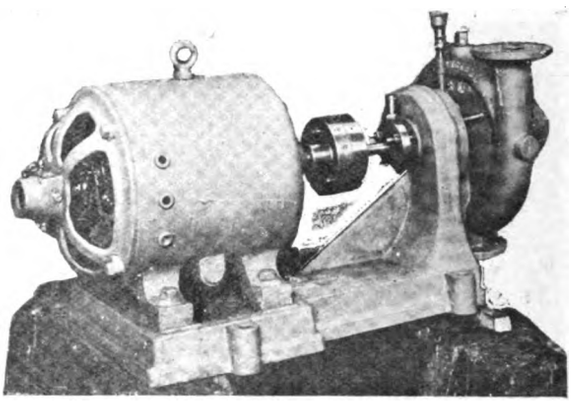

FIG. 6.—Motor attached to Centrifugal Pump.

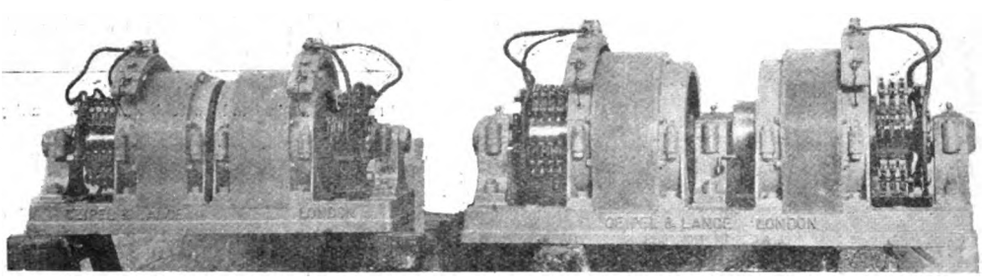

FIG. 5.—Machines used in the Navy.

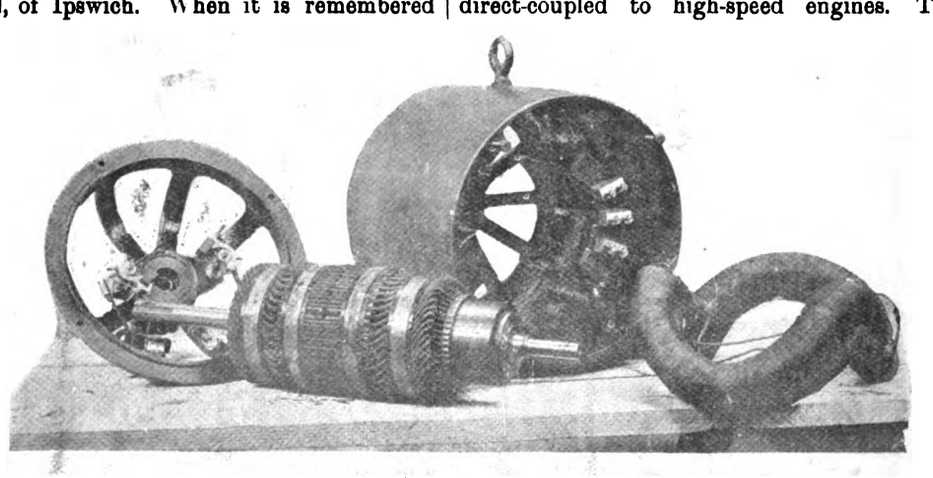

FIG. 7.—Parts of Motor.

Fig. 5 is a special form of machine largely used in the navy for working gunpowder hoists and the training and firing of guns automatically. But necessarily in a large

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establishment the types are many. Figs. 6 and 7 show a motor attached to a centrifugal pump and the various parts which, when put together, form the machine. It ought to be said that the shops at the time of our visit were largely engaged on Government work, and it is well known that the tests and specifications of this kind of work are very stringent, and that firms on the list must make the best of machines.

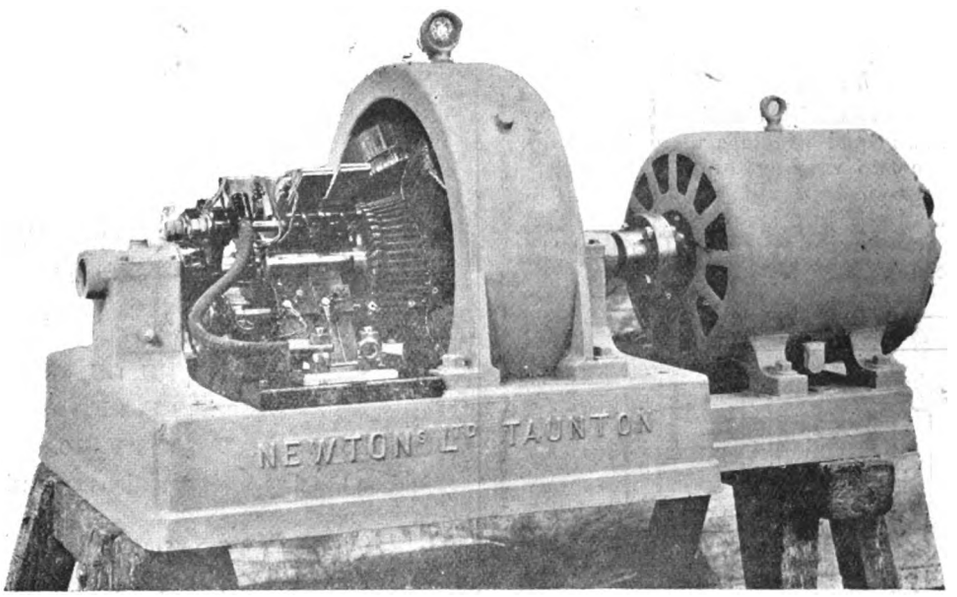

FIG. 8.—Motor Generator for Electro-Deposition of Metals.

NEW ALTERNATE-CURRENT INSTRUMENTS.*

BY W. E. SUMPNER, D.SC, AND J. W. RECORD.

(*Concluded from page 474.*)

APPENDIX.

Note I.—Summation Wattmeter.

A wattmeter to measure the total output of a set of generators would often prove useful in cases where, owing to the sectionising of 'bus bars and feeder circuits, it is not possible or convenient to so place a transformer that its primary is traversed by the total current. The new instruments here described can be conveniently used under such conditions. One indicator is required, and the same number of quadrature current transformers as there are circuits in parallel. The wattmeter connections are shown in Fig. 25.

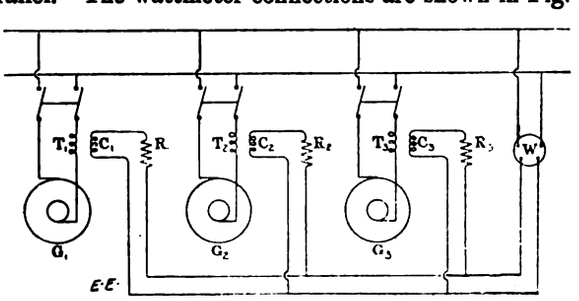

FIG. 25.

G_1, G_2, G_3 are the generators, each connected to the 'bus bars through a double-pole switch and the primary of a quadrature transformer, T. In each case the current through the primary coil generates an E.M.F., e, in the secondary coil, this coil being connected through a resistance, R, to two leads running to the moving coil of the wattmeter, W. This moving coil will have a resistance which is low in comparison with the resistances R_1, R_2, R_3. These latter must all be adjusted so that the wattmeter reads correctly in each of the cases for which there is only one generator in action. The adjustments for R_1, R_2, R_3 will be almost independent of each other under the conditions assumed. If the resistances are properly adjusted, the wattmeter will read correctly whatever the number of generators working in parallel. This follows from the fact that the current, **C**, through the moving coil is at any instant given by the equation

$$C = C_1 + C_2 + C_3,$$

where the currents forming the parts of **C** are such that

C_1 is calculated assuming $e_2 = e_3 = 0$.
C_2 „ „ $e_3 = e_1 = 0$.
C_3 „ „ $e_1 = e_2 = 0$.

The deflection of the wattmeter depends upon the mean value of the product of the field strength **F** and the moving-coil current **C**, but

$$F C = F C_1 + F C_2 + F C_3,$$

and if the values of R_1, R_2, and R_3 have been so adjusted that the wattmeter reads correctly for each generator acting alone, it will also read accurately when two or more are acting together. To test the above a standard wattmeter, with constant 20 watts per division, was used to measure the true power supplied to two loads in parallel. The currents A_1 and A_2 of the loads and the voltage **V** of the mains were read by hot-wire instruments, these being only approximately accurate, but sufficiently so to indicate the conditions of test. The summation wattmeter under test was connected up in a manner similar to that shown in Fig. 25, so that its moving coil formed the common portion of the secondary circuits of two quadrature transformers, the primaries of which were traversed by the currents A_1 and A_2. The pressure coils of the two wattmeters were joined across the mains at the same points, and the current coil of the standard instrument was traversed by the sum of the two branch currents A_1 and A_2. The load A_2 was in all cases non-inductive, and consisted of banks of lamps. This was also the case for the load A_1 except for the last two tests, in which choking coils were used to make the load inductive. A carbon resistance placed in the main circuit served as a fine adjustment to bring the reading of the standard wattmeter to 95 divisions in all cases. The corresponding readings of the summation wattmeter for different magnitudes of **V**, A_1, and A_2 are given in Table IV.

TABLE IV.

Test.	V.	A_1.	A_2.	Readings of wattmeter. Stand. W.	Sum. W.
1	91·0	0	20·8	95	94·7
2	91·0	20·6	0	95	95·1
3	91·0	9·0	11·7	95	94·8
4	93·5	13·8	10·7	95	95·0
5	94·5	9·9	17·9	95	94·8

The two first tests merely serve to show the correctness of the adjustment of the resistances of the secondary circuits of the transformers (43 ohms for one and 103 ohms for the other, exclusive of the resistance of the moving coil and fuse amounting to 16 ohms). The last three tests

* Paper read before the Institution of Electrical Engineers.

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show that the summation wattmeter acts correctly as closely as it was possible to read the instruments (95 divisions on the standard instrument measured only about 5in. on the scale). The frequency of the current was about 50, and the power factor of the load A_1 in test No. 5 was only about 0·2.

Note 2. — Neutral-Point Reactance Coil for Shunt-Magnet Wattmeters.

A small transformer core with closed magnetic circuit is twin wound with two equal windings of n turns, each of resistance r. These two windings are put in series, and the ends are joined to mains 1 and 2 at potentials $\mathbf{V}_1$ and $\mathbf{V}_2$. The potential of the junction of the two coils is $\mathbf{P}$, and, on ordinary transformer principles, this potential $\mathbf{P}$ is half-way between $\mathbf{V}_1$ and $\mathbf{V}_2$ at every instant. The

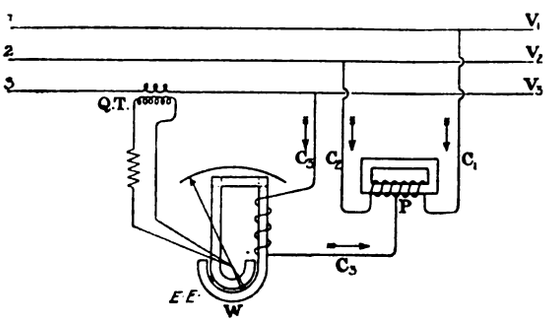

FIG. 26.

field-magnet coil of the wattmeter is joined to the junction P, and to the third main at potential $\mathbf{V}_3$. The quadrature transformer, Q T, of the wattmeter, W, is placed in the third main as shown in Fig. 26. All the potentials are reckoned from that of the neutral point N as a zero.

The vector diagram is shown in Fig. 27.

If the currents flowing to the point at potential $\mathbf{P}$ be $\mathbf{C}_1$, $\mathbf{C}_2$, and $\mathbf{C}_3$; if ρ be the resistance, m the number of turns, and $\mathbf{M}$ the magnetic flux through the core, of the electromagnet coil; and if $\mathbf{F}$ be the flux through the core of the auxiliary transformer, we have

$$\mathbf{V}_1+\mathbf{V}_2+\mathbf{V}_3=0$$
$$\mathbf{C}_1+\mathbf{C}_2+\mathbf{C}_3=0$$
$$\mathbf{V}_1-\mathbf{P}=r\,\mathbf{C}_1-n\,\dot{\mathbf{F}}$$
$$\mathbf{V}_2-\mathbf{P}=r\,\mathbf{C}_2-n\,\dot{\mathbf{F}}$$
$$\mathbf{V}_3-\mathbf{P}=\rho\,\mathbf{C}_3+m\,\dot{\mathbf{M}}$$

Hence

$$2\,\mathbf{V}_3-(\mathbf{V}_1+\mathbf{V}_2)=2\,\rho\,\mathbf{C}_3-r\,(\mathbf{C}_1+\mathbf{C}_2)+2\,m\,\dot{\mathbf{M}},$$

or

$$3\,\mathbf{V}_3=(2\,\rho+r)\,\mathbf{C}_3+2\,m\,\dot{\mathbf{M}},$$

or

$$1{\cdot}5\,\mathbf{V}_3=\left(\rho+\frac{r}{2}\right)\mathbf{C}_3+m\,\dot{\mathbf{M}},$$

or the flux in the instrument magnet will be exactly 1½ times that which would be produced by applying to

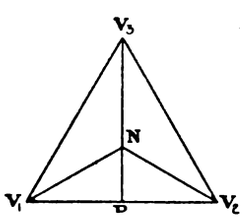

FIG. 27.

the magnet coil the voltage, $\mathbf{V}_3$, between the third main and the neutral point, provided the resistance of the field coil be considered increased by the parallel resistance of the two coils of the auxiliary transformer. The reading of the wattmeter, as standardised on a single-phase circuit, must be doubled to denote the power of the mains. It is found easy to construct a suitable small auxiliary transformer such that the parallel resistance of its windings is a small fraction of the resistance of the field-magnet coil.

It is also possible to construct a true neutral-point reactance coil by assembling magnetic stampings suitable for a small three-phase transformer so as to form three similar cores magnetically connected in parallel as indicated in Fig. 28. Around each core is wound a coil of n turns having a resistance r. Three corresponding ends of these coils are star connected at P, the other ends being connected to the three mains at potentials $\mathbf{V}_1$, $\mathbf{V}_2$, $\mathbf{V}_3$. If $\mathbf{C}_1$, $\mathbf{C}_2$, and $\mathbf{C}_3$ are the coil currents flowing to the point P, if $\mathbf{F}_1$, $\mathbf{F}_2$, $\mathbf{F}_3$ are the core fluxes, and if the potential of P be denoted by $\mathbf{P}$, we have

$$\mathbf{V}_1-\mathbf{P}=r\,\mathbf{C}_1+n\,\dot{\mathbf{F}}_1$$
$$\mathbf{V}_2-\mathbf{P}=r\,\mathbf{C}_2+n\,\dot{\mathbf{F}}_2$$
$$\mathbf{V}_3-\mathbf{P}=r\,\mathbf{C}_3+n\,\dot{\mathbf{F}}_3.$$

Also, if the field coil of the wattmeter be connected between the third main and the point P, we have as before

$$\mathbf{V}_3-\mathbf{P}=\rho\,\mathbf{C}+m\,\dot{\mathbf{M}},$$

where $\mathbf{C}$ is the current in the field coil.

The conditions of continuity are

$$\mathbf{C}+\mathbf{C}_1+\mathbf{C}_2+\mathbf{C}_3=0$$
$$\mathbf{F}_1+\mathbf{F}_2+\mathbf{F}_3=0,$$

and we also have $\mathbf{V}_1+\mathbf{V}_2+\mathbf{V}_3=0$.

By adding the first three equations and using the last three we obtain

$$-3\,\mathbf{P}=r\,(\mathbf{C}_1+\mathbf{C}_2+\mathbf{C}_3)\text{ or }\mathbf{P}=\frac{1}{3}\,r\,\mathbf{C},$$

whence

$$\mathbf{V}_3=\left(\rho+\frac{1}{3}\,r\right)\mathbf{C}+m\,\dot{\mathbf{M}}.$$

Thus the flux $\mathbf{M}$ of the electromagnet is exactly what would result from applying to the field coil the voltage $\mathbf{V}_3$ between the third main and the true neutral point, provided the resistance ρ of this coil be increased by the

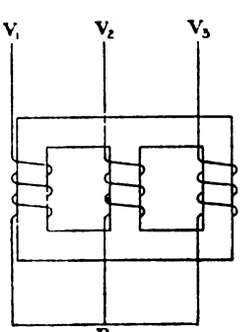

FIG. 28.

parallel resistance of the three windings of the choking coil.

By the employment of such a reactance coil it is possible to use a single wattmeter to measure in succession the power corresponding with each phase of a three-phase circuit. A quadrature transformer is needed for each of the three mains, and a light two-pole three-way switch similar to that shown in Fig. 10. However badly balanced the main currents may be, the true power of each phase can be measured, and the wattmeter may be normally left connected with that phase which best represents the total power supplied to the load.

DISCUSSION.

Mr. S. EVERSHED congratulated the authors on the progress they had made in the development of these instruments within the last four years. The application of iron to measuring currents was one of the oldest principles used, but there had always been disadvantages in its use, one of the chief of which was hysteresis. With alternating-current instruments this disadvantage was lost, but other difficulties remained. In his younger days he sought for an iron that had no hysteresis, and learned from a text-book that a mineral which was found in Italy—magnetite—had no hysteresis. He soon discovered, however, that this mineral had about as much corrosive force and hysteresis as bad cast iron. He then set to work on the basis that the reason for hysteresis was molecular friction in the iron, and thought the remedy was to be found in the making of an iron fluid. He dissolved iron in mercury by an electrolytic means, but the result was disappointing, as hysteresis set in after a little time. He had never been able to get over the hysteresis of soft iron, and had always been of the opinion that the true application of iron lay in the direction of alternating-current instruments, though he had never been able to under-

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stand how it ought to be applied until Dr. Sumpner showed the way. He admired the instruments shown by Dr. Sumpner more than he did the paper, for he thought that the authors had not made their explanations quite clear. Too many subjects were touched upon, so that none got dealt with exhaustively. He rather wished the authors had devoted the whole of their paper to the wattmeter. He would like to know how Dr. Sumpner got over the difficulty of the current induced in the moving-coil circuit by the induction in the shunt magnet. The speaker had found the E.M.F. in the moving-coil circuit to be roughly 1·8 volts and the resistance 100 ohms, which gave an induced current of 18 milliamperes. This differed very much from the current moving the instrument, which was only four milliamperes, which was probably explained by the fact that it was out of phase with the induction, and did not do anything towards altering the deflection. He came to the conclusion that it might cause considerable error if the same wattmeter was used for measuring watts on circuits of different voltages. Probably the authors did not intend to use their instruments over a wide range of pressures, and intended it primarily for switchboard use where the pressure did not vary greatly. He would like to know how the matter had been dealt with, because in designing ordinary dynamometer wattmeters the E.M.F. induced by the mutual induction between the two coils was a great difficulty. The Sumpner and Record wattmeter was the first in which the difficulty had been overcome. Mr. Evershed next dealt with some of the more detailed points in the paper; the air-gap of 20 mils on each side between the moving coil and pole-pieces seemed to him a reasonable clearance; it was within one mil of what he used in the "Megger." He thought the authors had brought their air-gap down to a point below which it was not reasonable to go. With regard to the watt scale and volt scale of a combined instrument, he thought buyers ought to appreciate more generally that every alternate-current instrument must have a parabolic law. Mr. Evershed complained of the present methods of testing capacity, and demonstrated by means of his own constant-pressure generating set, which was coupled to a condenser, that capacity tests could be quickly and accurately carried out. With regard to phasemeters, it seemed to him that these were never described in sufficiently simple language to enable people to get to the principle involved. There was still room for another mode of description of the phasemeter, and he proceeded to explain his own method by means of a diagram which he drew on the blackboard. In conclusion, he said the authors had shown an instrument which was independent of frequency, temperature, and power factor. But no instrument was independent of the English buyer, who was having a bad effect upon the design of instruments. If a buyer wanted a first-class instrument, he must learn to pay for it.

Prof. Ernest Wilson discussed a theoretical view by means of two diagrams. The point he brought out was that Dr. Sumpner's wattmeter was not independent of frequency, and he proved mathematically that the instrument would give deflections truly proportional to the deflections in the circuit. But he thought that the electrostatic instrument could be made perfect if one of the differentials could be turned into an integral. He congratulated Dr. Sumpner on applying his knowledge of mathematics to the problem before making an instrument, and he was convinced that his instrument would be accurate when made.

Mr. Kenelm Edgcumbe wished more papers of this class were read in which the authors described their own inventions. He admired the paper almost more than he did the instruments. He thought the authors overlooked the virtue of the dynamometer pattern. It was said that these instruments were not free from stray magnetic fields, but he pointed out that the quadrature transformer was not free in this respect. It might have a shield placed round it to protect it from stray fields, but the current coil of a dynamometer might just as effectively be shielded in the same way. The authors had pointed out the disadvantages of the use of iron cores, but he noticed that they used an iron core in their quadrature transformer. He was glad to see them inveigh against the indiscriminate connection of instruments on one transformer. He could not agree with the authors' rating of the instruments, and he hoped the important question of rating wattmeters would be dealt with by the Engineering Standards Committee. It was essential in the case of a complicated instrument like a wattmeter that it should be capable of being easily checked on direct current, and it seemed to him a disadvantage that the authors' standard instrument could not do this.

Prof. Gisbert Kapp said he had tested one of the first of the instruments made by Dr. Sumpner, and was astonished at its wonderful accuracy. Whatever faults he found were faults rather of imperfection than of the system. He had found the instrument independent of frequency. He thought the practice adopted by Dr. Sumpner of using iron in voltmeters and wattmeters was the right practice. There were good wattmeters which had no iron, but they took such a great amount of power that the matter became serious in testing iron samples, whilst they had to be handled with great care. It was also a good thing that the authors had adapted their wattmeters to read capacity. He wanted to correct an impression which the authors might have created in saying that no wattmeter was accurate for unbalanced loads. There were wattmeters which were accurate on unbalanced loads, and he referred particularly to the Behn-Eschenberg method, in which two wattmeters were used to measure the unbalanced three-phase loads; that method was correct, but errors would be introduced if the two meters were too close together. Within recent years, however, Messrs. Siemens and Halske had brought out a meter in which these errors were avoided.

Dr. C. V. Drysdale drew attention to the beauty of the principle involved in the instruments, and to the remarkable number of applications. With regard to the wattmeter, this instrument was good in principle and was robust. It would be a matter of interest to know what the instrument really was. At first sight it would appear to be of the dynamometer type, but he thought that Dr. Sumpner's instrument was really an induction-type wattmeter in a new form, in which the induction took place outside the wattmeter itself, instead of inside. He said it was an advantage to be able to check on direct current, and to do this it was necessary to take care that the ratio of the amount of iron in the circuit was not too great for the air in the gap. He sketched on the blackboard a diagram of an instrument which he had made on this principle.

Mr. J. T. Irwin drew attention to a method of compensating for errors in Dr. Sumpner's wattmeter, and Mr. J. W. Record dealt briefly with hysteresis and capacity. Owing to the lateness of the hour, Dr. Sumpner intimated that he would reserve his reply.

Dr. Sumpner's reply (*communicated*) was as follows: I hav to thank several speakers for their generous appreciation of the instruments we have described, and am pleased that the paper has caused such a good discussion. Mr. Evershed's speech contained many valuable observations, but I shall only refer to those which seem to call for a reply. He criticised some of the explanations as incomplete, but this was largely intentional, as we had no wish to repeat what is to be found in previous papers. The phasemeter was more fully dealt with, as it is now for the first time brought to the notice of the Institution. Its explanation on the ohmmeter principle, represented by Figs. 16 and 17, was the simplest Mr. Record and I could think of. I expected it to appeal to a maker of ohmmeters, but this seems not to be the case. Mr. Evershed has clearly grasped the importance of the E.M.F. induced in the moving-coil circuit, and his estimate of its value is correct. It is one of the extraordinary facts about these instruments that the current due to this induced voltage is often greater than that due to the working current. The conditions have to be, and can easily be made, such that the induced current does not affect the deflection. Dr. Drysdale's contention that these instruments are merely forms of the familiar induction wattmeter is erroneous, since the induction effect has to be made negligible before the deflection becomes a true measure of the power. But it would take too long to fully discuss the important point raised by Mr. Evershed. It must suffice to say that this matter has formed the subject of a thorough investigation, the results of which are to be shortly published by the Royal Society (*Proceedings* of the Royal Society, Jan. 16, 1908, "Alternate-Current Measurement"). Those who honour me by reading that paper will find that Mr. Evershed's question is very fully answered. The effect in question, though striking, is, after all, nothing new in wattmeters. An ordinary instrument taking 10 amperes at power factor 0·6 is traversed by an in-phase current of six amperes producing the true deflection, and also by a quadrature current of eight amperes, which is supposed to have no effect at all. Mr. Edgcumbe considers that the quadrature transformer is not free from magnetic disturbances, but he has probably overlooked the fact that only the secondary coil need be shielded. A stray flux passing simply through the primary does not affect the deflection at all. The secondary coil is absolutely shielded by the iron because it is placed in the air-gap, and is magnetically short-circuited so far as stray fields are concerned. He is more to the point when he says that the troubles of the iron-cored electromagnet have been removed from the instrument only to reappear in the transformer. The answer to this is that iron may be used for two purposes: to increase the sensitiveness or to shield the coils from stray fields. It is used for both purposes in the shunt electromagnet without giving rise to error, but in the quadrature transformer it is merely used for shielding, because the instrument is already highly sensitive. The result is that the air-gap can be so increased that the troubles of the series magnet disappear. The iron of the transformer has hardly any effect on the sensitiveness of the instrument. The result of a long and troublesome investigation on these transformers has been to show that it is a mistake to use the iron so as to increase the flux much above what it would be if the iron were removed. For this reason the form of watt-

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meter shown by Dr. Drysdale is of special interest to me. Dr. Drysdale states that he still prefers the series form of electromagnet. On this point we must agree to differ. The wattmeter he shows is certainly very simple to construct. I notice that he has designed the electromagnet like the quadrature transformer, and has placed the magnetising coil in a similar position. This form of magnet I pointed out in my previous paper as the best form to adopt, but my tests have shown that if the air-gap is large enough to sufficiently reduce the hysteresis error there is not much gain in sensitiveness due to the presence of the iron.

Mr. Edgcumbe thinks we have overlooked the virtues of the dynamometer wattmeter. The new instrument is itself of the dynamometer pattern, because perfectly definite paths are provided for the magnetising and moving-coil currents. The ordinary dynamometer instrument, however good it may be for alternate currents, is equally good for direct currents. Why then is it never used for Wheatstone bridges, potentiometers, and induction tests? How is it that the Siemens dynamometer, which at one time was employed mainly on direct-current circuits, is now hardly ever used except with alternate currents? Of course, it is because there are other direct-current instruments much more sensitive and satisfactory even than those of the dynamometer class. This investigation really started with the definite object of finding, if possible, instruments for alternate-current circuits having the desirable properties of those of the permanent-magnet moving-coil type. I consider that this object is now attainable, and is only attainable, with the aid of the shunt excited electromagnet.

Mr. Edgcumbe objects to our way of rating wattmeters, but if the rating he suggests were adopted the wattmeter would either deflect off the scale for full-load current whenever the power factor exceeded 0·5, or else the instrument would be rated for a current for which it would not be commercially used. It is no doubt an advantage possessed by most good alternate-current instruments that they can be checked on direct current. But such checking is usually done with the aid of good portable permanent-magnet instruments, and when similar instruments are available, as I believe is now the case for alternate-current testing, the need of direct-current checking disappears. It is no more a disadvantage of these new instruments that they can only be used with alternate currents than it is a disadvantage of permanent-magnet instruments that they can only be used with direct currents.

Prof. Kapp's remarks, I am gratified to note, were mainly commendatory. As regards the question of wattmeters on unbalanced loads, he correctly supposes that I was referring to the case in which a single wattmeter is expected to measure the total power of an unbalanced multiphase circuit. The multiphase instruments he alludes to are not single instruments, but two or more instruments put into one case, and arranged to operate on a single moving system. Such instruments, like the more complicated commercial forms of phasemeter, are only correct on one assumption which can never be quite true in practice. It is this. The multiple instrument really consists of two or more complete instruments, each of which when properly connected to the circuit will act by itself, and will have its own scale. The assumption is that the scale markings are in exactly the same position for each scale. Many of the best firms claim, as a sign of their care in manufacture, that each instrument they make is independently calibrated. This is not only a proof of careful manufacture, it is also a confession that even with the best firms it is not possible to construct instruments to work exactly to a predetermined scale. But this power is exactly what is assumed by a firm issuing a multiple instrument. Until such perfect construction is possible, multiple wattmeters and phasemeters cannot be quite correct on unbalanced three-phase loads.

Dr. Drysdale regards the new instrument as an "old friend," as an induction wattmeter spoilt by additional complexity. I totally dissent from such a view. At best it amounts to using the new quadrature principle to give another aspect to the action of an old instrument, and to add one more to the various conflicting theories of its working. But the explanation is almost wholly assumption, and would involve as a consequence that induction ammeters and voltmeters could not work at all. The eddy-current disc and the series magnet do not fulfil the conditions necessary for a quadrature transformer. The reactive influence of the eddy currents on the magnet is wholly ignored, and also the self-induction of the current circuits. Nothing is said of the eddy currents due to the shunt magnet. It would be just as logical to assume that the disc forms the secondary of the shunt magnet winding, the eddy currents being in phase with the voltage and acted on by the series magnet flux in phase with the line current. This view would make the induction instrument appear like another "old friend"—the dynamometer wattmeter. But neither of these views is correct. They are each the result of assumptions which remind one of the definition of faith once given by a schoolboy—the belief in that which we *know* to be untrue. In the new instrument each part has its definite function to perform, and the precision with which it acts can be accurately verified by measurements which are quite independent of the normal action of the instrument. The mathematical theory of the eddy-current instrument has been as yet far too complex for solution, whereas the theory of the new instruments has been very completely worked out.

Mr. Irwin's resistance method of compensation is one of the two methods referred to in the paper as having been investigated and found satisfactory. The other method, involving an extra winding on the electromagnet with the ends of this winding connected through a condenser, is described in one of the patents (No. 2,416 of 1907) taken out in connection with these instruments. The resistance method is very simple and convenient, and is applicable when the line current is at low potential and not too great in magnitude, as, for instance, when the instrument currents are supplied through current transformers. I am much indebted to Mr. Irwin for recalling my attention to this method, for although I had noticed it before, I had not fully realised its possibilities. In many cases the condenser method is preferable, and has the great advantage that it can be used not only for the quadrature wattmeter, but also for neutralising the errors due to ordinary current transformers, which errors in practice are usually more serious than those intrinsic to the actual wattmeter used. The error of the new instrument is small and obeys a precise law. This makes exact compensation easy. The resulting advantages are clear, for the instrument can be made smaller, less expensive, and even more accurate.

RESISTANCE LEADS FOR COMMUTATORS.

A patent granted to Messrs. Siemens Bros. Dynamo Works, Limited, relates to resistance leads for single-phase commutator motors which are constructed so as to obviate the use of sweated or soldered joints, thereby enabling the resistance to withstand undue heating. The resistances, A (Figs. 1 and 2), are in the form of flat strips, *a*, stamped out of sheet metal, preferably German silver. Fig. 1 shows half the strip, and the other half is of similar shape but reversed and bent round parallel to the part shown, at the point *b*. The two parts, *a*, are separated by

FIG. 1.

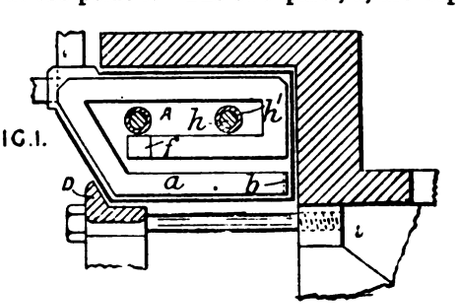


FIG. 2.

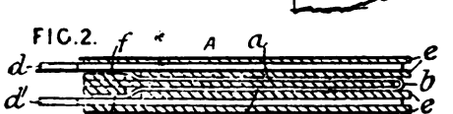
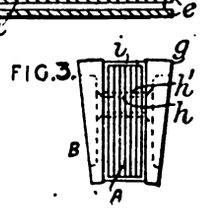


FIG. 3.



mica strips, *e*, from each other and from the copper plates, *d* d^1, which are connected respectively to the armature winding and the commutator, the copper plates being of the same external contour as the resistances. The ends, *f* f^1, of the resistance strips pass through apertures in the mica strips into direct contact with the plates, *d* d^1. A group of resistance elements thus formed is clamped together between side plates, *g* (Fig. 3), and held by rivets, *h*, in insulating sleeves, h^1, between the fold of the resistance strips, one of the rivets being preferably placed just over the contacts, *f* f^1. The resistance elements, A, may be further protected by surrounding them with an insulating envelope, *i*, before clamping, and space may be saved by omitting one of the outer mica plates, *e*. The blocks, B, are assembled in a circular series at either end of the armature, the blocks being secured, in position by a clamping ring, D, which is, preferably formed in sections,

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THE NEW GERRARD EXCHANGE OF THE NATIONAL TELEPHONE COMPANY.

During the past week we have, through the courtesy of the National Telephone Company, been allowed to make a thorough inspection of the new exchange they have completed in Gerrard-street. This exchange has now an ultimate capacity of 10,000 subscribers' lines, and the necessary junctions to the other exchanges within the metropolitan area. It replaces the previous equipment which was placed in an adjoining building. The company acquired additional space near the old exchange, on which the present buildings were erected. The plans were drawn up in such a way that when the 10,000 subscribers provided for in the new switchroom have been connected, a second exchange, also for 10,000 subscribers, can be placed partly in the new building now completed and partly in the buildings now nearly completed, which occupy the site of the old exchange. It would seem from this to be the policy of the company not to erect switchgear for a larger number of subscribers than 10,000. When more subscribers' lines need to be dealt with from a given area, they prefer to use two exchanges in the same building with trunk connections between them, just in the same way as if they were a mile or two apart. One factor in coming to this decision is obviously the distance which an operator can reach in order to make connections between one subscriber and another. The operators are divided into two distinct classes, according to the incoming calls they deal with. Those occupying what the company term "A" positions deal with subscribers' calls from those subscribers directly connected to the Gerrard-street exchange. These positions are equipped for 93 subscribers' wires, and at present each girl has to deal with 81 lines. On the vertical face of the switchboard opposite her she has jack connections for each subscriber in the Gerrard-street exchange, and also jack connections for numerous junction wires to other exchanges These latter are arranged at the lower part of the vertical face of the board, and the subscribers' numbers are placed above a horizontal division in

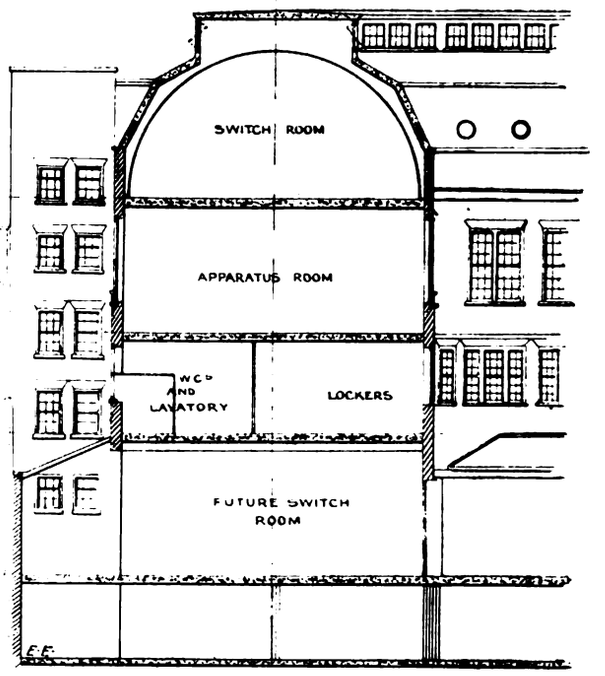

FIG. 1.—Vertical Section of the Gerrard Street Exchange.

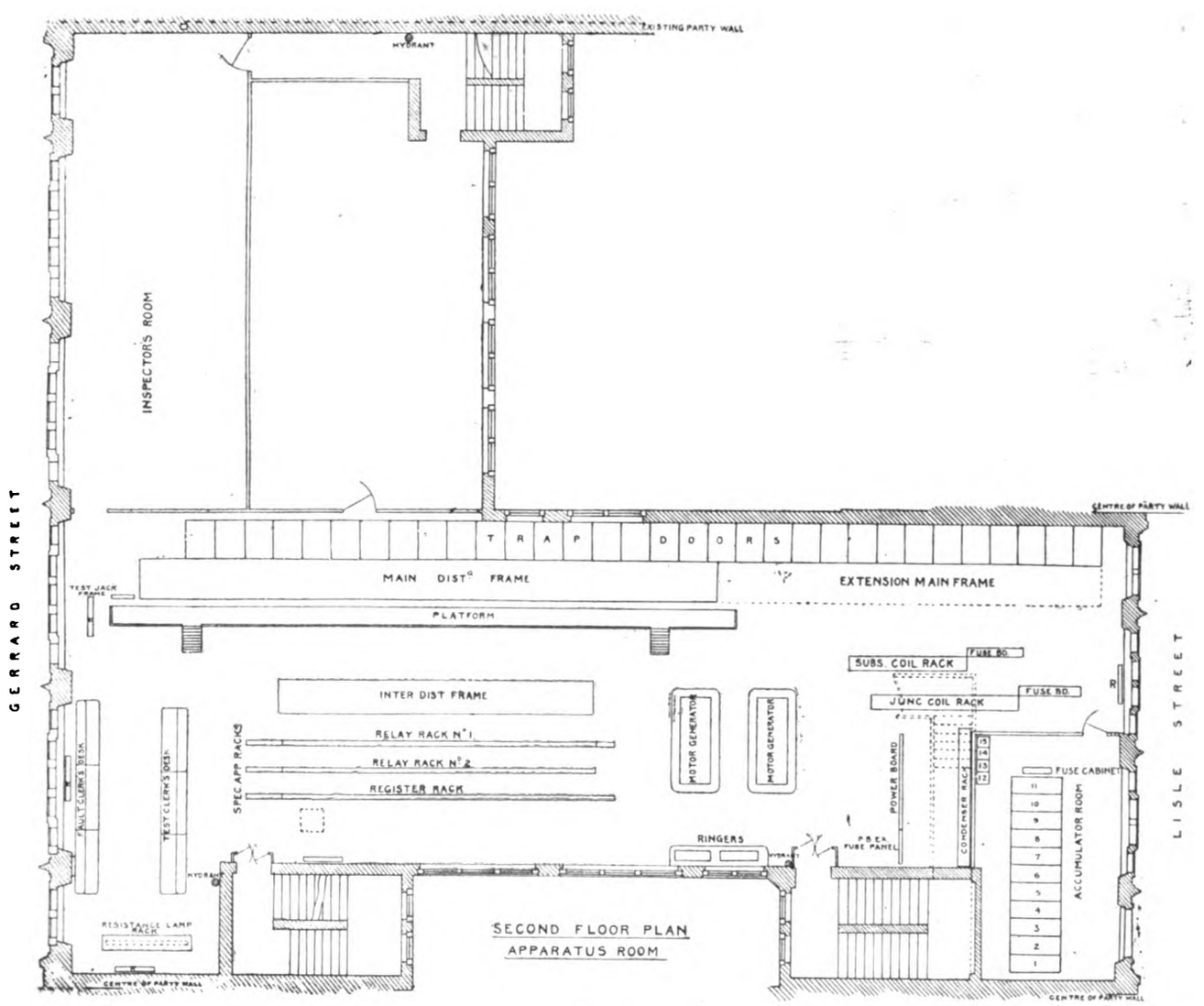

FIG. 2.

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this board. Thus she has connection to 9,520 subscribers' lines and 1,520 outgoing junction wires. These connections are repeated along the board at regular intervals, and the extreme distance between the first and last connection horizontally is 6ft. 3in. There are nine panels in

Those operators occupying what the National Telephone Company call the "B" positions receive the incoming calls from other exchanges. The junction wires used for this purpose have naturally a much higher load factor than any subscriber's line, hence the operator can deal with a smaller

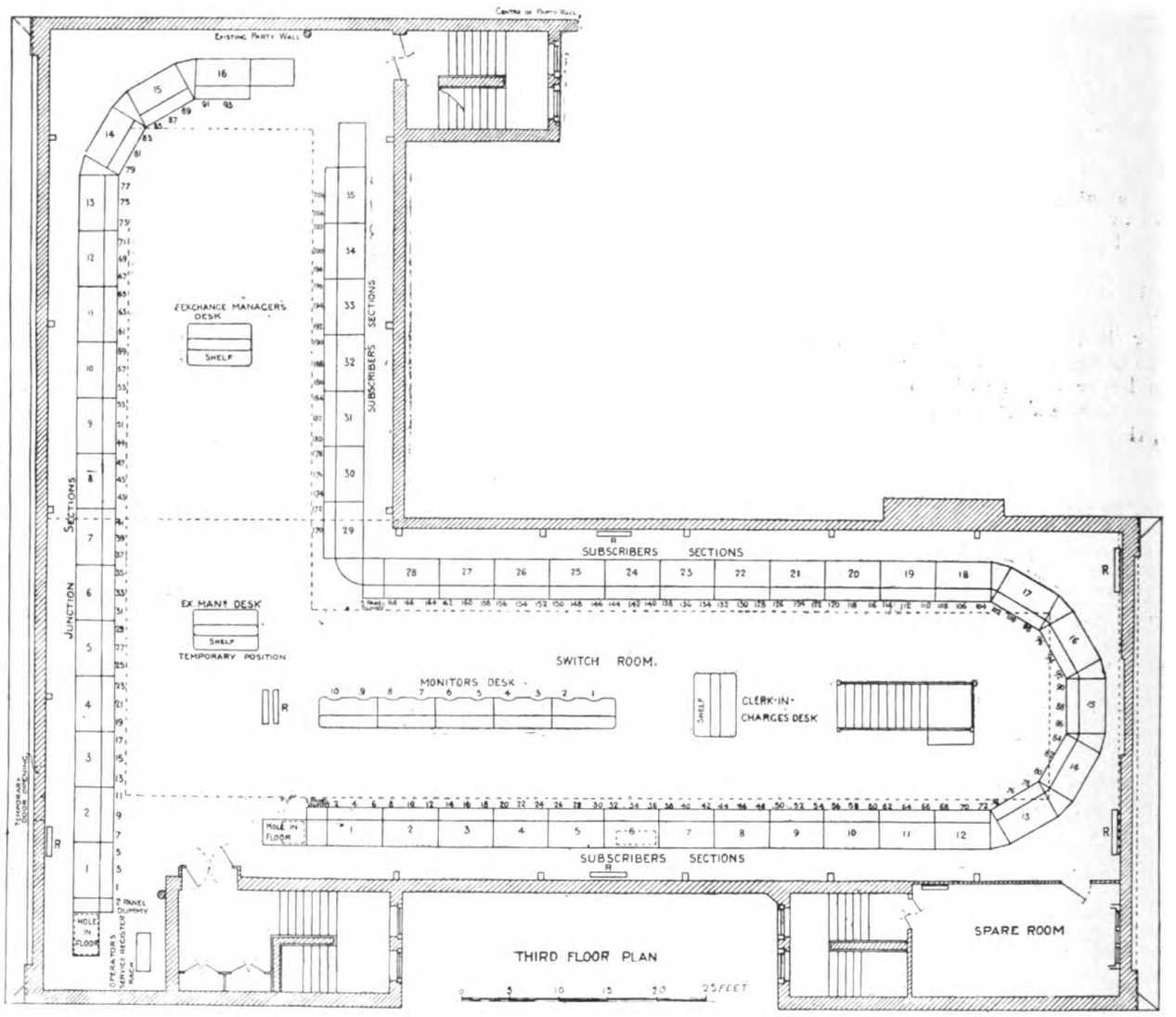

FIG. 3.—Plan of the Gerrard Street Switch Room.

this width, and the girl may thus have to reach 3ft. 1½in. in either direction from the centre line of her position in order to complete a call. About 80 per cent. of the calls she receives, however, cannot be completed within the exchange, due to the fact that numbers on other exchanges are called. It is for this reason that

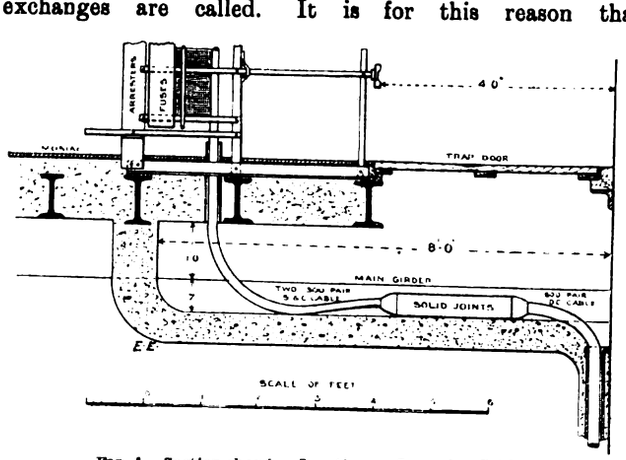

FIG. 4.—Section showing Junction on Incoming Cables.

the junction wires are placed at the lower portion of the board, where they are most easily accessible. These junction wires are multipled every 4ft. 3½in. along the board. When dealing with such calls the subscriber is plugged on to that junction wire which the operator in the distant exchange indicates.

number. At Gerrard street the "B" positions are equipped for 27 incoming junctions, and at present each girl has this number to deal with. In this case she has to complete calls originating from other exchanges by connecting a given Gerrard subscriber with a junction wire to the calling exchange. She has nothing whatever to do with calls originating in the home exchange or with any outgoing junctions. Hence there is no need to place multiple junction connections along the vertical face of the switchboard opposite the "B" operators. The Gerrard numbers only need to be multipled, and the full number of these can be contained in a space 4ft. 3½in. wide. Hence the operators in these positions have not to reach so far one way or the other to complete a call.

Before proceeding to describe the equipment at Gerrard-street, it will be of interest to give a few more particulars as to the magnitude of the completed work, the detail of which reflects the greatest credit on the engineers. In this case there was no adaptation of existing buildings to suit the equipment, but both buildings and the gear contained in them were designed by the staff of the company. In other words, the Gerrard exchange represents an engineering work designed on paper and laid down to working drawings without rule-of-thumb alterations which rendered so many earlier exchanges a tangle of inflammable material. In the Gerrard-street exchange the total ultimate capacity is as follows:

Subscribers' lines	10,400
Incoming junctions	1,269
Outgoing junctions	1,520

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"A" positions	102
"B" ,,	47
Main distribution frame	44,190
Calling equipment	9,520
Number of subscribers working	6,708
,, junction circuits working	1,917
,, working "A" positions	72
,, ,, "B" ,,	35
,, subscribers' lines per position (average)	81
,, junction lines per position (average)	27
,, calls dealt with per day (average)	175,000
,, ,, ,, busy hour (average)	24,000
,, ,, ,, operator per day (average)	700
,, ,, ,, ,, busy hour (average)	145
,, subscribers per position (average)	80·9
Mileage of single wire in cable upwards of	6,800
Number of soldered connections ,,	3,300,000
,, incandescent lamps ,,	26,000
,, working contact points ,,	2,200,000
,, cords and plugs	4,194
,, jacks	528,700
,, circuits connected to main frame	21,800
,, miles of jumper wire on main frame	40
,, underground cables leading into exchange	34
,, aerial ,, ,, ,,	6
,, electric clocks	24
,, relays in exchange	12,966
,, subscribers' registers	5,800
,, total operating staff	326
,, cost of exchange equipment (exclusive of leading in cable and building)	£92,000

In Fig. 1 we give a section through one portion of the Gerrard-street exchange which, in connection with the plans (Figs. 2 and 3), will enable our readers to follow the general arrangement of the equipment. The cables enter from below the street level at a point under the old exchange. They are carried on iron cable racks along to the new building, and then up the wall to the apparatus room, which is on the first floor. Each of these lead-covered, paper, and air-core cables contains 600 pairs of wires. The paper insulation round the wires is applied in the form of a tube, which leaves considerable air space, and reduces the capacity of the lines. Where these cables rise from the basement to the instrument room they are contained in iron pipes, which protect the lead against mechanical injury. Fig. 4 is a section showing how these lead cables are jointed on to the silk and cotton covered wires under the apparatus-room floor. The dry-core cable is seen on the right coming up out of the iron pipe. The joint after being carefully made is filled up solid with a suitable compound which effectually seals the end of the cable coming in from the street. This joint is made immediately opposite that section of the main frame to which the incoming wires have to be attached. This main frame, shown in Fig. 5, is arranged in vertical sections, each containing provision for 300 subscribers. Thus each of the main cables coming in from the street is connected on to two of these vertical sections. Each incoming wire is provided on the main frame with a fuse, lightning arrester, and heat coil, which are designed to prevent any extraneous current from other systems or from the clouds passing into the exchange. The height of this main frame is such that the platform shown in Fig. 5 has to be placed along its length, so that the electricians can reach any portion of the equipment. At the right-hand side of the steps to this platform will be seen the portable electric lamps which serve to light any part of this main frame. Each lamp is supported from a wheel running on a stretched wire extending the full length of the frame, and the flexible cord is also supported in the same way at frequent intervals. This prevents this flexible cord being dragged across the front of the main frame or lying on the floor, as would be the case if the ordinary arrangements were used. This neat device is one of the great number used in the exchange to reduce fire risks in every conceivable way.

The subscribers' wires coming in on to the main frame are connected to the vertical contacts in what may be termed the main frame order. At the back of this main frame there are horizontal contacts which are cross connected to the vertical ones by means of jumper wires. On the horizontal side the order is numerical, and the incoming wires are there connected on to the subscribers' exchange numbers. From this horizontal side of the main frame 42 wire cables are carried along to the end of the frame and then over to the intermediate distributing frame shown in Fig. 6. On this the incoming subscribers are grouped up on to the various operators in an order chosen by trial in such a way as to prevent any congestion of calls. On certain days in the year records are taken of the number of calls made per hour during the busiest time of the day by each group of subscribers. Each operator is then given a proper proportion of extremely busy lines to deal with, with, of course, a larger proportion of lines which are not so busy. On the right-hand side of Fig. 6 will be seen the flame-proof cables coming into this intermediate distributing frame, and also the jumper wires used for cross-connecting subscribers to the incoming lines to the operators. The vertical wires passing up on the right of the photograph are those going to the operators. The two lines of gear to the left of these are respectively the relays and the message recorders. So far these recorders are only placed on those subscribers who pay by message rate. Fig. 7 shows the flame-proof cables leaving the intermediate distributing frame and passing along the

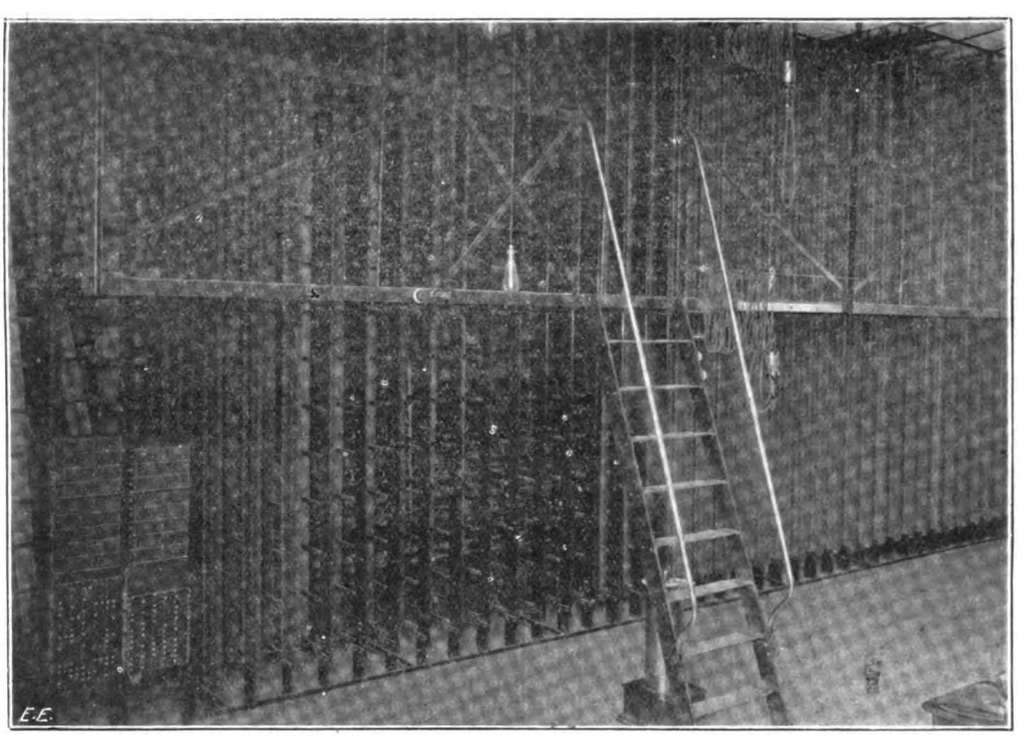

FIG. 5.—View of the Gerrard Street Main Frame.

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hanging racks on their way to the switchroom. The extreme neatness of this work, and, in fact, of all the cable connections in this exchange, is worthy of special note. These cables were all cut to lengths ascertained from the drawings before being placed in position. Fig. 8 gives a further view of these cables up to the point of

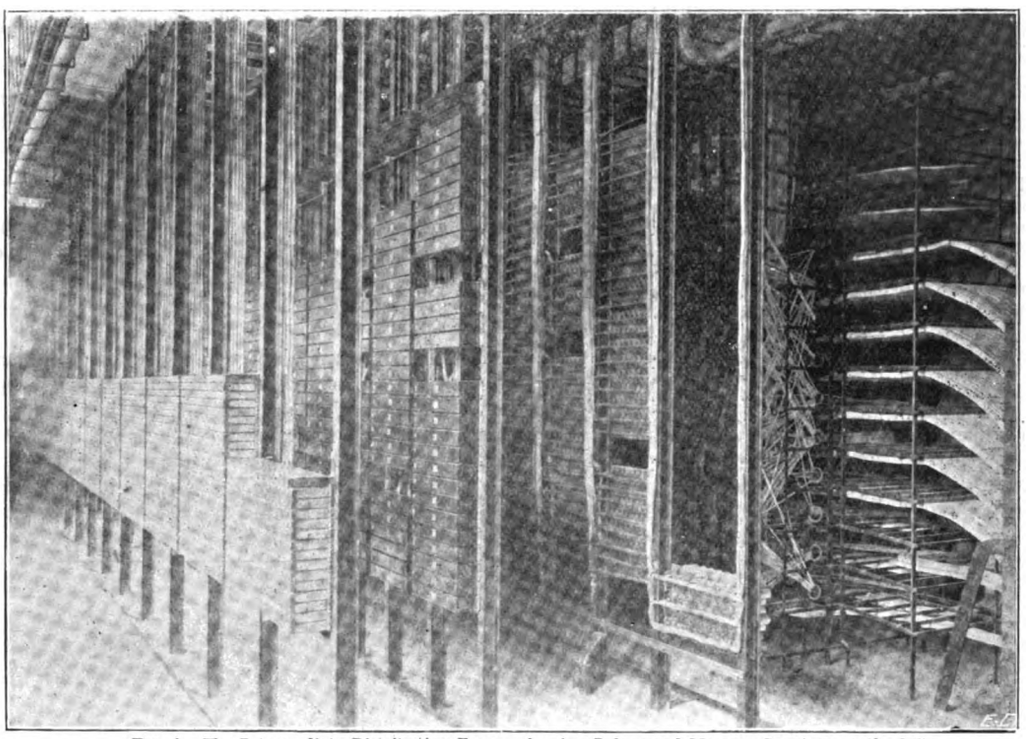

FIG. 6.—The Intermediate Distributing Frame, showing Relays and Message Counters on the left.

which they pass through the ceiling on their way to the switchroom. This view also shows the fault-testing department, and we were extremely pleased with the system adopted for quickly locating and removing faults. The electricians on the left receive all the complaints from the monitors in the switchroom, with a note as to their

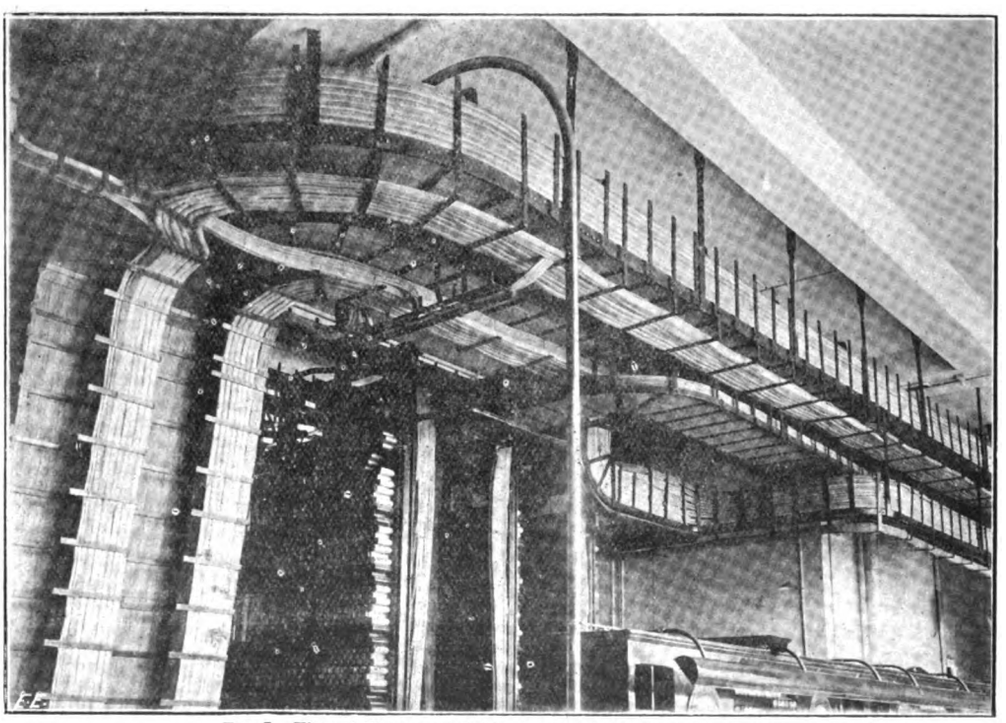

FIG. 7.—View of Flameproof Cables leaving the Intermediate Frame.

conclusions as to the nature of the fault They are then connected on to the line complained of, and tests are made for earths, insulation, resistance, etc., both on the subscriber's line and also on the subscriber's circuit within the exchange. The results of these tests are entered on the ticket which passes over to the

men on the right-hand side of the photograph. Previous records are then consulted, and if work is needed outside the card is placed in a certain division in a rack. The outside electricians call up at frequent intervals, and are then informed of faults which have to be dealt with in their particular section When these have been seen to, word is again sent by telephone as to what has been done and the time when the repair was effected. This is again entered on the card, and the interval between the complaint and the repair noted. A casual glance at a number of these cards showed how quickly this system enabled repairs to be made, and the systematic card records also show how many times any one subscriber's line has given trouble. Intermittent earths are, of course, the nightmare of the telephone engineer, as they refuse to reveal their presence at regular intervals when he is testing for them.

Fig. 9 shows the switchroom of the exchange with the girls at work. The operators seen at the switchboard running all

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round this portion of the switchroom are the "A" operators, who, as explained above, deal with the incoming calls from the Gerrard subscribers The operators in the middle of the room handle all complaints and inquiries from subscribers. The strict rule of the National Telephone Company is that the "A" operators must not reply to any questions or complaints from a subscriber, as the time so spent would interfere with the service to other subscribers in her section. We were pleased to note the speed with which connections were completed, and to see that one operator was always ready to help her neighbour on either side when there were two or more calls to be dealt with simultaneously. Fig. 10 is a view of the back of the switchboard. In the upper portion of this photograph are seen the multiple cable connections, which extend all round that part of the switchroom seen in the previous illustration. As explained above, the line from each of the Gerrard subscribers is connected to a succession of jacks spaced 6ft. 3in. apart. These multiple cables rest on an iron plate, which effectively insulate them as far as fire is concerned from the cables below which serve to multiple the outgoing junctions to other exchanges. The inclined screens of uralite (Fig. 10) again divide these cables off from the space below. These screens can be easily withdrawn to give access to the multiple cables in question. Below these screens are the relays for the cord circuits of each operator and the cables connecting each group of subscribers to the operators who deal with their incoming calls. The plug cords cannot be seen in this view, as they are hidden by the perforated screen below the relays. The back of the switchboard is screened off by rolling shutters which are practically dustproof. In the "B" section of the switchboard, which, as shown in Fig. 2, extends along the other side of the switchroom, is similar in construction, except that the Gerrard-street subscribers' cables are arranged to multiple in a length of 4ft. 3½in., and there

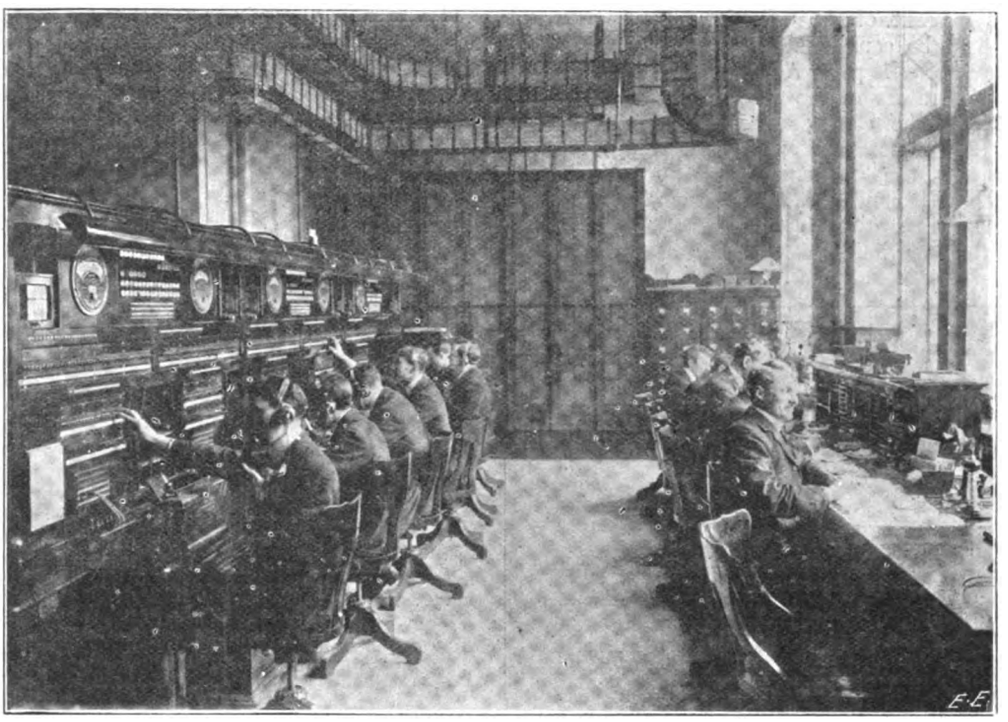

FIG. 8.—The Fault Testing Department.

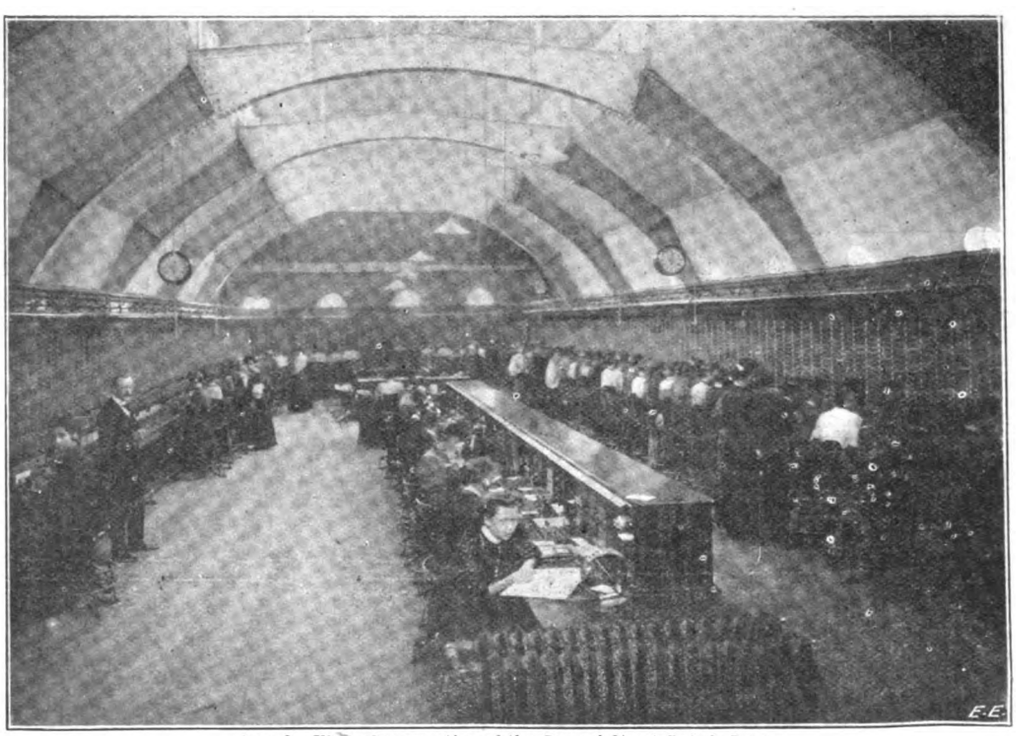

FIG. 9.—View of one portion of the Gerrard Street Switch Room

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are no outgoing junctions to provide for. In consequence of this the vertical height of the multiple cables is considerably greater than in Fig. 10, and there is only one fireproof division needed.

To show the volume of business dealt with in the switch-room, it has been found that there are some 175,000 calls (subscribers' and junction) dealt with in the course of the day, and the number per hour rises to 24,000 in the busy hour. Some 78 per cent. of the calls from Gerrard street subscribers have to be completed by outgoing junctions. Again, the number of calls per "A" position per busy hour is 145, and the operators in the "B" position deal with no less than 264. The staff of the exchange includes no less than 226 operators. We propose to leave the description of the power equipment until our next issue, and will conclude the present portion by saying that the cost of the exchange equipment, excluding the leading-in cables and buildings, has been about £92,000.

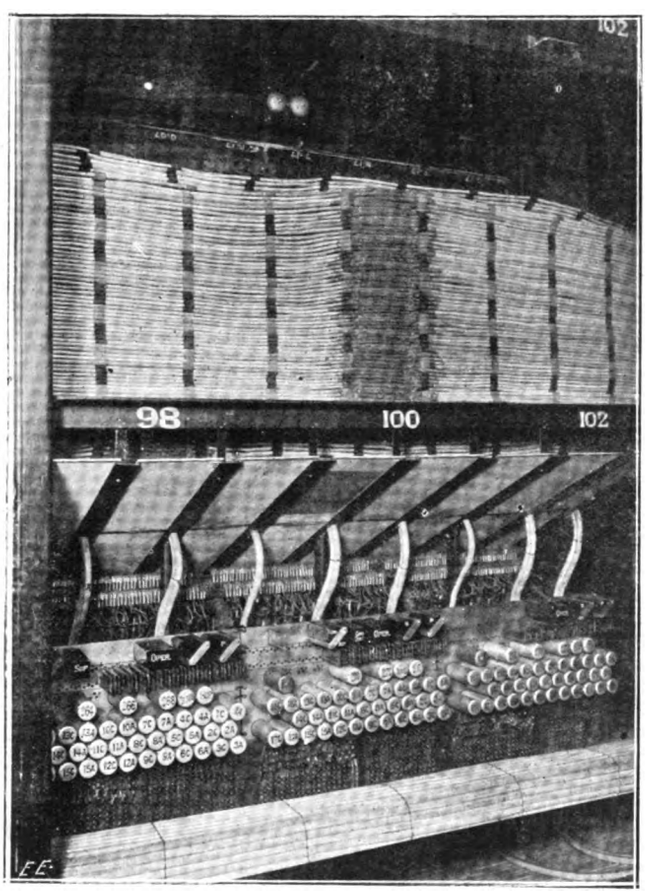

FIG. 10.—The Back of the (A) Section Switchgear.

It has involved the use of 26,000 small incandescent lamps, 6,800 miles of wire, 2,200,000 working contact points, and 3,300,000 soldered connections.

(To be continued.)

TUNGSTEN LAMP IN TOPEKA.

The Topeka Edison Company (U.S.A.) has taken up the large candle-power tungsten units to compete with the mantle gas lamp, and to replace enclosed arc lamps where their use produces bills beyond the means of the customer. It is considered that the ideal method under which to furnish high candle-power tungsten lamps for the illumination of stores or large rooms is on a lamp-hour basis in connection with a timing device, which need be nothing more than a common clock mechanism arranged to start and stop by a magnet which is energised from the lamp circuit. This would be much cheaper and far simpler than any of the present form of meters, and suitable for circuits in stores where all lamps are operated at the same time, and also adapted for use in residences as well, in which case a separate mechanism would be required in each lamp. The Topeka Company is about to try the experiment of furnishing 100-watt tungsten lamps at a rental charge of wo cents per day.

TRANSFORMERS FOR METALLIC-FILAMENT LAMPS.

The use of metallic-filament lamps has now become generally established, but there remains the difficulty of making lamps of small candle-power for 100 to 130 volts. This difficulty raises the question of transforming the supply voltage to such pressure as will allow the use of low-voltage metal-filament lamps. The present method of

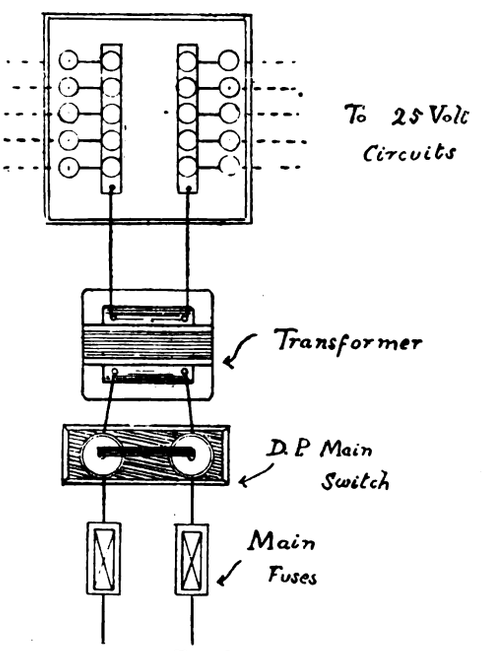

FIG. 1.

using series adaptors compels the user to have two lamps of at least 30 c.p. each where a 16-c.p. might be sufficient for his purpose. There are various types of ceiling and house transformers at present on the market which give satisfactory promise. One of these types is the "Foster" patent auto-transformer, made by the Foster Arc Lamp and Engineering Company, Limited, Worple-road,

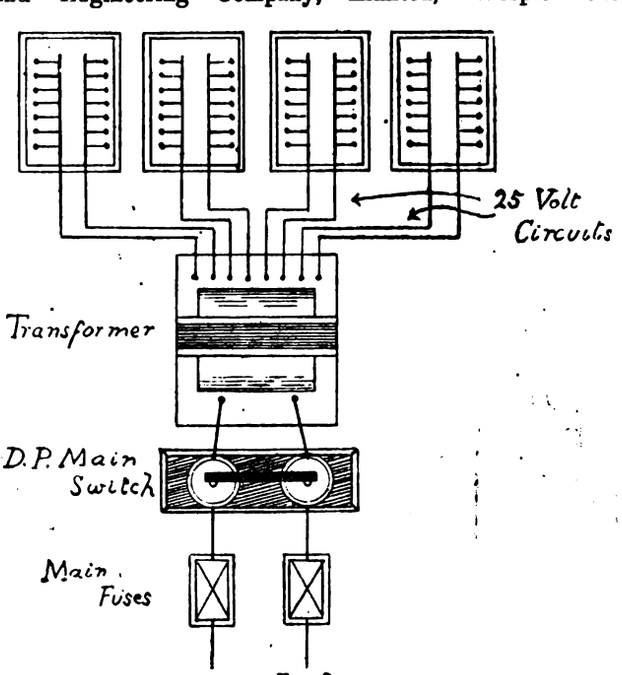

FIG. 2.

Wimbledon, London, S.W., which reduces the pressure of the supply mains to 25 volts with a loss of only 3 to 4 per cent. A diagram of connection is shown in Fig. 1. The transformer occupies a space of about 7in. each way, and this gives it a great advantage. It is made of iron and copper, and is calculated for the exact requirements of the installation upon which it has to work with a view to obtaining highest possible efficiency.

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Where it is possible to divide an installation into two or more sections, and where it is anticipated that a more or less equal number of lamps will be in use on the same circuit, it is advisable to install a transformer provided with terminals for each section, so designed as to deal with the maximum out-of-balance load in any circuit or circuits. Transformers are provided for two or more circuits, either at 25, 50, 100, or similar voltages, and Fig. 2 shows the arrangement of an installation on these lines. Fig. 3 shows

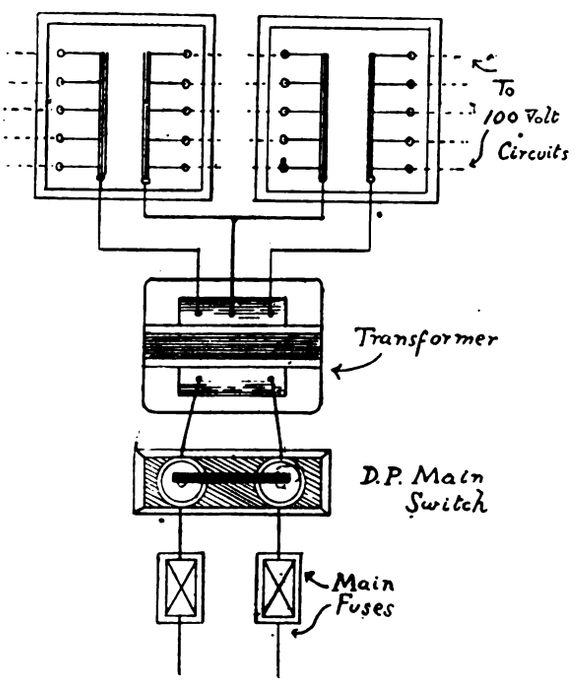

FIG. 3.

the connection when the secondary voltage is half that of the primary, as in an installation of 30-c.p. and 50-c.p. lamps. It must be remembered that with this system the only thing which governs the size of the transformer is the out-of-balance load. Provided, therefore, that the difference in current taken between the two circuits was

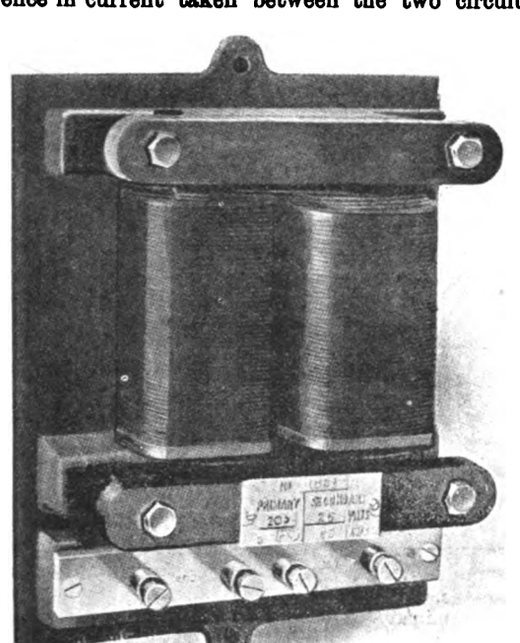

FIG. 4.

never greater than five amperes, any number of lamps might be installed upon a 500-watt transformer.

The Union Electric Company, Park-street, Southwark, London, S.E., have also various types of auto-transformers having a secondary voltage of 25 volts, being particularly suitable for low candle-power metallic-filament lamps. These are constructed in a great variety of ratings for various primary pressures as usually found on supply companies' mains and for the whole range of periodicity in use in this country. The two chief patterns are those with a single-circuit secondary and those with a multiple-circuit secondary. Fig. 4 shows a single secondary for transforming from 205 volts to 25 volts. The cores of the transformers are constructed of a special metal having a very high permeability, thus reducing the iron core losses to a minimum. To further increase the working efficiency, the core plates are interleaved at the joints. The accom-

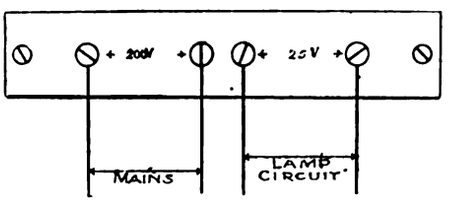

FIG. 5.

panying diagrams show the terminal boards of the transformers. Every board is marked with arrows and numbers to show the values of the voltages between the various stout brass terminals. Fig. 5 shows the terminal board

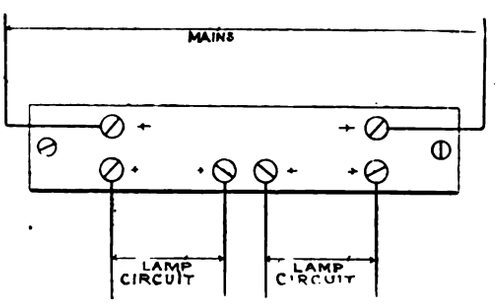

FIG. 6.

for transformers with single secondary circuit; the supply mains must be connected to the two terminals on the left-hand side of the board and the lamp circuit to the terminals on the right-hand side. Fig. 6 and 7 show the terminal boards for the multiple-circuit transformers. The main terminals are placed on the uppermost back of the

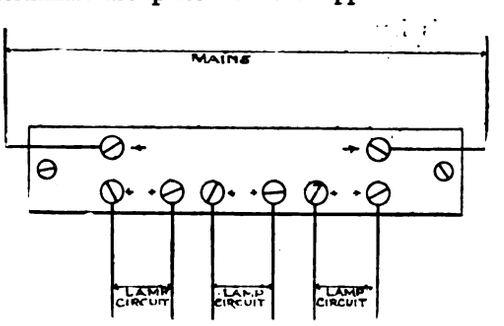

FIG. 7.

board, and the lamp circuit terminals, whether there be two or three circuits, arranged at the bottom. It will be noticed that the "Union" transformers supply a separate terminal for every lead, so that no wires need be bunched.

LONDON POWER BILLS.

The London and District Electricity Supply, the London Electric Supply, and the London (Westminster and Kensington) Electric Supply Companies' Bills have been referred to a select committee of the House of Lords for consideration. The committee will consist of Earl Cromer (chairman), Earl Lytton, Viscount Cobham, Lord Lamington, and Lord Welby. Their lordships will meet on May 7, when they will at once proceed with the hearing of the arguments and evidence.

The Metropolitan Electric Tramways Bill, having passed through the whole of its stages in the House of Lords, has been sent to the House of Commons, where it will be presented for first reading after the Easter recess.

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FIREBRICKS IN BOILER FURNACES.

Of late years the use of mechanical stokers, hot air, forced or induced draught, and other causes have brought about a considerably heavier duty on the linings of boiler furnaces than used to be the case in earlier times. Concurrently with this has arisen a considerable amount of scientific and continuous investigation of the performance of boilers by means of CO_2 recorders, draught gauges and the like, and, moreover, mechanical engineers have apparently conceived a much more commercial view of boiler repairs than they formerly had, necessitating the repairs and maintenance costs of boilers being kept down to the uttermost farthing. All these causes have made it extremely essential that furnaces should be built very well to meet these rigid conditions of modern practice.

As a result of this increased demand for durability in furnace linings, manufacturers of firebricks have given a good deal of care and attention to their manufacturing processes, and have supplemented the supply of bricks by placing on the market several good preparations for rendering the bricks still more durable and giving the brickwork an almost unbroken surface. In past days, when little attention was given to per 5lb. of coal per pound of steam or per square foot of grate area, the extra quality of the firebrick used was almost immaterial, and it was not an urgent matter as to whether any skill was exercised in the building of the furnace. Nowadays a boiler engineer is ably assisted by the firebrick manufacturer, who can be depended upon to do his best to produce an article suited for its work.

It must not be taken for granted that one brand of firebrick can be adopted universally. Each district, which has usually its own class of coal, will require a firebrick suitable more or less to the nature of the coal, and also, of course, to the amount of work done in the furnace. The boiler engineer should experiment with two or three brands of firebrick and note their exact behaviour, so that a fair comparison can be arrived at as to the one most suited for the conditions of its work. It is advisable to take the manufacturer into confidence on the subject, so that he may be able to give his valuable help in arriving at the best result.

Where it is important to keep the cost of brickwork down, it is advisable to grade the quality of the firebricks according to the furnace temperature which they will meet. The brick that will do for an ordinary kitchen boiler, although cheap in first cost, is useless when placed in the lining of a cupola furnace, whereas if the brickwork of an ordinary boiler were faced with cupola firebricks, the initial cost would be excessive. Where a large line of furnaces or kilns are to be erected it is worth while using high heat-resisting bricks only in close proximity to the fires, and grading off the quality until in the flues the character of the bricks approximates to that of the ordinary clay.

The setting of the bricks is a matter calling for the best skill in a bricklayer, as the result of placing the best quality of brick in the hands of a clumsy man is an immediate failure. The most important point to watch is that the joints are kept to a minimum. The fireclay cement should be perfectly liquid, and the bricks should be dipped into the fluid just enough to give them a kind of wash. This means that in fire-arches especially it is essential that the bricks should be nice and true and meet over the spring of the arch without cutting. If cutting is unavoidable, the cut face should be rubbed down to make it as smooth as possible. The firebricks for use in a furnace should have been kept under cover and free from wet. They should not be dried quickly or artificially, and bricks that have been once used in a furnace should not be used again, at any rate for best bricks. If in good condition, they may be used up for packing or filling up.

It is not economy to try and patch up any parts of the furnace in case of repair, as the trimming round necessary to join in the new work to the old disturbs the surrounding construction. In the long run it is better to renew the brickwork entirely, in order to make a satisfactory job, on the principle of the old proverb, "Do not put new wine into old bottles."

After building the brickwork in boilers it should stand for at least 48 hours, if possible, and then dried off slowly by subjecting it to the heat from a slow fire; the more slowly it is allowed to dry the better it will stand, and the same principle applies to its treatment during operation when cooling down the boiler. This should be accomplished as slowly as possible, otherwise the deterioration of the brickwork will be very great. These conditions are not always possible in cases of emergency, so that opportunities should be seized to renew the brickwork linings of boilers when the full time requisite can be allowed, and should not be delayed until the arches fall in.

Fireclay in itself contracts and crumbles away if subjected to heat, so that the less of it used the more solid is the work. If any water chances to get on or through to the furnace, especially if the brickwork is hot without the fires being actually alight, this will do a great deal of harm by causing the bricks to crack and break away. All leakage through the boiler tubes or drums should be carefully watched and stopped immediately, and if any water has got into the brickwork this should be speedily renewed, as it will almost certainly give out after the renewal of active firing.

There are some patent preparations on the market for mixing with the fireclay in order to improve the binding qualities of the latter, and these can be used with some measure of success on ordinary or indifferent work; their use on first class work can, however, be put in the same category as painting the lily. If the brickwork is likely to be attacked at any particular point by the flame, or where brickwork is put up in order to divert or direct the flame, this can with advantage be coated with some of the covering preparations sold for this purpose, and this will be found to greatly help bricks to resist the fierce heat. A little experimenting with one or two of the different materials recommended for each particular class of work will show what is the most suitable for their work. It is within the writer's experience that arches put up by contractors for boilers, and which came down a few months afterwards, have stood for two years when built and coated over as described.

The whole conditions of the furnace need to be carefully studied in order to obtain the best construction consistent with good steaming qualities, and it is impossible to lay down hard-and fast rules. An arrangement which will suit one engineer is scoffed at by another, and what one man may be prepared to sacrifice in economy the other is prepared to risk in upkeep. The above general principles, however, afford some slight idea as to the methods to be adopted in overcoming difficulties connected with brickwork linings in boilers.

EXTENSION OF ELECTRICITY PLANT AT BERMONDSEY.

Some extensions to the generating plant at the Bermondsey Corporation electricity works were proposed by the Electricity and Street-Lighting Committee and supported by the Finance Committee at a meeting of the Bermondsey Borough Council on Tuesday evening. The electrical engineer reported that the engine-room has space available for two steam dynamos. This space could be occupied by either two steam-turbine-driven dynamos of 1,000 kw. capacity each, or by two dynamos driven by reciprocating steam-engines of 750 kw. capacity each. He preferred to install machines of the largest possible size in the space available, and expressed the opinion that it would be better policy to install at the present time a steam dynamo of 750 kw. capacity. Accordingly, his estimate was as follows:

One steam dynamo, 750 kw. capacity	£5,810
One marine boiler, 14,000lb. evaporation	1,900
One condenser, 25,000lb.	3,460
Total	£11,170

The present plant capacity is 1,475 kw., and the highest load observed was 1,055 kw. The proposed plant will be capable of generating 1,835,000 units a year, with a load factor of 28 per cent.; this at 1·75d. per unit will produce £13,380; if the total working expenses at ·82d. per unit (£6,269) are deducted, together with £793 repayment of loan and interest, it leaves a surplus of £6,318.

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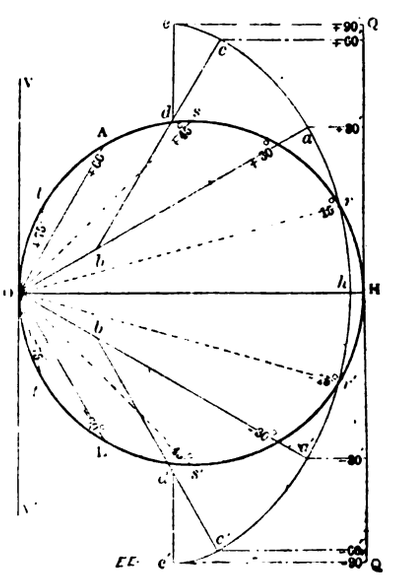
A NEW METHOD OF DETERMINING MEAN SPHERICAL AND MEAN HEMISPHERICAL CANDLE-POWER FROM THE CURVE OF LIGHT DISTRIBUTION.

There is a well-known graphic method, generally known as the method of "Rousseau diagram," for determining the mean spherical intensity of a luminous source when the curve of mean luminous intensity in altitude—or, briefly, the polar curve—has been obtained. The Rousseau diagram has been much used by photometrists, and has been frequently referred to in photometrical literature, so that no detailed description of it is needed here. Briefly, a circle is described on the diagram about the luminous source as centre, and horizontal lines are drawn at successive angular distances, from the zenith to the nadir. Along each horizontal line the mean azimuthal intensity for the corresponding angular distance is laid off by measurement of the given curve, all horizontal distances being taken from a common vertical. The outlying ends of the various horizontals are then joined by a broken line, and the area contained between the broken line and the vertical is measured. The horizontal length of that rectangle which on the same vertical base contains an area equal to the measured area, is the mean spherical intensity of the source to the scale of the original polar curve.

Dr. A. E. Kennelly in an article in the *Electrical World* suggests a new method for which he claims the advantage



of yielding the mean spherical intensity as the length of a certain vertical straight line, or as a one-dimensional quantity. This dispenses with the use of a planimeter or equivalent surface-measuring device. It consists essentially in determining graphically from the given polar curve an evolute, and the involute of the same, and then projecting this involute upon a vertical line. Half the length of the projection is equal to the mean spherical intensity, to the same scale as the original polar curve. The entire process requires only an angle protractor and a pair of compasses.

The new graphical method may best be explained by reference to the diagram, which shows its application to the particular case of a simple circular polar curve, O A H B. This polar curve roughly corresponds to the distribution of intensity from an inverted incandescent lamp having its base at V and tip at V', except that the tip candle-power does not usually fall off so much as the curve between B and O. The mean horizontal intensity would be O H, the diameter of the circle, and corresponding, say, to 10 c.p. The construction is adapted to zones of 30deg. Find the radii of the midzones—*i.e.*, at +75deg., +45deg., +15deg., −15deg., −45deg., −75deg. Mark these by the dotted lines O *t*, O *s*, O *r*, O *r'*, O *s'*, O *t'* respectively.

With radius O *r* and centre O, describe the arc *h r a* through an angle of 30deg. Draw the radius O *a* at the end of the arc. Measure from *a*, along *a* O, a distance *a b'* equal to O *s*, the second midzone radius. With centre *b*, and radius O *s*, describe the arc *a c* through an angle of 30deg., so that *b c* makes an angle of 60deg. with the horizontal O H. Draw the line *b c* at the end of this arc. From *c* toward *b* mark off a distance *c d* equal to O *t*, the third midzone radius. With centre *d* and radius O *t* describe the arc *c e* through an angle of 30deg., so that *d e* makes an angle of 90deg. with the horizontal O H. Draw the line *d e*. Extend the arc *h a' c' e'* from the horizontal to the vertical beneath in the same manner as above, by steps of 30deg., with centres O, *b'*, and *d'* and radii O *r'*, O *s'*, and O *t'* respectively. The curve *e c a r r' a' c' e'* will now be continuous and complete. Draw a vertical line Q Q' through the convenient point H, and project horizontally the points *e*, *c*, *a*, *a'*, *c'*, and *e'* upon the same. Then half the distance Q Q' between the end projections will be equal to the mean spherical intensity of the lamp. The length H Q is the upper hemispherical intensity. The length H Q' is the lower hemispherical intensity. By measurement the half length of Q Q' is found to be 7·78 units. The lamp, therefore, has a mean spherical candle-power of 7·78, and a spherical reduction factor of ·778. In Table I. the theoretical value is worked out, and equals ·776.

TABLE I.—Analysis of Construction followed in the Figure for a Lamp of Simple Circular Polar Curve.

Elevation θ.	Sin θ.	Difference Δ sin θ.	Elevation of midzone β.	Cos β.	Projected length cos β (Δ sin θ).
90°	1·00	—	—	—	—
60°	0·866	0·134	75°	0·2588	0·034,68
30°	0·50	0·366	45°	0·7071	0·258,82
0°	0·00	0·500	15°	0·9659	0·482,95
					0·776,45

Dr. Kennelly shows the application to various other forms of distribution curves, and proves that 15deg. or even 20deg. zones give ample accuracy for practical purposes. He concludes: "The new graphic method for evaluating the mean spherical intensity of a lamp directly from its polar curve, above described, expresses the result as a straight line. It performs the same function as the Rousseau diagram, but dispenses with the planimeter, requiring only compasses and protractor. It possesses, theoretically at least, as great a degree of accuracy as the Rousseau diagram for a given number of zones. It gives at a glance the upper and the lower hemispherical intensities, the mean of which is the mean spherical intensity. It further enables the luminous flux through any zone, per radian of azimuth, to be read off directly from the line of projection. It has been found practically useful."

THE WEDEKIND PRIMARY CELL.

A. Wedekind has recently brought out a new copper-zinc-alkali cell which shows a considerable advance on existing cells. It has an open-circuit voltage of just over one volt, has a high discharge capacity (the largest size can supply 80 amperes), and is readily regenerated. The positive element consist of a cast-iron case, which also forms the outer containing vessel. The inner faces of this case are copper plated, and are provided with slots and pegs to hold the oxide of copper active material. The whole is heated and forms a solid black mass. During discharge this mass becomes red through conversion to copper. Recharging is accomplished by heating the case for three or four hours in a bake oven. When the substance has once more turned black the operation is complete, as the action takes place from the inside outwards. Numerous tests have been made on three sizes of cell—viz, for 1, 2½, and 40 amperes discharge—both by the manufacturers and by the Reichsanstalt. One of the large cells gave 40 amperes for 19 hours, or 760 ampere-hours, at a terminal voltage falling from ·57 at the start to ·41 at the end,

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The watt-hours given out were, therefore, about 380. The consumption of zinc was 1·28 grammes per ampere-hour, as against a theoretical value of 1·19 grammes. The internal resistance of a cell varies from ·01 ohm to ·001 ohm. The active materials are zinc and caustic potash, which naturally prove somewhat expensive as a fuel, in spite of the close approximation to the theoretical consumption which is attained. The cell is, therefore, not likely to come in for automobile work or other heavy power work, but should prove advantageous as a substitute for many of the older forms of primary cell.—*Centralblatt für Accumulatoren und Galvanotechnik.*

UNIVERSITY COLLEGE.

The following appointments have been made for the year 1908-9: the Right Hon. Lord Reay to be chairman of the College Committee; Sir Edward Busk to be vice-chairman; Sir Felix Schuster to be treasurer. The committee have received the sum of £1,528. 12s. 6d., being the bequest of the late Madame Halfon, for the foundation of two prizes to be called "The L. M. Rothschild Prize" and "The Hester Rothschild Prize." In accordance with Madame Halfon's will, the subjects for which the prizes are to be awarded will be determined in consultation with the Chief Rabbi. The report of the College Committee for the year 1907-8 has just been issued. During last session there were 1,191 students, of whom 171 were registered as post-graduate and research students.

The report contains a record of the extension of the college buildings that has been made possible by the removal of University College School, and by the provision of a new building for the advanced medical departments. Among the departments that have specially benefited by the recent enlargements are those of engineering. The drawing office has been enlarged and completely rearranged. It is now worked in two sections: (*a*) a junior office, providing 85 drawing-bench places; (*b*) a senior office, providing 50 drawing-bench places. An engineering museum, with a demonstration room adjoining, is being equipped. In the basement a new hydraulic laboratory will be equipped, and space is available for extensions to the heat-engine laboratory, with a room adjoining it for carrying out calculations and for research work.

The department of electrical engineering, which before was much cramped, has been provided with almost as much floor space again as it had before. The new rooms comprise a lecture room, with apparatus room adjoining it on one side and a demonstration room on the other; a research laboratory, at the present time equipped mainly for the study of high-frequency electric currents and radio-telegraphy, generating apparatus being provided both for spark and arc telegraphy, and for measurements and investigations necessary in connection with it; a new dynamo room; the old lecture room is to be reconstructed so as to make room for dynamo machines; a new professor's private room.

The report also deals in full with the work of the faculties for the past year, and gives a list of the researches and original papers published during that year. This list occupies 13 octavo pages. Among the departments that seem to have been specially productive may be noted the department of applied mathematics under Prof. Karl Pearson, from which no less than 28 important papers have issued during the year. Seven of these were from the Francis Galton Laboratory of National Eugenics. The departments of chemistry under Prof. Sir William Ramsay and Prof. J. Norman Collie produced 24 original papers, while the sub-department of spectroscopy issued seven. In the faculty of arts six important publications were issued from the department of German, six from the departments of history (five of them by Prof. Pollard), while the department of Egyptology was responsible for four.

The list of post-graduate courses is valuable as an indication of the extensive provision for higher work that is now to be found in London. The short reports of the students' societies show that the corporate life of the college is in a healthy condition. Among the new societies is specially to be noted the Intercollegiate Law Students' Society, which is an evidence of the growth and activity of the law faculty. The report contains a *résumé* of the results of the Treasury visitation. These results are for the most part eminently satisfactory to the college. The Treasury visitors dwell, however, upon the need of new accommodation for the department of chemistry. The report concludes with a summary of the urgent needs of the college if it is to meet the demands made upon it.

ALTERNATORS IN PARALLEL.

At a recent meeting of the electrical section of the Western Society of Engineers (U.S.A.) an experimental lecture on the paralleling of alternators was given by Prof. Morgan Brooks. The interesting feature of the evening was a demonstration of ordinary synchronisation and Prof. Brooks's self-synchronisation method. Through the courtesy of the Commonwealth Edison Company, a synchroniser and ammeter at the lecture hall in the Monadnock Building were connected to the switchboard gallery at the Harrison-street station so that all the usual switchboard indications of phase difference and current could be read direct by the audience in the lecture room.

A 200-kw. rotary converter was motor-driven and thrown in parallel with the station 'bus bar. The first experiment was done as accurately as possible with no noticeable ammeter deflection. In the second experiment the motor-generator was switched in at perhaps 15deg. out of phase, when a rush of current amounting to 2,000 amperes was observed, representing a momentary overload of about 50 per cent. Then a reactance coil was connected between the 200-kw. machine and the 'bus bars, and synchronising was done 30deg, 90deg., and 180deg. out of phase, the maximum current being about 600 amperes at 180deg. As a final exhibit, the motor was speeded up until a considerable difference in speed was attained, the synchroniser revolving too rapidly for proper switch closing. A paralleling switch was then thrown, and speed adjusted until the machine was running steadily. The coil actually used for this work consisted of 120lb. of No. 0 copper wire wound on a reel just as it came from the storeroom

In discussing the paper, several speakers spoke of the reduction of synchronising difficulties to-day as compared with conditions of 10 years ago before the introduction of the synchronising instruments. Mr. E. F. Smith, of the Commonwealth Edison Company, stated that damage due to synchronism was a negligible factor in their operation to-day, and that no trouble had arisen for many years He suggested, however, that this method would doubtless serve for quicker synchronising of frequency changers. In such a use reactance coils would be connected both in the motor and generator circuits, and both motor and generator switches closed at once. Mr. Abbott, also of the Commonwealth Edison Company, stated that a smaller size of wire could be used for synchronising than in this case, and he believed that under favourable conditions ½lb. of copper per kilowatt would be sufficient for such a coil.

Prof. Brooks closed the discussion by calling attention to the rather unexpected reactance of such small coils in this work, such a coil probably being cheaper than a reactance with an iron core. A considerable current overload might safely be carried, since the coil was in use for such a very short time. When the inductance depends on the magnetisation of an iron core a large momentary rush of current may occur, and the very purpose of the coil be thereby destroyed.—*Electrical World* (New York).

THE ELECTRICAL ENGINEERS' BALL, 1908.

This, the fifth annual function of its kind, was more than usually successful as regards both the number of guests attending and the financial result. At their meeting held on March 31 the committee were enabled to vote from the available balance for the year a sum of £75 for the benevolent fund of the Institution of Electrical Engineers,

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TO CORRESPONDENTS.

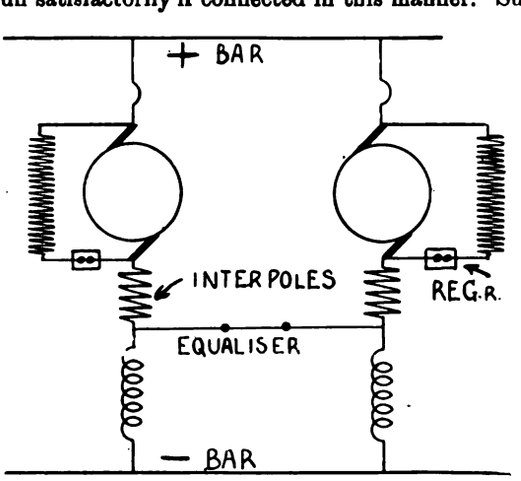
All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

QUESTION No. 1,051.

Sir,—Kindly allow me to point out an error in the sketch (Fig. 2) given by "R." It will be seen that the equaliser bar is connected directly across the brush posts. Compound-wound machines fitted with interpoles would not run satisfactorily if connected in this manner. Suppose



one machine to be running on the load and that it is required to run another in parallel, if the series windings are in, on the negative wire, which is in accordance with modern practice, the equaliser and negative switches will be closed first. Now the interpoles and series winding of the incoming machine will be in parallel with the windings of the machine which is already on load, therefore one-half of the current (assuming their resistances to be equal) in the latter will flow through the interpoles and series winding of the former, and, since the armature of the former is practically unloaded, vicious sparking at the brushes will take place, owing to the heavy currents induced in the coils undergoing commutation. The correct connections for two compound-wound machines fitted with commutating poles are those shown in the accompanying diagram, from which it will be seen the only current that passes through the interpoles is the armature current.—Yours, etc.,

M. Moreton.

TELEPHONE RATES.

Sir,—Mr. H. Laws Webb says in your issue of March 26, "Certainly the unit of the local telephone service is the effective call. What else should it be?" If the unit in telephony be the effective call as the loaf in a bakery, the book in the publishing trade, or a newspaper, why does the National Telephone Company not sell a single effective call as the baker sells a single loaf and the bookseller sells a single book?

Why does the Telephone Company not sell a single effective call before the subscriber has paid 500 or 600 calls, neither effective nor ineffective, but non-existing calls? The answer is as simple as the question: because the effective call is *not* the unit of sold matter as the loaf is in a bakery or the book in the publishing trade.—Yours, etc.,

J. Baumann,
Editor *Zeitschrift für Schwachstromtechnik.*

THE FUTURE OF THE TELEPHONE SERVICE.

Sir,—Perhaps you will allow me to say again that I have no position in the National Telephone Company's organisation, and therefore no title. Since Mr. Bennett prefers to deal only with personal matters, and you apparently think them of so much importance, perhaps you will also allow me to say the following: In the first place, I should think that knowledge of the working of the largest commercial telephone organisation in the world would entitle one to speak on telephone matters. I have been more or less in touch with the work of the National Telephone Company for the past 14 years, and in fairly close touch with it for the past five. But also I have been 13 years in telephone work in America and have made not less than a dozen visits to the Continent, sometimes quite long visits, almost exclusively to study telephone work. So that not only do I know English and American telephone conditions, but also those of almost all the countries of Europe, from Norway to Spain, and from Belgium to Russia. I have friendly relations with telephone engineers and administrators in all the principal capitals, and often exchange information with them. I am consulting engineer to the French Association of Telephone Subscribers, whose work during the last four years has done much towards influencing the French Government to reconstruct the Paris telephone system (on common-battery lines) and to recommend to the French Parliament the adoption of a measured-rate tariff.

Consequently, when I say that the great majority of experienced telephone men and students of the telephone question are agreed that the measured-rate principle makes both for the soundest development and the highest efficiency of the telephone service, I speak with knowledge, and the exact truth. No bias I may have in favour of commercial working of a growing industry like the telephone service instead of Government or municipal working has any bearing on that.

I discuss bias and personal matters solely because these are Mr. Bennett's chosen ground, to which he always returns with such fervid insistence. One can pardon his ill-temper, because it is a not uncommon trait in human nature to fall back on abuse when beaten in argument. But surely talk of bias on this particular subject comes oddly from one who established a very successful and lucrative monopoly in advising municipal telephone systems, and quite naturally desires an extension of those systems and of that monopoly.

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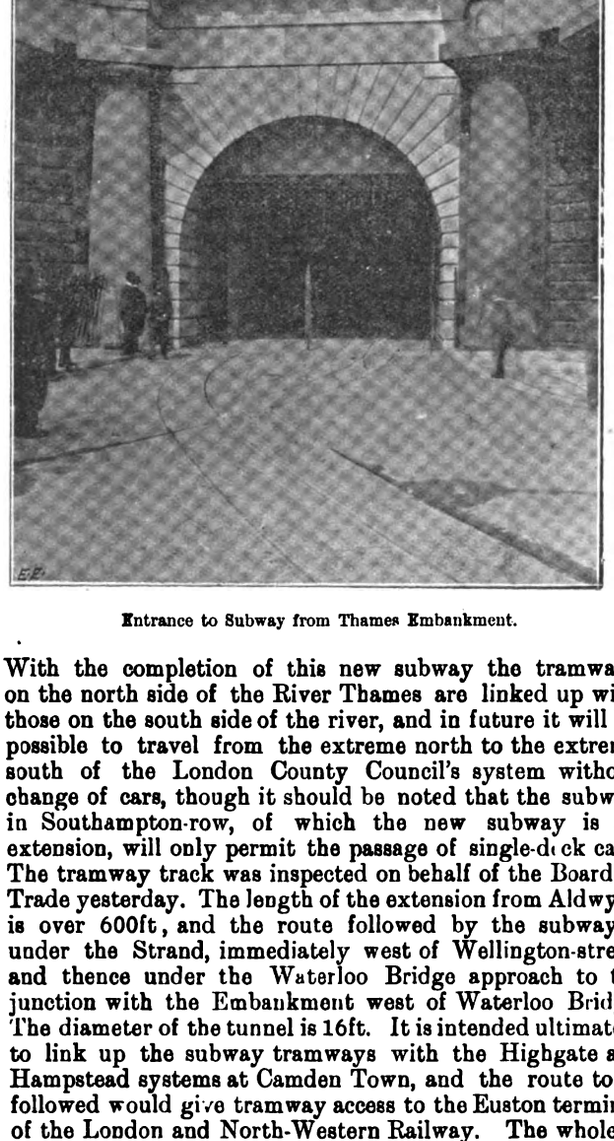
Let us agree, Mr. Editor, that Mr. Bennett has nailed the flat-rate flag to his mast and I the measured-rate flag to mine, and if we have to argue telephone questions, let us argue them on their merits, without personalities, without heat, and without crudity of expression. The rapier is so much more interesting a weapon than the bludgeon.—Yours, etc., HERBERT LAWS WEBB.

[Let me be personal for once. I do wish that every personal question could be avoided in this and all controversy. Let it be assumed that gentlemen on opposite sides do come honestly and squarely to the opinions they hold. My brief is to listen to all sides, to remain an unbiassed observer, and to record all views, so that, as Carlyle said, "by much speaking we ultimately get the real truth."—C. H. W. B.]

LONDON COUNTY COUNCIL.

The official opening of the Strand to the Embankment subway extension has been fixed for to-day (Friday).

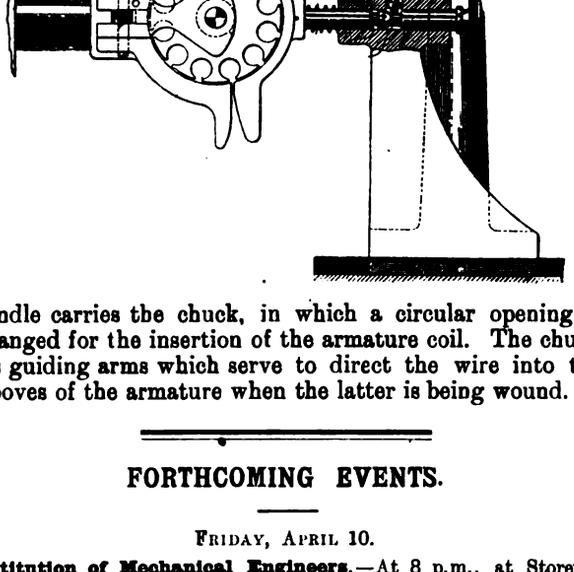


Entrance to Subway from Thames Embankment.

With the completion of this new subway the tramways on the north side of the River Thames are linked up with those on the south side of the river, and in future it will be possible to travel from the extreme north to the extreme south of the London County Council's system without change of cars, though it should be noted that the subway in Southampton-row, of which the new subway is an extension, will only permit the passage of single-deck cars. The tramway track was inspected on behalf of the Board of Trade yesterday. The length of the extension from Aldwych is over 600ft, and the route followed by the subway is under the Strand, immediately west of Wellington-street, and thence under the Waterloo Bridge approach to the junction with the Embankment west of Waterloo Bridge. The diameter of the tunnel is 16ft. It is intended ultimately to link up the subway tramways with the Highgate and Hampstead systems at Camden Town, and the route to be followed would give tramway access to the Euston terminus of the London and North-Western Railway. The whole of the work has been carried out to the designs of Mr. Maurice Fitzmaurice, chief engineer to the London County Council, with Mr. F. O. Stanford as resident engineer.

AN ARMATURE COIL-WINDING MACHINE.

A type of coil-winding chuck recently patented in America by F. R Kunkel was described in the *Electrical World*, and a diagram of which is shown below. A rotatable



spindle carries the chuck, in which a circular opening is arranged for the insertion of the armature coil. The chuck has guiding arms which serve to direct the wire into the grooves of the armature when the latter is being wound.

FORTHCOMING EVENTS.

FRIDAY, APRIL 10.

Institution of Mechanical Engineers.—At 8 p.m., at Storey's-gate, St. James's Park, S.W., "The Effect of Mixture, Strength, and Scavenging upon Thermal Efficiency," by Prof. Bertram Hopkinson; "The Governing and the Regularity of Gas-Engines," by Mr. James Atkinson.

Royal Institution.—At 9 p.m., "The Carriers of Positive Electricity," by Prof. J. J. Thomson.

Physical Society.—At 8 p.m., at the Royal College of Science, South Kensington, papers by Prof. Bragg and Mr. Madsen, and Mr. W. Duddell.

SATURDAY, APRIL 11.

Institution of Electrical Engineers (Students' Section).—Visit to the electric lighting station of the London and North-Western Railway, Chalk Farm.

Royal Institution.—At 3 p.m., "Electrical Discharges through Gases," by Prof. J. J. Thomson. (Lecture VI.)

Birmingham and District Electric Club.—At 7 p.m., at the Colonnade Hotel, New-street, "Electric Train Lighting," by Mr. T. H. Bridcutt.

MONDAY, APRIL 13.

Institution of Mechanical Engineers.—At 8 p.m., "Mechanical Stokers," by Mr. E. B. Ellington.

TUESDAY, APRIL 14.

Institution of Electrical Engineers (Manchester Local Section).—At 7.30 p.m., at the University (Physical Laboratory), "The Management of Engineering Workshops," by Mr. Eustace Thomas.

ELECTRICAL ENGINEERS (LONDON DIVISION).

Orders for week ending Saturday, April 18.

MONDAY, APRIL 13.—"A" Coy.—Infantry drill, 6 p.m.
Technical drill, 7 p.m.

TUESDAY, APRIL 14.—"B" Coy.—Infantry drill, 6 p.m.
Technical drill, 7.30 p.m.
Recruiting at 6 p.m.

THURSDAY, APRIL 16.—"C" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

FRIDAY, APRIL 17.—"D" Coy.—Infantry drill, 6.30 p.m.
Technical drill, 7.30 p.m.

Arms are now being issued to all men who have signed on in the Territorial Force.

Men who have not signed on in the Territorial Force can do so on their Company night.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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LIVERPOOL TRAMWAYS.

Few tramway schemes have so interesting history as that of Liverpool. In 1897 the Corporation acquired the company's concern for £567,375, and the first electrical section was opened in November, 1898, so that in the course of a few months the child of 1898 will be 10 years old. During a considerable portion of that time conversion was going on, so that no clear vision could be obtained of the value of the undertaking when normal conditions prevailed. However, the time has come when such conditions hold and unbiassed men can see the real value of the work We were interested to see if the Liverpool Corporation's capital account contained an item "£567,375 purchase money lost," as suggested by the eminent accountants to the London County Council. It does not. It shows:

Net expenditure to Dec. 31, 1907	£1,913,188 14 6
To meet this expenditure Liverpool raised	1,904,173 8 0
Liverpool owes bank	59,028 16 3
Since commencing operations Liverpool has paid off loans	294,136 19 4
and still owes on capital account	1,560,022 18 11
But it has also sinking funds	282 588 18 6
and renewal, reserve, and depreciation funds	272,449 5 6

Practically these figures show that already there are liquid funds in hand to about one-quarter of the amount owing on capital account. Put another way, in 10 years—and these include the years of conversion—capital has been depreciated almost 50 per cent, and the undertaking as an asset is, we venture to say, to-day worth more than has been expended upon it. Put these figures in opposition to the biassed criticisms on municipal work and draw honest deductions, then we shall agree that business men can and do successfully conduct a large municipal undertaking upon the strictest business lines. Now let us see what the annual work means. The population served approximates to the million. The number of passengers carried during 1907 was 124,043,239, the receipts amounting to £572,822 and the mileage to 12,231,799. The following summary is interesting:

SUMMARY OF THE PRINCIPAL FIGURES APPLICABLE TO THE LIVERPOOL TRAMWAYS FOR THE YEARS 1906 AND 1907 RESPECTIVELY.

	1906.	1907.
Capital expenditure to Dec. 31	£1,901,997 3 10	£1,913 188 14 6
Total revenue	583,619 14 6	598,365 11 8
Operating costs (including rental of leased lines)	391,282 0 0	404,625 2 1
Percentage of operating costs to total revenue	67·0 per cent.	67·6 per cent.
Gross profits	£192,337 14 6	£193,740 9 7
Percentage of gross profits to capital expenditure	10·1 per cent.	10·1 per cent.
Interest and sinking fund	£109,580 18 0	£110,361 6 5
Balance	82,756 16 6	83,379 3 2
Divided as follows:		
Reserve, renewal, and depreciation	55,171 4 4	55,586 2 1
Transferred to general rate account	27,585 12 2	27,793 1 1
Total operating costs per car mile	7·751d.	7·939d.
Interest and sinking fund per car mile	2·171d.	2·165d.
Total charges	9·922d.	10·104d.
Car mile earnings	11·17d.	11·24d.
Average fare per passenger	1·108d.	1·108d.
Average length of penny stage	2 miles 699 yards	2 miles 639 yards
Length of track operated	104 miles	104 miles

We must heartily congratulate Mr. C. W. Mallins, the energetic and genial traffic manager, upon this continued and continuous success.

ELECTRIC SUPPLY PROSPECTS AND CHARGES AS AFFECTED BY METALLIC-FILAMENT LAMPS AND ELECTRIC HEATING.*

BY H. W. HANDCOCK AND A. H. DYKES, MEMBERS.

It is very satisfactory at the moment to be able to induce a wavering possible consumer to decide in favour of electricity by pointing out that with the new metallic-filament lamps two to three times the light can be obtained for the same current as compared with the ordinary carbon lamps which he has used hitherto. He is added to the list of consumers, and the output of the station is increased. He may or may not consume the same amount of current as the old consumers using carbon-filament lamps, but he has increased the output of the station. It is also satisfactory when a present consumer replaces a single 16 c.p. lamp with two 25-c.p tantalum or Osram lamps run in series. He gets a magnificent light, and, if he does not do it throughout his house, his bill is not greatly affected. But what will happen when every consumer uses high-efficiency lamps throughout? Can we feel sure that the only effect will be that the consumer will get more light, and will use as much as or more current than before?

When the gas mantle was first introduced its effect was to give at each burner a greatly increased light for about the same consumption of gas as before. Although undoubtedly one effect was to accustom people to a higher standard of illumination, it was found that the consumption of gas per consumer fell off seriously, and the rate of increase of gas production was checked. Fortunately for the gas industry, the change came at a time when electricity for lighting was pushing them hard, and the mantle enabled them to retain, and even to win back, a number of consumers who otherwise would have used electricity. Owing, also, to the low cost per service, it did not matter nearly so much to the gas companies if one man's consumption fell off, provided only thereby his neighbour was attracted. The vigorous efforts made by the companies to push gas for heating and cooking purposes (for which they required no additional meters or special rates) also served to stem the ebb tide, and prevented the receipts from actually falling off. In conversation with a number of gas authorities we gather that the new inverted mantle, although nothing like as economical as it is claimed to be in some quarters, does reduce the consumption of gas per point, and has in places had an appreciable effect on the output of the works.

The present 110-volt tantalum or Osram lamps, giving 23 c.p. to 30 c.p. at a consumption of 40 watts, although they have usually to be arranged in series, might appear to correspond very closely with the original gas mantles in gas lighting. In some cases consumers will be able to do with fewer points and thus reduce their consumption. In others it will happen that they will improve their lighting, but not very greatly reduce their consumption. Some engineers seem to think the first state of affairs will predominate, whilst others incline to the latter. If metallic-filament lamps were always to remain at the present price, and were only available in comparatively large units and at 100 volts, it is probable that the total effect on the station supplying principally private consumers would not be very marked. The cost of the lamp—4s. for Osrams and 2s. 9d. for tantalums—is a very considerable item, and consumers, therefore, will not adopt them to any great extent unless they can feel assured that their *total* lighting bill will be reduced, or at any rate not increased.

In the case of private consumers, where a large proportion of the points are single lights, with separate switches for each point, the saving in current, if any, with two lamps in series will, except where current is dear, not be great enough to ensure a general adoption of the lamps at present prices. In the case of shops, halls, and factories it generally happens that the lamps are mostly on all at once, so that the question as to whether a switch controls one or two lamps does not come in. The effect in this case, even if the same total number of lamps be used, is to decrease the current consumption by about one-third, with an increase in the illumination of 50 per cent. or more. The total saving thus effected, after allowing for the increased cost of lamp renewals, depends on (*a*) the price charged for current; (*b*) the price of the lamps; (*c*) the life of the lamps. Table I. gives the total cost of lighting at different prices for current, and at varying lengths of life of the lamps, and at various prices for the lamps. It shows clearly how, at the present cost of the renewals, the saving effected varies as the price for current is reduced.

When lamps are run in series their life depends very much on the fluctuation in voltage on the circuit, and under ordinary conditions it is considerably less than when they are run in parallel. It is claimed that the 100 and 110 volt Osram lamps have a useful life of 750 hours, but this counts

* Paper read before the Institution of Electrical Engineers.

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from the time that the lamp is safely fitted into its lamp-holder and current turned on. No doubt, as in the case of gas mantles, improvements will be effected, and the breakages which now takes place before even the lamp gets into its final position will be reduced; but at present breakages in transit are a serious item to be borne in mind when calculating the cost of renewals. With tantalum lamps we have obtained guarantees of an average life of 750 hours when run in parallel, and of the same life when run two in series, provided (*a*) that the lamps be properly paired to begin with; (*b*) that if one burns out both be replaced, and the partially worn-out one paired up with another partially worn-out one; and (*c*) that the voltage of the lamp corresponds, not with the declared voltage, but with the highest voltage actually obtaining on the circuit in question.

It is common knowledge that even with the drawbacks above referred to, many large business consumers are putting in metallic-filament lamps, two in series, and many stations can testify to testify to great reductions occasioned thereby in consumers' accounts. One thing is certain, that if a larger proportion of the total annual outlay on lighting is to be paid to the lampmakers, the amount coming to the supply station must be considerably reduced if the total is to be reduced, or even to remain the same. If the consumption per consumer be reduced by, say, one-third, it is not sufficient to increase the number of consumers by 50 per cent., as this only just keeps the output at its former figure, without allowing for increased capital outlay on services, and increased expense in meter reading and general administration. It is, moreover, very doubtful if there are many districts where the number of consumers could be *quickly doubled*, whatever may be the result in the long run. The foregoing remarks apply to those cases where 100-volt 25-c.p. to 30-c.p. lamps are used, two in series, on 200 volts or thereabouts.

In our own private houses we last year tested a plan which appears likely to become very general where alternating supply is available. This consists in putting down an auto-transformer or "distributor," by which the 200-volt supply is broken up into eight circuits of 25 volts each, thus permitting the use of 25-volt metallic-filament lamps of 8 and 14 British candle-power, which are both cheaper in first cost and more efficient and stronger than the 100-volt lamps. The 8 c p. 25-volt Osram lamp is rated at 10 watts and the 14-c.p. at 16 watts. We have carefully studied the behaviour of both lamps and transformers and find them in every way satisfactory.

It may be objected that the transformer losses during the daytime would go far towards neutralising the saving in current during the lighting hours. In our own case we obviated this by keeping carbon-filament lamps in bedrooms, and arranging two-way switches on the ground and bedroom floors, by means of which the transformers are switched off last thing at night and not turned on again until the downstair lights are required again. There is now, however, on the market more than one switch which automatically switches the transformer off when the last lamp is turned off and switches it on again when a lamp is turned on. Under these circumstances we find that the consumption of current for the same illumination is only from one-third to one-half of what it was formerly. In shops and business premises the provision of a switch to turn off the transformer during the non-lighting hours presents no difficulty. We have taken tests of transformers made by different makers, each wound for eight circuits of 25 volts—200 volts across outers—for four to five amperes per circuit at 50 ~ per second. We find that the no-load consumption, all lamps turned off, varies from 15 to 20 watts. The lamp, unlike the 110-volt one, can be used in any position and fits any ordinary shade, is listed at 3s., and as an electrolier with six 8-c.p. lamps only consumes the same amount of energy as an ordinary carbon-filament 16-c p. lamp, it is evident that the system presents many advantages.

A well-known London company was last year approached many times by the makers of metallic-filament lamps, but refused to make any change, as most of their lighting was by means of 8-c.p. lamps on three and five light electroliers, with the lamps at varying angles, and in many cases enclosed in rather small glass flambeaux. They subsequently adopted the 25-volt auto-transformer system, which met all their requirements. For the satisfaction of the directors a meter was put in circuit with the lights on a portion of the installation, consisting of 50 8-c.p. lamps (carbon filaments), the meter reading over two hours being 3·25 units. An auto-transformer was then put in the basement below the distribution board, and the lamps changed to 8-c p. 25-volt Osrams, when the meter reading over the same length of time was only 1·10 units. Since then these transformers have been made in large quantities, and it is quite evident that as soon as they become general the accounts of consumers on alternating-current systems will be reduced by at least one-half.

Continuous-current stations are not affected in the same way, but who can doubt that before long the price of metallic-filament lamps will be largely reduced, and a satisfactory 200-volt lamp put on the market? Indeed, we are already promised within the next few weeks a 50-watt, 40-c.p, 200-volt lamp.* Both these events would largely increase the number of users of high-efficiency lamps and lead to a general reduction in lighting accounts. This will not affect so seriously the large companies in the manufacturing centres which have a large power load and are able to supply lighting current at very low rates, but it will, we think, prove most serious for the large number of stations in residential districts dependent almost entirely on the supply of current for lighting. What steps are the supply stations going to take to meet this? For some time to come it is hopeless to expect that the number of new consumers attracted by lower bills will keep the receipts up to the present level if the present rates and methods of charging be adhered to. Even in the case of the gas undertakings a severe check was received from the gas mantle, and from the very nature of the business electrical stations are in a far worse position to withstand any reduction in receipts. Taking the whole of the gas undertakings in the country, we find in the Board of Trade returns the following figures:

Total capital expenditure	£124,184,000
Total gross revenue	27,254,000
Total gross expenditure	20,496,000

For the electrical undertakings the figures are:

Total capital expenditure†	£50,767 000
Total gross revenue	6,514,000
Total gross expenditure	3,019,000

It will be thus seen that, whilst to obtain a gross revenue of £1 per annum a gasworks has to lay out £4. 10s, an electrical undertaking must spend £7. 10s.; and whilst the ratio of working expenses to receipts is 75 per cent. in the one case, in the other it is 46·3 per cent. This means, of course, that in a gas company a much smaller margin of receipts over working expenses is sufficient to pay interest and financial charges and profit on account of its smaller capital than is the case with an electrical company. An electrical undertaking requires a much greater margin between gross receipts and working expenses than a gas undertaking for two reasons: (1) because, as shown above, it has to pay interest on a much greater capital outlay per £1 of gross earnings; (2) because, in addition to paying this interest, it is generally liable to be bought out for a nominal sum at the end of 42 years, and has, therefore, also to provide out of the margin for a substantial sinking fund—a contingency that gas companies have not to meet.

(*To be continued.*)

REEL FOR THE USE OF ARMATURE WINDERS.

It has often been found desirable, particularly in the winding of dynamo-electric machines which are designed for relatively

* The progress of events is so rapid that even since this paper was written the prices of some makes of lamps have been reduced; new lamps have been put on the market and improvements made, all tending to popularise high-efficiency lamps.

† It is of interest to note that, owing to the fact that up to a certain point the rateable value of a concern is based on an assumed percentage on the capital involved, if two consumers pay similar accounts under similar conditions, one of them for electric light and one for gas, the former is called upon indirectly through the supply company to make a much larger contribution to the rates than the latter.

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high voltages, to employ substantially closed core slots and to wind the coils by threading the conductors of which they are composed back and forth through the proper slots. Windings formed in this way are preferable to those formed by forcing previously formed coils into the slots from one end, since such coils require a large number of joints or connections in the conductors in order to connect the proper turns of the winding together.

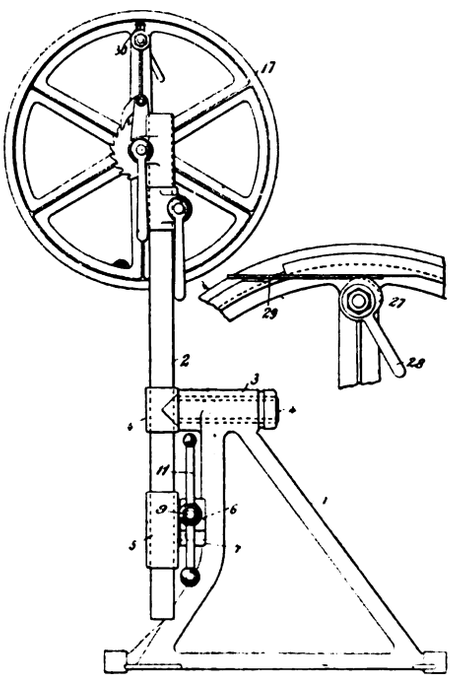

FIG. 1.

The winding of coils of the threaded construction, which are commonly known as hand-wound coils, has involved the use of a relatively large amount of floor space, since the conductors which are pulled through the slots by hand are usually of considerable length. Furthermore, the conductors are continually being drawn along the floor in the hand winding process, and considerable difficulty is, therefore, sometimes experienced in the use of machines so wound by reason of the rapid deterioration of the conductor insulation, which is largely due to the worn condition of the insulation and the impregnation of its fibre with dirt.

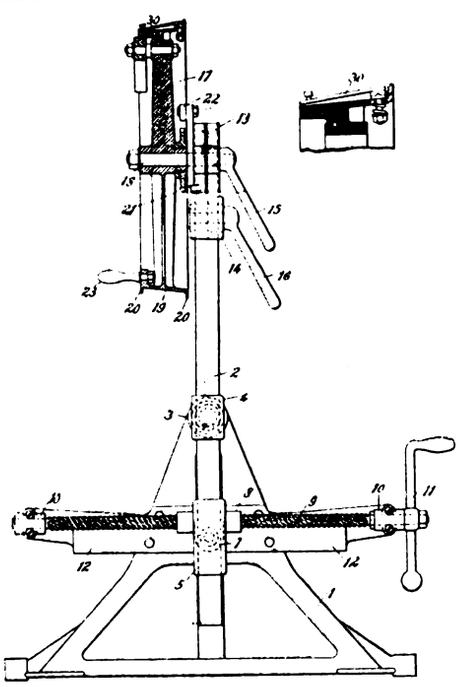

FIG. 2.

A reel has been invented by Isaac De Kaiser, of Wilkinsburg, Pa., upon which the conductor may be coiled and from which it may be readily removed without injury, so that the winding process is materially facilitated and the insulation of the conductor kept clean. This reel was recently patented and the patent assigned to the Westinghouse Electric and Manufacturing Company. The construction of the reel is shown by the two accompanying drawings. Fig. 1 shows a general elevation of the reel and a detail of the device for clamping the end of the conductor to it. Fig. 2 is an elevation at right angles to that of Fig. 1, the pulley being shown in section; a detail of part of the rim is also shown.

The outer surface of the pulley is conical, and is provided with flanges (20) which serve to keep the wire or similar conductor in place. A ratchet wheel (21) is rigidly fixed to the hub of the pulley, and may be engaged by a pawl (22) which is supported from the pulley shaft. A handle (23) that is attached to the pulley near its circumference is employed for rotating it while drawing the conductor through the core slot and winding it about the pulley surface, the ratchet and pawl being employed for preventing the backward turning of the pulley by reason of the strain exerted upon the conductor.

As the end of a conductor is first pulled through a core slot, it is clamped to the surface of the pulley by any convenient means—such, for example, as that illustrated in detail in Fig. 1. This clamping device consists of an eccentric cam (27), having a handle lever (28) to clamp the conductor against a plane surface, which is provided on the inside of the rim, a suitable opening (29) being provided in the rim, through which the end of the conductor may be thrust to be engaged by the clamp.

When the reel is properly adjusted in height by the split bushings (13) and (14) and the screw (9), and the end of the conductor is clamped to the pulley, the latter is rotated by means of the handle until the total length of free conductor is wound upon its surface. The conductor is held in place on the pulley by means of a number of guides (30), which are tangent to its surface and near one side while the conductor is being coiled, but which may be swung through an angle of 90deg. to extend across the surface of the pulley after the conductor has all been wound thereon. The end of the conductor is released from the clamp after the conductor has all been coiled and is threaded back through another predetermined slot to be received, at the other side of the machine, by another similar reel, which is properly adjusted for the slot from which the conductor issues, and the guides (30) serve to keep the coiled conductor from kinking or loosening back as the conductor is taken off. The conductor may be more readily removed from the pulley surface if the pulley is revolved upon the rod through an angle of substantially 90deg., so that the conductor is perpendicular to its plane of rotation.—*Western Electrician.*

INSTITUTION AND SOCIETY NOTES.

Institution of Electrical Engineers.

The following were elected at the meeting on the 2nd inst.:

Associate Members.—L. C. Bose, P.W.D., Kashmir State, Srinagar, Kashmir, India; A. R Gundry, H.M. Mint, Calcutta; H. F. Haworth, Ph.D., 27, Ennismore-avenue, Chiswick, W.; F. A. King, 205, Byars-road, Glasgow; G. Lloyd-Jones, 49, Clova-road, Forest Gate, E.; W. T. Maccall, 223, Burrage-road, Plumstead, S.E.

Associates.—F. Berry, 5, Bedford-street, Bolton; A. E. Kiralfy, 168, Hammersmith-road, W.

Students.—J. R. Abbott, 53, Kingsbury-road, Gravelly Hill, Birmingham; A. N. Aikman, Siemens Bros. Dynamo Works, Limited, Stafford; A. J. Airston, 39, Lysways-street, Walsall; C. G. Barker, 6, Marchwood-crescent, Ealing, W.; R. F. Blackmore, 595, Stretford-road, Old Trafford, Manchester; S. H. Bridcut, 83, Springfield-road, Moseley, Birmingham; H. Brittan, 316, Victoria-road, Aston Manor, Birmingham; W. A. A. Burgess, 21, Meldon-terrace, Heaton, Newcastle-on-Tyne; G. W. Burley, 257, Chesterfield-road, Meersbrook, Sheffield; H. Ching, 17, Henrietta-street, Old Trafford, Manchester; J. Cloughton, 28, Colwyn-street, Oldham; J. Davies, School of Technology, Manchester; A. E. H. Dinham-Peren, Bealings, Southbourne-on-Sea, Hants; S. Dudman, 8, Upper Belsize-terrace, Hampstead, N.W.; K. N. Eckhard, 4, Walpole-gardens, Gunnersbury, W.; A. C. Evans, 82, Hotspur-street, Heaton, Newcastle-on-Tyne; W. A. Fletcher, 176, Adelaide-road, Brockley, S.E.; W. B. Garrett, The Green, Banbury, Oxon; B. C. Gupta, 46, Grosvenor-road, Rugby; L. G. Harris, Beechwood, Gravelly Hill, Birmingham; C. D. Hayhurst, Faraday House, Southampton-row, W.C.; C. H. Hayward, Neroberg, Ventnor; H. C. Heath, 92, Navigation-road, Burslem, Staffs; L. R. Hickman, 186, Charles-road, Small Heath, Birmingham; A. R. Hinde, 112, Croxted-road, West Dulwich, S.E.; D. W. J. Janes, Allandale, Regent's Park-road, Finchley, N.W.; W. G. Johnson, 25, Culverden-road, Balham, S.W.; G. H. Landon, Johnson-Lundell Electric Traction Company, Spencer-street, Southall, Middlesex; F. C. Lunnon, Dalmuir, Tonbridge-road Maidstone; G. M. Meyer, 62, Maple-terrace, Newcastle-on-Tyne; P. Nutter, 10, Coronation-street, Chester-le-Street; D. A. Pearson, Knightwick, School-road, Moseley, Birmingham; G. F. H. Satow, 89, Seabank-road, Liscard, Cheshire; E. S. White, Holyrood, Gravelly Hill North, Birmingham; A. M. Willis, 88, Thomas-street Bristol

Royal Institution.

Mr. Marconi delivered the Friday evening discourse at the Royal Institution on the subject of "Wireless Telegraphy" on the 27th ult. He mentioned that so far back as March, 1899, communication was established by means of his system between England and France. There was then considerable discussion

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as to whether or not wireless telegraphy would be practicable for much longer distances than those then covered, and the general opinion prevailed that the curvature of the earth would be an insurmountable obstacle. Anticipated obstacles turned out to be easily surmountable, but in their place unexpected barriers manifested themselves. He had often been asked why he had not first endeavoured to establish commercial communication between places situated at shorter distance than across the Atlantic. The reply was that the existing systems of communication were mainly controlled by Governments, who would not allow any other system to interfere with the revenues they derived from their cables. Notwithstanding the cost of high-power stations he was convinced that it was more practicable to transmit messages at sixpence a word to America than at, say, a halfpenny a word across the English Channel, and that the economical advantage of wireless telegraphy over cables and land lines increased instead of diminished with the distance. He had not the slightest doubt but that telegraphy through space would soon be in the position of affording better communication between distant countries than could be done by either wires or cables. That was shown by what happened in connection with Transatlantic telegraphy. Although the stations had been worked for only a few hours daily 119,945 words of Press and commercial messages had been transmitted across the ocean up to the end of February last. Wireless telegraphy did not seek to injure the cable industry. They were endeavouring to demonstrate that the new method was not only valuable for shipping, but that it should be regarded as a new and cheap method of making communication with far-distant countries.

A general monthly meeting of the members of the Royal Institution was held on the 6th inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. Mr. W. P. Byrne, Mr. Greville Douglas, Miss Forbes, Mrs. Hamilton, Mr. W. A. Johnstone, Dr. H. W. McConnel, Mr. A. K. Nicholson, Mr. J. Oswald, J.P., and Mr. J. E. Stead, J.P., F.R.S., were elected members. The following are the lecture arrangements after Easter: Mr. Gerald Stoney, two lectures on "The Development of the Modern Turbine and its Application"; Prof. F. T. Trouton, two lectures on "(1) Why Light is believed to be a Vibration, (2) What is it which Vibrates? (Experimental Course)"; Prof. William Stirling, two lectures on "Animal Heat and Allied Phenomena"; Mr. W. Bateson, three lectures on "Medelian Heredity"; Dr. Alexander Scott, three lectures on "The Chemistry of Photography (Experimental Course)"; Mr. G. F. Scott Elliot, two lectures on "Chile and the Chilians"; Mr. Laurence Binyon, two lectures on "Japanese Prints"; and Dr. H. W. Davies, two lectures on "The Art of Bach and Future Developments" (with musical illustrations). The Friday evening meetings will be resumed on May 1, when Prof. Joseph Larmor will deliver a discourse on "The Scientific Work of Lord Kelvin" (with experiments and typical apparatus illustrative of his discoveries and inventions). Succeeding discourses will probably be given by Dr. J. Y. Buchanan, Dr. H. T. Bulstrode, Prof. Dr. J. C. Kapteyn, of the University of Groningen, Sir Ralph Payne-Gallwey, Bart., Prof. Sir James Dewar, and other gentlemen.

MANCHESTER ELECTRICAL EXHIBITION.

The complete prospectus of the Electrical Exhibition, 1908, to be held in Manchester from Saturday, Oct. 3, to Oct. 31 (both days inclusive) has now been issued. The following is the final list of the executive, committee, and officers: President—The Right Hon. Lord Stanley, C.B. Vice-presidents—The Right Hon. the Lord Mayor of Manchester; his Worship the Mayor of Salford; Sir William Preece, president of the 1905 electrical exhibition. Chairman—Councillor W. Kay, J.P., deputy chairman Manchester Corporation Electricity Committee. Deputy-chairman—Councillor W. Barrett, J.P., chairman Salford Corporation Electricity Committee. Executive committee—Messrs. H. H. Berry; H. Bevis; D. N. Dunlop; F. H. Nalder; C. D. Taite; H. Talbot. General committee—Representatives of corporations donating to the funds—Messrs. Arthur A. Day (borough electrical engineer, Bolton, Lancs.), T. Roles (city electrical engineer, Bradford), S. J. Watson (borough electrical engineer, Bury); representative of supply companies—Mr. C. D. Taite (chief engineer Lancashire Power Company); representatives of the Institution of Electrical Engineers—Messrs. M. B. Field (Ferranti's, Limited) and C. P. Sparks; representative of the Municipal Electrical Association and Nottingham Corporation—Mr. H. Talbot (city electrical engineer, Nottingham); representatives of the National Electrical Manufacturers' Association—Messrs. Herbert H. Berry (Messrs. Berry, Skinner, and Co., London), F. H. Nalder (Messrs. Nalder Bros. and Thompson, London), H. Oppenheimer (International Electric Company, London); representatives of the Electrical Contractors' Association—Messrs. J. McDermott, J.P. (Lancashire Electric Engineering Company, Ashton-under-Lyne), and Rashleigh Phipps (Rashleigh Phipps and Co., London); representatives from the general exhibitors—Messrs. H. Bevis (General Electric Company, Limited), O. H. Bishop (Edison and Swan, Limited), D. N. Dunlop (British Westinghouse Company, Limited), T. J. Grainger (Sunbeam Lamp Company) and B. Longbottom (Electromotors, Limited). Consulting electrical engineers—Messrs. S. L. Pearce and V. A. H. McCowen. Hon. consulting electrical engineer—S. G. Castle Russell. Bankers—Messrs. Williams, Deacon, and Co. General manager—Mr. C. S. Northcote. Secretary—Mr. W. Davenport. Organisers and business contractors—The International Trade Exhibitions, Limited, Broad-street House, London, E.C.

The exhibition, which will be under the entire control of the executive committee, will be run with a view solely of commercial and financial success, and not for private gain. The profits arising from the exhibition will be distributed by the committee as follows: (1) in a percentage return to exhibitors; (2) in a percentage return to contributors and donors; (3) contributions to charities connected with the electrical industry, and the surplus, if any, to be specially dealt with by the committee as they think fit. The exhibition will be of national as well as of international importance, and the probabilities are that it will create a record in comparison with any similar undertaking which has been held specialising a particular industry. Arrangements have been made with the Electricity Committee of Manchester for a full supply of necessary electric energy, direct current at 200 volts for lighting and 400 volts for power, alternating-current three-phase 400 volts. Motors above 3½ h.p. can only be supplied at 400 volts pressure. The management will deliver current to exhibitors' stands at a charge of 2d. per unit. for lighting and 1d. per unit for power, the rent for meter and necessary fuses being from 21s. to two guineas, according to the size demanded.

Having regard to the fact that the exhibition is to be held in Manchester, it is proposed to invite manufacturers of textile and mining machinery to be represented, and to arrange for various exhibitors to have working exhibits of such machinery, and owners of works, mills, factories, and mines (of which there are a vast number in the North) will be able for themselves to see exactly how electricity can be applied to the business in which they are interested. We have already given full particulars concerning this exhibition, and can now only remind our readers that applications for space will be dealt with in priority of receipt, and although except for special positions the charge for space varies but slightly, opportunities for selection will be afforded first to those firms making earliest application. We would suggest that any firm desiring to be represented should write at the earliest possible moment, giving some idea as to the amount of floor space desired and the class of goods to be shown. This will secure a favourable position, and it will also assist the committee in arranging the final details of the building. The London offices of the exhibition are at 2, Queen Anne's-gate, Westminster, S.W.

PROPOSED INTERNATIONAL CANDLE.

The *Electrical World* of New York learns that a joint committee of the Gas Institute, of the Institute of Electrical Engineers, and of the Illuminating Engineering Society has recently drawn up resolutions urging the National Bureau of Standards at Washington to take steps toward bringing about, if possible, an international candle corresponding, say, to a readjusted *bougie decimale* which should be acceptable to Belgium, Denmark, England, France, Holland, Italy, Norway, Sweden, and the United States. Such an international candle might well be established through the medium of interchanged standardised incandescent lamps, on the basis of mean values of, say, the British pentane candle, the French carcel, and the older British sperm candle as previously calculated in terms of the hefner, and hitherto employed in America. The compromise would involve not more than 3 per cent. change in any of the standards now existing, and would abolish the senseless multiplication of primary national photometric units. It would be very desirable to include Germany in the plan, but the hefner unit used in Germany is some 10 per cent. off the mean candle of other countries, and no one can be expected to make so great a change as that unit would involve industrially if universally accepted. However, the agreement of the countries not using the hefner upon an international candle, would at least reduce six existing standards to two. Each country would then have its own national standard, the pentane, carcel, hefner, etc., and also one international candle, maintained by lamp interchange and in known relation to the national lamp. At present, with six national standards, we have to keep a sort of cross-reference table with 36 entries in order to compare results. In time, the international candle might make reference to each special national standard unnecessary

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TRADE LITERATURE.

ELECTRICITY IN MINES.

"Electricity in Mines" is the title of a pamphlet recently issued by the British Thomson-Houston Company, Limited, Rugby, in which is described the application of electric power to mining machinery. This is a class of work to which the British Thomson-Houston Company, Limited, have devoted special attention, and judged by the great amount of colliery work which this company has carried out, some examples of which are depicted in the pamphlet before us, there can be no doubt as to their ability to prepare suitable and efficient schemes for the electrical equipment of collieries. The pamphlet is illustrated with views of electrical equipments installed at various collieries. The Silverwood Colliery is equipped with B.T.H. three-phase generators and motors aggregating over 2,400 h.p.; one of the illustrations gives a clear view of the picking belt and the end of the screening plant, driven by a 40-h.p. three-phase B.T.H. motor at this colliery, and another shows creepers, driven by a 40-h.p. three-phase motor, conveying coal to the screening plants. Then there is a centrifugal pump in the coal washery which is driven by a 65-h.p. motor. Among the other views those deserving particular mention are the three-phase sub-station switchboards, 8,500 volts, at the Minton Colliery; the high-tension (3,000 volts) sub-station switchboard installed at the Tredegar Colliery of the Powell Duffryn Steam Coal Company, Limited; and a 90-h.p. 500-volt direct-current motor driving air-compressor by belt, and installed underground at the Birtley Colliery.

MULTIPLE TRAIN CONTROL AND INDUCTION MOTORS.

Two new pamphlets have just come to hand from Messrs. Dick, Kerr, and Co., Limited, Abchurch-yard, Cannon-street, London, E.C. The first of these describes the Dick-Kerr multiple-unit system of train control, the principle of which is direct electromagnetic, with series solenoids, actuated by the negative or return current of the train motors. This system has been adopted on the Lancashire and Yorkshire electric line, but it is, of course, applicable to any electric train using continuous-current motors with multiple-unit control, and in this respect it may be mentioned that all patents are controlled by Messrs. Dick, Kerr, and Co., Limited.

"Induction Motors" is the title of the second pamphlet published by the same firm. The fundamental principle of this motor may be stated as follows. The static transformer and the induction motor are different applications of the same apparatus, the main difference between the two being the presence of an air-gap in the motor which does not exist in the static transformer. The induction motor consists of two parts, the primary and the secondary, one of which, usually the former, constitutes the stator, while the other constitutes the rotor. The primary is connected to the supply mains, whilst the secondary windings are short-circuited upon themselves, either through an external rheostat or permanently in the motor itself. The two types are known as "slip-ring" and "squirrel-cage" motors respectively. We need not enter into the constructional details of this motor, which have been dealt with in these columns before.

ROLLING-STOCK.

The catalogue of rolling-stock which the United Electric Car Company, Limited, has brought out should be of much interest and service to many. It illustrates the varied manufactures in which the company engages, and should be instructive to those who have not hitherto been aware of the company's productions, though their number must assuredly be comparatively small. The Preston works are capable of turning out upwards of 1,000 cars per year, and every possible kind of vehicle for tramways and light railways is manufactured. Some photographs of the company's timber-sheds give some idea of the very large stocks of seasoned timber for car building, amounting, we gather, to upwards of £50,000. Many novel and interesting features in the design of cars are disclosed in the catalogue.

MOTORCAR ACCESSORIES.

The new catalogue of the General Electric Company, which is the fourth edition of the "Motorcar Accessories," comes at an appropriate time. Sparking plugs, lanterns, lamps, tools, accumulators, etc., are included and described in this catalogue, which may not unaptly be termed the motorist's *vade mecum*. Coates's patent high-tension magnets, for ignition of internal-combustion engines, is a feature of the catalogue which deserves special attention. The principle, as well as the construction, of this system differs very considerably from any other system at present on the market, and from a detailed description we gather that economy has to a great extent been responsible for the Coates's system.

Messrs. Siemens Bros. and Co., Limited, Queen Anne's-chambers, Westminster, have issued a price list describing the optical pyrometer. The pyrometer is intended chiefly for use when the temperature to be measured lies above the range of the firm's other types of pyrometers, or when there are other difficulties present which preclude the use of these. The absorption device used with the optical pyrometer makes its upward range practically unlimited.

The Sloan Electrical Company, Limited, 15, Fore-street-avenue, London, E.C., have issued a new insulator catalogue, a copy of which will be sent to any of our readers.

Messrs. Elliott Bros., the Century Works, Lewisham, S.E., have sent us a copy of their new pamphlet (Section G) describing the Century portable mains testing set, which has been designed with a view to providing the mains superintendent and cable engineer with an instrument that will cover the whole range of testing that is likely to be met with in laying and maintenance of underground cables.

Mr. Fred. J. Down, 6, 7, and 8, Crutched-friars, London, E.C., draws attention to a process for removing vibration of machinery. By interposing an elastic bed, hum or vibration is absorbed. This system of foundation cushions, invented by a civil engineer of Paris, is said to break up indirect vibrations absolutely, and to absorb, without shock, any sudden variation of speed or extra twisting momentum.

Messrs. Eckstein, Heap, and Co., Salford, have sent us a number of lists, dealing respectively with "brush type" main switches, "field-breaking" switches, direct-current circuit breakers, handle-type oil-break switches and fuses, isolating switches, and "no-volt" release oil-break switches.

The Gratze Patent and Engineering Syndicate, Limited, 44-46, Whitfield-street, Tottenham Court-road, London, W.C., have just taken over the sole agency for this country for the new "Flexduct," which is a non-metallic flexible conduit.

Messrs. Wright and Wood, Limited, Century Works, Halifax, have issued a new list of continuous-current shunt and compound wound motors. We might mention that this company has appointed Mr. E. C. Amos, M.I.M.E., who has offices at 22, Walbrook, E.C., as London agent.

PUBLICATIONS RECEIVED.

"THE STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS," written and compiled by a staff of specialists for the McGraw Publishing Company, New York. London: E. and F. N. Spon, 57, Haymarket, S.W. Price, 17s. net.

"AN INTRODUCTION TO ELECTRICITY," by Bruno Kolbe; translated by Joseph Skellon. London: Kegan Paul, Trench, Trübner, and Co., Limited, 43, Gerrard-street, Soho.

"AN INTRODUCTION TO THE STUDY OF ELECTRICAL ENGINEERING," by H. M. Norris, M.E. New York: John Wiley and Sons. London: Chapman and Hall, Limited.

"EXPERIMENTAL ELECTRICAL ENGINEERING," by V. Karapetoff. New York: John Wiley and Sons. London: Chapman and Hall, Limited. Price, 25s. 6d. net.

"POWER-GAS PRODUCERS: THEIR DESIGN AND APPLICATION," by Philip W. Robson, of the National Gas-Engine Company, Limited. 105 illustrations. London: Edward Arnold, 41 and 43, Maddox-street, Bond-street, W. Price, 10s. 6d. net.

PERSONAL.

The Doncaster Town Council have increased the salary of Mr. E. S. Rayner, electrical engineer and tramways manager, from £375 to £400.

Mr. A. A. Barron, 15, Kidderpore-avenue, London, N.W., has dissolved partnership with Messrs. J. J. Smith and Co., agents for Messrs. W. Soutter and Sons, of Birmingham.

Mr. S. Derwin Jones, the borough electrical engineer of Batley, has been presented by the staff and employés at the electricity and destructor works with a three-section elastic bookcase on the occasion of his marriage.

We are informed that Messrs. F. W. Smith and Co. (1907) have changed offices at both Southport and Manchester. The new addresses are 128, Lord-street, London-square, Southport, and 12, Tib-lane, Cross-street, Manchester.

The annual dinner of the local staff of the National Telephone Co. was held at Barry's Hotel, Cardiff, on the 4th inst., and was attended by a large number of the members. Mr. B. Waite, district manager, presided, and a most enjoyable evening was spent.

The Accrington Town Council have decided to increase the salary of Mr. W. J. Newton, the borough engineer and surveyor, from £420 to £470 per annum owing to additional duties involved in the construction and supervision of the new electric tramways.

The partnership between Messrs. Clark, Fisher, and Wadsworth, carrying on business as electrical engineers at Ealing, has been dissolved by mutual consent. Arrangements have been made with the Reason Manufacturing Co., of Brighton, to carry on the business under the supervision of Mr. W. Fisher.

Mr. H. Bloodworth, who recently represented the Adams Manufacturing Co., and was formerly a buyer for Messrs. Edmundson's Elec-

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tricity Corporation, will in future represent Messrs. Siemens Bros. Dynamo Works. He has been attached to their London branch at 1, Abchurch-yard, Cannon-street, E.C.

The staff of the Yorkshire Electric Power Co. held their second annual dinner and smoking concert at the Railway Hotel, Dewsbury, on the 3rd inst. In the course of the evening Mr. Evans was presented with a marble clock on the occasion of his leaving the service of the company to enter that of Messrs. Siemens Bros.

Messrs. G. N. Boddy and Co., Newington Works, Liverpool, inform us that they have opened a branch depôt at Castle-hill, Sheffield, where they will keep a large and varied stock of electric lamps and electrical supplies. They have also placed on the market a very efficient auto-transformer for use in connection with the metallic lamp.

The house dinner at the Motor Club on Wednesday last was once more a huge success, and the enthusiastic audience which filled the little theatre proved that the concerts are still a popular feature. Despite this festivity, however, a cheery little breakfast party gathered together in the clubhouse early on Thursday morning as the guests of Mr. Chas. Jarrott, prior to his departure to Monte Carlo.

Messrs. Siemens Bros. Dynamo Works have opened a new branch office at Foster's-buildings, 22, High-street, Sheffield, with Mr. E. S. Saunders in charge, in order to cope with their extensive business in that district. On account of the great increase in the sales of tantalum lamps, the above firm have transferred their tantalum lamp department from White Mansion, York-street, Westminster, to their City stores at 6, Bath-street, City-road, E.C.

APPOINTMENTS VACANT.

Chief Electrical Engineer, Watford Urban District Council. Commencing salary, £250, rising to £400 per annum. Particulars from the Clerk. Applications by April 25.

Electrical Engineer, as assistant in the electric lighting works, Government of Malta. Salary, £120, rising by annual increments of £10 to £150 per annum. Applications to the Crown Agent for the Colonies, Whitehall-gardens, London, S.W., by April 13.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Rawtenstall.—The Town Council are seeking sanction to a loan of £34,000 for electric lighting, and an inquiry will be held by the Local Government Board on April 16.

Hove.—The Finance Committee are recommending the Town Council to apply for sanction to the borrowing of £1,C00 for extensions to the electric lighting at Aldrington.

Aston.—During the past month 288,862 units were sold at the Borough Council electricity works, being an increase of 111,834 over the corresponding period of 1907.

Brierley Hill.—The Urban District Council have decided to forward a complaint to the gas company respecting the poor quality of the gas supplied by them to the district.

Blackpool.—The Local Government Board will hold an inquiry on April 16 into the application of the Town Council for sanction to borrow £5,000 for electric lighting purposes.

Change of Address.—We are asked to state that the registered office of the South Metropolitan Electric Light and Power Co. is now 183 and 185, High-street, Lewisham, S.E

Hull.—The Corporation Electricity Committee have decided to recommend the Council to rent a shop in Waterworks-street for the purposes of a showroom and information bureau.

Eccles.—The Town Council have resolved to provide additional plant at the borough electricity works at an estimated cost of £4,000 in order to supply the demands of new consumers.

Airdrie.—The Council have decided to have electric bells fitted up in the residences of the members of the fire brigade to be connected to the police station. The estimated cost is £55.

Mersey Engine and Producer Co.—This company have amalgamated with the Power-Gas Corporation, and in future their different types of plant will be manufactured at Stockton-on-Tees.

York.—An inquiry will be held by the Local Government Board on April 14 into the application of the City Council for sanction to borrow £25,285 for the purposes of the electricity undertaking.

Wrexham.—The Council have decided to apply to the Local Government Board for sanction to the borrowing of £1,400 for mains and services, £300 for meters, and £3,000 for the purchase of motors for hiring.

Leeds.—The City Council have decided to reduce the charges for the supply of electricity by from 15 to 25 per cent., the prices being subject to a further reduction of 5 per cent. if the accounts are paid within the month.

Midland Electric Corporation for Power Distribution.—The accounts of the Midland Electric Corporation for Power Distribution for the year 1907 show a loss of £10,139, increasing the debit balance to be carried forward to £71,085.

Canada.—The Government hydro-electric plant at Niagara will soon be in a position to furnish effective horse power for power users in the area served at a cost of 9dol. per unit, the force of the falls thus being turned to striking economical use in this direction.

Notice of Intended Dividend.—The *London Gazette* announces that the last day for receiving proofs in the estate of Mr. W. Roderick, electrical engineer, 12, Penmaen-street, Swansea, and lately carrying on business as Aneurin Roderick and Co. at Adare-street, Bridgend, is April 18.

Anglo-American Telegraph Co.—The directors of the Anglo-American Telegraph Co. recommend, after placing £5,000 to the credit of the renewal fund, an interim dividend for the quarter ended March 31, 1908, of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, less income tax.

Leyton.—In moving the adoption of the Electric Light Committee's report at the meeting of the Urban District Council, Councillor Golightly said that for the first time in the history of the station they had set aside certain money as a reserve fund. They had now a very extensive plant, and ought to be able to meet any contingencies.

Rubber Cultivation in the Caucasus.—The experiments that have been made in cultivating indiarubber plantations in various districts adjoining the Black Sea have given most satisfactory results. Similar success has attended the growing of Manchurian gaolan in the Cuban territory. The plants, indeed, are said to excel those of Manchuria.

Keighley.—At the next meeting of the Town Council consideration will be given to a recommendation of the Electricity Committee, who ask to be empowered to make a charge of 7½ per cent. on the net cost of labour and material expended on work done for other departments, to cover the cost of tools and other standing charges at the electricity works.

Bristol.—Three men in the employ of the Bristol Gas Co. were engaged last week in a cobbled yard in the gasworks in the repair of an underground tank, when an explosion occurred, and the men were injured rather seriously, whilst a fourth workman had a narrow escape. The explosion created considerable alarm in the neighbourhood, and was of such volume that it could be heard at a considerable distance.

Fleetwood.—The terms upon which the electric lighting undertaking will be purchased by the Urban District Council have now been settled by the chairman of the Council, the chairman of the Finance and Parliamentary Committee, and the clerk of the Council. It is stated that the price and terms of purchase are very satisfactory, and that a good bargain has been made in the interests of the ratepayers.

Burgess Hill.—The Urban District Council have granted an application from the Burgess Hill and District Electric Supply Co. for permission to place a protected cable underground across Leyland's-road between the properties called "Wyberlye" and "Sheddingdean House," subject to the works being carried out to the satisfaction of the surveyor and on payment of the sum of 4d. per yard super for the ground opened.

Aberdeen.—The Corporation have decided, with a view of meeting additional expenditure on machinery, buildings, etc., the purchase price of the Deeside and District Electric Supply Co.'s undertaking, and the value of electrical apparatus hired to the public, to make application for sanction to borrow a sum of £80 000 for the purposes of the Aberdeen Electric Lighting Order, 1890, and the Aberdeen Corporation Electricity Act, 1907.

Dunfermline.—The Town Council have decided to communicate with a Liverpool firm of electrical engineers who have offered to erect a generating station, and guarantee that the Council should have no loss by its working, with a view to obtaining further particulars. The Council have also agreed to open negotiations with the Fife Electric Power Co. to ascertain the terms on which that company would purchase the provisional order of the Council.

Middlesbrough.—It was reported at the meeting of the Electric Lighting Committee of the Middlesbrough Corporation that the Guardians had decided to ask the Corporation for a supply of electricity for the purpose of lighting a portion of the workhouse with electric light, and the Council have asked their engineer to draw up the specifications for the installation. Another cable is to be laid down for the sub-station at a cost of £2,000.

Newport.—Delegates from the Parish Councils of Rogerstone, Graig, and Machen met at the Guardians' Offices, Newport, on the 1st inst. to consider a scheme for lighting the districts with electricity. The proceedings were private. We learn that, although there was a strong desire that a joint electric lighting scheme should be promoted, nothing definite was decided upon, the conference being adjourned so that the delegates might consult their respective councils.

Ferndown.—It was reported to the District Council at their last meeting by the surveyor that he had met the local manager of the National Telephone Co. at Ferndown, and had gone over the line of road with him, pointing out positions for placing the proposed telephone poles. The agreement between the company and the Council provided for the payment by the company of the wayleave of 1s. per pole in respect of 39. The Council decided to sign the agreement.

Stock Exchange.—The committee have appointed Tuesday, April 14, as a special settling day in the County of London Electric Supply Co.'s provisional certificates for a further issue of 10,026 6 per cent. cumulative preference shares of £10. each, £7 paid, Nos. 120,001 to 130,026, and have ordered the Rio de Janeiro Tramway, Light, and Power Co.'s 23,976,900dol. first-mortgage 30-year 5 per cent. gold bonds, Nos. 1 to 5,000 of 1,000dol., 5,001 to 29,361 of 500dol., and A 1 to 34,964, A 35,001 to 53,000, and A 58,001 to 73,000 of 100dol, each, to be quoted in the official list.

Newcastle.—A special meeting of the Watch Committee was held last Friday, when the question of reducing the estimates by £1,000 in accordance with the proposition of the City Council was considered. It was decided, after a long discussion, to postpone the lighting of Westgate-road extension by electricity. This will effect a saving of £180. It was agreed to reduce the estimate of £687 for new gas lamps, principally for the outlying districts, by £387. The main-

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tenance account was reduced by £180, and various economies at the police stations were expected to save £190.

Nevile Engineering Co.—The Nevile Engineering Co., of Worcester, makers of the patent Nevile cut-outs, regulators, and other types of electrical switchgear, have incorporated William Sprowson and Co., of Newton Heath, Manchester, London, and Glasgow, electric and hydraulic lift manufacturers. The company is extending its works at Worcester, building a new erecting shop, and adding to its present foundries. All communications in the future should be addressed to head office, Worcester. Mr. William Sprowson, as joint managing director, will have control of the lift department.

Acton.—With a view to increasing the income from the electrical undertaking, the Electricity Committee of the Urban District Council have decided to recommend the Council to levy a charge of 2s. 6d. per quarter for each meter, which will mean that the meter receipts will amount to £400 per annum, instead of £40, as at present. Another step towards cutting down expenses was the committee's decision to recommend that the Council's electric arc lamps used for street-lighting shall in future be turned on a quarter of an hour later than at present, also that they shall be turned off at 11.15 p.m. instead of at 1 a.m.

Bury.—The Town Council have received a petition, framed at a public meeting held recently, which asks the Council to call a meeting of ratepayers to discuss the electricity works extension proposals before they come before the Local Government Board's inspector at the forthcoming local inquiry. The Council, however, have adopted the view of the General Purposes Committee that such a meeting was not necessary. The Electricity Committee are willing to receive a deputation representing the signatories of the petition. The committee propose to spend £62,000 at first, and to obtain power to spend another £10,000 on mains for large consumers when necessary.

Oldham.—At the last meeting of the Electricity Committee it was reported that the number of units of electricity sold for lighting and power purposes was 59,395 during the past fortnight, against 41,444 in the same period last year; and for traction purposes 160,723 units, against 149,457 for the same period last year. The number of arc lamps connected up to date is 357, an increase of three in the fortnight; 24,504 incandescents, an increase of 46; and 393 motors, an increase of six. An application was read from the meter inspectors for an increase in wages of 2s. per week and payment for holidays. Their wages are 31s. for 44 hours a week. The committee decided that they could not see their way to entertain the application.

Arran.—Messrs. Stevenson and M'Guffie, of Glasgow, have, on the instructions of the Marquis of Graham, drawn up specifications for the supply of electric light and power to his two residences and the estate offices in Arran. The scheme will necessitate the construction of a dam on the side of Goatfell above 700ft. above sea-level, and the water will be carried to a power-house at Brodick, in which Pelton wheels for the driving of electric generators will be placed. The transmission lines will be altogether about 12 miles in length, and one of them will be carried over the side of the mountain, at a height of about 1,200ft. above sea-level. It is intended to raise the current to a p essure of 3,000 volts, and to transmit it to sub-stations at the two residences.

Rio de Janeiro.—The Rio de Janeiro Light and Power Co. have made important arrangements with French and Belgian financiers for the simultaneous introduction on the Paris and Brussels markets of the new 5 per cent. bonds which it is about to issue. The French group, composed of banks of the highest standing, have entrusted Messrs. Razsovitch and Gers, one of the firms participating in the operation, with the introduction of these bonds on the Paris Bourse. As regards the Belgian group who will introduce them on the official Brussels Bourse, it has been for a long time in close relations with the company, from whom it has bought during the last two years more than 6,000,000dol. worth of bonds, exclusive of the purchases which it has made on English and Canadian markets.

Edinburgh.—In view of the increased charges intimated by the Gas Commissioners for public gas lighting in Edinburgh, a meeting of the Cleansing and Lighting Committee of the Town Council discovered that it meant an additional expenditure to the city of about £2,500 in street-lighting and stair-lighting. It was agreed to substitute electric lighting for gas in West Nicolson-street, George-square, Charles-street, Crichton-street, and Buccleuch-place, and also to have a survey made of the central districts of the city with the view of ascertaining the comparative cost of lighting by electricity and gas. At a subsequent meeting the committee decided to light Rose-street from Hanover-street to Charlotte-square by means of suspended electric lamps. The lamps will be hung from the centre of a wire stretched across the street from building to building.

Dundee.—The Town Council, acting on Mr. Richardson's recommendation, have now finally passed the new system of charging for power. The price to be charged in future will be on a sliding scale, with a maximum of 2½d., while power will be had at as low a figure as ·45d. per unit, according to the number of units used. Mr. Richardson also recommended the Council to do away with the minimum charge for lighting and power altogether, and this has been done. A new feature in the scale of charges for next year will be the special price which is quoted for electric signs, and which is calculated to make this form of advertisement more popular in Dundee. Also a specially low rate is quoted for power to textile mills, etc., for which current can be obtained at ·5d. per unit for the units in excess of 50,000 per quarter, and at ·45d. per unit for those in excess of 200,000 units per quarter.

Wealdstone.—The Finance and Legal Committee of the Council reported to the last meeting that they had considered the question of the Wealdstone Electric Lighting Order, 1906, obtained by the North Metropolitan Electrical Power Distribution Co., and stated that the company had by Section 6 of the order to lay down suitable and sufficient distributing mains in Station-road from the northern boundary of Greenhill Farm to High-street, Wealdstone, High-street from Station-road to its junction with Risingholme-road, and Peel-road from High-street to the Urban District Council offices, for the purposes of general supply within a period of two years after the commencement of the order (order commenced July 20, 1906), but that no works had as yet been commenced by the company, nor were the committee aware that any were contemplated. The Council decided not to interfere until the time has expired.

Luton.—The Electric Light and Power Committee reported to the Town Council at the last meeting that the borough accountant had prepared a statement as to the estimated amount of the net profits on the electricity undertaking for the financial year ending March 31, and as a result it was resolved that the sum of £450 be transferred to the relief of the general district rate. The electrical engineer reported that since Feb. 27 last 119,593 units had been generated, an equivalent of 197 8-c.p. lamps and one motor of 3 h.p. connected, making a total of 476 consumers, with 26,150 lamps and 223 motors of 1,373 h.p.; that the number of units generated showed an increase of 108 per cent. over the number generated during the corresponding period of last year; and that at the present time applications were in for over 1,600 additional lamps and 297 h.p. in motors. The increase of 108 per cent. was partly due to the tramways, which took on an average 1,300 units per day.

Longton.—At the last Town Council meeting the Improvement Committee reported having received a report and estimate from the manager of the gas and electricity works with reference to the suggested provision of electric arc lamps in Stafford-street, Market-street, and Commerce-street. It appeared that the number of gas lamps that would be replaced was 41, the annual cost of which was £274. It was proposed to provide in the place of these 18 arc lamps, at a cost of £383, the annual charges in respect of which for current, trimming, cleaning, attendance, etc., would be £504. It was suggested, however, that the installation could be run in two circuits of nine lamps each, allowing of every alternate lamp being put out at any hour decided upon. It was recommended that the report be adopted and the work carried out; that nine lamps be switched off at 11.15 at night, and that the Gas and Electricity Committee be asked to make such a reduction in the annual charge for the supply of current, etc., as will meet the wishes of the Improvement Committee.

Ince.—At a meeting of the Wigan Electric Light Committee held on the 23rd ult., the town clerk submitted the draft agreements between the Corporation and the Ince District Council in regard to the transfer of the Ince electric lighting order and public electric lighting in Ince, and explained their provisions. It was resolved that the corporate common seal be affixed to the two agreements, on the understanding that the Ince District Council give an undertaking to the Corporation that they will not press the Corporation in respect of the carrying out of the order so far as Ince Green-lane and Belle Green-lane are concerned. The Electric Light Committee have resolved that the resolution of March 26, 1906, authorising application to be made to borrow the sum of £18,696, the amount overspent on capital account to that date, be rescinded, and that an amended application be made to the Local Government Board for sanction to borrow the sum of £22,696. 6s. in respect of the over-expenditure on the electric light undertaking to March 31, 1907, plus the sum of £346. 3s. 4d., being the commitments not included in the expenditure of the year ended on that date.

A Queenslander's Telegraphic Invention. — Mr. William Leivesley, a postmaster in Queensland, has just patented all over the world a telegraphic invention of considerable interest. The object of the invention is to provide circuits and a simple combination of apparatus and switching gear to facilitate the transmission of messages direct to their destinations, over long lines in a variety of directions, to a greater extent than has hitherto obtained; to permit any pre-arranged number of telegraph circuits to work with each other, just as though they were one and the same circuit; to enable a number of stations on different lines, not ordinarily in direct communication, to communicate directly with each other without hand repetition. Hand repetition and the delay, labour, and the possibility of mistakes incidental thereto, are also obviated or greatly reduced when an interruption on a line occurs. In newspaper messages the same news may be transmitted direct to its various destinations by one telegraphist by one operation of a telegraph key. The lines are relieved of the time taken up in receiving and transmitting at intermediate stations. The invention also allows of signalling four or more ways on the Morse system, and at the same time may embrace or combine other systems. It provides for repeating direct on to main lines, and different systems are also enabled to work together and interchange signals harmoniously. Other objects and advantages will be apparent on close investigation of the plans, which, in reproduced form, may be seen at the office of Sir Horace Tozer, Agent General for Queensland. The great economy in the "diversifier" system is that the old systems, machinery, and equipments of circuits may be adopted to the diversifier in the internal wiring of offices and joining to the switchboard. The inventor believes that £30,000 per annum will be saved when the new system is adopted throughout Australia.

TRACTION.

Nottingham.—The City Council have decided to seek powers to acquire the undertaking of the Notts and Derbyshire Tramways Co.

Leeds.—The Tramway Committee have decided to try the experiment of making workmen's cheap tickets available for use on the return journey before noon instead of only after noon as hitherto.

Brisbane Electric Tramways Investment Co.—Traffic receipts of the Brisbane tramways for the month ended March 31, 1908, amounted to £14,490; corresponding month last year, £13,199—increase, £1,291.

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Fenton.—The Urban District Council have decided to seal the petition submitted by Hanley against the North Staffordshire tramways (amendment) order, and the chairman has been asked to represent the Council at the conference on the matter.

Newport.—The total receipts of the Corporation tramways for the week ending April 4, 1908, were £605. 11s. 0½d., a decrease of £199. 3s. 5½d. as compared with the corresponding week of last year (Easter week). The number of passengers carried was 144,999.

Leith.—The Leith tramway traffic returns for the week ending April 4 amounted to £481. 16s. 6d., a decrease of £62. 7s. 5d., when compared with last year. The large decrease is accounted by the fact that the Easter holidays were held at this time last year.

Light Railways Act, 1896.—The Board of Trade have recently confirmed the undermentioned order made by the Light Railway Commissioners: London United Tramways Light Railways (Extension of Time) Order, 1908, amending the London United Tramways (Light Railway Extensions) Order, 1904.

Matlock.—The report of the working of the cable tramway to the Urban District Council for the past month shows a loss of £24. A new cable has been laid at a cost of £180 to meet the coming season's traffic. The financial status of the cable cars is reported to be better than anything known in the history of the undertaking.

Croydon.—At the last meeting of the Tramways Committee the town clerk reported that in the case of the Croydon and Southern District Tramways Bill the Standing Orders Committee of the House of Lords found that Standing Orders were not dispensed with in regard to the Bill, and that the Bill will, therefore, not proceed.

Edinburgh.—The Tramways Committee of the Edinburgh Town Council have suggested to the Board of Trade that the official inspection by the Board of the new Edinburgh tramway sections (Gilmore-place and Colinton, and Gorgie) might, if suitable, take place at the end of this week. It is stated that immediately after the inspection cars will be run on the new sections.

Swadlincote.—In view of the impending taking over of the bridge at Swadlincote, over which the light railway runs, by the Urban District Council, an inspection of the structure was made last week by representatives of the Midland Railway and the surveyor to the Council, and a report upon the matter will in all probability be presented to the local governing body at its next monthly meeting.

South Metropolitan Tramway Co.—A tramcar parcels express has been inaugurated by the South Metropolitan Co. in connection with the services of cars between Croydon and Wallington, Carshalton, Sutton, Mitcham, Tooting, and Penge. The conductors receive packages at any of the recognised stopping places, or they may be left with certain agents, and they are dealt with by special messengers. The rates for collection and delivery within half a mile of any part of the lines vary from 7lb. for 3d. to 56lb. for 7d.

Blackpool.—The traffic returns for the week ending March 25, 1908, show that during that period 190,769 passengers were carried on the Corporation tramways, the receipts amounting to £972. 12s. 9d., an increase of 4,141 passengers and £8. 8s. 5½d. receipts over the corresponding period last year. Parcels brought in revenue to the extent of £22. 1s. 1d. The total receipts for the 365 days' running in the working year up to and including March 25 amounted to £49,526. 10s. 11d., this being an increase of £3,798. 18s. 1½d. over 1907 and £6,955. 6s. 11d. over 1906.

Morecambe.—Trials on the newly-electrified portion of the Midland Railway between Morecambe and Heysham have been carried out, and have passed off successfully. Mr. Dalziel, the company's electrical engineer, was in charge at the trial run, and the cars ran smoothly. It is understood that the new service, the first of its kind in this country, will be opened for the use of the public on the 13th inst., though it is not proposed to run to Lancaster at present. The service will be confined to one between Morecambe and Heysham Harbour.

Hull.—Mr. J. H. Hargreaves, J.P., during the discussion at the City Council meeting with regard to the Midland-street improvement, gave some figures relating to the increases in the passengers carried by the Hull trams on the Hessle and Anlaby roads. The passengers carried during the year ending March 31, 1908, on the Hessle-road were 6,009,078, compared with 4 886,411 during the year ending March 31, 1901, an increase of 1,122,667. The passengers carried on the Anlaby-road for the year ending March 31, 1908, were 5,466.394, against 4,859,389 for the same period in 1901, an increase of 607,005.

Liverpool.—After discussion between the Liverpool Corporation Tramways Committee and the employés, a scheme has been arrived at under which the Corporation are to increase by 2d. per week the wages of each tramway man belonging to the benefit society in connection with the undertaking, the amount to be handed, however, to the treasurer of the superannuation fund. The men themselves are also to contribute, and the proceeds of unclaimed property left in the cars are to be added to the fund. It is hoped that the benefits to be distributed to incapacitated members of the benefit society will eventually amount to as much as £1 per week.

Dumbartonshire.—The contractors who are laying the tramway line which will link up Glasgow with Dumbarton and Loch Lomond are advancing the work rapidly. The tramway track has now been finished between Dumbarton and Renton, and the large staff will soon complete the further extension to Alexandria, when it is expected there will be a preliminary opening of the route between that town and Dumbarton. On the other section of the scheme, between Dumbarton and Dalmuir, progress is not so pronounced. The whole length of the line between Dalmuir and Balloch is operated from the single generating station within the county town.

Quarry Bank.—A special meeting of the Urban District Council was held last week to consider the light railway scheme. The heads of the proposed agreement, containing the full terms of an offer which had been before the Joint Committee for working the railways authorised by the Quarry Bank, Brierley Hill, and Rowley Regis Light Railway Order, 1903, was submitted and discussed. It was ultimately unanimously resolved as follows: "That this Council hereby approves and accepts the offer contained in the heads of the proposed agreement as submitted, and hereby authorises and empowers the Joint Committee and its solicitors to take all necessary steps for the purpose of entering into and adopting such agreement, and doing all acts which may be necessary for carrying the same into effect."

Aberdeen.—The traffic return of the Aberdeen Corporation tramways for the week ending March 25 shows an increase of £9. 10s. 9½d. in the receipts, which amounted to £1,187. 18s., as compared with £1,178. 7s. 2½d. for the corresponding week of last year. There were 285,001 passengers carried, 136 parcels delivered, and 545 luggage tickets issued. The expenditure per car mile was: electricity, 1·27 units; traffic wages, 2·2d.; and repair wages, ·3d. As compared with electricity, 1·25 units; traffic wages, 2·2d.; and repair wages, ·5d. for the same month of last year. The allowance to the Suburban Tramways Co. amounted to £33. 11s. 9½d., as against £33. 17s. 11½d. for the corresponding week of 1907. Since June 1 there is a decrease in the receipts of £1,231. 8s. 10d., the totals being £58,520. 9s. 3½d. for the present year and £59,751. 18s. 1½d. for the same period of last year.

Leeds.—In the year just ended the total traffic receipts from the city tramways amounted to £336,446, as against £323,912. 12s. 6d. in 1906-7, or an increase of £12,534. 4s. 6d., representing 3·86 per cent. The total mileage was 7,694,989, as compared with 7,358,185—increase 336,804, equalling 4·57. Passengers carried numbered 75,754,083, as against 73,024,853, or 2,709,230 more, representing 3·71 per cent. Receipts per mile come out at 10·49d., or ·07d. less, the average for 1906-7 being 10·56d. The difference between the average fare paid per passenger was infinitesimal; the amount in 1907-8 was 1·066d., and in 1906-7 1·065d. The population of Leeds was carried 161 times, as compared with 157½—an increase of 3½ per cent. The amount paid per head of population was 2d. more, 14s. 3½d. being received in 1907-8 and 14s. 1½d. in the previous year. The above comparisons reveal only one decrease, and that the slight one of $\frac{1}{100}$d. in the receipts per mile. The general figures, so far as they go, attest the efficiency of the city tramway system.

Haslingden.—The Corporation inaugurated their work of converting the tramway system from steam to electric traction on Monday week. The mayor and the chairman of the Tramways Committee, with the chairman of the General Works Committee, proceeded to the Baxenden end of the section, where, under the direction of the borough surveyor, the mayor dislodged a sett. The work proper was afterwards proceeded with. On the Tuesday about 20 men were engaged on the work, and the number is being increased as opportunity occurs. It has been estimated that with good weather progress may be made at the rate of one mile in five weeks, when the full complement of men has been got to work, and there are three miles of line to be converted. The generating station cannot be ready for some months. It is thought Accrington may supply current for the Haslingden trams a sfar as the Commercial Hotel, Haslingden, as a temporary measure. Failing this the old cars will have to run on the new lines for a time, and this will almost certainly have to be done in any case on other lengths of the section.

Stalybridge.—An electric tramcar on the Stalybridge, Hyde, Mossley, and Dukinfield joint tramways got out of control on a steep hill, known as Ditchcroft, at Millbrook, Stalybridge, on the 2nd inst., and, with rapidly increasing speed, dashed towards the foot of the hill. When near the bottom it jumped the metals, and breaking through a wall fell into a brook 20ft. below. The hill is one of the steepest in the district. Its danger is indicated by the fact that, although it is only 250 yards in length, the Board of Trade regulations for the tramways provide for four compulsory stops. The car was one of single-deck type, and it was about halfway down the hill when it got beyond control, owing, it is stated, to the greasy state of the metals. At the bottom of the hill the road turns suddenly, and the speed of the car was too great to permit of it rounding the curve. It left the rails and ran on the road for some 30 yards before toppling into the stream. The driver, conductor, and a passenger fell with the car into the water, the driver and the conductor trying to the last moment to bring the brakes into play. The car fell end on, and the driver had a remarkable escape from instant death. He was badly cut on the head and his right leg was injured. The conductor was flung off the car and was rendered insensible, but after receiving first-aid both men were able to go home. The passenger was unhurt.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Hungary.—Tenders are invited for the lighting of Cegled by electricity or gas. Tenders by April 18.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Dundee.—The Town Council invite tenders for the supply of stores to the electricity department. Tenders by April 13.

Queensland.—The Postmaster-General invites tenders for the supply of lead-covered cables. Tenders by April 20.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Innsbruck.—Tenders are invited by the Austrian Government Railways for an electric pump. Tenders by April 15.

Hungary.—The Municipality invite tenders for lighting Nagykoras by electricity. A deposit of £800 is required. Tenders by May 1.

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Hornsey.—The Town Council invite tenders for supply of cable, joint-boxes, and feeder pillar. Tenders to the Town Clerk by April 21.

Dunkirk.—The Government Marine Service Department invite tenders for the erection of a wireless telegraphy station. Tenders by April 15.

Madrid.—The Post and Telegraph Department invite tenders for the installation and working of telephones in Villagarcia. Tenders by April 13.

Madrid.—Tenders are invited by the Public Works Department for the construction of electric tramways in Bilbao. Tenders by April 30.

Kattowitz.—The Prussian Government Railways invite tenders for telegraph cable and telegraph construction material. Tenders by April 22.

Madrid.—Tenders are invited by the Post and Telegraph Department for the supply of 100,000 porcelain insulators. Tenders by April 11.

Buenos Ayres.—Tenders are invited for the construction and working of two sections of the underground electric railway. Tenders by May 1.

Bournemouth.—The Town Council invite tenders for the supply of coal to the tramways generating station. Tenders to the Town Clerk by April 20.

Czernovitz.—In connection with the water station on the Pruth river, tenders are invited for electrical machinery for driving purposes. Tenders by April 21.

Grimsby.—The Corporation invite tenders for arc lamp lowering gear (Specification No. 63). Particulars from the Borough Electrical Engineer. Tenders by April 24.

Limerick.—Tenders are invited for the annual supply of stores to the electricity department. Particulars from the Borough Electrical Engineer. Tenders by April 10.

Leek.—The Urban District Council invite tenders for gas-producer plant and one gas-driven generator. Tenders to the Chairman of the Electricity Committee by April 11.

Eccles.—The Corporation invite tenders for one Lancashire boiler and superheater and a 210-kw. steam-engine, alternator, and exciter. Tenders to the Town Clerk by April 27.

Hobart.—Tenders are invited by the Postmaster-General for 200 wall telephones, 800 telephone recorders, and extension of common-battery switchboard. Tenders by May 11.

Madrid.—Tenders are invited by the Public Works Department for the construction of electric tramways from Calle de Segovia to Glorietta del Puento. Tenders by April 15.

Southampton.—The Harbour Board invite tenders for alteration of the gantries of two electric cranes and other work appertaining thereto. Tenders to the Clerk by April 14.

South Shields.—The Corporation invite tenders for annual supplies of duplicate parts for overhead equipment, engineers' tools, etc., for the tramways department. Tenders by April 11.

Tasmania.—The Postmaster-General invites tenders for material for extension of common battery and switchboard, 200 wall telephones, and 800 telephone recorders and cords. Tenders by May 11.

Poplar.—The Electricity Committee invite tenders for the supply of switchboards and gear. Particulars from the Borough Eelectrical Engineer. Tenders by April 29. See advertisement in last issue

Tonbridge.—The Urban District Council invite tenders for the supply and erection of plant at the generating station. Particulars from Mr. W. P. Plunkett, electrical engineer. Tenders by April 22.

Rotherham.—The Corporation invite tenders for supply of one 500-kw. direct-current steam turbo-generator and surface-condensing plant. Tenders to the Town Clerk by April 16. See advertisement in last issue.

Wallasey.—The Urban District Council invite tenders for the supply of automatic overload and reverse-current single-pole circuit breakers. Tenders to the Clerk. Council Offices, Egremont, Cheshire, by April 15.

Sheffield.—The Tramways Committee invite tenders for the supply of clothing for the tramway employés. Particulars from the General Manager, Tramways Department, Division-street, Sheffield. Tenders by April 23.

Southend.—The Corporation invite tenders for the construction of a concrete tank and foundations for the proposed condenser to be erected at the Corporation electricity works. Tenders to the Town Clerk by April 10.

Sydney.—The Postmaster-General invites tenders for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators (best white porcelain, large). Tenders by May 20.

Colchester.—The Tramways Committee invite tenders for the supply of clothing for the tramways employés during 12 months ending March 21, 1909. Tenders to Mr. R C. Bullough, Car Depot, Colchester, by April 10.

Poplar.—The Electricity Committee invite tenders for the erection of a sub-station building at Millwall. Particulars from the Borough Electrical Engineer, Glaucus-street, Bromley-by-Bow. Tenders to the Town Clerk by April 29.

Weymouth.—The Weymouth and Melcombe Regis Corporation invite tenders for the supply of a 300-kw. steam-turbine and extension switchboard panel. Tenders to the Town Clerk by April 18. See advertisement in last issue.

Madrid.—The Post and Telegraph Department invite tenders for the installation and working of telephones between Las Palmas and Aurucas. Particulars from Direccion General de Correos y Telegrafos, 10, Carretas. Tenders by April 14.

New South Wales.—Tenders are invited by the Postmaster-General for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators, best white porcelain, large. Tenders by May 20.

Leek.—The Urban District Council invite tenders for engine, dynamo, and other foundations and extensions to their generating station buildings in Station-street, Leek. Tenders to the Chairman of the Electricity Committee by April 10.

Stockport.—The Tramway Committee invite tenders for the erection of new tramway offices in Mersey-square. Particulars from Mr. Robert Hyde, town clerk, Town Hall, Stockport. Tenders to the Chairman of the Tramways Committee by April 13.

Govan.—Tenders are invited for the annual supply of stores to the electricity department, including cables, electricity meters, house service fuse boxes, arc lamp carbons, motors, etc. Particulars from the Burgh Electrical Engineer. Tenders by April 27.

London, S.W.—The Metropolitan Asylums Board invite tenders for the installation of electric lighting at the South-Western Hospital and Ambulance Station, Landor-road. Stockwell, S.W. Tenders to Mr. T. Duncombe Mann, clerk, by April 15.

Haslingden.—The Corporation invite tenders for overhead lines in connection with the electric tramways. Specifications, etc., can be inspected at the office of Messrs. Handcock and Dykes, 1, Victoria-street, Westminster, S.W. Tenders to the Town Clerk by April 25.

Sydney.—The Government Railway Department invite tenders for the supply and installation of about 4½ miles of three-core, high-tension, paper-insulated, lead-covered feeder cable. Particulars from the Electrical Engineer, 51, Phillips-street, Sydney. Tenders by May 4.

Southampton.—The Corporation invite tenders for (A) supply and erection of a coal and ash conveyor; (B) supply of a quantity of rolled-steel joists; and (C) supply of a quantity of mild-steel plates at their electricity supply station. Tenders to the Town Clerk by April 13.

Dundee.—The Electricity Committee invite tenders for the supply and erection of water pumping plant and overhead travelling cranes, etc., in connection with the new Carolina Port main generating station. Particulars from Mr. H. Richardson, engineer in-charge. Tenders by April 27.

Melbourne (Australia).—The Postmaster-General invites tenders for the construction and laying complete of two submarine telegraph cables between the State of Victoria and the State of Tasmania. Tenders must be accompanied by a deposit of £1,000. Tenders to the Secretary, Postmaster-General's Department, 51, Spring-street, Melbourne, by April 14.

Christiania.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Christiania that tenders are invited by the Norwegian State Telegraphs for the supply of insulators, iron wire, bronze wire, bronze thread, steel cable, battery, zinc, and canal cable. Tenders are to be delivered at Telegrafstyrelsens Tekniske Avdeling, 3, Hasselgaarden, Christiania, by noon on April 13.

London, S.W.—The Agents for the Sind Light Railways invite tenders for the supply of 1,828 tons of rails with 46·2 tons of fish-plates, 29·4 tons of fishbolts and nuts, 128 tons of spikes, 12 sets of crossings and switches, and 11 sets of signals. Specifications may be obtained from Messrs. Molesworth and Molesworth, 39, Victoria-street, London, S.W., on payment of 7s. 6d. for each specification, which sums will not be returned. Tenders by April 14.

RESULTS OF TENDERS.

Hackney.—The Electric Lighting Committee recommend the acceptance of the tender of Geipel and Co. for arc lamp carbons.

Rawtenstall.—The Urban District Council have placed a contract with the Lancashire Dynamo and Motor Co. for an automatic reversible booster.

Durban.—The Municipality have placed a contract for a number of transformers with the South African General Electric Co., London and Johannesburg.

Johannesburg.—The Municipality have placed an order with the makers, through Reunert and Lenz, Johannesburg, for a 1,000-kw. and a 500-kw. Belliss-E.C.C. two-phase alternator.

Stockport.—The Electricity Committee have accepted the tender of W. B. Beattie for the labour and materials required in erection and completion of stores, offices, etc., in Millgate, adjoining the electricity generating station.

Bristol.—Thermit, Limited, 27, Martin's-lane, Cannon-street, E.C., have received an order from the Bristol Tramways and Carriage Co. for welding material for making the joints in connection with the extension of their tramway system.

Australia.—A contract has been placed with the Lancashire Dynamo and Motor Co., through Kincaid, Waller, Manville, and Dawson, for a motor-driven booster, 1,200 amperes 180 volts, for the Electric Lighting and Traction Co. of Australia (Adelaide Electricity Supply).

Beckenham.—The Urban District Council have accepted the tender of the Lancashire Dynamo and Motor Co. for an automatic reversible booster for £851. 10s.; that of Hyde and Co., Norwood Junction, for extensions and improvements to the electricity station, for £657; and the tender of the Tudor Accumulator Co. for accumulators.

Colchester.—The Town Council have accepted the following tenders for annual supplies to the electricity department: ironmongery and tools, Williams and Co.; oilman's sundries, Joslins, Limited; castings,

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Stanford and Co.; joiners' work, G. Appleton; prepayment meter installations, Joslins, Limited; fuse boxes, Lucy and Co., at 2s. 4d. each.

Sheffield.—Messrs. Marples, Leach, and Co. inform us that they have received the complete contract for the supply, delivery, and erection of 18 motors for driving the printing presses in the offices of the *Sheffield Daily Telegraph*. These motors are all specially designed for variable speeds where necessary, and are being wound for the Sheffield Corporation supply, 200 volts 50 periods, two phase.

OPENINGS FOR CONTRACTORS.

ABERAVON—Vicarage (£1,400).

ABERDEEN—Masonic temple, St. John's-place, Crown-street (£5,500).

ACCRINGTON—Council schools, New Royd-street, Education Committee.

ACTON—Municipal buildings (£18,000), Town Council.

ALCESTER—Secondary school, Warwick County Council.

ALLOA—Elementary school (£7,725), Education Committee.

ALVERSTOKE—Village hall (£1,400).

ALVERTHORPE—Two houses, Mr. Henry Pease.

ARDSLEY—House, Barnsley-road, Mr. J. B. Hinchcliffe.

ASHTON-ON-MERSEY—Extension to nursing home (£1,500).

AYLSHAM—Improvements, town hall, Parish Council.

AYR—Extension, grammar school (£5,805), School Board; Roman Catholic elementary school, Whitteits-road (£950).

AYR—Alterations, houses, Cromwell-place (£400), Mr. T. Muir; alterations, premises, South Quay, Mr. J. D. Dudgeon.

BACUP—Post office, Town Council.

BAKEWELL—Public baths, Town Council.

BARTON-ON-HUMBER—Alterations and additions, Constitutional club premises, Mr. R. Maden.

BELFAST—Extensions to asylum (£83,000), City Council.

BERKSHIRE—Restoration, Wootton Church (£580), Churchwardens.

BERMONDSEY, S.E.—Alterations, town hall (£700).

BEXHILL—Electric lighting purposes (£2,860), Town Council.

BILSTON—Council school, Bull Holes (£17,000), Educational Authority.

BIRKENHEAD—Laying of feeder mains (£4,114), Electricity Committee.

BISHOP'S STORTFORD—Secondary school, Herts Education Committee.

BITTLEFORD—Two houses, etc., Mr. Langdon.

BLACKPOOL—Public library and art gallery (£17,000), Town Council.

BOLTON-LE-SANDS—Additions, Church Cottage, Mr. Hodgson.

BOSTON—Elementary school, Carlton-road, Education Committee.

BOURNEMOUTH—Public conveniences (£3,250), Town Council.

BREDBURY—Two houses, Guywood-lane, Mr. J. H. Lamb; house, Gregory-avenue, Mr. E. G. Hilton.

BRIDLINGTON—Council school (£390), Education Committee.

BRISTOL—Alexandra-park School (£7,000), Education Committee.

BRITISH COLUMBIA—Sawmill, Cumshaw Inlet (350,000dol.), Moresby Island Lumber Co.

CAERPHILLY—Fourteen houses, Lawrence-street, Building Club.

CANTERBURY—Two houses, Oxford-road, Mr. E. Holtum; motor garage, Old Dover-road, Mr. Gill; additions, Zetland Lodge, London-road, Mr. J. Stonley.

CANTERBURY—Electricity supply undertaking (£4,000), City Council.

CARDIFF—Parish hall, Lewis-street, Rev. J. Baker.

CARDIFF—Day preparatory technical school, Technical Evening Schools Committee.

CASTLEDERG—Workmen's dwellings (£10,710), Rural District Council.

CATERHAM—Wesleyan chapel, Foot Guards depôt, Trustees.

CAWNPORE—Four boarding-houses (Rs.35,500), Directors of Land Record and Agriculture.

CHAPELTOWN—Enlargement of chapel and schools, Primitive Methodist Connexion.

CHELMSFORD—Hospital extensions, etc. (£2,250), Joint Hospital Board.

CHELTENHAM - Conversion of Victoria Rooms into a theatre, Town Council.

CLACTON—Two additional 50-h.p. engines and generating plant, electricity works (£5[illegible]0), Urban District Council.

COATBRIDGE—Higher-grade school (£15,700), Old Monkland School Board.

CONWAY—Conversion of old post office into municipal offices, Town Council.

COWDENBEATH—Mining school (£2,000), Fife and Clackmannan Coalowners' Association.

CROYDON—Secondary school, The Crescent (£18,250), County Council; additions to "Waingates," London-road (£559), Guardians.

CRUMLIN—Twenty houses opposite Bridgend Inn, Bridgend No. 1 Building Club.

CURRAGH CAMP—Nursing sisters' quarters, Directors of Barrack Construction

DALKIRK—Villa, Cortleferry-park, Mr. Jones, Perthshire.

DARFIELD—Elementary school, West Riding Education Committee.

DARLINGTON—Fourteen houses, Upper Victoria-street, Mr. J. Anwyll; two houses, Staindrop-road, Messrs. Copping and Johnson; 32 houses, Craig-street, Mr. J. E. Chilton; new science rooms, Messrs. Clark and Moscrop.

DARWEN—Fifteen houses, Cemetery-road, Messrs. R. and W. Knowles; extension, warehouse, Cotton Hall, Messrs. Haworth and Smith; garage, Elmhurst, Earnsdale-road, Mr. Joseph Catlow; extension, Anaglypta Works, Wall Paper Manufacturers, Limited; store and dwelling-house, Hey Fold, Darwen Industrial Co-operative Society; four houses, Hartington-road, Mr. James Whittaker; pump-house and fire station, Ainworth-street, Wall Paper Manufacturers, Limited; two houses, Earnsdale-avenue, Mr. E. Brooks; house, Sunnyhurst, Mr. T. E. Marsden; two houses off Manor-road, Mr. J. Cooker.

DEAL—Sixteen houses, Grove-road, Middle Deal, Mr. G. Gates.

DERBY—Extensions of the tramways (£6,500), Tramways Committee.

DEWSBURY—Wesleyan Sunday school at Hartishead, Trustees.

DONCASTER—Erecting and furnishing elementary school, Chequer-road (£5,534), Town Council.

DUMBARTON—Public library (£6,000), Town Council.

DUNBOYNE—New schools, Rev. B. Brady. Messrs. Byrne and Son, architects.

DUNDEE—Additions, property, Ann-street, Mr. James R. Benvie; additions, factory, Don's-road, Mr. J. F. Henderson; additions, premises, Erskine-street, Buist Spinning Co.; alteration, property, Hawkhill, Mr. James Knight; addition, property, Little Sisters of the Poor; alterations, property, North-street, Mr. Robert M'Culloch; alteration, property, South Tay-street and Artillery-lane, Mr. D. Ireland; additions and alterations, works, Walton-street, Messrs. J. Prain and Sons.

DURHAM—New church, Bearpark, Trustees, United Methodist Church; four houses, Clarence Ville, Coxhoe, Messrs. F. H. Todd and Son; house, Lower Barn, Mr. W. Hall; house, Framwellgate Moor, Mr. W. E. Hindson.

EASINGTON—House, High Wheatley, Dr. Russell; two houses, Wingate, Mr. W. Sexton; four houses, Cookson Estate, Murton, Mr. Jobson; institute at Shatton Colliery, Horden Collieries, Limited.

EASTBOURNE—Enlargement of Princess Alice Hospital, Committee.

EBBW VALE—Alterations and extensions to hospital, Ebbw Vale Workmen's Doctors Fund.

ECCLES—Extensions to Weaste and Patricroft Sunday school (£1,527).

EDINBURGH—Five houses, Arden-street, Mr. G. Cruikshank; two houses, Lismore avenue, Messrs. Fraser and M'Beath; three shops, West Richmond-street, Mr. E. Lynch; four villas, Willowbrae-avenue, Mr. W. Nicolson.

ELLERSLIE—Range of new stores, Blairgowrie-road. Mr. J. A. R. Macdonald, architect.

ELLESMERE—Free library, Station-road, Whitby Urban District Council.

ELLON—House and shop, Station-road. Mr. W. Davidson, architect.

ETAWAH (INDIA)—Civil surgeon's residence (Rs.16,000), Government of the United Provinces.

FAILSWORTH — Council school (£7,756), Lancashire Education Authority.

FALMOUTH—Residence on Gyllyngdune Estate. Mr. A. J. Cornelius, architect.

FOLKESTONE—Motor garage, etc., Turketal-road, Mr. A. Bromley, architect.

FOXHOLE—Elementary school, St. Austell and St. Columb District Education Committee.

FYVIE—Additions and alterations, public school, School Board.

GALASHIELS—Higher-grade school (£6,300) School Board.

GALGATE—Two houses, Whams Estate, Mr. Ingham.

GARW—Temporary school, Llest Colliery Tip, Education Committee.

GATESHEAD-ON-TYNE—Catholic elementary school, Rev. J. Newsham.

GLASGOW—Sub-station, Hagg-road. Mr. W. W. Lackie, electrical engineer.

GORLESTON—Alterations and additions to auction rooms, Pier-walk, Messrs. J. Camp, Limited.

GOSPORT—Council school to accommodate 400 scholars, Education Committee.

GRANGE—Elementary school (£8,000), Alloa Burgh School Board.

GREENOCK—House, Bawhirley-road, Messrs. Aitkenhead and Sons; villa, Armadale-place, Mr. J. Agnew; additions, premises, Ingleston-street, Aluminium Co.

HALIFAX—Building (£7,130). Messrs. Walsh and Nicholas, architects.

HAMPSTEAD, N.W.—Packing and receiving room to laundry of North-Western Fever Hospital, Metropolitan Asylums Board.

HAMSTALL RIDWARE — Elementary school, Staffordshire County Education Committee.

HASLEMERE—Drill hall (£5,000), Lads Rifle Brigade.

HAWARDEN—Public conveniences, District Council.

HEANOR—Mortuary, Urban District Council.

HENDON—Enlargement, etc., of St. Mary's Church (£5,500), Ecclesiastical Commissioners.

HOLLINWOOD—Mill off Chapel-road, Mr. Chadderton.

HOLMER GREEN (BUCKS)—Voluntary school, Education Committee.

HUNSLET—Council school (£17,000), Leeds City Council.

HYTHE—House, Earlsfield-road, Mr. S. Wise.

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KELLY BRAY—Chapel (£1,100), Wesleyans.
KILMARNOCK—Erection and equipment of technical school, Education Authority.
KINGSDOWN—Elementary school, Southwell-street, Bristol Education Committee.
KING'S NORTON—Permanent school, Urban District Council.
KINGSTOWN—Housing scheme (£13,000), Urban District Council.
KIRKBURTON—Two houses, Carr's-road, Mr. R. Griffiths.
KIRKCALDY—New school (£11,500), Dysart School Board.
LADYSMITH (B.C.)—Installing electric plant for lighting purposes, Municipality.
LEAMINGTON—Repairs to parish church (£3,500), Ecclesiastical Commissioners.
LEEDS—Alterations and additions to school buildings, Blenheim Baptist Church.
LEEDS—Firemen's dwellings, etc., Park-street, City Council.
LETCHWORTH—Council school (£8,975), Education Committee.
LITTLE HADHAM—House, Westland Green, Mr. E. Howard; four houses, Clinton Hall Farm, Mr. Harvey.
LITTLEOVER—Primitive Methodist church. Plans passed.
LLANDRINDOD WELLS—Police station, petty sessional court, etc. (£7,495), Radnorshire County Council.
LLANELLY—Ten houses. Plans passed by Rural District Council.
LOILEM—Hospital (Rs.18,750), Government of Burma.
LONGTON—Alterations to public baths (£500); court-house, Council.
LUCKNOW—Building in connection with Arabic College (Rs.50,000).
LUTON—Alterations, women's infirmary and laundry (£7,500), Board of Guardians.
LUTON—Storerooms, etc., Chapel-street, Mr. T. Ellwood; extensions, premises, Wellington-street, Mr. F. Linger; two houses, Talbot-road, Mr. A. Butt; 11 dwelling-houses, Kenilworth-road, Messrs. H. Lacey and Co.; plait store, Liverpool-road, Mr. W. Wren; two houses, Dunstable-road, Mr. H. Cook; storeroom and engineer's room, Dallow-road, Co-operative Wholesale Society; four houses, Reginald-street, Mr. W. Baxter; Sunday schools, Beech-road, etc., Trustees, Wesleyan Church; six houses, Dallow-road, Mr. G. Linger; alterations and additions, Park-street, Messrs. Rudd and Sons.
LYNTON—Church, local Wesleyans.
MACCLESFIELD—Nurses' home, Guardians.
MANCHESTER—Shelter, Brookdale Park, Town Council.
MANDALAY—Construction of quarters for assistant superintendents of police (Rs.55,000), Lieutenant-Governor of Burma.
MARGATE—Secondary school, Education Committee.
MARSKE—Renovation of church and new Sunday school, Wesleyans.
MAYMYO (BURMA)—Courthouse (Rs.28,000), Government.
MIDDLESTOWN—Six houses, Cross-road, Mr. J. Ingham; house, Low-lane, Mr. Talbot.
MILFORD HAVEN—Alterations and additions to premises, Priory-road, Co-operative Society.
MONTREAL—Can factory (200,000dol.), American Can Co.
MORLEY—Additional plant required to supply the power for the tramways (£7,942).
MOOSE JAW (CANADA)—Courthouse building, Deputy Commissioner of Public Works, Regina.
NELSON—Seven houses, Lime-street, Messrs. W. Boothman and Son.
NORTHWOOD—Two houses, Hilliard-terrace, Mr. J. Ford; house, Catling-lane, Mr. C. Jaques.
NOTTINGHAM—Alterations at Russell House. Mr. W. B. Starr, architect.
OVERTON—Two houses, Old-road, Mr. A. Lockwood.
OXENHOPE—Residence, Gate-lane. Messrs Moore and Crabtree, architects.
PAKOKKU—Office for the executive engineer (Rs.13,000), Burma Government.
PANTYGLAS—Thirty-six houses, Ely Valley, Pantyglas Building Club.
PENMAENRHOS—Elementary school, Board of Education.
PORTHCAWL—Extensions, rest convalescent home, Trustees.
PRESTBURY—Cottage (£338). Messrs. Prothero, Phillott, and Barnard, architects.
PUDSEY—Weaving shed, warehouse, etc., Robin-lane. Mr. W. Shackleton, architect.
PURTON—Alterations and additions, Royal George Inn. Messrs. Bishop and Fisher, architects.
RAMSGATE—Extensions to Council chamber, etc. (£435), Town Council.
RASTRICK—Shop and warehouse, Bridge End. Messrs. Jackson and Fox, architects.
REDDISH—Church for the parish of St. Agnes. Messrs. Mayor, Manchester, architects.
REIGATE—Holy Trinity Vicarage (£700), Ecclesiastical Commissioners.
RICHMOND—Secondary school, Parkshot (£17,000).
RICHMOND—Public conveniences, Terrace Gardens, Town Council.
RIPPONDEN—Engine-house, etc.; dwelling-house at Stones Mill. Messrs. Chas. F. L. Horsfall and Son, architects.
ROMILEY—Warehouse, Green-lane, Elder Mill Co.; three houses and shop, Stockport-road, Mr. J. W. Stenton.
ROTHERHAM—500-kw. direct-current steam turbo-generator, etc., Town Council.
RUABON—Six houses, Brynfields, Mr. W. Davies.
ST. ALBANS—Seven cottages, Catherine and Cross streets, Trustees of St. Peter's Charities.
ST. AUSTELL—Five houses, Golant. Mr. J. E. G. Cunningham; three houses, Porthpean-road, Mr. T. Adams; house, Trenance, Mr. N. Kent; house, Hendra-lane, Mr. F. Stephens; house, Rosevear, Captain T Gilbert.
SALFORD—Baths, Derby-road, Town Council.
SANDAL—Two houses, George-street, Mr. J. Ashton; alterations, Heathfield Lodge, Mr. J. Day.
SAWBRIDGEWORTH—Enlargement, Fawbert and Barnard's School (£945), Education Authorities.
SEDGLEY—Mission church, Trustees.
SHRIVENHAM—Alterations and additions to Manor House (£875). Messrs. Bishop and Fisher, architects.
SKIPTON—Public library, High-street. Mr. J. W. Broughton, architect.
SOUTH ELMSALL—Elementary school, West Riding Education Committee.
SOUTHMOLTON—Wesleyan minister's residence (£697). Messrs. W. C. Oliver and Son, architects.
SOUTHOWRAM—House and shop, Bank Top. Mr. C. C. Lloyd, Halifax, architect.
SOUTHWELL—Alterations and additions to premises (£1,364), Governors of the Southwell Minster Grammar School.
SPENNYMOOR—Six houses, Barber's-row, Mr. J. W. Kay; shop, Durham-road, Mr. D. Moore; reconstruction, six houses, Duke-street, Messrs. Raffle and Slade.
STAINDROP—Alterations and improvements to the parish church, Churchwardens.
STOCKTON—Elementary schools, Education Committee.
SUNDERLAND—Three houses, Bede street, Messrs. J. Potts and Son; 14 houses, Sea View-gardens, Messrs. Vaux and Mark; four houses, Valebrook-avenue, Messrs. Henderson and Hall; two houses, St. Leonard's-street, Mr. H. E. Robinson; laundry, Pallion-road, Mr. M. A. Spreight.
SWINFORD—Workmen's dwellings (£15,631), Rural District Council.
TEMPLE EWELL—Parish hall in connection with church, Churchwardens.
THRAPSTON—Elementary school, Northampton Education Committee.
TIBSHELF—Erection of new chapel (£1,000), Wesleyan Society.
TIPPERARY—Workmen's dwellings (£47,182), Rural District Council.
TOTTINGTON—Elementary school, Norfolk Education Committee.
TURTON—Eight houses, Rigby-lane, Mr. T. Ramsden.
VANCOUVER (B.C.)—Wireless or cable telegraph service, Dominion Government.
WALTHAMSTOW—Two additional blocks of school building, caretaker's house, Selwyn-avenue, Higham's Park, Education Committee.
WELLINGBOROUGH—Shop, Knox-road, Messrs. Barber Bros.; house, Oxford-street, Mr. W. Gillitt.
WEYMOUTH—300-kw. steam-turbine and direct-current generator, etc, Town Council.
WHITCHURCH—Church hall and institute. Mr. S. Williams, architect.
WINNIPEG—Installation of turbine pump with electric motor for the city waterworks.
WINSETT—Elementary school, East Suffolk Education Authority.
WOLSTANTON—Fire station, etc. (£825), Urban District Council.
WOMBWELL—Alterations and additions to premises, Pearson's Field, Barnsley British Co-operative Society.
WOMBWELL—Elementary school, Education Committee.
WORTHING—Additions to Christ Church Schools (£2,321), Education Authority.
WREXHAM—Extensions to electricity works (£6,850). Town Council.
YORK—Secondary school, Sycamore-terrace (£2,750), Corporation.
YORK—Electricity undertaking (£25,285), Corporation.
YORK—Workshops, Clarence-street, Mr. W. Chaloner; additions, premises, East Mount-road, Mr. Hepper; additions, Croft Villa, Mr. T. Clark; swimming-bath and house, Haxby-road, Messrs. Rowntree and Co.; house and shop, Burton-lane, Mr. W. T. Whincup; house, etc., Lawrence-street, Mr. J. R. Oliver; store shed, Hewarth Wesleyan Chapel, Trustees; bakehouse, Tower-street, Mr. W. Whittaker.

COMPANIES' MEETINGS AND REPORTS.

SOUTH LONDON ELECTRIC SUPPLY.

The annual meeting of the shareholders of the South London Electric Supply Corporation was held on Tuesday last, the chairman, Mr. J. Atherton, presiding.

In moving the adoption of the report, the CHAIRMAN alluded to the great progress that had been made in their business during the year. The number of lamps added to the circuits was the equivalent of 17,608 8-c.p. lamps. They had already added nearly 5,000 lamps to their mains since Jan. 1. The output had increased by 551,641 units, equal to 27 per cent., and producing an increased revenue of approximately £4,000. The units sold for industrial purposes, more particularly for electric driving of factories, had increased by over 46 per cent. From the returns for the past quarter he found they

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had sold over 100,000 more units than they did during the corresponding period of 1907, and as the whole of their supply during that quarter had been generated at a less cost than in the corresponding quarter of last year, they would see that the income from these additional units was practically all profit. At the end of last year they had over 1,700 h.p. of motors connected to the mains, being an increase of 300 h.p. during the year, and, with the applications they now had in hand, the figure this year would reach considerably over 2 000 h.p. The high price of coal last year compelled their keen competitors, the gas companies, to raise their rates considerably, and for the same reason this Company considered it an opportune time, in the second half of last year, to raise slightly their prices for lighting purposes. This had brought about a reasonable increase in the revenue without diminishing the number of their own consumers. Last year they were solely dependent for the revenue upon their own regular consumers, whereas in 1906 they had the last seven months of the temporary supply to the London County Council tramways. However, the very large drop in their gross receipts which necessarily followed the stoppage of that supply had not affected the gross profit earned in anything like the same proportion, for in 1906 the gross profit was £18,637, and for last year £15,799, although the gross receipts had been reduced by no less than £16,713. The balance of profit carried to the general balance-sheet and available for distribution amounted to £15,478, out of which they recommended a dividend at the rate of 4 per cent. per annum on the original capital, carrying forward a balance of £2,478.

Mr. BOOTH seconded the adoption of the report, which was carried unanimously.

The CHAIRMAN said that very good feeling existed between the local authority and the companies. He had personally attended several meetings in the district with the mayor and chairmen of the various committees present, and they were now discussing the question of lighting streets in Lambeth by electricity.

CALCUTTA TRAMWAYS.

The report of the Calcutta Tramways Co. for the year ended Dec. 31, 1907, to be submitted at the meeting on the 14th inst., shows gross traffic receipts £167,377, working expenses under all heads £104,235, and a revenue balance of £63,333. Against this have been debited debenture interest, interim dividend, and preference dividend, making a total of £48,084, leaving a balance of £15,248. To this must be added the amount brought from last year's account, £822, and interest earned on moneys in hand, £2,907, making a total of £18,979, from which the directors recommend that a final dividend at the rate of 2s. 6d. per share be paid and that £1,777 be carried forward. In view of the heavy amount charged for maintenance during the year the directors do not propose to make any addition to the depreciation fund which, after adding £2,185, interest on the depreciation fund investments, and the £5 000 transferred from the balance of profit and loss account for 1906, and deducting £5,817 written off during the year for renewals, now stands at £48,080. The gross receipts are in excess of those of the previous year, which then constituted a record by £8,521. The expenses, on the other hand, have increased by £17,317, made up of power expenses, £2 024, due wholly to the fact that the plant had to be overhauled in consequence of the excessive pressure put upon it by the increased traffic: traffic expenses, £1,710, due to increased efficiency of service; maintenance and repairs, £7,164, principally due to the difficulties experienced in maintaining the cars owing to the pressure of the traffic and inadequate space for repair shops; and general expenses, £6,418, mainly due to the necessarily increased amount payable for income tax and the settlement of claims of the Municipality for track rent in excess of the amount agreed for the original system. These claims had for a long time been in dispute, and a compromise was only arrived at last year. A very important factor in the reduced amount available for the service of the ordinary shares is that so much more has been needed for the fixed charges on the new capital raised for the construction of the extensions. During the year the new ordinary shares which had up to Dec. 31, 1906, been bearing interest at 5 per cent. per annum, ranked for 1907 *pari passu* with the old shares, and, in addition to this, it was found necessary to raise further capital in the shape of preference shares for the purposes of the extensions, which also became a charge upon the earnings in priority to the ordinary capital. These additions to capital only became revenue-producing to a small extent by reason of the unexpected delays in the construction and opening of the extensions.

CUBA SUBMARINE TELEGRAPH.

The report of the Cuba Submarine Telegraph Co. for the half-year ended Dec. 31, 1907, to be presented at the meeting on the 15th inst., states that the total receipts of the six months were £17,478, while the expenses amounted to £6,177, leaving £11,300, to which has to be added £6,500 brought forward, giving a total of £17,800 to be dealt with. The sum of £3,000 has been added to the reserve fund, which now stands at £106,000. The dividend on the preference shares will absorb £3,000, and leave £11,800, out of which the directors recommend the payment of a dividend at the rate of 6 per cent. per annum on the ordinary shares, free of income tax, the balance, £7,000, being carried forward to the current half-year. The cables continue in good working order.

BRITISH ELECTRIC TRANSFORMER.

The report of the British Electric Transformer Co. for the year ended Dec. 31 last states that the net trading profit is improved to the extent of about £1,800, as compared with that for the year ended Dec. 31, 1906. For the purposes of making this comparison allowance has been made for the sales of patents included in the 1906 account, and also for the fact that this year's account provides considerable sums for writing down stock, etc., not dealt with in the previous year. A block of £15,010 preference shares has been obtained in settlement of the debt, amounting to £10,010, the whole of which was written off last year. The accounts show that after writing down certain items of stock, etc., referred to above, and paying all manufacturing costs and the expenses of administration, there remains a net trading profit of £6,247. Deducting the loss brought forward from last year of £3,998, there remains an available balance of £2,249. The Board recommend that £1,300 be transferred to depreciation reserve, and that the preference dividend of 6 per cent. per annum for the six months ended Dec. 31, 1906, be paid, leaving to be carried forward a balance of £34.

GREAT NORTHERN TELEGRAPH OF DENMARK.

The directors of the Great Northern Telegraph Co. of Denmark state that, although the Company's receipts for last year have decreased by about £22,000 compared with those of the previous year, they intend to propose to the general meeting to distribute the same dividend and bonus as in 1906—namely, 20 per cent., inclusive of 5 per cent. already paid—and to carry the usual amounts to the reserve and pension funds—namely, £55,555 and £8,333 respectively—whilst the dividend equalisation fund will be increased only by the interest on the same for the year.

NORTH OF SCOTLAND ELECTRIC LIGHT AND POWER.

The annual report and statement of accounts of the North of Scotland Electric Light and Power Co. for the year ended Dec. 31, 1907, states that the result of the year's trading, including a balance brought forward of £101. 14s. 3d. from last year, shows a gross profit of £1,793. 1s. 4d. After allowing £611. 3s. 3d. for interest on debentures and loans, and writing off £115. 10s. 1d. balance of exhibition suspense account, and £467. 11s. 2d. depreciation on free wiring and meters, and putting £677. 6s. 1d. to reserve, there is a loss of £98. 9s. 3d. to be carried forward to next year. £2,539 of debenture stock has been allotted during the year. Of the directors, Messrs. Geo. A. Scott and Dr. V. Stone retire by rotation, and, being eligible, offer themselves for re-election. The auditor, Mr. Alex. Middleton, offers himself for re-election.

BATH ELECTRIC TRAMWAYS.

The report of the Bath Electric Tramways for the year ended Dec. 31, 1907, to be submitted at the meeting on the 14th inst., states that owing to the condition of the money market during the greater part of the past year the extension to Saltford was not proceeded with. It is proposed to construct this section at the first favourable opportunity. The additions to capital expenditure account during 1907 amounted to £1 284. The falling off in the number of passengers carried has adversely affected the revenue account. The decrease in earnings may be wholly attributed to the unsatisfactory weather conditions prevailing during 1907. After charging the expenses of operation and administration, there remains a balance of £13 368, which, with the balance brought forward of £380, makes a total of £13,748, from which have to be deducted interest on 4½ per cent. first mortgage debenture stock paid and accrued to date £6,075, interest on loans £1,435, and the dividend on the preference shares for the year to Dec. 31, 1907, paid July 1, 1907, and Jan. 1, 1908, £3,750, leaving a balance of £2,489, which the directors recommend should be carried forward.

LEGAL INTELLIGENCE.

THE RATING OF THE METROPOLITAN ELECTRIC TRAMWAYS CO.

In the King's Bench Division, the Lord Chief Justice, Mr. Justice Ridley, and Mr. Justice Darling on Monday last delivered judgment in the appeal as to the right of certain Middlesex magistrates to sit on the bench of the quarter sessions during the hearing of rating appeals.

In this case a rule *nisi* for a prohibition had been obtained by the Assessment Committee of the Hendon Union to prevent the justices of the Middlesex Bench who were also members of the Middlesex County Council, including Sir Ralph Littler, the chairman of the Middlesex Quarter Sessions, from adjudicating in an appeal by the Metropolitan Electric Tramways Co. against a decision of the Assessment Committee of the Hendon Union as to the rating of the tramway undertaking.

The Assessment Committee were the respondents to the appeal, their contention being that the justices were likely to be biassed by interest in the matter, or that reasonable people might think such a Court would not be impartial. It appeared that the tramways were leased by the County Council to the company, under an agreement dated Nov. 16, 1900, it being arranged that rent should be paid on a certain basis, and that there should be a deduction for rates. It was contended that the magistrates in question should not adjudicate in the case, as they were interested in the matter and would be biassed. On the other hand, it was urged that the magistrates would not be biassed in the way suggested, and that their minds would not be affected by the question whether sufficient deductions for repairs,

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insurance, etc., was made from the gross value for the purposes of rating.

The LORD CHIEF JUSTICE said he did not find as a fact that there was a possibility of bias, or that reasonable people would not think the tribunal impartial.

Mr. Justice RIDLEY and Mr. Justice DARLING concurred, and the rule was discharged, with costs.

WIRELESS TELEGRAPHY.

The Action against the Marconi Co.

Mr. Justice Bingham, in the King's Bench Division, continued the hearing on the 2nd inst. of the action brought by the Buitenlandsche Bankvereeniging against Marconi's Wireless Telegraphy Co. to recover damages for alleged breach of contract in connection with the erection of wireless telegraph stations in the Dutch East Indies and the formation of a company to take over and work the same. The case for the plaintiffs (which was reported in our last week's issue) was that, in consequence of the defendants having failed to erect the stations and to provide working capital for the proposed company, the company could not be formed, and the concession enabling the stations to be erected was lost.

Mr. SCRUTTON, K.C., for the defendants, submitted that the action could not be maintained. The agreement between the parties, he said, gave the defendants power to transfer all or any part of their obligations and benefits under it to any company, syndicate, or corporation they might form to acquire them. The defendants had formed the Sanfil Co. in Holland and assigned all their benefits and obligations under the agreement to it, and therefore they were under no liability to the plaintiffs.

After hearing the evidence, HIS LORDSHIP reserved judgment, which was delivered on the following day in favour of the defendants. He said the defendants contended that under the contract they were to be released from liability if they formed a company and assigned to that company all their benefits and obligations under the contract. It was clear that the defendants formed a company called Sanfil, Limited, and assigned to it all their benefits and obligations under the contract with the plaintiffs, and in his opinion the defendants were under no liability to the plaintiffs in respect of the failure to erect the telegraph stations and to provide the working capital for a company to be formed to take over and work the stations. Therefore, he entered judgment for the defendants, with costs. If the case should be taken further, and his decision was reversed, he assessed the amount of damages to which the plaintiffs would be entitled at £1,000.

ERNEST SCOTT AND MOUNTAIN v. KENT COLLIERIES.

In the Official Referee's Court on Friday last the action of Messrs. Ernest Scott and Mountain *v.* Kent Collieries was commenced before Mr. Muir Mackenzie, official referee. Plaintiffs claimed from the defendants a balance of £5,780, cost of machinery and plant supplied to the defendant company, besides money paid by the plaintiffs by way of wages to men lent to the plaintiff company. The defendants denied liability, pleaded that the plant supplied was not in accordance with the contract, and on that ground they counterclaimed. Mr. C. A. Russell, K.C., appeared for the plaintiffs, and Mr. Bousfield, K.C., for the defendants.

Counsel representing the plaintiffs said the claim was for a balance amounting to £3,249, alleged to be due under the contract above named. The plaintiffs contracted with the defendants for the supply of an electrical plant and driving engine at a cost of £5,780, and in addition £553, balance of the cost of a vertical spindle pump supplied by the plaintiffs. There was another claim by the plaintiffs for £847, wages of men lent by the plaintiffs to the defendants. Other claims were for £105 for goods supplied by the plaintiffs, and £46. 16s. 10d. for stripping and clearing one of the pumps. Counsel said the defence was that the plant was not in accordance with the contract, that the machinery was not capable of performing the work required of it, so that the pumps would not raise the necessary amount of 1,000 gallons from the shaft which the defendants desired to be unwatered. The specification was 1,000 gallons of water a minute against a head of 640ft. of water, at 1,440 revolutions of the motor which drove the pump. This machinery the plaintiffs said they had supplied. The defendants also said that the engines did not develop either the indicated or effective horse-power of 400 and 450 respectively, and that the output of the generators was less than 300 k.v.a. as specified. All these allegations the plaintiffs denied. The plaintiffs further said that it was contemplated that they were supplying engines and motors which would be worked continually or for an unlimited period, and that if the generators got overheated and broke down, they did so because they were not used fairly or reasonably. The defendants absolutely worked one of the pumps to death, and it was now in a ruinous condition. With regard to the counterclaim, the contract provided for the payment of the whole amount, irrespective of whether the machinery was tested or not, and the defendant company could not rely on that as a claim against the plaintiffs.

The case was adjourned.

BRUSH ELECTRICAL ENGINEERING CO.

On Saturday, April 4, in the Chancery Division, on the application of Mr. Thompson, Mr. Justice Neville made an order sanctioning the reduction of the capital of the Brush Electrical Engineering Co. by £170,484 in respect of loss of assets on freehold and leasehold factories, patents and goodwill, shares, and debentures held in other companies, etc.

PROVISIONAL PATENTS, 1908.

MARCH 27.

6795. Improvements in means for automatically transferring the currents of the accumulator, magneto, or similar ignition systems from one to the other for motorcar and the like engines. Charles Forryan Pougher and Henry Gardiner Atkinson, Prudential-buildings, Corporation-street, Birmingham.

MARCH 28.

6895. Improvements in electrical indicators. Siemens und Halske Aktien-Gesellschaft, 12, Queen Anne's-chambers, Broadway, Westminster. (Date applied for under Section 91 of the Act, March 28, 1907, being date of application in Germany.) (Complete specification.)

6897. Improved straight-line motion, applicable more especially for recording instruments. Edwin Joseph Murphy and Kelvin and James White, Limited, 65, Chancery-lane, London.

6898. Zero adjusting device for instruments. Edwin Joseph Murphy and Kelvin and James White, Limited, 65, Chancery-lane, London.

6904. Polar dynamo-electric generator and motor. Jules Lecoche, 41, Schubert-road, Putney, London.

6928. Improvements in mono-telephone relay transformers. Société des Télégraphes Multiplex (Système E. Mercadier), Birkbeck Bank-chambers, Southampton-buildings, London. (Application for patent of addition to No. 6767/08.) (Complete specification.)

6931. Improvements in means or apparatus for heating by electricity. Leopold Aron Frank, 1, Great James-street, Bedford row, London.

6953. Improvements in and relating to radiotelegraphy. The Amalgamated Radio-Telegraph Company, Limited, 7, Southampton-buildings, London. (Fritz Van Der Woude, Germany.) (Complete specification.)

6955. Improvements in electrical machines and the like. Birger Ljungström, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, April 12, 1907, being date of application in Sweden.) (Complete specification.)

6959. Improvements in and relating to alternating-current motors of the commutator type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

6960. Improvements in and relating to alternating-current motors of the commutator type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

6961. Improvements in and relating to alternating-current motors of the commutator type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

6962. Improvements in and relating to alternating electric current motors of the commutator type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

6963. Improvements in and relating to the control of alternating electric current motors of the commutator type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

MARCH 30.

6972. Improved system of electric wiring. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

6973. Improvements in electric accumulators. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

6974. Improvements in electric lampholders. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

6999. Improvements in or connected with electric accumulators. John Baker and George Hughes, 55, Chancery-lane, London.

7002. Improvements in or connected with induction coils, particularly applicable for use with internal-combustion engines. Samuel Raphael Cohen and Barnett Raphael Cohen, trading as the City Ignition Company, 33, Chancery-lane, London.

7014. Magneto-electric ignition apparatus. Arnold Zähringer, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

7027. Improved telephone call or number-recording apparatus. Alexander Elder Maxwell, 46, Lincoln's-inn-fields, London.

7028. Improvements in apparatus for alternative wireless telegraphy and telephony. Josef Schiessler, 46, Lincoln's-inn-fields, London. (Application for patent of addition to No. 1848/08.) (Complete specification.)

7041. Improvements relating to the production of powerful interrupted electric impulses of high frequency. Ernst Ruhmer, 22, Southampton-buildings, London. (Date applied for under Rule 13, Jan. 8, 1907. An invention comprised in application No. 539, dated Jan. 8, 1907.) (Complete specification.)

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7045. Improvements in dynamo-electric machines. Jakob Emil Noeggerath, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, April 1, 1907, being date of application in the United States.) (Complete specification.)

MARCH 31.

7048. Improvements in time element devices, applicable to electric circuit breakers and other apparatus. John Grice Statter, Norfolk House, Norfolk-street, Strand, London.

7077. Improvements in electric arc lamps. Henry Bevis and Arthur Ernest Angold, 3, Brown-street, Market-street, Manchester. (Date applied for under Rule 13, April 5, 1907. An invention comprised in application No. 7941, dated April 5, 1907.)

7119. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

APRIL 1.

7169. Improvements in electrical telephone and telegraph systems. John Gardner, 51, Deansgate-arcade, Manchester.

7188. Improvements in or relating to electric furnaces. Hans Nathusius and Westdeutsche Thomasphosphatwerke, G. m. b. H., 111, Hatton-garden, London. (Complete specification.)

7219. Improvements in electrically-controlled apparatus for seeing at a distance. Johannes Adamian, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

7223. Improvements in and relating to motor-generator sets for controlling electric supply. Robert Pohl, John Grice Statter, and the Phœnix Dynamo Manufacturing Company, Limited, 322, High Holborn, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on April 16.)

1906.

23951. Conversion of kinetic into potential energy in fluids. De Ferranti.

29086. Exciting Ruhmkorff and other electric coils. Lodge.

1907.

1596. Electrically-operated switches specially applicable to railway and other vehicles. Park and Mason.

6932. Electric igniting apparatus. Foster and Spoor.

7555. Electrical wiring, whether for electric lighting, motors, telegraphs, or other similar purposes. Handcock, Dykes, and Smith.

7556. Boxes for electrical wiring. Handcock, Dykes, and Smith.

7557. Boxes for electric wiring. Handcock, Dykes, and Smith.

7563. Electro-deposition of metal on hollow articles. Friedheim. (Date applied for under International Convention, March 30, 1906.)

7926. Electric arc lamps. Hatfield and Lewis.

8020. Systems of electric motor control. British Thomson-Houston Company. (General Electric Company.)

8388. Systems of lighting by electric arc lamps. British Thomson-Houston Company. (General Electric Company.)

8529. Utilisation of electrical energy in the case of intermittent or suddenly changing loads. Human.

8560. Driving wheels for electrically-propelled vehicles. Balachowsky and Caire. (Date applied for under International Convention, May 15, 1906.)

9270. Automatic electromagnetic sanding gear and foot sanding gear for use on electric railways and tramway vehicles. Cummins.

10931. Electric incandescent lamp bulbs. Campbell.

10972. Insulators for electric conductors. Porzellanfabrik Kahla, Filiale Hermsdorf Klosterlausnitz. (Date applied for under International Convention, May 14, 1906.)

12913. Reciprocating electric motors. Irving.

13342. Electrical treatment of gases or vapours, and especially of air or oxygen, for the production of ozone and apparatus therefor. Richardson and Vaughan.

16865. Insulating materials adapted for electric insulation, waterproof and like materials, and for other like uses, and the method of producing the same. Brookes. (Asbestos Wood Company.)

16968. Electrical resistance device for use with lamps and for other purposes. Martin.

17704. Loud-speaking telephone apparatus. Marzi. (Date applied for under International Convention, April 25, 1907.)

19101. Electrical water-heater. Rawson and Sager.

21104. Magazine fuses for electric light and power circuit. Fletcher.

24672. Centrifugal pumps and fans. Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.)

25126. Apparatus for the electro-deposition of metals. Cowper-Coles.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-⅝
—— Ord., 1,125 000	1	..	½-⅝
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1	..	11/16-¾
—— Ordinary, Nos 1 125,000	1	..	3/16-5/16
British Aluminium Co., Ordinary, 2 001-40,000	5	..	3⅝-4½
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4⅞-5⅛
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4½-5⅛
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅝-4½
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	100-103
—— 5 per cent. Loch Leven Deb. (Reg.) Red., 1-3 000	100	..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6½-6⅝
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅝-6½
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	92 97
British Westinghouse Elec. and Manuf. 10 per cent. Pref., 275 001-475 000	3	..	½-⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	0-½
—— Non. Cum., 6 per cent., Pref.	2	..	3/16-7/16
—— 4½ per cent 1st Debenture Stock	100	..	77-80
—— 4½ per cent. 2nd Debenture Stock	100	..	63-66
Callender's Cable, Debentures	100	..	106-108
—— Ordinary	5	..	10¼-11½
—— 5 per cent. Pref.	5	..	5⅜ 5½
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	5	..	1 11-16-1 15/16
—— 5 per cent Debentures	100	..	92-96
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼ xd
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Edison and Swan United, "A" Shares, 1-98 261	3	..	¾-1
—— "A" Shares, 01-017,139	5	..	1½-2½
—— 5 per cent. Debentures	100	..	85-87 xd
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112,100	2	..	¼-½
—— 7 per cent. Cumulative Pref.	2	..	1¼-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100	..	61-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red	100	..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅜-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	..	87-90 xd
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	4⅜-½
—— 4½ per cent. Debentures	100	..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	98-100 xd
National Electric Construction Co., 1-170,000	1	..	7/16-11/16
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	31-33
—— 4 per cent. Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4⅞-5½
Bournemouth and Poole, Ordinary	10	..	10¾-11¼ xd
—— 4½ per cent. Cum. Pref., 7 501-15 000	10	..	10-11
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	10½-11
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Bromley (Kent) Electric Light and Power Co.	5	..	4⅝-5½
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-99
Brompton and Kensington, Ordinary	5	..	7½-8½
—— 7 per cent. Preference	5	..	6¾-7⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6¾-7½
—— Nos. 80,000-100,000	5	..	6⅝-7⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	94-98 xd
—— 7 per cent. Cum. Pref. Stock	$100	..	106½-108¼ xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3⅝-4½
—— 4½ per cent. Cum Pref., 1-80,000	5	..	4-4½
—— 4 per cent. Debentnre Stock, Red.	100	..	96-99
—— "City Undertaking," 4½ p c Cum. Pref., 1-40,000	5	..	4-4½
—— ditto (1905) 40,001-80,000	5	..	4⅜-4⅞
Chelsea Electricity Supply	5	..	3½-3⅝
—— 4½ per cent. Debentures	100	..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9½-10⅝ xd
—— 6 per cent. Cumulative Pref.	10	..	11¼-12¼ xd
—— 5 per cent. Debenture Stock	100	..	123-126
—— 4½ per cent. 2nd Deb. Stk., Red.	100	..	101-104
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3-3⅛
—— 5 per cent Preference, 1-50,000	5	..	4½-4⅝
County of London Elec. Supply, Ordinary	10	..	7⅜-7⅝
—— 6 per cent. Cum Pref.	10	..	10⅞-11½ xd
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100	..	106-109
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	97-100
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	⅛-¼
—— 6 per cent. Cum Pref.	5	..	½-1½
—— 4½ per cent. First Mort. Deb	100	..	58-63
Electrical Development Co. of Ontario 5 per cent. 1st Mort. 20-year Gold Bonds, 10 751-15 750	—	..	74-77 p.o.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2½-2⅝
—— 5 per cent Debenture Stock, Red	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	91-94
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4¼-5 xd
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	4¼-5⅛ xd
—— 4½ per cent. First Deb Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-13,000	5	..	6¼-6⅜ xd
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. stock, Red.	100	..	96-99
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. stk., Red	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	⅛-¼
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	7⅜-8⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	97-101 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9⅜-10⅛

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Name.	Amount paid.		Last price.
	£		£
London Electric, Ordinary	5	..	1¼-1⅝
—— 6 per cent. Pref.	5	..	4½-5
—— 4 per cent 1st Mortgage Debenture Stock, Red....	100	..	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	..	92-96
Metropolitan Ordinary, 100,001-200,000	5	..	5-5¼
—— 4½ per cent. First Mortgage Debenture Stock.....	100	..	107-111
—— 4½ per cent. Cum. Pref.	5	..	4⅝-5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100	..	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000	—	..	75-77 p.c.
Mexican Light and Power Co., Capital Stock	$100	..	49-51
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	..	84-86
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5	..	5⅛-5⅛
—— do., 57,010-75,000	5	..	5⅛-5⅛
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	..	5⅛-5⅜
—— 5 per cent., Pref., 1-57,009	5	..	5⅛-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)....	5	..	5⅛-5⅜ xd
Notting Hill Electric Lighting	10	..	11½-12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	..	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	..	5⅜-5½
—— 4 per cent. Debenture Stock	100	..	93-96
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120,507	1	..	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	..	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red.	100	..	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	..	4⅜-5⅛ xd
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	..	4⅜-5⅛ xd
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	..	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	..	½-1½
—— 4 per cent. Debenture Stock	100	..	70-74
South London, Ordinary	5	..	2⅝-2¾
South Metropolitan Electric Light and Power, Ord.	1	..	⅞-⅞
—— 7 per cent Cum Pref.	1	..	1⅛-1⅜
—— 4½ per cent 1st Mort. Deb.	100	..	99-102 xd
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	7½-8½
—— 7 per cent. Pref.	5	..	6½-7
—— 3½ per cent. Deb.	100	..	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	..	1⅜-2⅛ xd
—— 5 per cent. Cumulative Preference, 50 001 80,000....	5	..	1⅞-2⅛ xd
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	..	87-90 xd
Westminster, Ordinary	5	..	7½-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	..	5-5½

Electric Tramways.—

Name.	Amount paid.		Last price.
	£		£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5	..	6-6¼
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007 ..	5	..	8⅛-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	129-132
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	..	104-107
Barcelona Tramways, Ord., 1-20 000	10	..	—
—— 5 per cent. Cum. Pref. shares, 1-10,000	10	..	—
—— 5 per cent. Deb., Red., 1-600	100	..	—
—— 4½ per cent. Red. Deb. Stock	100	..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	..	½-⅝
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	..	13/16-15/16
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100	..	93-96
Blackpool and Fleetwood Tramroad	10	..	13⅞-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	..	9⅝-10½
—— 4½ per cent. Deb. Stock, Red.	100	..	94½-96½
Brisbane Tramway Invest., Ord., 1-75,000	5	..	3½-4⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4⅜ 5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. ..	100	..	97-101
British Columbia Electric Railway Co., Ord Def.	100	..	132-135
—— Ord. Pref.	100	..	110-114
—— 5 per cent. Cum. Perpetual Pref. Stock	100	..	105-109
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	..	101-104
—— 4½ per cent. Vancouver Power Deb.	100	..	101-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	..	1⅛-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10	..	4-4⅛
—— 5 per cent. Perpetual Debenture Stock	100	..	93½-96½ xd
—— 4½ per cent. 2nd Deb. Stock	100	..	72-76
Bueno Ayres and Belgrano Trams	5	..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	..	110-116
—— Prov. Cert., all paid	100	..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	..	96-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	..	97-101 xd
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	92-95
Calcutta Tramways, Ord., Nos 1-137,610	5	..	5⅜-6⅛
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5	..	5-5⅜
—— 4½ per cent. 1st Deb. Stock. Red.	100	..	102-106
Cape Electric Tramways, Nos. 1-480,000	1	..	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	..	4⅜-7⅛
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	..	98-101
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	..	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red. 1985	100	..	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	..	89-93
Cork Electric Tramway and Lighting Co., Ordinary	10	..	13-14
—— 6 per cent. Cum. Pref.	10	..	12⅜-13⅜
—— 4 per cent. Debentures	100	..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	..	96-98 xd
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	..	81-86
Imperial Tramways, Ordinary	all	..	18-19
—— 6 per cent. Cum. Pref.	all	..	14-14½
—— 4½ per cent. Deb. Stock	100	..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	½-1⅜
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100	..	87-91
—— 6 per cent. "B" Deb. Stock	100	..	71-75
Kidderminster and District Lighting and Traction, Pref....	5	..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100		91-94
—— £286,500 2nd Mort. Deb. Stock	—	..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188....	1	..	½-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	..	½-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	..	90-95

Name.	Amount paid.		Last price.
	£		£
London United Trys. (1901), 5 per cent. Cum. Pref.	10	..	6-7
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100		80-85
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100		96-98
Manila Elec. R. R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Stkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	..	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	..	4½-5
——4½ per cent 1st Mort. Deb Stock, Red.	100	..	85-90 xd
Metropolitan Elec Trams., Defd., 1,000,001-1 314 016	1	..	1/16-3/16
—— 5 per cent. Cum Pref., 500,001-1,000 000	1		⅜-½
—— ½ per cent. Deb. Stock, Red.	100	..	85-90
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	..	82½-84½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort. Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	..	103-106
Montreal Street Rail., 4½ per cent. Sterling Deb., 001-2,000 1922	100	..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10 000 and 34 001-74,000	5	..	½-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	2
—— 5 per cent. Cum. Pref.	10	..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	..	103-106
Potteries Electric Traction, Ordinary, 1-245.000	1	..	⅛-⅛
—— per cent Cum Pref., 300,001-545 000	1	..	⅛-⅛
—— per cent. Debenture Stock	100	..	93-96
Provincial Tramways Co., Ordinary, 1-24.912	10	..	4½-5
—— per cent. Cum. Pref., 1-10,000	10	..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5	..	5⅛-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	..	127-132 xd
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500	..	96½ 97½ p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	..	½-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100	..	78 82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1.600	100	..	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,961	5	..	5-5⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	..	84-87

Electric Railways.—

Name.	Amount paid		Last price.
	£		£
Central London, Ordinary	100	..	73-76
—— 4 per cent. Pref.	100	..	82-84
—— " deferred	100	..	53-56
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid) ..	100	..	100-103
City and South London, Consolidated Ordinary	100	..	39-41
—— 4 per cent Debenture Stock	100	..	101-104
—— 5 per cent. Pref. Stock '91	100	..	113-116
—— " " " '96	100	..	112-115
—— " " " '01	100	..	110 113
—— " " " '05	100	..	106-109
Liverpool Overhead, 5 per cent. Pref.	10	..	10-10½
—— Ordinary, 1-50 000	10	..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	—	..	40-44
—— Deposit Receipts	—	..	40-44

Telegraphs and Telephones.—

Name.	Amount paid.		Last price.
	£		£
Amazon Telegraph Co., 1-25,000	10	..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1 000	..	85 87
Anglo-American Telegraph Co., Ordinary	100	..	55-58
—— 6 per cent. Preferred Ordinary	100	..	98½-100½
—— Deferred Ordinary	100	..	13½-13⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	98½-101½
Chili Telephone Co., 1-44,000	5	..	7-7½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red..	100	..	85-88 xd
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	..	7½-8½
—— 10 per cent Preference, 1-6,000	10	..	16-17
Direct Spanish Telegraph Co., Ordinary	5	..	3¼-3½ xd
—— 10 per cent. Cum. Preference	5	..	8¼-9½ xd
—— 4½ per cent. Debs., 1-600	50	..	99½-102½
Direct United States Cable Co.	20	..	13⅝-14⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	..	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	..	99½-101½
Eastern Extension, Australasia and China, 1-300,000	10	..	12⅜-13⅜
—— 4 per cent. Mort. Deb. Stock, Perp.	100	..	98-102
Eastern Telegraph Co., Ordinary Stock	100	..	130-135
—— 3½ per cent. Preference Stock	100	..	84-87
—— 4 per cent. Mortgage Debenture Stock	100	..	101-104
Great Northern Telegraph Co. (of Copenhagen)	10	..	31-33
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100	..	99-101
Indo-European Telegraph Co.	25	..	54-57
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1	..	7/16-9/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	1	..	½-1
National Telephone, Preferred	100	..	107-109
—— Deferred Stock	100	..	108-110
—— 6 per cent. Cum. First Pref.	10	..	10-12
—— 6 per cent Cum. Second Pref.	10	..	10-12
—— 5 per cent. Non-Cum. Third Pref.	5	..	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	..	97½-99½
—— 4 per cent. Deb. Stock, Red.	100	..	101½-103½
Oriental Telephone and Electric Company	1	..	1 5/16-1 9/16
—— 6 per cent. Cum. Pref.	1	..	1⅛-1⅛
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	..	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5	..	6-6½
—— 5 per cent. Cum. Pref., 1-40,000	5	..	4⅜-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	98-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	..	99-102
West African Telegraph Co.	10	..	10-10½
West Coast of America, 1-30,000 and 53,001-53,008	2½	..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph ..	100	..	98-101
West India and Panama Telegraph Co., Ordinary	10	..	17/32-21/32
—— 6 per cent. Cum. 1st Preference	10	..	8⅛-9
—— 6 per cent. Cum. 2nd Preference	10	..	8⅛-9
—— 5 per cent. Debs., Red., 1-800	100	..	100-103
Western Telegraph Co., 1-207,930	10	..	13½-13⅝ xd
—— 4 per cent. Debenture Stock, Red.	100	..	99-102

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	April 1	1,251	1,3 9	- 108	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	Mar. 28	181	210	- 28	—	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	April 4	3 075	2,230	+ 845	+10,774	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Mar 29	1,0?4	.,(58	- 14	+ 520	23·53	23·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 28	6.273	5,595	+ 678	—	56½	56½	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 25	972	954	+ 8	+ 3,798	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 26	358	500	- 142	- 1,217	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	April 5	2,2 0	2,243	- 3	- 535	42	42	March 31	111,294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 1	1,476	2,557	- 1,081	—	23¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	Mar. 28	4,257	4 836	- 599	+ 4,818	98	95	,, 31	232,427	46,728,977	5,1 7 261	1·193	10 79	2,421	—
Brighton Corporation	April 5	716	1 057	- 341	- 71	17·191	17·191	,, 31	50,652	10,759,310	1,7 8,305	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 3	4 5 8	6,818	- 2,280	—	53½	51½	,, 31	265,769	66,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 4	1,324	1,335	- 11	—	19¾	19¾	,, 31	62,699	11,967,488	1,205,830	1·31	12·48	5,825	8·21
Burton Corporation	,, 5	260	315	- 55	- 686	9⅝	8½	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,86	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	April 4	163	20)	- 37	+ 32	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 4	6,054	5,564	+ 490	- 1,790	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,357	5·22a
Charing X, Euston, & Hamp. Ry	,, 4	3,2 0	—	—	—	7⅜	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 5	3,173	2 689	+ 484	+ 5,444	9	6¼	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 1	165	3 5	- 150	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. P. and L. Company	,, 2	392	503	- 116	- 468	15½	15½	Dec. 31	25,032	5,966,364	891,998	—	6·74	—	4 78
Croydon Corporation	,, 3	535	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502,408	1·08	9·76	3,125	6 67
Darwen Corporation	,, 5	241	302	- 61	- 158	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	—	—	—	—	—	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	,, 3	93	156	- 65	- 51h	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 3	4 7 0	5,758	- 1,008	+ 804	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 1	1,126	1 192	- 66	+ 2 201	22	22	May 15	57,672	15.554 905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	,, 4	858	1,170	- 301	- 235	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7 14
Glasgow Corporation	,, 4	17,640	18 956	-1,316	+16,161h	177½	169	May 31	387,381	224,063,088	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 1	215	401	- 186	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	,, 4	5,625	3,685	+2 005	+23,471	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,996	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	Mar. 21	1,443	1,471	- 28	+ 3 269	35½	35	,, 31	81,196	15 252,150	1,804,745	1·22	10·79	2,770	5·32
Hull Corporation	April 4	2 501	2,5 4	- 93	- 811	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	Mar 14	39:	414	- 23	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	April 1	129	206	- 75	—	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 1	216	307	- 61	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1,733	4 95
Lancashire United Tramways	,, 1	1,258	2 613	- 1,355	- 339	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	Mar. 23	6 207	6 673	- 465	+12,752	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5 58
Leicester Corporation	April 4	2,199	2,737	- 537	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	Mar. 28	11,276	11,251	+ 25	+ 1,919	104	104	Dec. 31	563,793	122,094,528	12.115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	April 5	1,424	1,593	- 169	- 164h	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	Mar. 2	30 045	29,023	+1,022	+ 41,824	98	98	March 31	1378,014	314,227,090	30,130 297	1·05	10 98	—	8 56
Lowestoft Corporation	April 4	138	207	- 69	—	3½	—	Sept. 30	11 079	2,622,922	343,190	1·03	7 9	2,156	6·39
Maidstone Corporation	,, 3	167	157	+ 10	—	3¼	2	March 31	5,913	1.186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 4	14,195	16 193	- 1 998	- 1 014	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 4	9,276	7,259	+ 2 017	+11 982	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 5	15,373	16,145	- 772	+ 2,595	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 4	127	—	—	—	2¾	2¾	March 31	7,709	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	Mar. 28	3,717	4,229	- 512	+ 534	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 28	692	694	- 92	+ 1 943	14½	14½	,, 31	32,421	7,760,403	772.753	1 03	10 01	1,525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·259
Portsmouth Corporation	Mar. 28	1,460	2,086	- 626	—	28½	28½	,, 31	98,911	20.668.825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	558	+ 9	- 788	13½	13½	,, 31	32,661	8,130.179	918,825	96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	25,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	Mar. 30	4,394	6,225	-1,831	+ 6 827	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78c	4·78c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	April 5	5 448	6,145	- 697	+ 2 621	65¼	65¾	March 25	276,907	73,966,299	6,804,656	898	9 767	4,174	5·94
Southampton Corporation	Mar. 25	841	849	- 7	+ 3,235	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	April 1	580	286	+ 294	- 226	9	9	,, 31	20,076	4,431,728	390,578	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	Mar. 29	1,062	1,472	- 410	- 3 566	20	20	,, 31	72,396	17,483.132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	April 2	206	—	—	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 4	787	1,034	- 247	- 439	12 68	12·43	‡ ,, 31	42,810	8,312,592	890,906	—	11·53	—	—
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,965 296	429 785	—	10 724	1,989	6·95
West Ham Corporation	,, 2	2,165	3,240	-1,075	- 1,075	14·7	14·7	,, 31	132,881	35,102,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 1	803	1,185	- 382	+ 158	20	20	,, 31	43,823	9,276,023	966,133	—	10 886	2,159	6·095

* 1905-6 figures. ‡ 1907-8 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures

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THE

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ARTIFICIAL DIAMONDS.

All the world—at least, all the scientific world—has been amused, if not exactly edified, with recent legal proceedings in connection with the assumed ability to make diamonds. If we remember rightly, there is a rather fashionable brand of champagne of the same name as the would-be maker of diamonds, and in our opinion the champagne maker at the end of his tether will probably own more saleable diamonds than will the diamond maker. But this is merely a supposition, for diamonds have been and can be made; and that is a starting point from which there is no getting away. The solution of the problem how to get size and quality may in this age of analytic and synthetic experiment come about at any moment, but, so far as we know, is not yet. The introduction of the electric furnace opened up new fields for experiment at previously unattainable high temperatures, while at the other end of the scale we have the experimental work of Dewar and others at extremely low temperatures. It is, however, with the high temperature and high pressures that the artificial production of the diamond, so far as we know such production for a certainty, is concerned, and the great high-priest of discoveries in these directions was the late Prof. Henri Moissan. At the end of last year Dr. G. F. Kunz gave a lecture to the American Electrochemical Society describing the work that had been done in this direction. He attributes the investigations to the discoveries made by Koenig, Prof. A. E. Foote, and others in regard to the "supposed" meteorite of Cañon Diablo, Arizona. We say "supposed," because more recent discoveries have shown that this and similar deposits may have been ejected from the interior of the earth. At any rate, about 1891 the study and development of the electric furnace began, especially by E. G. Acheson and A. H Cowles in America and Prof. Moissan in France, and one of the first results obtained originally in each case was the silicon compound subsequently introduced commercially as carborundum. Scientifically, this is known as silicon carbide and carbon silicide. It is the product of factories using electrical apparatus in large quantities, and is principally used as an abrasive because of its hardness. But as to our real scientific knowledge of diamond making, Mr. Kunz puts it in a few sentences. Moissan at first failed, but with the results obtained by Stanislaus-Meunier iron was found an ingredient in the ash of the natural diamond; hence iron somehow entered into the natural method of production. Ultimately the conclusion was reached that, besides solution of carbon in iron, enormous pressure must be a necessary condition for crystallising the carbon as diamond—the dense variety. The analogous case of the transformations of phosphorus under great pressure by Troost and Hautefeuille afforded a precedent. In studying how to bring about such a condition with carbon in molten iron, Moissan finally conceived his method of suddenly cooling the exterior of the crucible by immersion in water, and thereby compelling the interior mass to solidify under the immense pressure of its own tendency to expand, prevented by the solidification of the outside as the confining envelope. At last the problem was solved and the goal attained, and the dissolved carbon appeared as minute crystals of actual diamond. That is the latest scientific dictum on the subject. The experiments have been again and again repeated, always with success. Whether there is something more to be added to this by methods which seem to savour of rule of thumb rather than of scientific knowledge remains to be seen, but till full details are given we remain dubious. The refusal of M. Lemoine to conduct his experiments before scientists

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who would be capable of following the same does not raise one's estimate of the value of the secret in the envelope so zealously guarded in a London bank.

TECHNICAL EDUCATION IN AMERICA.

Sir William Preece is rendering a very useful service in giving us the impressions which he gathered on his recent tour in America. This tour embraced the leading industrial centres, where there were naturally much to be seen and not a little to be learned. It is to our advantage that the modern industrial development which, in America, has reached an unprecedented state, should be closely investigated by an engineer of such lengthy experience and wide versatility and with such a keen sense of observation and lucid description as Sir William Preece is possessed of. In the paper, "America Revisited—1907," read before the Institution of Electrical Engineers recently, Sir William gave an interesting account of the development of electrical science and industry in the States since his previous visits there. In another paper which he read before the Royal Society of Arts last week Sir William dealt with technical education in America, giving particular attention to the technical schools of the Carnegie Institute in Pittsburg, which is, indeed, a remarkable institution of its kind. Broadly speaking, technical education in America divides itself into three classes: (1) primary, (2) secondary, and (3) advanced. The first is intended to meet the requirements of workmen and foremen, and is provided in what are called trade schools. The second is for draughtsmen, designers, and supervisors, and the schools in which such education is given are designated colleges of technology. Advanced education is given only in the universities to post-graduates, teachers, engineers, architects, and manufacturers. Sir William visited the Westinghouse electrical works in Pittsburg, where he found unmistakable traces of the beneficial effect of the American training colleges. "All the heads of departments, supervisors, and inspectors are," he says, "college graduates and trained scientific assistants, and the works bear the impress of culture, science, and technical training." The system of apprenticeship in the United States, as in the United Kingdom, is now virtually a function of the past, and one of the chief endeavours of the primary technical schools is to replace apprenticeship by technical training. Sir William Preece sees no reason to lament the progress of technology in England, but he complains that the wealth of British fortunate citizens does not flow freely in the direction of educational endowments. In America it is not so much by legacy that wealth is bestowed as by the millionaire in his lifetime.

ELECTRIC SUPPLY AND METALLIC-FILAMENT LAMPS.

The paper presented to the Institution of Electrical Engineers last Thursday by Messrs. Handcock and Dykes is a valuable contribution to the temporary difficulty which station engineers are now experiencing, due to the introduction of the metallic-filament lamp. There is no question as to the ultimate advantage of these lamps to all concerned, but there is bound to be some small adjustment made in the conditions of supply in order that the benefits from these lamps may be more equally divided. For example, the authors give figures for a particular installation where the introduction of Osram lamps will reduce the annual bill for current from £524 down to £181. The lamp bill, on the other hand, will increase £80. 12s. up to £241. 16s. The net saving to the firm works out at one-third of the previous bill. We know of other cases where the saving is even a higher percentage than this. The item for lamp renewals given by the authors seem to us to be on the high side, and with the increased output of metallic-filament lamps the price per lamp is bound to come down. It is, however, the supply undertaking which now feels the pinch when the largest consumers suddenly drop their consumption by from 50 to 70 per cent. Most of these undertakings have reduced at regular intervals for the past ten years their charges for electrical energy, and in the case of municipal undertakings the present price is fixed so as to just clear capital charges when carbon lamps convert the energy into light. The idea seems to be prevalent that no municipal undertaking can ever increase its charge for current. This, of course, is quite fallacious, but it is difficult to have two charges—one for electricity to be used through carbon lamps, and the other when metallic-filament lamps are employed. It must be remembered, however, that when the 220-volt carbon lamps were introduced, station engineers offered reductions sometimes amounting to one penny per unit to induce consumers to change over from 110 volts. Hence there is some precedent for a differential charge. The other solution would be for the undertakers to supply the lamps as well as the electrical energy on an inclusive scale, which could be determined from the previous accounts for each consumer. Messrs. Handcock and Dykes suggest a modification of the old Manchester system for charging, which meets the difficulty in another way, and which will be keenly considered by all station engineers.

THE NEW CHANCELLOR OF CAMBRIDGE.

Cambridge University has conferred the highest honour which it has at its disposal upon Lord Rayleigh in electing him chancellor in succession to the late Duke of Devonshire. The new chancellor is one of the most distinguished sons of the university, where as a graduate he had a most successful career, carrying off the senior wranglership of his year. Lord Rayleigh's scientific investigations cover a very wide field, and have been directed in almost every branch of physics. In practical invention Lord Rayleigh may have been outshone by the illustrious Lord Kelvin, but his work has not been without influence on practical affairs. He is probably best known among electrical engineers for his labours in connection with standardisation, and the elaborate determinations of electrical units which he made at the Cavendish Laboratory form the basis of the legal definitions of the ohm, volt, and ampere, and have had an important influence in promoting accurate measurements in electrical engineering. Lord Rayleigh has been professor of natural philosophy at the Royal Institution, a position which he held from 1887 to 1905, in which year he was elected to the presidency of the Royal Society. He has been awarded the Nobel prize for physics, and was one of the select few to be admitted to the Order of Merit instituted by King Edward some years ago.

ELECTRIC SUPPLY PROSPECTS AND CHARGES AS AFFECTED BY METALLIC-FILAMENT LAMPS AND ELECTRIC HEATING.*

BY H. W. HANDCOCK AND A. H. DYKES, MEMBERS.

(*Concluded from page 526.*)

The two causes, both disadvantageous *per se* to electrical supply, have really a cumulative effect, as an increase in the first increases the second. They also render loss of

* Paper read before the Institution of Electrical Engineers.

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TABLE I.

COST PER C.P.-HOUR AND PERCENTAGE SAVING WITH DIFFERENT TYPES OF LAMPS.

As Compared with 8 c.p. Carbon Filament Lamps, Costing 1/- each, live 750 hours.

Type	Candle-power.	Price of Lamp.	Watt Consumption per lamp.	Assumed Life of Lamp in Hours.	Total Units used during life.	Price of Energy per unit.	During life of lamp. Total paid by Consumer (including lamp cost).	During life of lamp. Total received by Supply Company.	Total paid by Consumer per c.p.-hour	Total received by Supply Company per c.p. hour.	Amount received by Lamp Maker per c.p.-hour	Percentage saving to Consumer per c.p.-hour.	Percentage Reduction in Current sold by Supply Company per c.p.-hour	Percentage Increase or Decreased Yield to Lamp Maker per c.p.-hour
						d.	d.	d.	d.	d.	d.		Per cent	
Carbon	8	1/-	30	750	22·5	2	57·0	45·0	0·00950	0·00750	0·00200	—	—	—
						3	79·5	67·5	0·01325	0·01120				
						4	102·0	90·0	0·01700	0·01500				
						5	124·5	112·5	0·02075	0·01870				
Carbon	16	1/-	60	750	45·0	2	102·0	90·0	0·00850	0·00750	0·00100	10·50	—	50 per cent. decrease
						3	147·0	135·0	0·01220	0·01120		7·90		
						4	192·0	180·0	0·01600	0·01500		5·90		
						5	237·0	225·0	0.02000	0·01870		3·60		
Tantalum . ..	16	2/9	24	750	18·0	2	69·0	30·0	0·00575	0·00300	0·00275	39·50	60·0	37·5 per cent. increase
						3	87·0	54·0	0·00725	0·00450		45·28		
						4	105·0	72·0	0·00875	0·00600		48·53		
						5	123·0	90·0	0·01025	0·00750		50·48		
Tantalum	23	2/9	40	750	30·0	2	93·0	60·0	0·00530	0·00340	0·00191	44·20	54·0	4·5 per cent. decrease
						3	123·0	90·0	0·00720	0·00520		45·66		
						4	155·0	120·0	0·00900	0·00690		47·16		
						5	183·0	150·0	0·01060	0·00860		48·01		
Stearn series lamp ...	10	1/-	14	750	10·5	2	33·0	21·0	0·00440	0·00280	0·00160	53·00	62·5	20 per cent. decrease
						3	43·5	31·5	0·00580	0·00420		56·23		
						4	54·0	42·0	0·00720	0·00560		57·65		
						5	64·5	52·5	0·00860	0·00700		58·55		
Osram	8	3/-	10	750	7·5	2	51·0	15·0	0·00850	0·00250	0·00600	10·52	66·5	200 per cent. increase
						3	58·5	22·5	0·00975	0·00375		26·41		
						4	66·0	30·0	0·01100	0·00500		35·30		
						5	73·5	37·5	0·01220	0·00625		41·20		
Osram	14	3/-	16	750	12·0	2	60·0	24·0	0·00570	0·00228	0·00348	40·00	69·4	74 per cent. increase
						3	72·0	36·0	0·00690	0·00343		47·92		
						4	84·0	48·0	0·00800	0·00457		52·94		
						5	96·0	60·0	0·00910	0·00572		56·14		
Osram	30	4/-	40	750	30·0	2	108·0	60·0	0·00490	0·00270	0·00213	48·40	64·5	6 per cent. increase
						3	138·0	90·0	0·00610	0·00400		53·96		
						4	168·0	120·0	0·00750	0·00533		55·88		
						5	198·0	150·0	0·00880	0·00660		58·07		
Carbon	8	1/-	30	1,000	30·0	2	72·0	60·0	0·00900	0·00750	0·00150	5·25	Nil.	25 per cent. decrease
						3	102·0	90·0	0·01270	0·01110		3·80		
						4	132·0	120·0	0·01650	0·01500		2·90		
						5	162·0	150·0	0·02020	0·01870		2·50		
Carbon	16	1/-	60	1,000	60 0	2	132 0	120·0	0·00825	0·00750	0·00075	13·30	Nil.	62·5 per cent. decrease
						3	192·0	180·0	0·01260	0·01100		4·50		
						4	252·0	240·0	0·01640	0·01500		3·50		
						5	312·0	300·0	0·02020	0·01860		2·50		
Tantalum	16	2/9	24	1,000	24·0	2	81·0	48·0	0·00500	0·00300	0·00200	42·00	60·0	Nil.
						3	105·0	72·0	0·00650	0·00450		50·70		
						4	129·0	96·0	0·00806	0·00600		53·00		
						5	153·0	120·0	0·00956	0·00750		56·00		
Tantalum	23	2/9	40	1,000	40·0	2	113·0	80·0	0·00491	0·00340	0·00140	48·00	54·6	30 per cent. decrease
						3	153·0	120·0	0·00665	0·00520		50·00		
						4	193·0	160·0	0·00839	0·00690		51·00		
						5	233·0	200·0	0·01010	0·00860		51·00		
Stearn series lamp ...	10	1/-	14	1,000	14·0	2	40·0	28·0	0·00400	0·00280	0·00120	57·00	60·2	40 per cent. decrease
						3	54·0	42·0	0·00540	0·00420		59·00		
						4	68·0	56·0	0·00680	0·00560		60 00		
						5	82·0	70·0	0·00820	0·00700		60·00		
Osram	8	3/-	10	1,000	10·0	2	56·0	20·0	0·00700	0·00250	0·00459	26·30	66·5	125 per cent. increase
						3	66·0	30·0	0·00820	0·00375		38·10		
						4	76·0	40·0	0·00950	0·00500		44·12		
						5	86·0	50·0	0·01070	0·00625		48·43		
Osram	14	3/-	16	1,000	16·0	2	68·0	32·0	0·00480	0·00228	0·00257	50·00	69·4	28·5 per cent. increase
						3	84·0	48·0	0·00600	0·00343		54·71		
						4	100·0	64·0	0·00710	0·00457		58·23		
						5	116·0	80·0	0·00830	0·00572		60·00		
Osram	30	4/-	40	1,000	40·0	2	128·0	80·0	0·00427	0·00260	0·00169	55·60	64·3	20 per cent. decrease
						3	168·0	120·0	0·00560	0·00400		57·73		
						4	208·0	160·0	0·00690	0·00533		59·41		
						5	248·0	200·0	0·00830	0·00667		60·00		
The following examples show the effect of a material reduction in the cost of lamps.														
Carbon	8	-/6	30	750	22·5	2	51·0	45·0	0·00850	0·00750	0·00100	10·50	Nil.	50 per cent. reduction
						3	73·5	67·5	0·01225	0·01120		7·90		
						4	96·0	90·0	0·01600	0·01500		5·90		
						5	118·5	112·5	0·01975	0·01870		3·60		
Osram	8	1/6	10	750	7	2	33 0	15·0	0·00500	0·00250	0·00300	42·10	66·6	50 per cent. increase
						3	40·5	22·5	0·00680	0·00375		48·07		
						4	48·0	30·0	0·00800	0·00500		52·94		
						5	55·5	37·5	0·00925	0·00625		55·42		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

The figures are given for average lives of 750 and 1,000 hours.
Column 13 shows for prices of current from 2d. to 5d. per unit, the total percentage saving to be effected by substituting any of the lamps enumerated for a carbon filament 30 watt lamp, costing 1s., and having a useful life of 750 hours.
Columns 14 and 15 show how the Supply Station and Lamp Makers respectively are affected by the same change.

N.B.—The fifth and thirteenth lines should read, instead of "Stearn series lamp," "Stearn compound lamp per single element for renewal"

output a much more serious matter than to a gas company. This we deal with at greater length later. Again, the average cost of a gas service is £1 to £1. 10s., but an electric service, exclusive of meter, will not in most cases cost less than £5 to £6; whilst, if a supply be required for heating, it does not, as with gas, simply pass through the same meter, but additional expense has to be incurred for separate meters and wiring, with all its incidental complications both to the supply station and to the consumer. In fact, in the case of electrical energy, by far the greater part of the charge is due to standing charges, interest, and sinking fund, which are independent of the amount used by the consumer, the actual cost of production of the current being relatively small. In this respect electrical supply resembles much more closely water supply, where the actual water costs little and all the expense is incurred in being in a position to supply, rather than gas supply, where the actual costs of production are high as compared with the standing charges. It follows from this that if any individual consumer reduces his consumption by one half, the reduction in the amount of profit to the supply company is much greater in the case of electricity than it is with gas. Suppose that a gas and an electrical company each lose 20 per cent. of their business. From the figures above given the profit in the case of the first is £25 and in the second £53·145 per £100 gross receipts. Even assuming, therefore, that the working costs were in each case reduced *pro rata* with diminished output, which is not the case, the former loses £5 and the latter £10. 15s. of their profit, and in order to keep their dividends the same it would be necessary for the gas company to raise its price by 6·25 per cent., whilst the electrical company, to be in the same position, must increase its rate by no less than 13·4 per cent.

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Many gas engineers are of opinion that it was the introduction of slot meters and the large accession of small consumers consequent thereon which, together with the increase in gas cooking and heating, saved the gas companies when the gas mantle was introduced. With their low capital charges and low service costs they can profitably supply small consumers; indeed, the average revenue per gas consumer throughout the country works out from the Board of Trade returns at £5. 8s. In the case of one district only which we investigated recently, we found that a gas company was in possession, and paying, to the satisfaction of its shareholders, the full statutory dividend of 10 per cent. From the figures supplied to us it appeared that a large proportion of the consumers had about six lights in use, and their bills, including meter rents, did not average more than £1. 16s. per annum. We came to the conclusion that such consumers were not likely to furnish a very satisfactory load for an electricity undertaking. Some form of so-called "free wiring" would be absolutely necessary in order to supplant gas, as the interest on this, with the cost of meter and service, would come to some 12s. to 15s. per annum before any current could be supplied at all. We should like to hear the experience of other engineers in the matter of small consumers. We have made many attempts to solve the problem of economically and profitably supplying them, but we have to confess that, speaking broadly, we have not found this class of consumer remunerative.

When we came to reckon up the cost of "free wiring" repairs, renewals, cost of slot meters, services, etc., we were forced to the conclusion that under ordinary circumstances such consumers do not pay. The new lamps reduce the old 20-light consumer, who could be profitably supplied, to about the same as a former eight to ten light consumer; in other words, they reduce the demand of a profitable consumer to an unremunerative amount, so that the difficulty of finding fresh consumers likely to pay the station is increased just at the moment when they are most urgently needed. In the case of the installation previously referred to, they formerly had 686 8-c.p. lamps consuming 36,260 units per annum, at an average price of 3·47d. per unit—a fairly low rate. This made their annual account:

Total cost of current per annum	£524	0	0
Lamp renewals (1,612 lamps at 1s.)	80	12	0
Total	£604	12	0

The 25-volt Osram lamps have now been adopted throughout, but unfortunately a sufficient time has not elapsed to allow the exact saving to be ascertained. The present costs for slightly better illumination than before, at the same charge per unit, would be approximately:

12,500 units at 3·47d. per unit	£180	14	7
Lamp renewals (1,612 lamps at 3s.)	241	16	0
Total	£422	10	7

It will be seen that whilst the lampmaker now receives £241. 16s. instead of £80. 12s., the supply station only sells 12,500 where it formerly sold 36,260, or, in other words, it has lost 65 per cent. of its business, and in order to keep its profits the same would, on the average figures given a few paragraphs above, need to almost exactly double its charge for current, or, in other words, charge 6·94d. per unit. In practice, of course, the result would be different, as owing to new consumers coming on and old consumers raising their standard of illumination, such a reduction in the total output as 65 per cent. is not likely to obtain, and an increase in the price of from 10 per cent. to 15 per cent., depending on circumstances, would probably put the station in a favourable position again. Fortunately for the supply company, the installation above cited is supplied on a sliding scale depending solely on the quantity consumed, and as a matter of fact their bill will be:

10,000 units at 4d. per unit	£166	13	0
2,500 units at 3½d. per unit	36	9	0
	205	2	0
Lamp renewals (1,612 lamps at 3s.)	241	16	0
Total	£446	18	0

or an average price of $\frac{£205 \times 240}{12,500} = 3{\cdot}93$d. per unit.

Had they been charged on the maximum demand system, the price per unit would have remained at 3·47d., as the total maximum demand has been reduced in the same proportion as the total consumption. One of the directors of the company referred to above who knows but little about electricity supply, but is an able business man, exclaimed at the end of the test with the 25-volt Osram lamps, that one thing was certain—namely, the lighting companies would have to raise the price of current. If the consumer is to save money, and the lampmaker to get a higher price for his lamps, is it unfair to ask that the supply station should get a higher price for its current, or, at any rate, that the present downward tendency in the price charged should be checked? It appears to us that the time is opportune for a further consideration of the method of charging in the case of those electricity supply companies a large proportion of whose current is sold for lighting purposes, to see whether by any rearrangement it is possible, without raising the price to the average profitable consumer, to make those contribute their fair proportion who at present do not do so, and also to encourage the use of current for various purposes besides lighting, thereby extending the hours over which the station's large capital expenditure is earning interest. It is probable that nobody has done more to advance the electrical industry than Mr. Arthur Wright by his masterly exposition of the principles underlying the costs of electric supply. All interested in these matters are naturally familiar with Mr. Wright's papers on the subject, more especially the one read by him before the Institution in 1901.

The situation created by the introduction of metallic filaments only serves to lend additional force to the principles he then enunciated. Unfortunately, however, the public have not always realised the advantages that the use of the maximum demand indicator confers. In many cases stations which formerly charged on the maximum demand system have now reverted to, or offer as an alternative, the flat rate, not because the latter is a fair and equitable system, but because of the trouble in getting consumers to understand the theoretically more perfect one. In addition a lower rate is granted for current required for heating or power. The inherent absurdity of the present arrangement of differentiating between the charges for lighting and heating can best be shown by an example. A dining-room has an electric hot-plate, for instance, supplied with current from a plug near the fireplace. The plug is wired on a separate heater circuit, and above the plug is a small red lamp which serves as an indicator to tell whether the current is switched on to the hot-plate or not. This current is probably charged at 2d. per unit, and is often being used at dinner time—that is to say, on the peak of the station load. At the side of the plug is another one supplying current to two standard lamps on the mantel-shelf, the current for which being used for general lighting (and not for red lamps) is charged at 5½d. per unit. Can anything be more illogical? Why should current consumed during peak times be charged at low rates simply because it is not used for lighting? It cannot even be contended that the hot-plate in question is a long-hour consumer. Take another case, that of a small electric lift in a private house. It is only used a few times a day, generally just at the time of maximum lighting load, and yet the current used is charged for at less price than the current taken by the lamps in the hall in the same house, which run for longer hours. Surely all the current used at the same time of the day should be charged at the same price for whatever purpose it may be used.

Section 19 of the Electric Lighting Act of 1882 provides that every person shall be entitled to a supply of electricity on the same terms on which any other company or person is entitled under similar circumstances to a corresponding supply. As this particular Act relates to "the supply of electricity for lighting *and other purposes*," we fail to see why a consumer who at a certain hour requires, say, five amperes for lighting purposes should not be entitled to demand it at the same price as the consumer who requires the same amount of energy at the same time for heating purposes. Section 20 of the same Act provides that no undue preference shall be shown to any consumer. Every station

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engineer has on his books a certain number who, on a flat rate, are not paying a fair proportion of the costs of supply. On the other hand, there are also on the books a number of long-hour consumers who are contributing very much more than their fair share, so much so that in certain cases, if the short-hour consumers were dispensed with, the long-hour consumers could be supplied at a cheaper rate. Under these circumstances, can it be contended that the short-hour consumer is not receiving undue preference?

Under Section 31 of the Electric Lighting Clauses Act, 1899, undertakers may charge for electrical energy by the actual amount of energy supplied, or alternatively by such other method as may for the time being be approved by the Board of Trade, and in most orders the Board have fixed the maximum charge for any amount up to 20 units at 13s. 4d., and for each unit over 20 units 8d. In some cases the rate of 7d. is substituted for 8d. This entirely fails to meet the case of the very short-hour consumer or the man who wires his house for, say, 1,000 lights, thereby entailing a considerable capital outlay on the part of the supply company, owing to their liability to supply him at any moment, and may tender the company the magnificent sum of 13s. 4d. per quarter. Neither have either of these cases been met in the past by the maximum demand system, limited as it is by the maximum charge of 8d. per unit and the minimum of 13s. 4d. per quarter. The general reduction in accounts, due to the adoption of high-efficiency lamps, will make the position still more unsatisfactory, more especially at the point where remunerative consumers are rendered unremunerative by the change. In our view the only satisfactory system is one which is intermediate between the flat-rate system of gas charging and the fixed rental of the water companies, in the same way that the conditions controlling the cost of supply are intermediate between these of gas and water; in other words, a fixed rental in addition to the charge per unit. Attempts to carry out such a system of charging have been made in many districts, perhaps the best known one being that introduced into Manchester by the late Dr. John Hopkinson, in which the price charged depended on a fixed rental plus a proportional charge for energy. The fixed rental was determined by the number of 8-c.p. lamps, or the equivalent thereof, wired. In Manchester the system has now been abandoned, partly, we believe, because the tendency was to keep down the number of lights per house to a minimum.

A variation of this is the system which was adopted at Hastings by Mr. Andrews, and also by Mr. Ruthven Murray, of the North Metropolitan Power Company, and others. In these cases the fixed rental is based not on the number of lamps wired, but on the maximum number in use in any quarter as shown on a maximum demand indicator. At Hastings the charge was 10s. per annum for each 8-c.p. lamp of maximum demand, and in addition 1½d. for each unit consumed, as shown on the ordinary meter. As an alternative, consumers could pay a flat rate of 6d. per unit, and in addition there was a special rate for power. It will be noted that nearly every station has to give flat rates as an alternative, and also special rates for power. Indeed, many large stations, having abandoned the use of demand indicators and the maximum demand system of charging, get over the difficulty in a rough-and-ready sort of way by quoting each customer a special flat rate depending on what they consider is likely to be the nature of his demand. The difficulty here is, of course, in making one consumer who is charged, say, 5d. per unit understand why he should pay more than his neighbour, who perhaps has a smaller consumption, but is only charged 2d. per unit. This may work in a large London district where no one knows his neighbour, but it would be unworkable in a country town.

Section 31 of the Clauses Act further provides that in the event of the undertakers charging by any special method approved by the Board of Trade, any consumer has the right by giving one month's notice in writing to require the undertakers to charge him by the actual amount of energy supplied to him. The result of this is, of course, that if it pays a man to take a supply on any special system, he accepts it, whilst those at the other end of the scale who are unprofitable at a flate rate, but would be forced to pay more on a special system, naturally elect to pay a flat rate, so that any special system at a point where it would become advantageous to the company is defeated by the provisions of the Electric Lighting Acts. In addition, many engineers will make various concessions to a consumer who threatens to give up using electricity, quite overlooking the fact that it may be much more profitable to let a very short-hour unremunerative consumer go, and to replace him with a more profitable one, rather than spend more money, worth 7 per cent. or 8 per cent., on mains and plant to keep him on the circuit. Owing to the conditions that pertain, electricity when in competition with gas should be able to show a considerable advantage to long-hour consumers, while gas, on the other hand, should be able to supply very short-hour consumers at a profit where an electric supply company would possibly make a loss.

If electrical undertakings are to be helped at the present juncture by the extended use of current for power, cooking, and similar uses, in the same way that the gas stove and cooker came to the rescue of the gas companies, it is essential that the whole of the business be simplified. It must not be necessary to put in a separate meter, separate wiring, and to render two separate accounts, but, nevertheless, it is equally essential that current for power should not be sold for a low rate simply because it is for power, and the loss made good by lighting consumers. The great majority of domestic heating appliances take a current of under five amperes, and it should be possible to attach any such piece of apparatus to any convenient plug on the general house wiring. The ordinary householder will not buy an electric kettle—he will not even use it if given him free—if he has to pull the house about to put in special wiring and to pay 3s. per quarter for the rent of a second meter. Electric heating appliances could be put on the market much more cheaply than at present if the demand were greater, but there is little inducement to the makers to cheapen them under existing conditions. It appears to us that all the above difficulties, practical and theoretical, might be met if the present minimum charge authorised by the Board of Trade were made to depend on the maximum power with which any consumer should be entitled to be supplied.

Section 28 of the Clauses Act of 1899 entitles the consumer to a supply up to the maximum that may reasonably be anticipated on his premises, and why his standing charge should not be based on the number of kilowatts corresponding to that maximum instead of on an arbitrary 20 units it is difficult to see. If a suitable *maximum* figure per kilowatt were fixed by the Board of Trade for that purpose, the actual figure charged by the station could be made to correspond to the standing charges of that station, when it is clear that the charge per unit would resolve itself into production costs and nothing more. We venture to make the following suggestions for working out the system in practice: A consumer applying for a service states as at present the number and candle-power of lamps he proposes to use, say, for example, 200 8-c.p lamps. From his knowledge of the district the station manager estimates that the maximum demand he is ever likely to make on the station is, say, 3 kw., which he accordingly enters as his "contract demand." (We use the term "contract demand" for the "maximum power" referred to in Section 28 of the Clauses Act, for want of a better word to distinguish it on the one hand from the maximum demand as given during any quarter on a demand indicator, and on the other from the maximum possible demand corresponding to all lights being on at once. In practice the sum of the consumers' "contract demands" will be somewhat greater than the sum of their maximum demands as shown on their demand indicators for the heaviest quarter, but considerably less than the total of their maximum possible demands.) For the privilege of having the call at any time on power up to 3 kw. the consumer will pay per annum a fixed sum, and in addition a small charge per unit for the actual energy supplied as measured on the ordinary meter. The fixed charge represents the cost the station is put to in placing at his disposal a supply up to 3 kw., and is independent of whether he actually uses a unit or not. It is arrived at by

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dividing the sum representing the whole of the "preparation costs"—that is, all those which are independent of the actual output of the station, including, in the case of companies, a reasonable dividend—by the sum of the consumers' "contract demands." The charge per unit is intended to represent the "production cost" per unit consumed with a reasonable margin of profit.

The following examples will show how the charges would work out. A certain alternating-current station, for instance, has a maximum load of 713 kw. on the station feeders, and the sum of the consumers' "contract demands" would probably be found to be about 990 kw., depending on the nature of the load supplied.

The interest and sinking fund charges absorbed	£6,203
The rest of the "preparation costs" amounted to	4,449
Giving a total of	£10,652

This divided by 990 = £10. 15s.* as the standing charges per "contract" kilowatt demanded. The "production costs" per unit were 0·87d., say 0·95d., allowing a margin for profit. The charges would, therefore, be £10. 15s. per "contract" kilowatt demanded, and 0·95d. per unit consumed. As an illustration take two typical houses, A and B: "A" has an equivalent of 60 lamps of 8 c.p., and consumes 655 units at 5½d. per unit, the present flat rate, = £15. The "contract demand" would probably be fixed at 0·9 kw., and the charges under the new system would, therefore, be:

0·9 kw. at £10. 15s. per kilowatt	£9	13	6
655 units at 0·95d. per unit	2	11	10
Total	£12	5	4

=4·5d. per unit.

"B" has an equivalent of 55 lamps of 8 c.p., and consumes 350 units at 5½d. per unit. The present flat rate = £8. With the "contract demand" fixed at 0·9 kw. the charge would be:

0·9 kw. at £10. 15s. per kilowatt	£9	13	6
350 units at 0·95d. per unit	1	7	8
Total	£11	1	2

=7·58d. per unit.

The tramways take 360,000 units per annum. Assuming 100 kw. "contract demand" the charge would be:

100 kw. at £10. 15s. per kilowatt	£1,075
360,000 units at 0·95d. per unit	1,425
Total	£2,500

=1·67d. per unit.

Take next a shop as an example: Lamps installed, say, 20 of 40 watts each, consuming, say, 400 units per annum. "Contract demand," say, 0·8 kw. The charge would be:

0·8 kw. "contract demand" at £10. 15s. per kilowatt	£8	12	0
400 units at 0·95d. per unit	1	11	8
Total	£10	3	8

=6·11d. per unit.

As applied to a motor load, take, for example, a 10-h.p. motor giving a variable load for, say, 50 hours per week. The charge would here be as follows:

"Contract demand," say, 10 kw. at £10. 15s. per kilowatt	£107	10	0
Say 13,500 units per annum at 0·95d. per unit	53	8	9
Total	£160	18	9

=2·86d. per unit.

This consumer cannot be profitably charged at a lower figure, even on a flat rate, as he has the privilege of coming on at peak load. If, however, the consumer would agree not to work his motor during lighting hours, or, at all events, during the period covering peak load, *but not otherwise*, his rate per "contract kilowatt" demanded should be fixed as a matter of equity at, say, £5 per kilowatt. His account would then become:

"Contract demand," 10 kw. at £5 per kilowatt	£50	0	0
13,500 units at 0·95d. per unit	53	8	9
Total	£103	8	9

which represents 1·84d. per unit instead of 2·86d.

* By taking 990 kw. instead of 713 kw., the maximum load on the station feeders, the consumer gets due allowance for the diversity factor.

The question will naturally be asked, How does the station know that any consumer will not exceed the demand he has contracted for? One might reply that when some companies quote, as they do now, a different flat rate for different consumers based on what they estimate their load factor is likely to be, they back their judgment and take the risk. Although this is now done every day and appears to work to the satisfaction of the companies employing this method, we do not consider it one to be recommended. It would be preferable, therefore, to insert in every house a "limit indicator," the function of which is to throw a resistance into the circuit, and thus indicate to the consumer by a reduction in the brilliancy of his lamps when he is exceeding his contract limit. A number of methods by which such a signal can be given will doubtless occur to members, one being the use of a small armature controlled by a spring. When the predetermined limit is reached the armature rotates sufficiently to open a circuit, throwing a resistance into the main circuit. The effect of introducing this resistance is to produce an oscillatory movement, which is reflected in the lights until the consumer switches off sufficient lamps to bring him within his contract limit. If the consumer thinks that his demand is not so high as the station engineer suggests, the latter will set the instrument to a lower limit, when the contract charge will be correspondingly reduced. In the event of the consumer having underestimated his contract demand, he will soon ask for his limit to be increased, when his account will automatically increase in the same way.

The point in which this method differs from the Wright system is that the consumer can determine his own maximum, and unless he asks for his limit to be raised he knows within a little just exactly what his bill for current is to be. He cannot, as with the maximum demand system, inadvertently switch on a number of lights for an hour or so, with the result that he finds that he has a much higher bill than the previous quarter when he used the same number of units. That he had under these circumstances to pay a higher bill might be quite just, but it is precisely because the average consumer could not be got to see this that the system, admirable as it is, has been given up in many districts. On the new plan if he exceeds his demand he knows it, and has either to reduce it or to apply to the station to have his limit indicator set higher, thereby acknowledging that his requirements are greater, and, therefore, should be paid for accordingly. It appears to us that the method is one which appeals to all consumers, and its advantages to the stations are obvious. All pay their fair proportion, whether short or long hour consumers, whether the current be used in the small lamp for lighting or the large lamp for heating, the desirable long-hour consumer is encouraged, and those with a very bad load factor either pay their proportion or go off the main to make room for more profitable consumers. There is every inducement to use radiators and cooking apparatus. When an electric kettle can be bought as an ordinary article, taken home and plugged into any of the ordinary plug sockets, the demand will be such that the price will quickly come down and their use increase at compound interest rate, for as long as they are used in such a way as not to increase the load beyond the contract limit, the only charge will be the small one for so much additional current, in the case of the station above referred to, for instance, 0·95d. per unit. The contract rental will, of course, be regulated to suit the prevailing conditions, and include the ordinary meter rental, which will disappear. Special circuits and meters for heaters and motors will also be no longer necessary. If still more economical lamps are introduced, thus reducing the aggregate of consumers' contract demands, the contract rental per kilowatt will be raised. If the gradual expansion of the station reduces the cost per kilowatt of contract demand, the rental per kilowatt will be reduced.

It may be objected that in some of the examples given above the charge for current for motors appears high. The answer is, that if motors have the right to come on the mains at any time, the current consumed by them must be paid for at the same rate as the current for lighting under

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the same conditions; it is only when the motor current does not increase the peak load that it should be charged at a lower rate. It is an undoubted fact that many stations are now penalising their lighting consumers to supply current for power and heating at low rates, and if the demand for such power increases, the price as compared with the price for lighting current would have to be raised. It is not as though it were true, as is sometimes assumed for the purpose of fixing charges, that energy for power purposes is used in daylight only, and lighting current after dark. The two overlap, and it is just as reasonable to let the lighting consumer have current at a low rate, because he uses the machinery at night, when it would otherwise be doing nothing, as the day load is shut down, as to let power consumers have power current at a price which only covers the works cost. If, on the other hand, in a special case a power consumer were to undertake to use his motors only between certain hours, he would thereby enable the station, for the same capital expenditure, to supply a larger aggregate of demand, thus reducing the price per kilowatt of contract demand. He would then be entitled to charge at a lower contract rental per kilowatt.

Although in our opinion the use of a limit indicator is the best method of working the system, it is obvious that it can be dispensed with, and the contract rental arbitrarily fixed by the station, as is now being done in the case of varying flat rates, or an ordinary maximum demand indicator can be installed and the consumer informed that the contract rental will be so much, provided that the indicator does not show that the assumed contract demand has been exceeded at any period during the whole year. This latter arrangement, although at first sight similar, differs fundamentally from Mr. Andrews's and Mr. Ruthven Murray's systems in that the rental is not dependent on the demand as shown on the maximum demand indicator, but is the same each quarter of the year, this instrument being merely introduced to show whether the agreed contract demand has been exceeded. It is, however, open to the same objection referred to above—namely, that the limit may be exceeded and the contract rental thus increased without the consumer, who cannot be expected to watch his demand indicator all day, being any the wiser.

The present paper does not pretend to put forward any new facts or investigations, nor do we suggest that the subject matter is novel; our object is to endeavour to focus the present position to bring out clearly, among other things, the new factors introduced into the electrical industry by the advent of high-efficiency lamps, to show the possibilities of a heating load in a residential district, given a suitable method of charging, and to induce a thorough discussion of the subject generally, as we believe that the time has arrived when much is to be gained by a general exchange of views on the subject. The original method of charging for electrical energy was based on a false analogy with gas. During the quarter century that has elapsed since it was formulated the conditions have completely changed, and the advent of the new lamp renders it absolutely necessary that the whole question should be reconsidered. If as a result of the discussion the Institution comes to the conclusion that a change is desirable, there is no doubt that the Board of Trade would be found ready, as it always is, to bring about such alterations as it may consider in the best interests of all parties concerned.

Addendum.

Since this paper was written our attention has been called to an interesting system adopted by Mr. F. W. Long, city electrical engineer of Norwich.

Private consumers in Norwich have the option of taking a supply either at a flat rate of 4½d. or on an "assessment tariff." This tariff consists of a fixed charge of 12 per cent. upon the net assessment of the house and 1d. per unit for all current used. The system possesses many of the practical advantages of the one suggested in the paper, in that it encourages the long-hour consumer, and also the use of radiators, kettles, etc., without requiring a separate meter. Mr. Long informs us that "the result has been that people have used considerably more current and that radiators are becoming popular." He is quite satisfied with the working.

Discussion.

Mr. A. H. Dykes, in opening the discussion, said the object of the paper, of which he was one of the joint authors, being to ensure a thorough discussion of the subject, he did not propose to add much then. He merely wanted to bring out clearly two points: The advisability of alteration in the present methods of charging had been apparent to the authors for some time, and the advent of metallic-filament lamps had only accentuated the need. The whole conditions of the business had been altered, and business men would have to see how best to meet them. When a manufacturer found he could no longer supply his goods at the old prices, what courses were open to him? One was to raise his prices all round, the other, and sounder way, to rearrange them so that the great part of the increase was borne by his most unremunerative customers, thus avoiding upsetting as far as possible his best ones. At the same time he tried to open up new avenues for the sale of his goods. This was sound business, and was what the "contract demand" system endeavoured to carry out. Put the increase on the short-hour consumer, and encourage the use of current for other purposes beside lighting. The second point he wished to make clear was that the authors had no fears as regards the future of the electric supply business, if the new conditions were properly grappled with. Take the case of a consumer now getting current at 5d. per unit and paying 1s. each for his 8-c.p. carbon lamps. If he replaced them with Osram 8-c.p. lamps at a cost of 3s., the amount he could afford to pay per unit for current, without increasing the total cost of lighting, would be no less than 11·8d. and if he used Osram 14-c.p. lamps 14·6d. It was quite clear, therefore, that there was ample margin for the total cost of electric lighting to be considerably cheapened, and for the stations still to get a satisfactory price for their current. This fact must in the long run be in favour of the stations.

Mr. Arthur Wright said the authors were to be thanked for bringing the subject into discussion. The authors asked how the new lamps would affect central stations, but in his opinion it all depended on the men and the management. If the distribution of metallic-filament lamps was entirely left to the wiring contractor, for the next two or three years very little advantage would be gained, but if left to the central stations, the new lamps were likely to benefit the industry considerably. He next referred to the great advantage which the gas companies enjoyed over the electric lighting companies in the way of having no restrictions, such as fire restrictions and Government departmental rules. We made a mistake in trying to make the industry too safe. With regard to the effect of the metallic-filament lamps, he said we must not overlook the enormous new field of business which it brought into existence, especially that type of consumer who was once considered altogether outside the range of electric lighting politics. The speaker next pointed to the enormous reducing power of an increased output from the station, a fact which the authors had not sufficiently emphasised in the paper. The increment cost of extending the business was nothing like the average cost. At St. Marylebone, for instance, the average cost was 4½d., but by increasing the output 8 per cent. the average cost was reduced to 2½d. It was of the utmost importance to increase the output of central stations. We all suffered from the disadvantage of the high cost of connections to houses, which cost nearly as much per kilowatt as it did to build a power station. The present cost—£9 to £10 per service—was fatal to small consumers. He suggested that the cost might be considerably reduced by some means of overhead supply to tenements, or by means of outside tube.

Mr. H. Hirst explained that he had just handed in to the secretary of the Institution a communication in which he had compiled much historical data concerning incandescent electric lamps, and in which he had treated the metallic-filament lamp very fully in all its aspects. He felt that if his paper had been read before that of the authors', or if the latter had had it before them, their conclusions would have been different. He defended the Osram lamp, and pointed out that the 40-watt tungsten lamp gave 32 c.p. to 33 c.p. The life of the lamp was considerably higher than carbon lamps. The conditions of running stated in the paper did not exist to-day. He pointed out that the loss in the life of the Osram lamp could be very much reduced by putting a new lamp against an old one. The lamps thus paired ran very well. There seemed to be a grievance that the lampmaker was making too much money out of the metallic-filament lamp. But this lamp was such a valuable asset to the electrical industry that the least the central-station engineers could do was to contribute something to the great capital expenditure involved, and that capital was the momentary reduced revenue of the stations. There was plenty of room for fighting gas. He mentioned that 12 months ago, when it became evident that the use of the metallic-filament lamp would become generally established, he approached 15 of the leading central stations in London, and asked them if they would take over the supply of metallic-filament lamps to contractors and others. If these stations had accepted the proposal, it was intended to extend it to other stations in London and the country. This

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he considered an excellent plan for placing the sale and distribution of metallic-filament lamps on a systematic and organised basis, and well calculated to cope with gas competition. But the engineers whom he approached received his idea with cold suspicion, thinking that it was put forward solely for the benefit of the lamp manufacturer, so that it came to nothing.

Mr. C. Bottomley Smith thought the "contract demand" system would be very unpopular from the consumer's point of view. The minimum demand was tried, and had to be done away with. The question of house services was the question which would affect them if they were to make up for the probable loss of consumers already connected.

Mr. W. R. Rawlings took up the cudgels on behalf of the electrical contractor, and he said that, judging from the attack made upon the body of electrical contractors by Mr. Arthur Wright, that gentleman had had some bad experience with a "jerry" worker, or he would not otherwise have expressed the opinion that he did. Mr. Rawlings retorted upon Mr. Wright by alluding to the unsatisfactoriness of the Wright indicator, about which he had heard more bad language expressed than about anything else. He then referred to the triplicating of wiring on consumers' premises, and expressed the opinion that the practice would tend to check the development of the industry. The authors' system of charging would encourage the use of small apparatus for domestic uses. Moreover, their system was based upon sound financial grounds, and he (the speaker) quoted a number of examples where the adoption of this system had proved its financial advantage. From some data which he had collected the average consumption came out at 15 units per 8-c.p. lamp; on a two-thirds maximum demand the cost for one year would work out at 384s., while on the authors' system the cost would be 353s. for one year. He suggested that there should be some method of charging a fee for special illumination, such as was required for parties, temporary displays, etc.

Mr. F. M. Long (borough electrical engineer, Norwich), to whose system of charging the authors made reference in an addendum to their paper, gave some further particulars concerning the system adopted at Norwich, by which means every consumer was profitable to the central station. The basis of charging for private houses was fixing the standing cost on the rateable assessment of the house. He took the aggregate of the units and divided it by the aggregate of the rateable value, which came to seven units per £1 assessment. This figure was the same for a small house as for a large house. There was only one system of wires needed, there was no meter rent, and the consumer had a pretty accurate idea as to what his bill was likely to amount to. The system was started at Norwich at the beginning of 1907 with 400 consumers. Now there were 800 consumers. Mr. Long was not yet able to give results based on the later figure. Taking the first 250, he found that they increased their consumption 20 per cent.; at the same time the amount of revenue went down about 20 per cent., and the average price brought in was 3·1d. per unit instead of 4½d. per unit. He pointed out, however, that who came in first got the advantage. The system had worked well, and was looked upon as reasonable. The result was that people now used electric light all over the house instead of in special rooms as formerly. In addition they had supplied over 100 radiators. The radiators were a useful load, were used largely in bedrooms, and did not come much on the peak. He did not think the suggestion of a contract demand was as suitable as the assessment basis. Business premises had to be treated on a different basis, and here he had adopted the author's suggestion of taking the maximum demand of the place and charging £10 per kilowatt and 1d. per unit. He did not think the limiting arrangement which the authors recommended was satisfactory, and considered it would be better to include the maintenance of the lamps in the charge. A fixed charge of 1d. per unit afforded considerable scope; current for signs and advertisements could be charged at a lower rate, but the current would go through the one meter. He thought that central-station engineers should aim at getting for business premises the charge based on £10 per kilowatt and 1d. per unit, and for private houses a charge fixed upon the rateable value.

The discussion was adjourned till Thursday, April 23.

EMERGENCY OPERATIONS IN BOILER PLANT.

However well designed an ordinary steam-raising plant may be, breakdowns due to defective workmanship, bad treatment, or extraordinary causes are sure to occur from time to time, and a knowledge of how to meet such cases is necessary to anyone in charge of such plant. The most probable causes of failure connected with boilers are shortness of water, excess of pressure, and weakness of material, and the results attendant on an accident from any of these causes may be very serious indeed, not only to the boiler plant, but to life.

To avoid the first cause, it is necessary to give careful attention to the water-gauge and frequent clearing of the passages leading thereto in order to escape the rendering of false levels in the gauge glass. Before the fires are lighted in the boiler it should be made certain that the blow-off cock is closed without possibility of leakage. While the boiler is under steam the waste-pipe from the blow-off should be felt occasionally in order to see if it is hot, excess of temperature indicating a leak. Should the water-level fall out of sight in the gauge glass, there is danger of overheating the boiler tubes or plates. In slow-steaming boilers, if the water has only just disappeared, it is probable that no harm has been done, and it is possible to get up the level quickly by putting the pumps away at their fastest speed. If, however, the water has disappeared for any length of time, the boiler must be cooled as quickly as ever possible consistent with avoidance of rupturing the plates. To do this, the air-doors of the furnace should be opened wide, the back damper of the boiler entirely shut, and wet ashes should be piled on to the fire. It is a great mistake to attempt to rake out a fire, as a sudden burst of heat ensuing from the disturbance of the fire bed would probably finish the impending danger. Moreover, it is not safe where a large amount of water has escaped to pump cold water rapidly into the boiler, as this would cause a sudden contraction of the overheated part, probably resulting in rupture. After the boiler has cooled a little it will be safe to start away the feed pump until the water again shows, but it is always advisable to discontinue the use of the boiler until after a thorough inspection.

Shortage of water in a multitubular boiler, either of the marine or land type, speedily causes local heating, and probably fracture. The method described above should be followed, and as soon as danger is entirely over the fire should be drawn. It is hardly necessary to point out, after the recent Greenwich disaster, that large drums, owing to their great area of heating surfaces, are more dangerous, on account of explosive risks, than small tubes. Tank boilers of the Cornish or Lancashire type are usually provided with a fusible plug of soft metal—as, for example, an alloy of lead, one part by weight of tin, bismuth five, which will melt at 246deg. F.; or equal parts of lead and tin, melting at 256deg. F.; tin parts two, bismuth one, melting at 243deg. F.; tin three parts, bismuth one, at 392deg. F. This metal should be adjusted in composition to melt at somewhat above the temperature corresponding to the working pressure of steam in the boiler, and should be placed a little below the low-level water-line. If due to shortage of water the fusible plug becomes uncovered, it becomes overheated by the furnace gases, melts, and allows steam and priming water to blow out on the fire, extinguishing it.

Local overheating of the plates may be caused by foreign substances in the boiler, such as oil carried in by condensed water or components of meretricious boiler compositions mistakenly used in the boiler. Should signs of weakness from this cause be noticed, the boiler should be put out of action as quickly as possible. If there is serious damage owing to a boiler plate or tube giving out, everyone in the vicinity should be warned, and in extreme cases the danger of loss of life must be balanced against any chance of saving the plant.

Serious excess of pressure can only be produced when the safety valve is out of order, or when the load on the boiler is suddenly removed, as, for example, when main switchboard fuses or circuit breakers operate. To prevent the former cause, the safety valve of each boiler should be tried every day by the engineer-in-charge. Stokers who have been cautioned about excessive blowing-off at their safety valve sometimes jam it down or put additional weights on it to keep it quiet. Any man found doing this should be instantly discharged. Firemen do not seem to realise the importance of the safety valve. They have been known to hang wet overcoats and other impedimenta on the levers when deadweight valves were not in use, which constitutes an important argument in favour of deadweight valves. The boiler steam-pressure gauge should be tried frequently and compared with others to see that

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it reads correctly. Should the excess steam generated be too much for the safety valve to deal with, causing a dangerous rise of pressure, as would be the case if all the engine-room load were suddenly moved, the damper and front doors of the boiler should be immediately shut and the boiler feed started fast, preferably feeding cold water. If excess pressure from this cause is not removed immediately, there is danger of the boiler breaking away under the strain.

Weakness of parts, which is an ever-present danger, can only be guarded against by frequent inspection when the boiler is standing, and watchfulness when it is on load. The tube of a water-tube boiler that is going to split can frequently be seen to bulge slightly if it is at the bottom row of the firing doors, and this is the likeliest place for failure, inasmuch as the metal of the tube catches the hottest flame, and there is the probability of heavy internal coating due to sediment. Weeping or slight leakages from any part of a boiler when under pressure should be noted, and should be scrupulously attended to when the boiler is down. However slight the weep may be, if the water from it is caught and retained by the brickwork setting or boiler lagging, dangerous corrosion is sure to occur. Inspection of boilers for mechanical defects, such as grooving, pitting, etc., should also be made when the boiler is down.

Certain trouble may endanger the supply or quality of the steam while not damaging the boiler. Careless stoking may clog the fires. In this case the feed should be entirely checked, the fires winged or drawn to the side, the clinker and useless combustible drawn as quickly as possible, the fires re-spread, and light stoking resumed. If possible, the work should be thrown into the other boilers for a time. Foaming or priming of the boilers, due to high-water level or impurity of water, should be remedied by reducing the level of the water in the drum by means of the blow-off cock, and, if possible, checking the fires a little. A breakdown of stoker gear if hand firing cannot be resorted to, or failure of feed water, may necessitate removals of load in the engine-room even to the extent of pulling off some of the feeding circuits, until the fresh boiler can be got away. If the boiler water-level has been excessively reduced owing to failure of feed, it is not advisable to attempt to pump up again, but the foregoing instructions for overheating should be followed as soon as a fresh boiler can be got in. Cases of overheating of bearer bars, resulting in the collapse of the whole of the grate and the fire on it, have occurred, causing the immediate crippling of the boiler. The bars should, therefore, be watched during heavy loads for signs of overheating. It is the engineer's duty as far as possible to map out for himself the course of action he would take with the plant as to its disposal in the event of a breakdown of any part, interruption of supply being, of course, the last resource.

The shutting down of a boiler may involve the rapid setting to work of another. A water-tube boiler is more useful than the tank type in this respect; such a boiler of 2,000lb. of water per hour capacity has been forced from 30lb. to 180lb. pressure in 35 minutes. The same boiler took one hour to rise from zero to full pressure, the contained water being nearly boiling. With cold water—that is to say, about 80deg. F.—it took 1½ hours to get full pressure. In getting up steam rapidly the cold water in a boiler should be run off at the blow-off and hot water pumped in. The fires may in times of extreme difficulty be forced regardless of risk of boiler distortion, although this is risky. Where hot feed cannot be secured in any other way, it is good practice even with shortage of steam to blow live steam into the feed tank, if this is possible. The same course can be pursued with regard to the interior of a Lancashire boiler, though forcing may not be carried to the same extent. In the worst case possible, that of a Lancashire boiler standing cold with only a cold feed available, the best course to pursue is to give as good a fire as is safely possible and to wedge up the safety valve so that it remains fully open, the water then boiling at atmospheric pressure. Then run off the cold water which lies at the bottom of the boiler owing to inevitable defective circulation, which will be replaced by the hot water that lies over the furnace flues; pump in fresh water, heated, if possible, by the waste gases from the boiler, and as soon as vigorous steaming commences close the safety valve. This enables steam to be raised in a comparatively short time by converting the boiler into its own hot-water tank.

It is not, of course, possible to enumerate all the varied circumstances which may arise in emergency operations upon steam-raising plant, but the foregoing notes may be of some value in assisting engineers who have periodically to deal with trying conditions.

THE USE OF CRUDE MINERAL OIL AS BOILER FUEL.

Crude mineral oil—petroleum, naphtha, etc.—is obtained chiefly from North America, Russia, Roumania, and Galicia. It is a mixture of a large number of hydro-carbon combinations, and forms the basis of all benzines, gasolines, refined petroleums, and lubricating materials. Naphtha has long been used for locomotive firing and on board steamers in Southern Russia and also in America, and the increasing scarcity of coal of recent years has turned increased attention to this liquid fuel. Crude mineral oil possesses a high heating value, small volume, and burns smokelessly. The thermal value is about 11,000 calories per kilogramme, and the density about ·8. Eighty-seven parts by weight are carbonaceous and 13 parts hydrogen compounds with traces of acid.

The oil is forced by means of a steam-jet into a suitable combustion chamber, and is burnt there after it has been thoroughly mixed with air and split up into a fine spray. The mixing of the oil and air is carried out in a special three-fold nozzle for oil, steam, and air. The steam serves to warm the oil into a state of low viscosity, and to split it up into spray, as well as to suck in the necessary air and to mix the air and oil thoroughly. The oil is supplied either from a raised reservoir or from a reservoir on the floor level, kept at a pressure of one or two atmospheres. Sometimes the necessary air is supplied under pressure by means of fans or blowers, and no chimney is then required. More usually, however, the steam-jet is employed, the amount of steam being only from 3 to 5 per cent. of the steam produced. The combustion chamber requires nothing in the way of a grate or ash receptacle, but must be lined with some fireproof material. In order to start the combustion it is only necessary to provide a temporary external flame such as can be given by a wad of waste. The advantages of liquid fuel are: high calorific value, smokeless combustion, higher efficiency than with coal, rapid steam raising, small amount of attention, absence of loss through slag and ash, small storage space required for the fuel. It is a disadvantage that steam of at least two atmospheres pressure must be available for starting up.—*Elektrotechnik und Maschinenbau.*

A NOVEL FLYWHEEL FOR SLOW-SPEED PUMPS.

The pumping installation at Zwartkopjes (Rand, Transvaal) consists of 10 pumps running at 20 r.p.m. and driven by electric motors through worm gear. The pump crankshafts carry flywheels 14ft. in diameter and having concrete rims. The bosses are of cast iron, with 16 spokes made of 4in. diameter tube screwed in. The base of the rim consists of a ¼in. sheet-iron strip surrounding the spokes, and a second similar strip forms the outside of the rim. The two strips are bolted together with distance pieces between. The actual concrete rim is 13in wide and 13in. deep, and is placed between the two sheet rims, and is strengthened by four ¼in. iron wires interlaced with the distance pieces. The rim weighs 6,000lb., and the whole wheel 8,000lb. The cement is composed of one part cement, one and a half parts fine and three parts coarse quarry stone.

Something like £2,000 has been saved on the 10 wheels by making them in this way instead of in cast iron, chiefly because of the high cost of carriage.

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THE NEW GERRARD EXCHANGE OF THE NATIONAL TELEPHONE COMPANY.

(*Concluded from page 518.*)

The whole of the equipment in this exchange, as well as that in the subsidiary exchanges in the numerous hotels and other buildings connected with it, is designed for common-battery working. In other words, all the electricity required for speaking, ringing, and for giving the distinctive signals indicating that a line or junction wire is engaged, is distributed from the apparatus room. This electricity is obtained by duplicate feeders from the 200-volt circuits of the Charing Cross and Strand Electricity Supply Company. It has all to be converted into either direct current at 30 volts for speaking circuits, or into alternating current at 75 volts for the ringing circuits. Fig. 11 shows the two motor-generators, manufactured by the Western Electric Company, which deal with the speaking current.

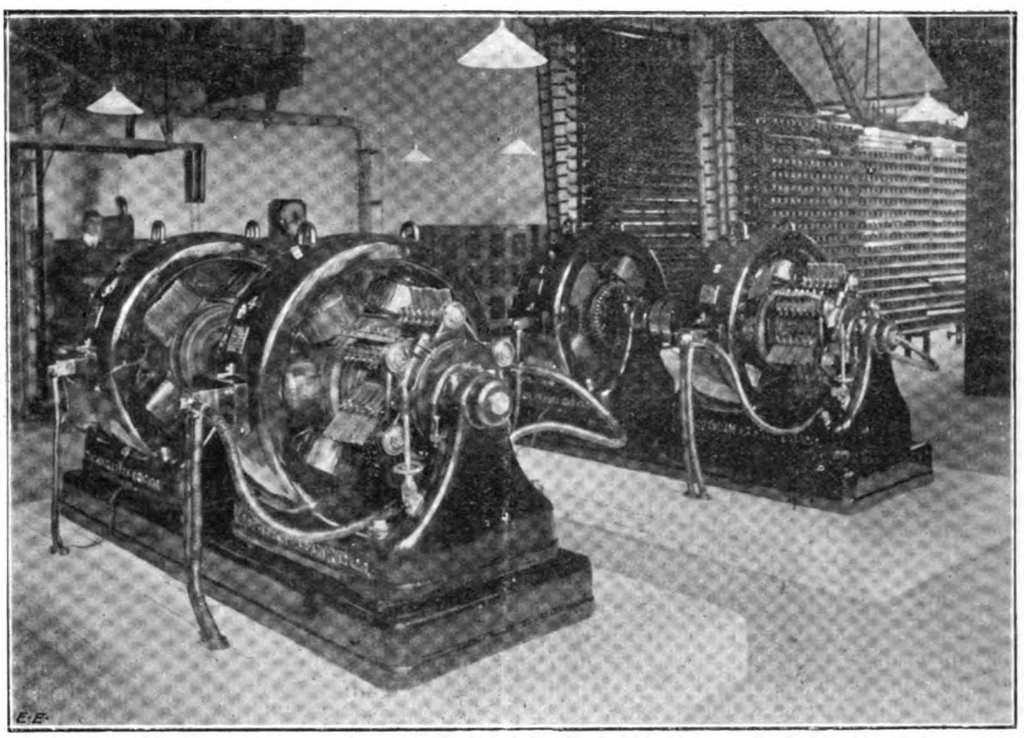

FIG. 11.—The Direct-Current Motor-Generators for the Speaking Circuits.

Each of these sets consist of a 200-volt direct-current motor, which is supplied from the public mains. The motor drives a specially constructed six-pole generator which is capable of producing 880 amperes at 30 volts. The special feature of this generator is the large number of commutator sections and the width of the brushes. This width is such that five or six segments are under a brush at one time. The object of this construction is to reduce the pulsation in the current due to commutation. The current from these machines is passed round a large choke coil as a further precaution, but we understand that the commutator construction renders this further precaution almost unnecessary. The exchange is supplied from one of these machines in parallel with the battery of Chloride accumulators shown in Fig. 12. There are 11 cells of the C.M. type in this battery, which has a capacity of 4,230 ampere-hours on the nine-hour discharge rate. The fuseboard seen at the end of the line of batteries contains fuses for the main charge

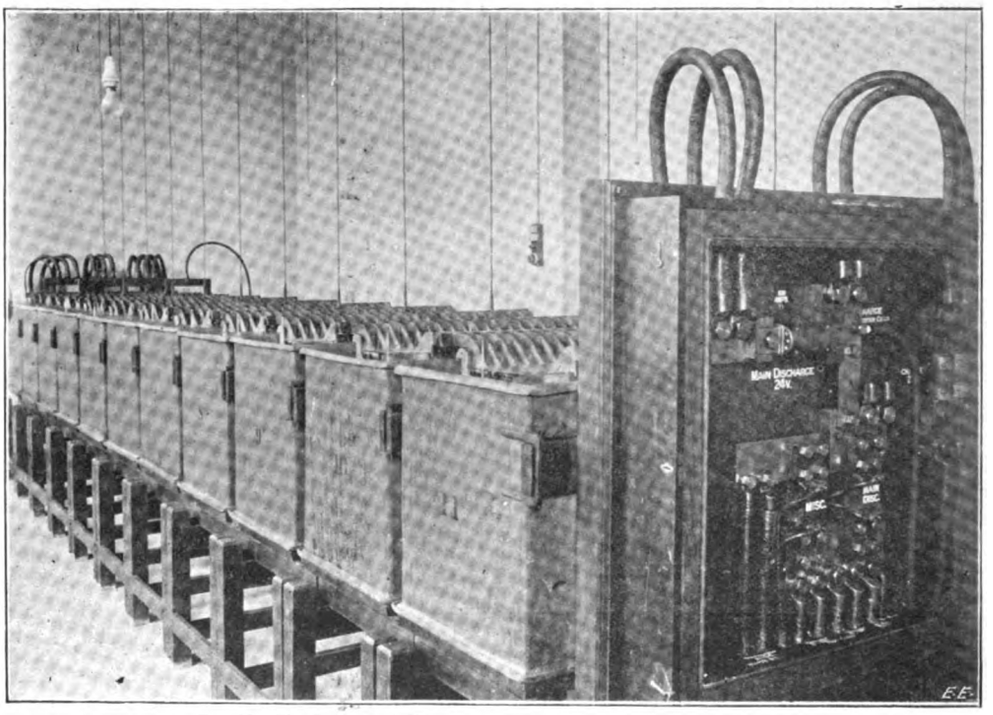

FIG. 12.—The Battery of Chloride Accumulators at the Gerrard Exchange.

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and discharge circuits, and is an additional precaution against fire. Perhaps the most interesting machines to the electrical engineer are the two ringing motor-generators shown in Fig. 13. Here again the motor is of the direct-current type, wound for 200 volts. The small alternator driven by the motor has an output of four amperes at 75 volts.

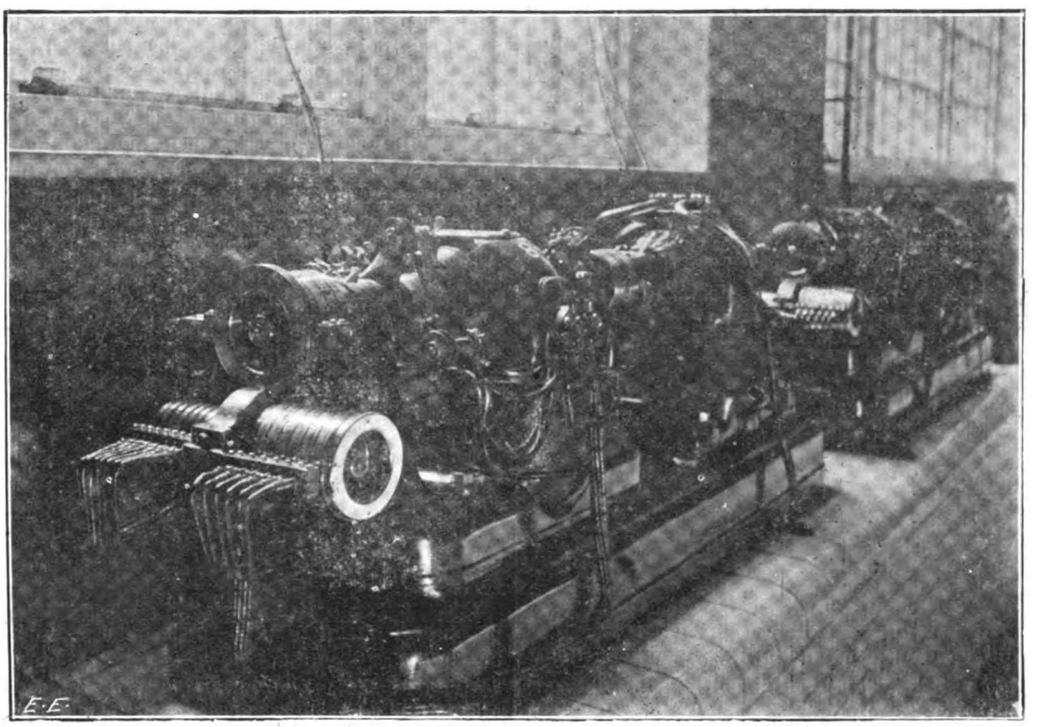

FIG. 13.—The Motor Generators for the Ringing Circuits.

One of these machines, developing four-tenths of a horse-power, supplies all the ringing current for the 10,000 subscribers and the 1,500 outgoing junctions. When one remembers the energy each subscriber was apt to put into the handle of his magneto when there was delay in getting

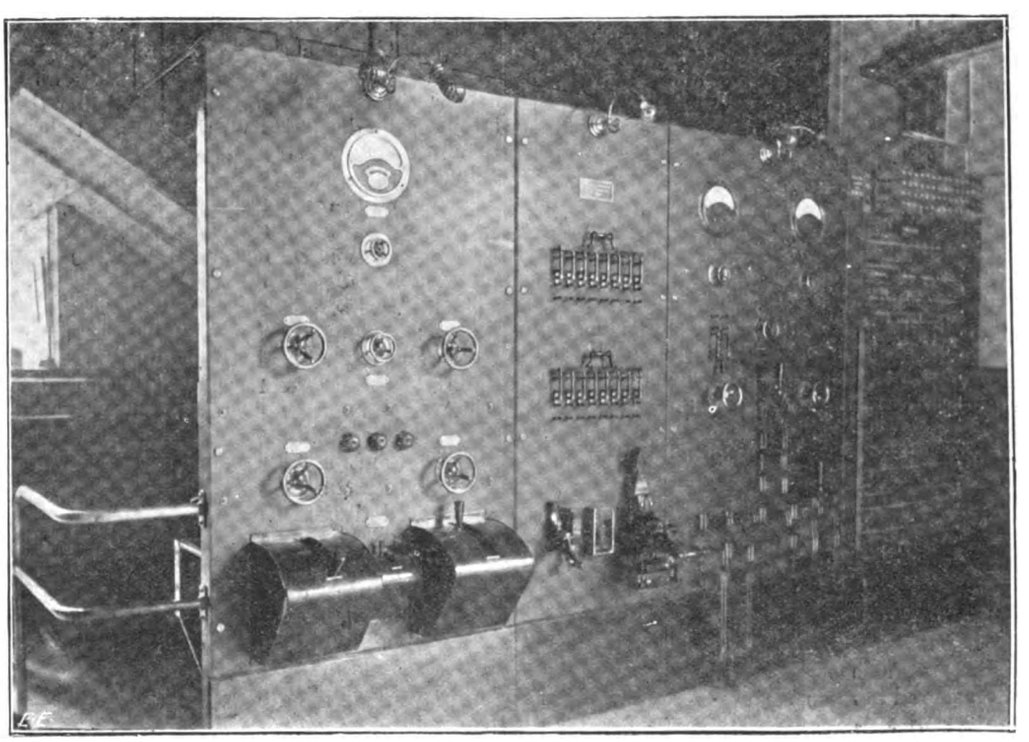

FIG. 14.—The Main Power Switchboard at the Gerrard Exchange.

connection under the old system, it is obvious that the horse-power saved by the common-battery system must be enormous. In Fig. 13 the alternator is the machine in the foreground. The first set of collector rings seen behind the brush rocker supply the ringing circuits with alternating currents. As the alternator has a speed of 1,000 r.p.m. and two poles, it follows that the frequency is about 16½ complete cycles per second. The next commutator on the spindle of the alternator which is seen in the illustration is used to break up this alternating current into periods of ringing and silence, which is found to be more effective than a continuous ring. There is also on this spindle another interrupter which gives the engaged tone. The horizontal commutators which are shown at right angles to the alternator shaft are designed for party-line ringing. These are driven by means of a worm and wheel from the alternator shaft. These two machines were also built by the Western Electric Company.

The main power switchboard in Fig. 14 is built up in four panels. The first of these controls the large generators for direct-current conversion. The second panel deals with the ringing circuits. The third panel contains the accumu-

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lator switchgear. The last panel, which, owing to want of light, is not so clear as we should like, is used to distribute speaking and ringing current to the sub-exchanges in the hotels and other large buildings which have internal telephone exchanges.

It is interesting to note that in this large exchange, dealing with 175,000 calls per day, the total energy required from the public mains, excluding lighting, averages about 130 units per day. In conclusion, we have to thank the many courteous officials of the National Telephone Company for so kindly helping in the preparation of the above description. We would particularly mention the name of Mr. W. M. France, from the head office, and Mr. F. O. Steed, the head electrician at the exchange. We understand that the architect of the building was Mr. L. Stokes, and that the Western Electric Company were sole contractors for the equipment.

HIGH-SPEED ELECTRICAL MACHINERY.*

BY GERALD STONEY, B.ENG., MEMBER, AND A. H. LAW, B.ENG., ASSOCIATE.

The introduction of electrical machinery some 25 years ago familiarised engineers with comparatively high speeds of rotation, the small dynamos of that date generally running at from 1,000 r.p.m. to 1,500 r.p.m., necessitating as a rule a belt drive to raise the speed from that of the engine to that of the dynamo. The first high-sped dynamo made for direct coupling to a steam-turbine was, we believe, designed and constructed in 1884 by the Hon. C. A. Parsons (see Patent 14,723/84). The chief features of interest as described in the patent are those which relate to the provisions to meet the centrifugal forces, the spiral end windings of the drum armature, and the construction of the commutator segments in short lengths dovetailed into steel rings with asbestos insulation.

Fig. 1 shows the construction of this dynamo; the armature is 2⅝in. in external diameter, and the core, built of very thin iron plate, is 2¼in. diameter and 8in. long. There are 50 conductors, and at 18,000 r.p.m. (the normal speed) the output was 75 amperes at 100 volts, or 10 e.h.p. The surface speed of about 206ft. per second of the armature was a great advance on previous practice, but still more unusual was the speed of alternation of magnetism in the iron of the armature, which in the absence of any but external cooling necessitated the losses in the armature being kept a minimum. Internal cooling by means of a flow of oil through a hole in the armature shaft was tried, but was in later plants discarded as relatively ineffective. Thus at a single step the ordinary speed of dynamos was increased from 10 to 15 times, which ratio it is of interest to note still fairly represents the difference in speed between reciprocating engine and steam-turbine practice for given sizes of electrical generating plants. Although at this early date in the history of the steam-turbine it was naturally the turbine that created most interest, it can safely be said that without the high-speed dynamo—in many ways quite as difficult or even a more difficult problem—there would have been no steam-turbine as we know it to-day. It will be easily understood that an entirely new set of mechanical problems had to be faced when it is mentioned that, since this early armature was 2⅝in. diameter and had a surface speed of about 206ft. per second, the centrifugal force was about 12,000 times gravity, or, in other words, every pound weight had a centrifugal force of about 5½ tons.

In this early armature the spindle was of high carbon steel to give the greatest possible strength, the diameter at the centre being 1¼in., and the bearing ½in. diameter by 3½in. long. The core is smooth, 2¼in. diameter, with notched driving discs of red fibre at each end, and on it is wound a drum winding with barrel ends, the whole being held together by binding wire to withstand the centrifugal force. The commutator is made up of sections held by dovetailed rings with asbestos insulation. It will be seen that from the first the necessity of long cores of small diameter was recognised, and it is remarkable how closely the magnetic densities, ampere-turns per inch diameter of core, and other electrical quantities agree with what we would now adopt if we were called upon to make a similar dynamo, and this is all the more remarkable as the theory of the dynamo was very imperfectly understood 24 years ago, little being known about magnetic densities, and still less about hysteresis and eddy currents. The iron available in those days for the core plates had about four times the hysteresis loss of modern armature iron, but this was probably to some extent counterbalanced by the very high periodicities, which made the hysteresis losses small in comparison to the eddy-current losses. It is interesting to note that with 80lb. per square inch pressure at the stop-valve the steam consumption of this first steam-turbine, which was non-condensing, was 129lb. per kilowatt-hour.

These armatures gradually increased in size, until in 1889 they reached the size of 60 kw. at 6,000 r.p.m., the cores being 7in. diameter and 18in. long, the output being 600 amperes at 100 volts. These early types of dynamos were all bipolar with shunt wound horseshoe magnets. The number of commutator segments were usually 12 for 50 or 65 volts, and 18 for from 80 to 100 volts, and in all but the smallest sizes there was only one complete armature turn per segment. In these plants the sparking was not at that time considered excessive at full load, though it would be considered so according to present practice; but even as early as 1885 it was recognised that it ought to be possible to avoid both sparking and shifting of the brushes by a compensating winding, and such a winding through holes in the cast-iron pole-faces (see Fig. 2) was tried, but the benefit was found to be very small, and it was not gone on with. It is now known that the reason of its want of success was that the ampere-turns of the compensating winding were only about three-quarters of those on the armature, and that, had these ampere-turns been trebled, the great improvement effected by the adoption of compensating windings in 1903 would have been accomplished some 18 years sooner.

In 1889, on account of the temporary loss of the 1884 patent for spiral drum-end connections, an armature was constructed with a series of insulated discs at each end of the core, each connected to opposite conductors, an arrangement identical electrically with the ordinary drum winding, but although it worked very well the cost and difficulty of manufacture were found to be excessive, and it was decided to adopt a Gramme armature. Besides this, it was early seen that for a given voltage a certain number of commutator segments were necessary, and that the sparking to a large degree depended on the ampere-turns in the armature, and since the Gramme armature had twice as many segments as the drum for the same number of conductors it appeared that the result should be better. Several turbo-dynamos were made with armatures of this type, the most noticeable being some of 400 kw. for 500 volts running at 2,200 r.p.m., and some of 150 kw. for the same voltage at 3,000 r.p.m. The former of these sets had two armatures to each machine, these armatures being both mounted on the same spindle with their commutators at opposite ends, and both these and the 150-kw. plants are doing good work to-day. At this time also was introduced the construction of commutator with steel rings shrunk on over mica holding the segments in place against the centrifugal force, a construction which has been universally adopted by all makers of high-speed dynamos. Also, in some cases, fan blades were fitted to these commutator rings for the purpose of both cooling the armature and also the commutator.

The chief defects of these armatures were that sparking was not reduced, owing to the large self-induction of a Gramme winding, and that the heating was excessive both on account of the difficulties of effective ventilation and also through the heating of the spindle due to its revolving in the stationary internal field of the armature. For these and other reasons on the recovery of the patents in 1894 the drum armature was reverted to with considerable improvements in detail, ventilating ducts being provided along the cores to give internal cooling, and the conductors being much more efficiently laminated. And here it may be said that in all these high-speed armatures the cores are smooth or nearly so, and the windings extensively sub-divided to prevent eddy currents. Slotted cores for

* Paper read before the Institution of Electrical Engineers.

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high-speed armatures have been used with some success, but on account of the much higher self-induction of the windings it is impossible to obtain as good results as with the smooth-core type. Slotted-core armatures have been built by Messrs. C. A. Parsons and Co. on several occasions, but results were never obtained which could in any way compare with those given by smooth or nearly smooth cores.

In some of the most recently built armatures of large size the conductors have been laid in slight grooves in the core. These grooves provide a means of preventing the conductors from moving, and the iron between the conductors reduces the reluctance of the air-gap to some extent. The conductors are held to the core by binding wire made of steel piano wire, a material which long experience has shown to combine the qualities of reliability and high tensile strength, which render it immensely superior to such material as phosphor bronze. Its magnetic properties are its one defect, but careful tests have shown that these are relatively of minor importance.

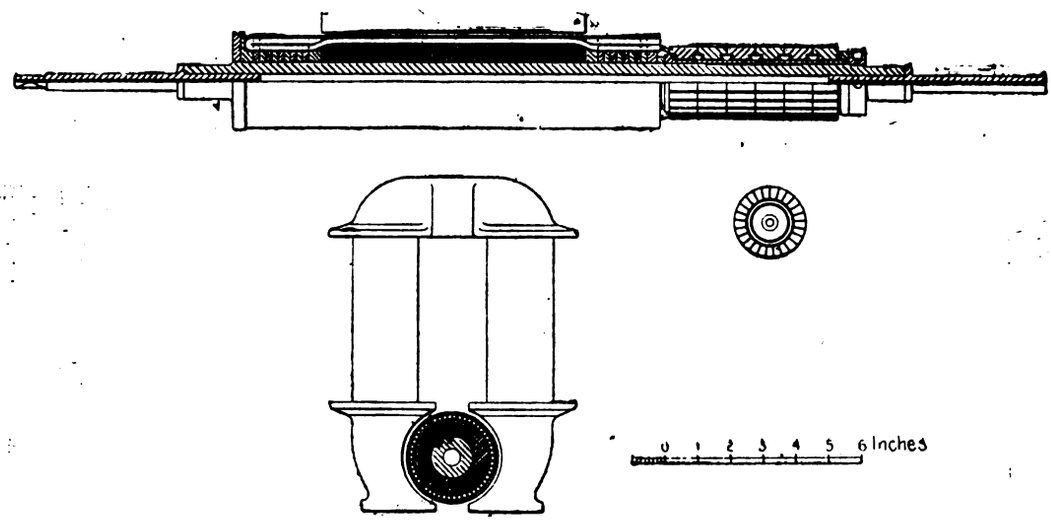

FIG. 1.—Old Type Continuous-Current Armature.

A series of experiments made about 1887 showed that in small turbo-dynamos of 12 kw. to 16 kw., running at speeds of from 8,000 r.p.m. to 9,000 r.p.m., giving periodicities as high as 130 to 150, the saving in power obtained by using phosphor bronze instead of steel wire amounted to only about 2 per cent., and a further series of experiments conducted in 1904 on two 150-kw. armatures at 3,600 r.p.m. showed a saving in power of less than 0·30 per cent. by using phosphor-bronze wire, and it is still less in larger armatures. Against this saving must be set the fact that phosphor bronze has much lower tensile strength, and therefore a larger quantity is required. Also bronze wire is liable to have occasional soft spots of weaker material, which is a fatal defect, and it is a matter of experience that steel binding wire, when properly applied, is extremely reliable. Further, the surface construction enables the insulation of the conductors to be carried out in a very complete manner, so that there is no danger of insulation being cut locally by sharp corners or projections from the core plates.

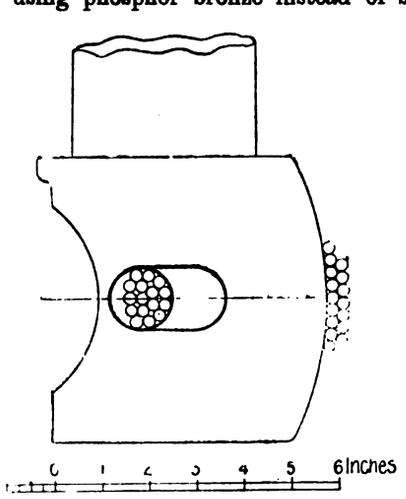

FIG. 2.—Compensating Winding made 1885. Copy of Original Drawing.

In all these earlier dynamos the magnets were of the ordinary type, generally horseshoe; but even when the size was limited to 200 kw. at 3,000 r.p.m., although the commutation was good when the brushes were properly set for the load, heavy sparking was experienced on large variations of load, such as is met with in the case of traction plants. The first method of meeting the difficulty was to automatically shift the brushes according to the load, this being effected (see Parsons and Stoney's patent 9,203/00) by moving the brush rocker by a piston controlled by a spring and actuated by the steam pressure at the inlet to the turbine. The angular movement required by the brush rocker is approximately proportional to the load, and the pressure at the inlet to a turbine is also proportional to the load, so that it is easy to arrange for the brushes to be shifted the right amount. This arrangement, however, had the defect that it was not rapid enough to meet sudden and large changes of load, and under such circumstances some sparking occurred during the interval of lag.

In the year 1891 Prof. Forbes took out a patent for a special winding to prevent distortion of the magnetic field in homopolar dynamos. The primary object of this patent is stated to be the correction of distortion in homopolar machines, but the patent is also extended to other classes of dynamo-electric machinery. In Prof. Forbes's arrangement the current passed along one pole in a direction opposite to the direction of the current in the armature under that pole, and back along the other pole. In the early Parsons arrangement of 1885 what corresponds to a ring winding was used, the active wires being embedded in the pole-face, while the return was made at the back of the poles, as shown in Fig. 2. The Forbes's specification definitely states that the number of wires on the polar

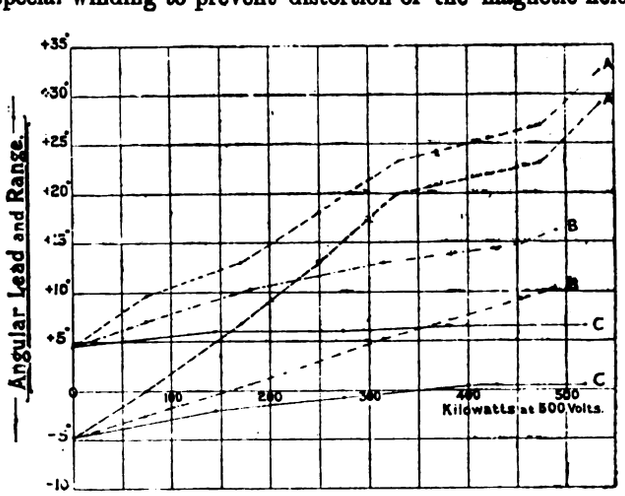

FIG. 3.—500-kw. Turbo-Generator. Brush Ranges.

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faces is half the number on adjacent parts of the armature, and this gives a number of ampere-turns in the compensating winding equal to the ampere-turns of the armature, and the want of sufficient ampere turns was the reason why the arrangement did not yield the remarkable results obtained in later years.

In 1903, after a series of experiments, Messrs. C. A. Parsons and Co. constructed a 300-kw. two-pole compensated dynamo working at 3,000 r.p.m. at a voltage of 500, in which the ratio of compensating ampere-turns to armature ampere-turns were as high as 2 4. The armature dimensions (with the exception of the commutator, which was, of course, larger) were similar to the standard 200-kw. plant of that date, and at once remarkable results were obtained, since it could be loaded up to 800 kw., and when that, and even greater loads, were thrown on and off with a circuit breaker, there was no need to alter the position of the brushes nor any excessive sparking. This type of compensating winding is now being exclusively used by the above firm, with modifications of detail only, on all their continuous-current turbo-generators. As this compensating winding, which generally is chiefly concentrated on the pole-pieces, is made with from two to two and a half times the number of ampere-turns that are on the armature, there is a very large excess sufficient both to neutralise the distorting effect of the armature windings on the field and at the same time to provide a commutating field for reversing, without sparking, the current in the coil undergoing commutation. Owing to the width of this field the brushes need not be so accurately set, and there is considerable range of sparkless commutation at all loads.

Since this method of compensating has no iron commutating pole, it has the advantage that there is no self-induction to cause time lag at sudden changes of load; as the field in the gap between the poles is entirely in air it instantly responds to changes of current in the compensating winding, and thus the sparking often seen when there is a sudden change of load with commutating poles is avoided, and the risk of a flash-over largely reduced. Also, since there is no iron to become saturated, the commutating field is always strictly proportional to the load, and thus the trouble due to saturation causing sparking at some loads and not at others is avoided. This advantage is felt still more when the dynamo is required to give varying voltages, and to commutate well at any of them without any adjustment of the compensating winding by diverters or otherwise. The effect of this compensation is clearly shown in the diagrams in Fig 3. These curves are commutation curves taken off exactly similar machines with varying amounts of compensating winding. Each pair of curves represents the limits of brush movement, expressed in degrees, within which the commutation was sparkless. The two curves marked A A were taken on a machine (500 kw.) with the compensating winding cut entirely out of action. It will be seen that only about 120 kw. could be carried without having to move the brushes, while at about 300 kw. the limits became very narrow, and beyond this no satisfactory commutation position could be found. Curves B B show the limits with a ratio of compensation—that is, ampere-turns on field to ampere-turns on armature—of 1·6. In this case 300 kw. could be carried without having to move the brushes, and though the limits narrowed slightly considerable overloads could be easily carried without sparking if the brushes were slightly rocked forward. It may be of interest to state that this machine was one of the first to be fitted with compensating winding, and as a slight brush movement was required up to full load it was also fitted with automatic brush gear. Curves C C show a sister machine to the above-mentioned with compensating of about 2 2 times the armature ampere-turns, and here it will be seen that there is no brush movement, and that were the machine used as a motor it would be quite reversible so far as commutation is concerned, and that it can carry safely heavy overloads.

The advantages of a compensating winding will easily be seen to be much more than those due to fixed brushes and better commutation, since it has enabled not only the

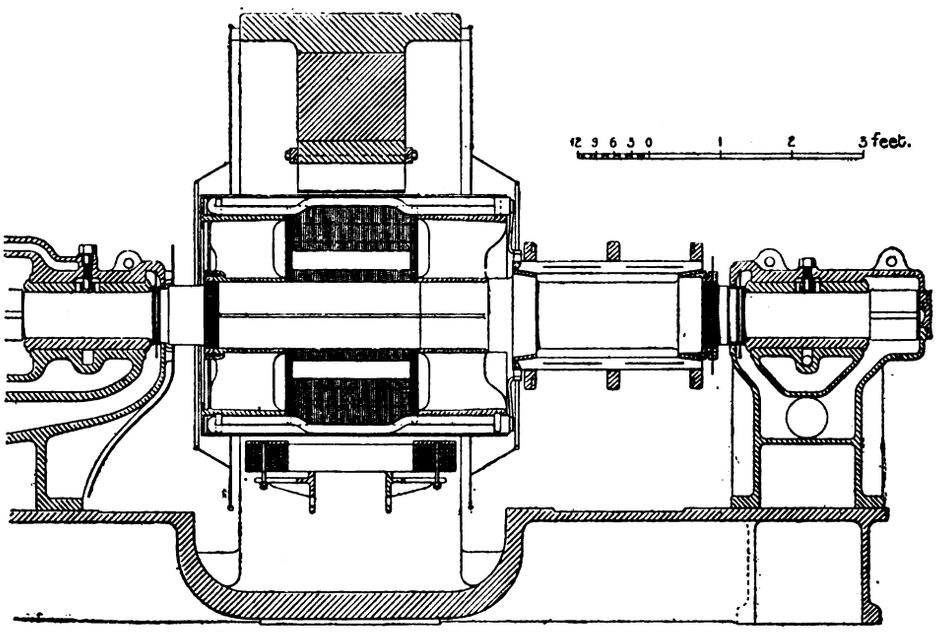

FIG. 4.—1,000-kw. Turbo-Generator, 500 volts, 1,200 revs Longitudinal Section through Dynamo.

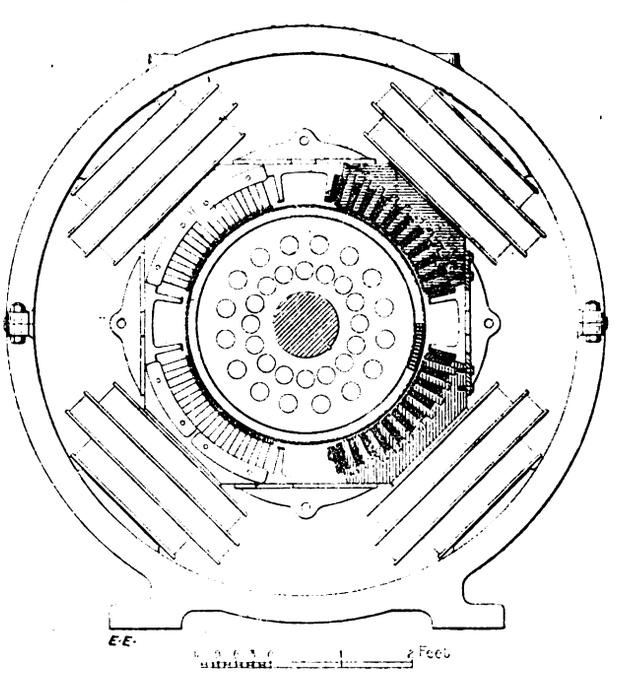

FIG. 5.—1,000 kw Turbo-Generator, 500 volts, 1,200 revs. Cross Section.

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number of segments for any given voltage to be reduced, but also the ampere-turns on a given diameter of armature to be increased. This enables a larger output to be obtained for a given speed, or, what is the same thing, a higher speed to be used for a given output. Before compensating was adopted, a 500 kw. at 1,800 r.p.m. was the extreme limit of size for that speed, and the machine would not carry more than 10 per cent. overload; now we have made a 500-kw. running at 3,000 r.p.m., or a 750-kw. running at 1,800 r.p.m., carrying 25 or 30 per cent. overload without sparking, and 50 per cent. for a short time without injurious sparking. This has enabled not only the cost of the turbine to be largely reduced, but also the steam consumption to be lowered by some 10 per cent. It may here be mentioned that no difficulty has been experienced in running these compensated dynamos in parallel with one another or with other types, although in all cases they are self-exciting, no separate exciter being used.

Figs. 4 and 5 show a 1,000-kw. dynamo for 500 volts running at 1,200 r.p.m., two of these being coupled to a 2,000-kw. turbine. These dynamos are for 500 to 600 volts, and carry an overload of 25 per cent. for two hours without sparking or undue heating. They are four-pole, the armature core being 36in. in diameter and 25in. long, with 192 conductors. The commutators have 96 segments, and are 18in. in diameter, with an effective length of 24in. Fig. 6 is a 750-kw. at 1,800 r.p.m. for 480 to 560 volts. It is a two-pole, the core being 27in. in diameter and 25½in. long, the commutator having 42 segments, the diameter being 14in. and the effective length 33in., the number of conductors being 84. This machine has very good commutation, an overload of 33 per cent., or 1,000 kw., being able to be suddenly thrown on or off without any sparking whatever being visible at the brushes. We have found brass-wire brushes running on a grooved commutator to give the best results. The grooving has the advantage of increasing the surface of contact, and of allowing the brush to better follow the irregularities of the commutator.

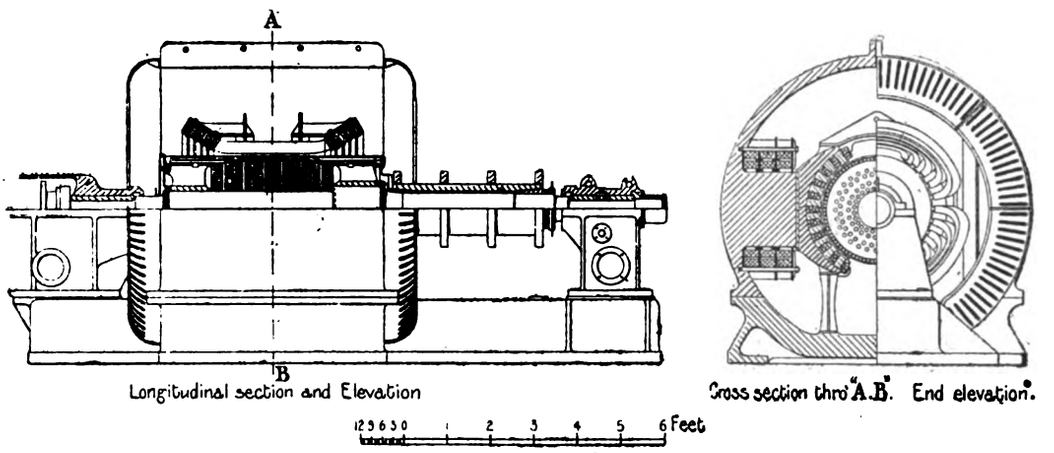

FIG. 6.—750-kw. Turbo-Generator, 480 to 560 volts, 1,800 revs.

The formation of commutator above referred to, and at present used by all manufacturers of high-speed continuous-current dynamos, was first designed in 1890 by Mr. Parsons, and has since been used with very few modifications, and a brief description of the commutator and the method of building it up may be of interest. The bars are held in place against centrifugal force by massive steel rings shrunk on over mica bushes, and the commutator as a whole is supported on cones at each end. One of these cones is so arranged that it has a small amount of liberty to slide along the shaft longitudinally, and thus allow for the expansion and contraction of the copper. In building the commutator, the bars with mica insulating strips attached are first assembled and held in place by massive clamps, or by one or two layers of steel binding wire put on temporarily. The mica for one of the rings is then built up by slipping pieces of leaf mica under large rubber bands, and when a sufficient thickness has been obtained the mica is tied in place with string and the rubber bands removed. A steel ring is then slipped on at a red heat, stops being arranged to make it take up its proper position. As it goes on it burns away the string and grips the mica so tightly that the latter can readily be turned and trimmed back

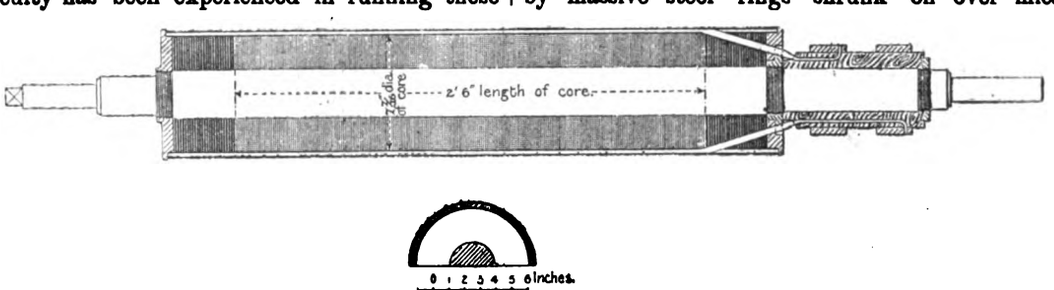

FIG. 7.—75-kw. Single-Phase Turbo-Alternator Armature.

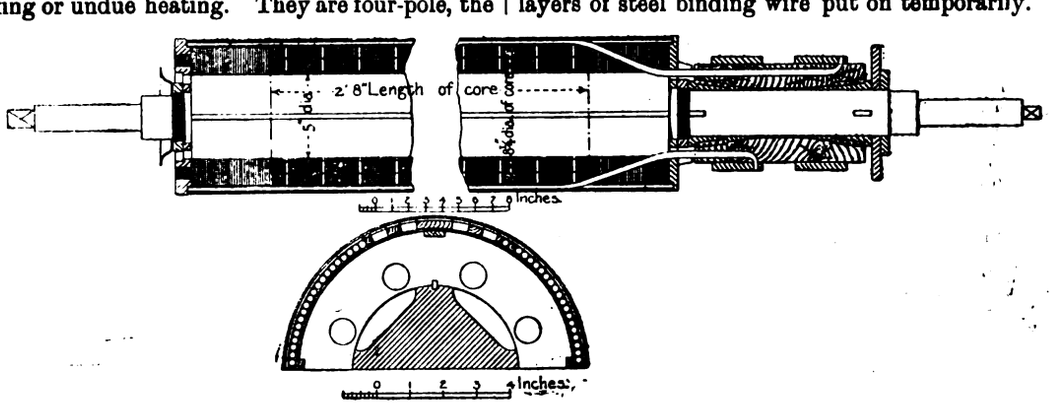

FIG. 8.—150-kw. Single-Phase Turbo-Alternator Armature, showing Air-Cooling Ducts.

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close to the ring, and presents a smooth black surface like a solid mica sleeve. In a commutator with only one section there are two of these steel rings, one at each end, but in long commutators several are required to counteract the centrifugal force tending to bend the commutator bars.

The first turbo-alternators made were for the Newcastle and District Electric Lighting Company, Limited, four 75-kw. sets being installed in 1889 in their Forth Banks station. They generated single-phase current at 1,000 volts, and being two-pole on the supply at 80 ~ ran at 4,800 r.p.m. (see Fig. 7). They were of the revolving armature type, and had a smooth core 7½in. diameter by 30in. long with a single shuttle winding held on by binding wire, the ends being brought to slip-rings. External or surface ventilation was solely relied upon for the dissipation of heat. These early alternators ran quite satisfactorily for about 15 years, when they were removed to make room for larger units. A considerable number of turbo-alternators of 150 kw. at 4,800 revolutions were made for the electric supply stations in Newcastle, Cambridge, Scarborough, and other places, having cores 8¼in. diameter and 32in. long. As it was seen, however, that in the larger alternaators more surface for the dissipation of heat would have to be provided than that presented by the exterior of the armature alone, a square 4in. spindle was employed with radial ducts and holes through the winding to pass air for cooling, as shown in Fig. 8. Many of these machines which were made between 1891 and 1894 are still running and doing good work.

In 1894 the first of a series of 350-kw. turbo-alternators were made for the Manchester-square station of the Metropolitan Electric Supply Company. These supplied single-phase current at 1,000 volts, and had four-pole revolving armatures running at 3,000 r.p.m., giving 100 ~. Their cores were 17½in. diameter by 57in. long, and were provided with 12 1¼in. holes passing the whole length of the armature, air being drawn through by a fan though no radial cooling was provided. The first few were surface-wound, but owing chiefly to the eddy currents developed in the conductors, which were large and insufficiently laminated, there was considerable trouble from heating, and they were subsequently altered to a tunnel winding with 60 holes ¾in. diameter—40 of which were filled each with one conductor. the remaining 20 holes being empty since the alternator was single-phase. We may mention that in Plate XV. of Prof. Silvanus Thompson's "Dynamo-Electric Machinery," 1896 edition, there is a section of these alternators. This type of alternator was very satisfactory for single-phase work, the largest made being of 1,000 kw. for the city of Eberfeld, in Germany. The armature core was 36in. in diameter by 48in. long, and the machine ran at 1,500 revolutions, giving 4,000 volts at 50 ~. Two and three phase alternators were also made on the same lines up to 500 kw. at 500 volts, and even 2,000 volts, the most noticeable of this type being the two 1,500-kw. two-phase 2,000-volt plants which were installed in 1904 at the Neepsend station of the Sheffield Corporation, and have run ever since without giving any trouble. The crossing of the windings at the ends, however, makes the problem of a revolving polyphase armature much more difficult, especially at high voltages, though, on the other hand, the iron loss, especially in two-pole plants, is only about one-third of what it is

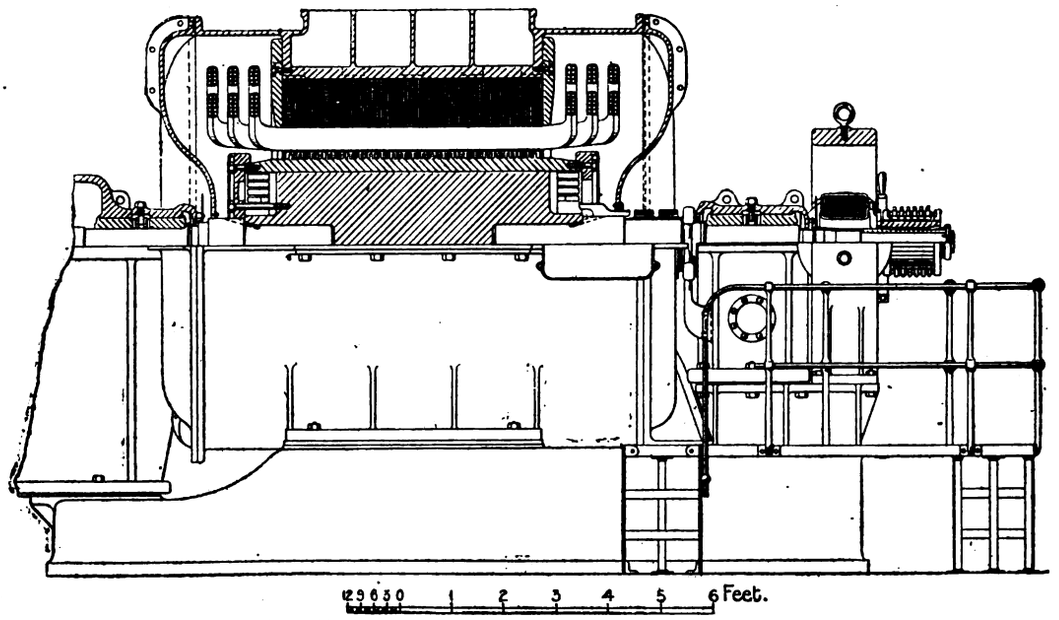

FIG. 9.—4,000-kw. Three-Phase Turbo-Alternator with Exciter, 6,000 volts.

with a revolving field. The real trouble came when it was attempted to make a 1,500-kw., 40-periodicity, four-pole, three-phase alternator with a revolving armature running at 1,200 r.p.m. and a voltage of 6,000. It was found impossible to sufficiently insulate the end windings and at the same time get rid of the heat generated, and as a result the modern type of revolving field was adopted.

In revolving-field high-speed alternators of various constructions there is comparatively little difference in the

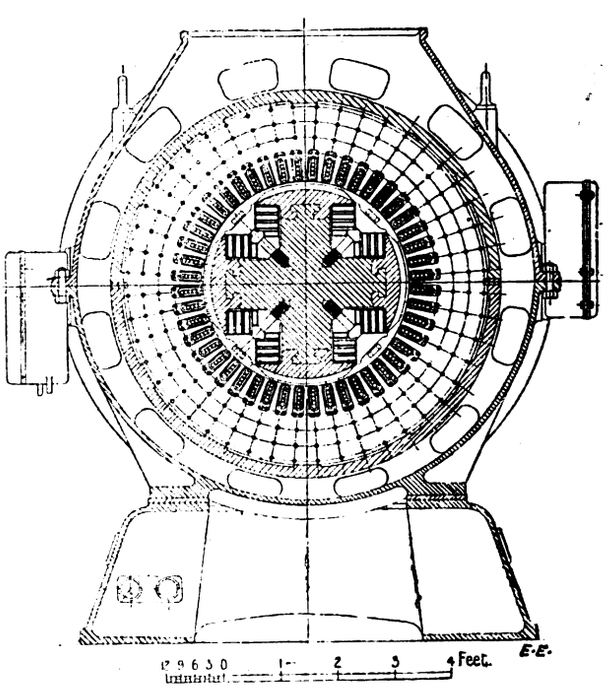

FIG. 10.—4,000-kw. Three-Phase Turbo-Alternator, 6,000 volts. Cross Section.

design of the stationary or high-tension element. This follows low-speed practice fairly closely, though the external appearance is widely different owing to the few poles, small diameters, and greater length of the high-speed plant. It has, however, been found necessary to introduce a special system of brackets or clamping rings to hold the end windings against the enormous forces developed in case of a short or other serious disturbance on a system. In the

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case of several alternators running in parallel these forces may be so great that every precaution must be taken to prevent movement of the coils, and no make of turbo-alternators has been free from trouble from this cause, though in our recent designs the coils are so stayed as to be proof against the most severe short-circuits, and the necessity of thus supporting the end windings as firmly as possible is now recognised by practically all makers of high-speed alternators.

Figs. 9 and 10 show a longitudinal and cross section of the 4,000-kw. three-phase alternators at 6,000 volts installed at Carville power station. The stators are split along the horizontal diameter and so arranged that the top half can be lifted by breaking only four electrical joints. This construction has the advantage for plants of large size that the rotor can be lifted out direct, but it rather complicates the end windings. The plant illustrated is capable of carrying 6,000 kw. for two hours, and on its official trial was loaded for half an hour up to 7,000 kw. There are under construction at the present time two 5,000-kw. alternators for 6,000 volts at 750 r.p.m. of this type for the Sydney tramways. These plants are guaranteed to do 6,250 kw. continuously, 7,500 kw. for two hours, and to have a temperature rise not exceeding 45deg. F. when run continuously at full load.

It is, however, in the rotors of high-speed alternators that the greatest diversities of design are to be found. A great deal has been said as to the relative merits of salient-pole as compared with cylindrical-type rotors, especially as regards the voltage regulation of the alternators, some designers advocating the former as strongly as others support the latter, but it appears that a much more important question is whether one design shows marked advantages mechanically over the other. Any difference there may be in the two types as regards voltage regulation is certainly small, and can easily be compensated for at small expense by other features in the design. A large number of alternators of the salient-pole type are in successful operation, and though in the early days there were mechanical troubles caused by the coils moving and chafing the insulation, modern methods of construction have quite done away with this source of trouble. The question of ventilation is of very great importance in modern high-speed plant owing to the compact nature of the machines, which is a result of the limit placed on the diameter of the revolving portions by the high speeds of revolution, and, in consequence, it becomes necessary to make the maximum possible use of the space in the rotor which is at the designer's disposal.

The material which has to be got into this space may be classified as follows: (1) iron to carry the required flux; (2) copper to carry the required magnetising current, with the necessary insulation; (3) area to carry air ventilation; (4) materials included for mechanical purposes only. The correct proportioning of these various parts with a view to a maximum of effectiveness and a minimum of cost, both for labour and material, is the problem that the designer has to face. The output of a given design may be regarded as directly proportional to the first of these—namely, the iron—and nearly proportional to the second, the copper, so that if these can be increased at the expense of (3) and (4) a valuable saving may result. This has been effected in many cases by providing artificial ventilation for cooling the iron and copper of the stationary element. The ventilation scheme which some makers have adopted is to provide a centrifugal fan at each end of the rotating element, or to make the rotor itself create the draught. Thus air is driven both round the end windings of the stator and also through the ducts in the iron core, and out through a chimney at the top of the stator casing. In other cases a separately-driven fan is provided, forcing air through both the stator and rotor of the alternator. In both these methods, or a combination of them, the extra pressure obtained results in the passing through the generators of large quantities of air, which is often arranged to be drawn from outside the building, so as to be as cold as possible, thus largely reducing the final temperature of the windings.

Among other stations, the Carville power station of the Newcastle-upon-Tyne Electric Supply Company, Limited, has a ventilation scheme with separately-driven fans, which were installed to enable the alternators to carry heavier overloads, although in the first instance the machines were run for some years with natural ventilation, and were well inside the figures guaranteed for temperature rise. Messrs. C. A. Parsons and Co. have constructed two, four, and six pole rotors of the salient-pole type. In the smaller two-pole and four-pole designs a solid construction with the coils wound in place is adopted. The two-pole rotor is thus very similar in appearance to the old Siemens shuttle or H-type armature, with which many of us must have been familiar in the early days of electric lighting. The formation is excellent mechanically, since there are few loose parts, and the solidity of the construction enables great mechanical strength to be secured. The rotor body is bored at each end, and shaft ends of special high tensile steel forced in, and then the whole turned up and accurately balanced. The balancing is done in three stages before winding the coil: (1) by ensuring static balance on a pair of carefully levelled knife-edges; (2) by careful measurement; (3) by running up about one-third above normal speed in a specially constructed balancing machine. The combination of these three methods is essential, since, while the balance may be perfect on the knife-edges, this may be the result of one end of the rotor being heavy at one side while the other end is heavy on the other. In this case, though in perfect balance on the knife-edges, there will be present when running a powerful couple travelling round at the same speed as the rotor and causing vibration. Careful measurement will generally show where weight should be removed or added to give both good static and dynamic balance, which is corrected and improved by actually running and fitting weights as required. The rotor, after being thus balanced, is put into a horizontal winding machine, and the coils wound into coil cases, which are made of tinned steel and completely soldered up after the winding is completed. The ends of the coil are brought out through a brass lip, soldered into the case, and fitting tightly round the connection to the next coil or to the slip-rings, thus making a hermetically sealed coil. Up to the date of writing there has not been a single case among a large number of machines of a coil wound on this system becoming earthed or giving trouble in any way.

(*To be continued.*)

A NEW ARC LAMP COUPLING.

In the ordinary types of arc lamp couplings fitted with strain release it is essential that the user should hoist the lamp as far as possible and then lower back slightly on the winch, thus bringing a locking gear into action and releasing the strain from the suspension rope. To subsequently lower the lamp, it must again be hoisted higher than when originally locking same in order to release the locking catches, and it can then be lowered down. To ensure safety and ease in working, it is essential that these upward and downward movements of the lamp should be definitely limited by stops in the coupling, so that the locking and release of the lamp does not depend on the skill or trustworthiness of the trimmer.

The Union Electric Company have introduced a new arc lamp coupling with strain release, in which all the movements requisite to lock or release the lamp are definitely limited by fixed stops. The lamp-trimmer hoists the lamp until he feels that he is against a stop, then lowers the lamp slightly, and the lamp is securely locked, and the strain on the suspension rope released. To lower the lamp, he again hoists until he feels the stop and then lowers There is absolutely no trial by the trimmer whether the lock has come into action or not, and, therefore, a great saving in time and far greater safety. In the new coupling the locking action is controlled by metal balls, which are used in sets of two, one forming the top and the other the bottom stop. The mechanism can be supplied either simply as a strain release, or as a combined arc lamp coupling with strain release, in which case the circuit contacts are made with massive pins. The general appearance of the combined

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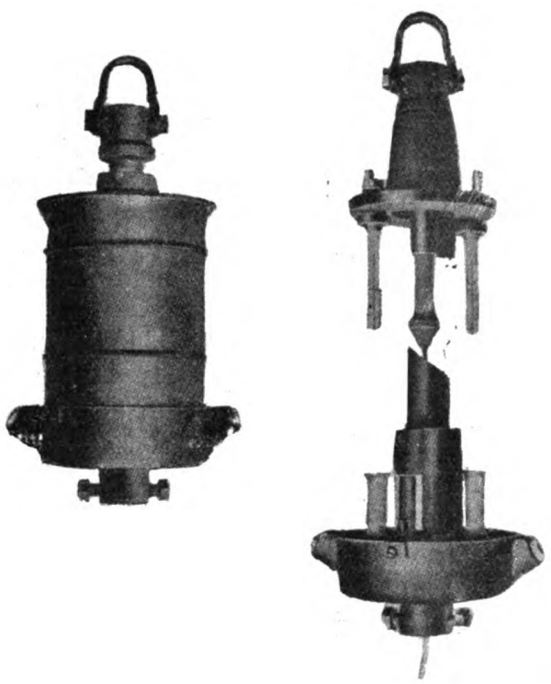
coupling and strain release is shown in Fig. 1, Fig. 2 illustrating a strain release only. As both illustrations are drawn to the same scale, the difference in size of the two arrangements is clearly visible. Figs. 3 and 4 show the coupling or strain release separated, and with the protecting enclosing cover removed. The sectional drawings (Fig. 5) show the three steps of locking strain taken off suspension cord, and lowering the lamp.



Arc Lamp Coupling and Strain Release, with Cover.

Arc Lamp Coupling and Strain Release, without Cover.

The rope clamp, *a*, in Fig. 5 supports a guide tube fitted with projecting boss, *b*, and a sleeve, *c*, which is free to turn on the guide tube, and carries the two contact pins. On hoisting the lamp the boss, *b*, enters tube, *d*, which is attached to the lamp bracket or other fixture. This tube is fitted with two longitudinal slots surrounded by a sleeve, *e*, which is free to move, and takes a bearing on screw, *f*. In this sleeve on each side are two depressions, e_1 and e_2,

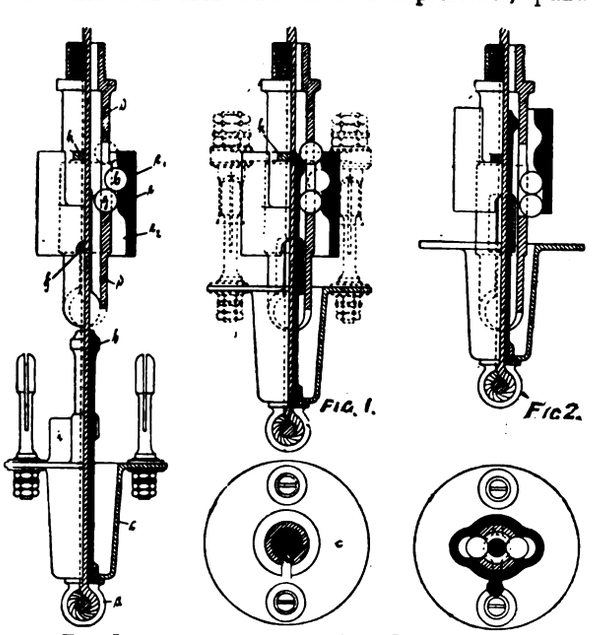


FIG. 5. FIGS. 3 AND 4.

which allow entry of balls *g* and *h* from the longitudinal slots of tube, *d*. On hoisting up the lamp (position 1) the boss, *b*, enters tube, *d*, and pushes the lower set of balls, *g*, into the depressions e^1, thus pushing the balls *h* upwards, so that the boss, *b*, having passed balls *g* meets balls *h*, which thus form a fixed stop (position 2). If the winch is now turned backwards, then boss, *b*, rests on balls *g*, and thus hoisting rope is no longer under strain. Balls *h* also fall back into the depressions e_1. During these movements the contact pins for the circuit have entered the corresponding bushes; to ensure correct polarity, tube, *d*, is suitably pointed and slotted, and a guide pin, *i*, on the lower sleeve, *c*, engages therewith. To release the lamp, the winch is again wound upwards, thus raising boss, *b*, and with it sleeve *e*, until this releases the fixed arm, *k* (position 3); owing to this movement of sleeve *e* both parts of balls drop into the lower depressions e^2. In this position the sleeve is held by the friction of the circuit contacts, until on lowering by the winch the boss, *b*, passing the two balls bears on the guide sleeve of pin, *i*, thus bringing the weight of the lamp into action to withdraw the contact pins from the bushes; sleeve *e* then falls down to its original position. The strain release without arc lamp coupling is of practically the same construction as the above description, but the friction necessary to retain the ball sleeve in its top position is in this instance produced by two flat springs acting on sleeve *c*.

The main advantages of this new type of coupling and strain release are that all movements which are in any way controlled by the action of the winch are definitely limited by fixed stops, and also the use of locking balls, whose movement is restricted to a definite path, but uncontrolled by any mechanical connections. The whole mechanism is without joints or pins which might lead to stickiness and consequent failure. If at any time it is necessary to take it apart, only one screw, *f*, has to be withdrawn to release every part of the mechanism. To ensure continuous action under all conditions of service, the various materials used and the finish of the working parts have received most careful attention. All parts carrying current are insulated throughout with mica and porcelain, and the whole coupling is enclosed in an enamelled sheet metal cover, rendering it perfectly rainproof, whilst the sleeve, *c*, fitting tight against the cover, prevents dust entering the coupling.

ELECTRIC HEADLIGHTS ON LOCOMOTIVE ENGINES.

Owing to the numerous reports the Board of Railway Commissioners has received from its inspectors relating to the poor condition of the headlights on a large number of locomotive engines in use on the different railway systems in Canada, the *Canadian Engineer* states that the Board has had under consideration the advisability of requiring the railway companies subject to its jurisdiction to use an electric system of headlights, or some other good system that will give satisfactory light for the protection of life and property. Through their secretary, Mr. A. D. Cartwright, the Board are requesting suggestions, in writing, in reference to such a proposal.

PERSONAL.

Mr. H. G. Thompson, Swansea, has been appointed electrical engineer at Neath at a salary of £200 per annum.

The Goole Urban District Council have decided to grant £52. 10s. to the ex-surveyor (Mr. F. E. Franklin) for extra services rendered in connection with the electric lighting order and other special work.

Mr. Charles Burgess, assistant tramways manager, Kirkcaldy electric tramways, has been appointed traffic manager of the Wigan Corporation tramways, at a commencing salary of £200 per annum.

As a result of the recent scholarship examination the governors of Faraday House have awarded an exhibition of 20 guineas per annum, tenable for three years, to Cyril Lancelot Underwood, of the Grammar School, Bedford.

Mr. J. Arthur Sykes, A.M.I.E.E., deputy engineer and manager of the Heston-Isleworth electric light works, is about to take up the appointment of head of the electrical department of one of the largest rolling mill, shipbuilding, and steel works in Scotland.

Mr. Benjamin Deakin, manager of the Electric Supply Co. of Victoria, in Australia, has been appointed by the Governor of Victoria, with two others, to inquire into the management, working, and maintenance of the St. Kilda and Brighton electric street railway.

FORTHCOMING EVENTS.

THURSDAY, APRIL 23.

Institution of Electrical Engineers.—At 8 p.m., at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W., adjourned discussion on Messrs. Handcock and Dykes's paper on "The Effect of Metallic-Filament Lamps on Electricity Supply Undertakings."

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE FUTURE OF THE TELEPHONE SERVICE.

SIR,—I have troubled you once or twice lately on this subject in order to point out that the measured-rate principle of telephone tariff makes for the best development and the highest efficiency of the telephone service. The application to the telephone business of the ordinary business principle of payment in proportion to service rendered is opposed only by those large users of the telephone who desire unlimited service at a flat rate, and disregard the injury to the interests of the great majority of small and moderate users which such special treatment of large users necessarily involves.

I have previously pointed out that the measured-rate principle of telephone tariff, long ago in general use throughout the United States, has recently been adopted by Germany and Austria, and is under consideration by other Continental telephone administrations. The latest official convert to the measured-rate principle is the Government of the French Republic, which, in a Bill authorising expenditure on the reconstruction of the Paris telephone system with central battery plant, speaks as follows on the general question of telephone rates:

"It should be stated that the flat-rate telephone tariff is most inequitable, as it requires all subscribers to pay the same price whatever the number of calls made by each of them. The most rational system of tariff is that in which the price is proportionate to the service rendered—that is to say, that which requires each subscriber to pay in proportion to the number of calls he makes. There is no technical reason why such a tariff as this should not be adopted in the Paris system, and efforts should be made to satisfy public opinion, which for a long time past has emphatically demanded the adoption of this measure."

It is stated in the Bill that measured rates for telephone service are already in force in France in towns of less than 80,000 inhabitants, with good results, and it is recommended that the measured-rate tariff should be adopted not only in Paris, but in the other 16 French cities of over 80,000 inhabitants.—Yours, etc.,

HERBERT LAWS WEBB.

SIR,—Mr. Webb seems dreadfully afraid of acknowledging that he is a confidential agent of the National Telephone Company, but he owned (under pressure) at Brighton that he was in that company's employ—an admission which cannot be neutralised by a quibble on the word "organisation." His meaning (carefully read) is not a repudiation of his Brighton confession, but a denial that he is a member of the company's regular staff, which, as a special service agent, he naturally is not. He receives a salary from the National Telephone Company to push their interests, and I contend that he has consequently no right to pose as an independent expert. If the rapier which Mr. Webb advises me to adopt means tactics like his own, I emphatically refuse to have anything to do with it. Mr. Webb is apt to be eloquent about his qualifications as a telephone engineer, but, so far as I have ever heard, he has never designed or constructed a telephone system, while his name is not associated with the invention of any piece of telephonic apparatus or technical improvement. If I am wrong, he will no doubt give full particulars. He boasts of being the consulting engineer to the Paris Telephone Subscribers, but it is rather the work of a commercial agent than an engineer to say, "Use So-and-so's common battery system." An engineer, according to my view, should be capable of designing things himself. It is nonsense to suggest that visiting foreign telephone exchanges can make a telephone engineer.—Yours, etc.,

A. R. BENNETT.

TELEPHONE RATES.

SIR,—With reference to the letter of Mr. J. Baumann, all telephone companies and administrations *do* sell single effective calls at public stations. It is not practicable to sell to a permanent subscriber fewer than a certain minimum number of calls in a year, for the simple reason that the fixed charges on the amount of plant maintained for a permanent subscriber, and the maintenance charges on that plant, have to be met whether calls are sent or not. It is quite probable in the course of time that the use of the telephone service may become so general, and that the telephone plant in large cities may become so extensive, that it will be practicable to put in telephones simply on a payment per call basis without any guarantee of use. This is exactly what is done with the public telephone station to-day, and with the public telephone station I suppose Mr. Baumann would not dispute that the effective call is "the unit of sold matter."—Yours, etc,

HERBERT LAWS WEBB.

ELECTRIC ROCK DRILL AND IRON SAW.

SIR,—I shall be much obliged if, through your very valuable paper, you or any of your readers will give me the address of a reliable firm manufacturing electric rock drills. Also the address of a firm making electric portable saws. The material to be sawn consists for the most part of 1½in. round iron bars.—Thanking you in anticipation, yours, etc.,

K. A. J.

[There have been a number of electric rock drills put upon the market with more or less success, but we believe the best combination at present is to place small electrically-driven air-compressors at distant parts of the quarry or mine, and to supply compressed air to drills from them. The electric transmission is much more economic than carrying compressed air to great distances. Any of the large contracting firms advertising in our paper would quote "K. A. J." for these compressors or for the iron saw.—ED. *E. E.*]

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THE TUNGSTEN LAMP.

In an address before the New York section of the American Electrochemical Society delivered by Dr. Clayton H. Sharp on March 27, and reported in the *Electrical World*, the following considerations relating to the tungsten lamp were presented.

There are certain main difficulties in producing a filament from a material like tungsten due to the fact that the tungsten is not ductile and unites readily with oxygen or carbon. Hence it is the practice to produce filaments from tungsten in the form of a very fine powder, which is held together by some sort of binder which can be removed after the filament has been squirted; this removal must leave the filament free from oxygen and carbon. A number of processes have been described. The first to appear was that of Kuzel, in which a collodial solution of tungsten is formed by making an arc between tungsten terminals under water. This solution when of the proper constituency is squirted into filaments which consist entirely of pure tungsten and water. When the water has been driven out, the tungsten particles can be sintered together by heating the filament by means of the electric current in an atmosphere containing no oxygen. In Welsbach's process an organic binder is used to make a paste which can be squirted through a die. The binder is removed by heating in an atmosphere which will oxidise the carbon and which contains at the same time sufficient hydrogen to reduce any tungsten which may have been oxidised. For the Just-Hanaman process, a very fine filament of carbon is heated in an atmosphere of chloride of tungsten and hydrogen. This results in a deposit of tungsten upon the filament or a substitution of tungsten for carbon. The carbon must afterward be removed by some such process as indicated above. In the "Z" process, a binder of collodion is used which can be made to burn itself out entirely. It has been found possible also to use binders of paraffine, which material can be removed simply by heat; or a slow-melting metallic alloy may be used as a binder, the foreign metals being driven off by heat. An account was given of the results of a manufacturer's test on 15 series tungsten lamps in which the average candle-power did not change during 2,135 hours of burning. Of these lamps, five survived at the end of the test and only three had actually burned out.

TEST OF A HIGH-SPEED DIESEL ENGINE.

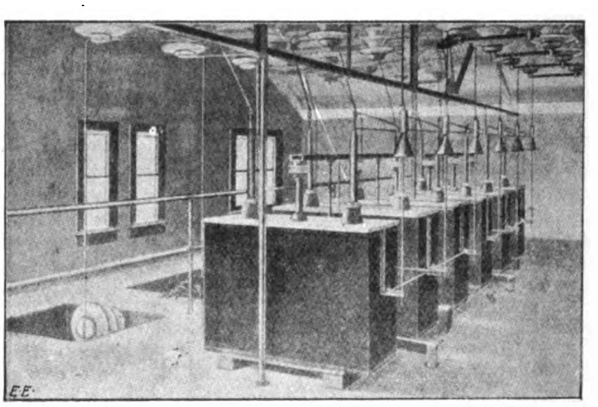
The following tests were carried out on a 300-b.h.p. 400-revolution Diesel engine made by the Augsburg Vereinigte Maschinenfabrik. It is a four-cycle, four-cylinder, vertical engine with the cranks set at 180deg. A two-throw air-pump, common to all four cylinders, is used, and there are four oil-pumps for the fuel, two lubricating pumps, and two cooling pumps. The complete weight, including a flywheel giving an irregular factor of $\frac{1}{40}$, is, roughly, 10 tons. The ordinary slow-speed engine for the same output would weigh about 66 tons. The load consisted of a direct-coupled, direct-current dynamo working on wire resistances, and whose efficiency at all loads had been previously determined.

The fuel used had a calorific value of 10,070 kilogramme-calories per kilogramme (18,100 B.Th.U. per pound). It was found that the engine could readily develop a higher output and could run at a higher speed than the rated values (300 h.p., 400 r.p.m.). A speed of 500 (for which the engine was mechanically designed) was quite allowable without much change in the rate of consumption. Thus at 250 r.p.m. the consumption of fuel was ·418lb. per brake horse-power, at 300 revolutions it was ·424lb., and at 400 revolutions ·434lb., an increase of only 4 per cent., chiefly due to the increased work done by the air-pumps. At 500 revolutions the increase in consumption was still only 7·4 per cent. On reducing the load to half full load the consumption per brake horse-power rises some 12 per cent., as against 14 per cent. in the slow-speed type. A heat balance-sheet shows that at normal full load some 31 to 33 per cent. of the heat of the fuel is converted into useful work, 32 to 34 per cent. is lost in the cooling water, and 23 to 25 per cent. in the exhaust gases.

The mechanical efficiency of the engine averaged 80 per cent. at full load between 250 and 500 revolutions and 70 per cent. at half load, figures which differ little from those of the slow-speed engine. No trouble whatever was found in the lubricating of this higher speed engine — *Elektrotechnik und Maschinenbau.*

HIGH-VOLTAGE OIL CIRCUIT BREAKERS.

An interesting installation of what is said to be the first 75,000-volt automatic oil circuit breakers that have been placed in regular service on any transmission system is described in the *Electrical World*, and is shown herewith. The circuit breakers operate without the use of series transformers, and the illustrations show the breakers as installed in the Edison Electric Company's sub-station at Fernando, Cal. In the construction of the mechanism of this switch, the movable contacts, which are of the knife-blade type, constitute part of a simple pantograph, the lower part of which is pivoted to the metal cap of the central insulator and the upper part to the end of a wooden rod, which is attached to a special porcelain insulator secured to the channel iron cross-bar. A vertical movement of the cross-bar imparts a horizontal movement to the ends of the blades as they leave the fixed



contacts, these ends being brought together in the centre of the tank in the open position of the switch. The cross-bar is carried on two guide rods placed in cast-iron frames between the tanks, as shown in the illustration, the vertical movement being given to it by means of a rocker shaft beneath the central tank, on which are two arms which are connected to the lower ends of the guide rods by means of links. The counterweight is also mounted on the rocker shaft. Coil springs for opening the breaker when tripped are placed in each cast-iron frame between the tanks, where they operate directly on the guide rods. The tanks are of iron and the covers of marble, made in two pieces, either one or both of these pieces being removable, without disturbing anything else, for the purposes of inspection.

The circuit breakers shown in the illustration are arranged for hand closing, the handle being carried loosely on the rocker shaft and connected to the closing mechanism by means of a short lever and a dog, the dog being released by the action of the tripping mechanism in the event of an overload or short-circuit. The tripping mechanism, which is very simple in design, is set in motion by any one or any two of the trip coils independently, or by all three acting together, and is automatically reset each time the circuit breaker opens.

The trip coils, consisting of only a few turns of wire of small diameter, are placed directly in the line, being suspended from the insulators of the disconnecting switches and supported by the connection to the switch terminals. The movable core has a very long creepage surface, approximately 60in., and a dielectric strength of at least three times the line voltage, thus giving the insulation of the coils a very much higher factor of safety than that of the best series transformers.

These circuit breakers have been installed in the sub-

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stations of the Edison Electric Company's 75,000-volt transmission line from Kern River to Los Angeles, and have operated automatically numerous times with success. They are manufactured by J. N. Kolman, 1,000, North Main-street, Los Angeles, Cal.

THE SPEED CONTROL OF STARTING SWITCHES.

One of the points which, apparently unimportant, exercises a considerable practical influence on the relative advantage of the adoption of direct-current or polyphase alternating-current methods of power transmission in factories, is the simplicity or otherwise of the arrangement for starting the machinery. Of late years the squirrel-cage type of induction motor has, however, come into permanent use for workshop purposes, in spite of the fact that it is not always easy to obtain uniform speed at all conditions of load, nor is it possible without considerable complication to run such a motor at two or three definite speeds in the same way that a shunt-wound direct-current motor can be controlled by means of a shunt resistance. The very fact, therefore, that alternating-current drive is becoming so much adopted is the proof that the starting gear is one of the most likely points in which trouble may be experienced if direct-current motors are used.

One of the most important things to be kept in view when designing a starting switch that shall be "fool-proof" is the necessity of arranging the switch so that the resistance cannot be cut out of circuit too quickly, thus causing the motor to take an excessive starting current, and either blow the fuses or cause an unpleasant blink in the neighbouring lights. However well the resistance may be designed with the object of giving a starting current free from kicks and producing an even accelerating torque in the motor, the whole work of the designer is rendered of little avail if the starting switch be operated too quickly.

The means taken to attain the desired end—compulsory slow starting—are many, and often ingenious. Perhaps the earliest method adopted was the dashpot. This could be easily arranged for a slow forward motion and a quick return. It was much used for liquid starters, and is still used for lift motor controllers. Another method is to fit some form of epicyclic reduction gearing between the operating handle and the contact mechanism. This necessitates some type of disengagement should the starter be required to return quickly to the "off" position. It has also the disadvantage, in common with the dashpot, that the motion is practically uniform, thus giving a comparatively long period of partial contact between the switch arm and the contacts. This is obviated by the ratchet type of starting gear, in which the switch arm is moved forward in definite steps by a vibratory motion of the starting handle. This moves the arms quickly over to full contact, thus diminishing sparking and burning, and allows it to remain there for a definite period, while the handle is being moved back for another stroke, which will move it quickly over to the next contact. This method is eminently suitable for a loose handle, allowing the switch arm to return to the "off" position quickly from any position in case of the failure of supply or of an overload. These methods have one thing in common: they protect the motor from the recklessly energetic operator by giving him something on which to waste his superfluous energy, and they take no heed of the conditions under which the motor is starting, loaded or light.

A method which prevents the starting switch or controller being removed from one contact to the next until the current has been dropped to a predetermined value has not this last-named drawback. The principle of the method is generally a coil in series with the armature controlling a detent which does not release until the current is above a certain value. This has been used for traction purposes and for large motors, but is, perhaps, rather costly for small machines.

There is a danger to which motor starters fitted with gearing between the operating handle and the contact arm are liable if the inefficiency of the gearing renders it irreversible. The resistance may be partially cut out, and the rest left in circuit with the risk of being burned out. Some starters are arranged so that the operator has to hold up a special contact until the switch is full on, or keep the operating handle in engagement against a spring, but others have no arrangement of this type.

NEW ELECTRIC DOUBLE CANTILEVER CRANE AT LIVERPOOL.

The members of the Liverpool and District Electrical Association, by the kind permission of Mr. G. Hughes, chief mechanical engineer to the Lancashire and Yorkshire Railway, paid a visit to the new electric cantilever crane recently erected in that company's North Mersey Goods Station, Bootle, on Saturday, April 11. It is a well-designed and imposing structure, costing £10,000, manufactured by Messrs. C. and A Musker, of Tue Brook, the electrical equipment being supplied by Messrs. Dick, Kerr, and Co., and has been built to meet the increasing growth of business.

The crane is of the cantilever type, and the total weight is about 150 tons. It runs on 14 wheels, on a track of about 540 yards long and about 10 yards in width, and having a clearance height of 30ft. can not only lift and stack goods to shortly within that height, but can move up and down the immense goods yard with ease, passing over goods, wagons, and locomotives. As it has a cross traverse of about 172ft., the crane can pick up a load and deposit it at any point within an area of about 31,000 square yards, thus having a very wide field of operation, and only occupying a very small floor space. Two motors of 90 h.p. each are provided for lifting and longitudinal travelling respectively, and a 25-h.p. motor for cross travelling; the lifting speed being about 90ft. per minute, longitudinal travelling about 400ft. per minute, and cross travelling about 600ft. per minute, and more than fulfils all expectations.

The visitors had an opportunity of seeing the crane in motion, and were quite pleased with the ease of operation and control. Current is obtained from the company's Formby power station, a portion of the electrified line, which is running near, being tapped for the purpose. Direct current at 600 volts is taken from an overhead conductor by means of two ordinary trolley poles, trailing in opposite directions. The party, who were accompanied by the hon. secretary and treasurer, Mr. Samuel Frith, were exceedingly gratified with the visit, having spent a most interesting time, due in no small measure to the kindness and attention of the company's local mechanical engineer, Mr. A. W. Cunliffe, also of Inspector Roberts, of the electrical department. In conclusion, it might be added that the erection of this truly fine specimen of engineering work is no doubt due to the up-to-date and energetic policy pursued by Mr. John A. F. Aspinall, the company's general manager, in which he is ably assisted by their local goods manager, Mr. W. J. Carmichael.

THE RESISTANCE OF EARTH CONNECTIONS.

Some interesting tests on the resistance of iron gas-pipes driven into a clay loam soil, made by Mr. J. L. R. Haden at Schenectady, are described in a recent American Institute of Electrical Engineers' paper. The pipes were 2½in. in diameter, and were driven into a lawn with 15·75ft. between pipes I. and II., and 7·4ft. between II. and III. The pipes I., II., and III. were driven in to a depth of 3·75ft., 2·75ft., and 3 1ft. respectively. The resistance was measured with an alternating current at 120 volts and 60 ~, the return earth connection being the city water-pipe system (which was found to have a resistance less than ·01 ohm, and so was neglected). Readings were taken at irregular intervals, but generally every day, the variation during a day being found very small. Fig. 1 shows the variation in the resistance (as indicated by the amperes passed at 120 volts) during 1905, 1906, and 1907. Fig. 2 shows the variation from September, 1906, to January, 1907, to an enlarged scale, together with the corresponding average daily temperature and the rainfall.

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The curves show very plainly the sudden rise of conductivity at rainfall, and the gradual decrease during the following dry period. The maximum of conductivity occurs in July and August. It seems that the increase of conductivity of the moisture at high summer temperature amounts to more than the increase of moisture during the wet but cooler spring season. The minimum of conductivity is towards the end of March. Since thunderstorms

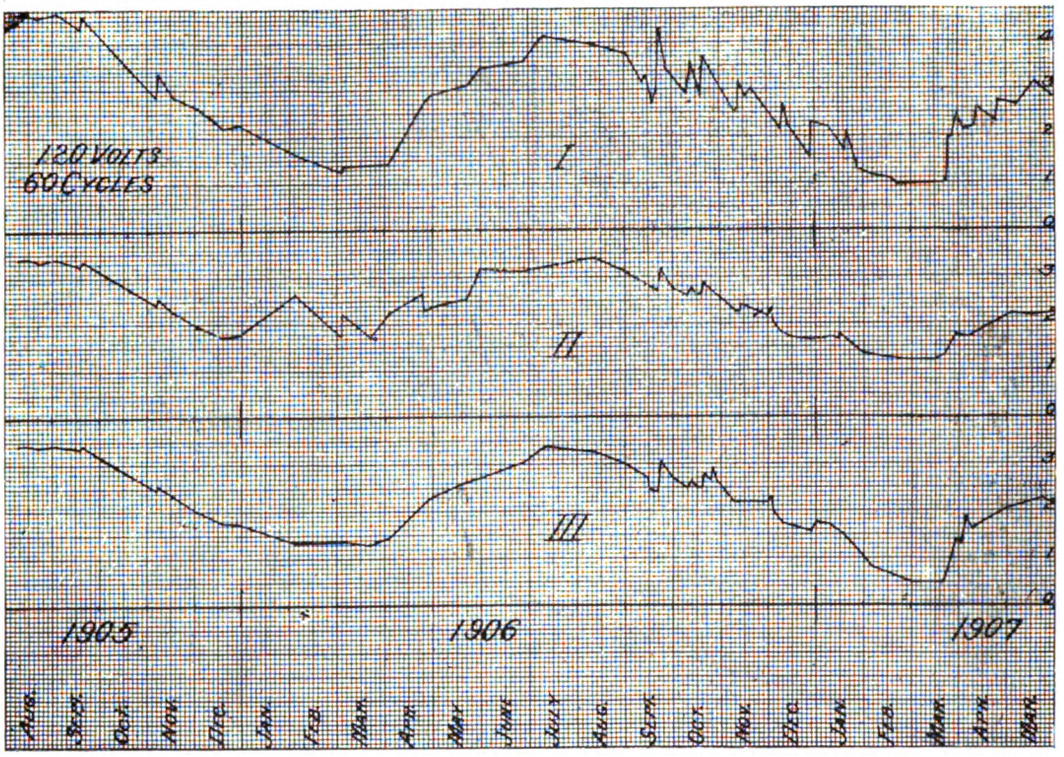

FIG. 1.

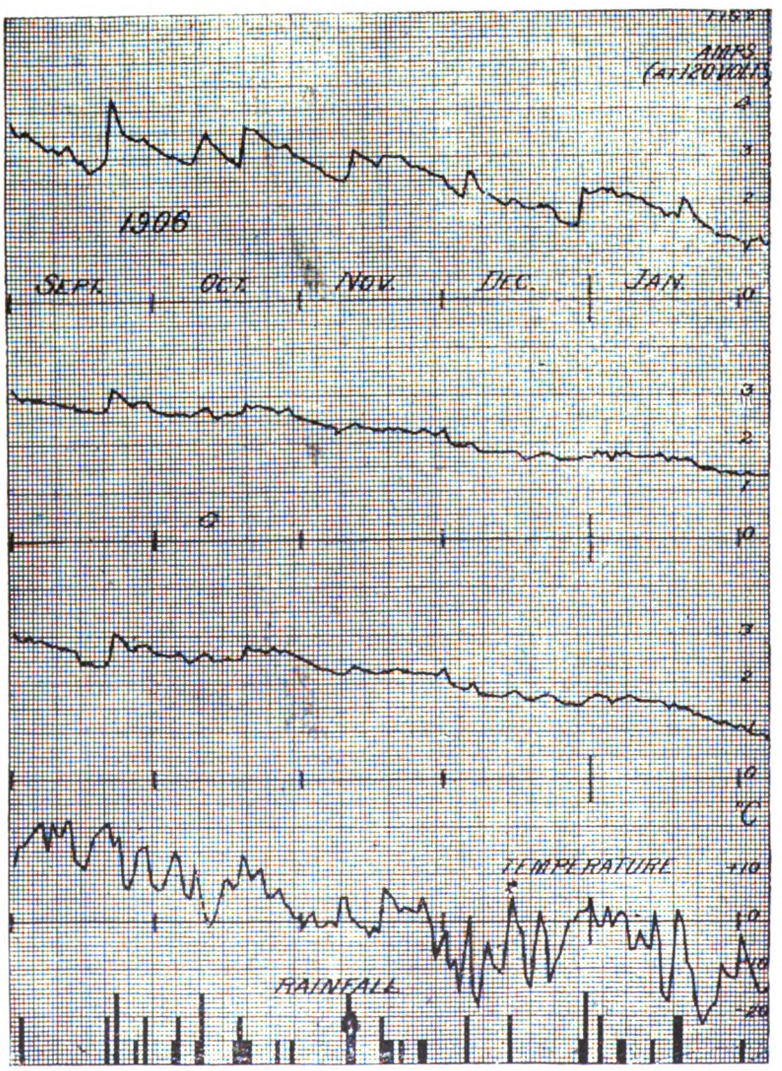

FIG. 2.

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occasionally occur before this period, this feature requires serious consideration.

Interesting is the great difference between the three grounds, although closely adjacent to another, shown in the curves, from which it seems that gas-pipe grounds are permanent at least for some years, but show a marked annual variation, the conductivity greatly decreasing during winter. But, against expectations, even at the winter minimum, a very appreciable conductivity is left. The most important conclusion is, however, that such grounds show very great individual difference in their annual variation, even when closely adjacent to each other. This matter requires a further and more extended investigation, which has been started, and will be reported upon at a future time.

An interesting and useful feature observed was that by the passage of an alternating current through the pipe into the ground, the conductivity gradually increased; for instance:

Circuit closed at noon:

0	hours after:	3·40	amperes at	120 volts.
7	" "	3·90	"	"
9	" "	4·33	"	"
22	" "	4·42	"	"
43	" "	4·50	"	"
52	" "	4 69	"	"
75	" "	4 78	"	"
103	" "	4 74	"	"
120	" "	4·73	"	"

Circuit opened at noon:

0	hours after:	4·73	amperes at	120 volts.
7	" "	4·02	"	"
23	" "	3·62	"	"

The tests show that at least during the period of observation of nearly three years the gas-pipe earth showed no permanent change, but merely periodic variation with the seasons. The tests are to be continued on a larger scale.

THE DEVELOPMENT OF WATER POWER IN CANADA.

An interesting paper was recently read in New York by Mr. Cecil B. Smith on the development of water power, especially in connection with electrical work. This development has been of very recent occurrence. Twenty years ago industries went with the water power and located where it could be found and best developed. To-day water power is developed and transmitted in the form of electric energy to distributed points, and at a greater or less distance from the falls.

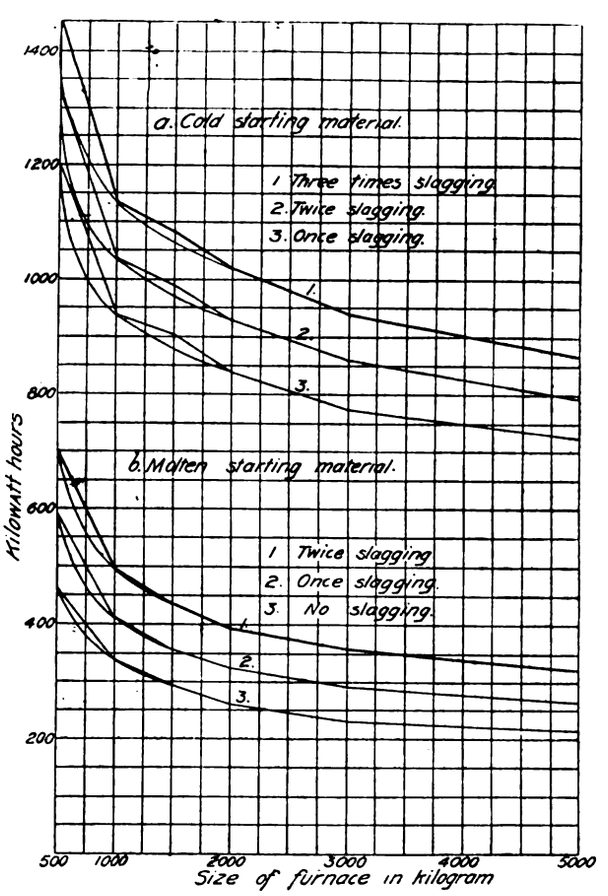
The United States has more fully developed its water powers than any other country, largely through the diversity of its climate. Canada's water powers come next in order, where 400,000 h.p. has been developed; and next to that stands Italy. Mr. Smith had the pleasure of examining the water powers of Italy a few years ago, and brought back the highest regard for the Italian engineers. He said that he came back to Canada very much humbled, as it were, after seeing the wonderful progress that foreign engineers had made in developing water powers for manufacturing purposes.

Canada is a country stretching from ocean to ocean, and to the North Pole. On the two seaboards there is an abundance of coal. Nova Scotia and Cape Breton supply the New England States, and in turn Pennsylvania supplies Ottawa. In the far West, British Columbia supplies San Francisco; and all through the Canadian mountain ranges coal is to be found in enormous quantities. Geologists have scarcely formed as yet any conception of the natural resources of Canada. Unfortunately, however, between these two extremes and in the most populous parts of Canada no coal is to be found. Therefore, dependence must be placed upon shipments by rail of coal from distant points, whether in the United States or Canada, for fuel, and for heating and power purposes. It will easily be seen that in the lower central and lake provinces every effort should be put forth to make the most of the natural resources there abounding—namely, the almost unlimited water powers.

At the Long Sault, for instance, near Massena, N.Y., there are developments projected something like 700,000 h.p. Although Mr. Smith would hesitate to say that a dam would ever be built across the St. Lawrence River, nevertheless to do so would result in untold benefits to both Canada and the United States. If it should be the case that the International Conference gives permission to place a dam across the Long Sault, thereby making it necessary for all the lake shipping vessels on their way to the sea to go through canals, there would be one of the greatest hydro-electric developments in the world at our doors, as great, in fact, as Niagara Falls, because the respective Governments have already limited the amount of water to be taken out for power purposes at Niagara.

DEVELOPMENTS IN THE ELECTRIC FURNACE.

The progress which electric refining of steel is making in Germany and the attention which it attracts is indicated in the various articles that are appearing in German technical journals. In *Stahl und Eisen* Prof. H. Wedding deals with new developments in the design of the



Roechling-Rodenhauser induction furnace. The chief new feature of this furnace, which distinguishes it from the Colby-Kjellin design, is that it combines two methods of electric heating: first, the ordinary heating by electric induction currents, while the second kind of heating also employs induction currents, which, however, are introduced into the molten bath through metal plates, called electrodes. This second method of heating has, therefore, some similarity with ordinary alternating-current furnace practice. Turning to an article in the current issue of the New York contemporary, *Electrochemical and Metallurgical Industry*, we find an interesting discussion of the problem of steel refining by Director O. Thallner, of the Bismarckhütte, in Upper Silesia, who also gives an account of some practice with a Héroult furnace. The first 1·5-ton Héroult furnace in the Lindenberg works in Remscheid has stood 2,337 charges (between four and ten a day), cold and molten charges alternating irregularly and intermittently

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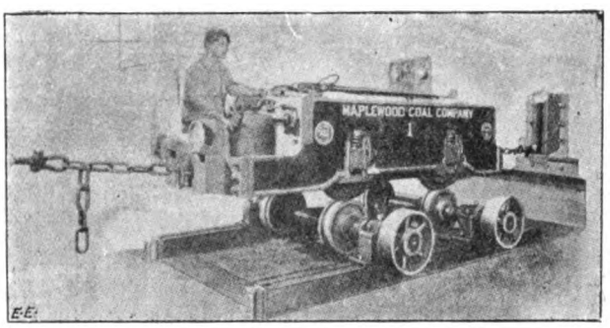
without, it is said, any essential repairs being necessary. The slag did not attack the furnace. When the furnace had been emptied it was at once ready again for a new charge. Small repairs, if necessary, required neither considerable time nor great expense. The accompanying diagram shows the consumption of energy when starting with cold and with molten metal. The curves give the consumption of energy in kilowatt-hours per ton of steel for different sizes of the furnace. Other diagrams given on the basis of 307 charges with molten metal and 40 charges with cold metal showed that in practical operation the certainty with which the impurities could be held below predetermined limits was very great.

TESTING ELECTRIC LOCOMOTIVES.

In order to determine the actual performance of Baldwin-Westinghouse mine and industrial locomotives under service conditions before they leave the works, the Baldwin Locomotive Works has erected a testing plant similar to the locomotive testing plant that was used at the St. Louis Exposition.

This plant, as shown in the accompanying illustration, consists of a pair of adjustable rolls upon which are placed wheels that may be moved to accommodate locomotives built for any gauge. Provision for varying wheel base is made by movement of the rolls toward or away from each other.

The locomotive to be tested is anchored in position by chains attached to the ends. Suitable Prony brakes are used to measure the power developed by the motors, and



a switchboard provided with the necessary electrical instruments enables a complete record to be made of the performance of every locomotive.

Although a thorough test of the electrical equipment is always made before it leaves the Westinghouse works at East Pittsburg, this test of the assembled locomotive is found to be of great advantage in that it insures the ability of the locomotive to operate continuously under service conditions.—*Western Electrician.*

NORTH-WEST LONDON RAILWAY.

The *Financial Times* states that the proposed construction of a new "tube" line from Victoria to Cricklewood is receiving so much encouragement as to make its materialisation little more than a matter of time. The memorial lists of the committee formed for the purpose of urging its early construction have met with an enthusiastic response from residents in the Edgware-road and neighbourhood, no fewer than 30,000 signatures having been received in less than a week. The Board of the Metropolitan Electric Tramways, Limited, our contemporary understands, has had the question of the new "tube" under consideration, and believes that it would adequately meet all the requirements of the district. Should its construction be commenced, therefore, no further steps would be taken in the direction of the alternative suggestion of a surface line.

Stations on the projected line would be at Victoria, Hyde Park Corner, Marble Arch, St. John's Wood-road, Kilburn, Brondesbury, and Cricklewood, amongst others, thus giving many valuable connections with the North-West and West-end of London. Underground passages are intended to be provided at the first three stations named for connection with the Metropolitan and other underground lines, and also with the South-Eastern and Chatham and the London, Brighton, and South Coast Railways, while by its connections at the Victoria end three convenient continuations to the City, giving rapid access to all parts of London, would be afforded. The present time, in view of the recent completion and opening of the London County Council tramway subway from Aldwych to the Embankment, seems highly auspicious for such a project.

THE BRITISH "METALITE" LAMP.

The Bryant Trading Syndicate, Limited, has just issued a new catalogue dealing with the "Metalite" metallic-filament incandescent lamp. Tests have shown that it is a great economy to under-run this lamp if reduced candle-power is required; thus if a British "Metalite' is burning at ·9 watt per candle, and is a 115-volt 20-candle type, it will be suitable for 100 volts, and gives about 10 c.p., at an efficiency of 1·5 watts per candle-power. The lamp will burn at any angle. It is not purely a wolfram lamp (tungsten), but is a combination of metals, and is made exclusively by the Bryant Trading Syndicate, Limited, who have secured the sole rights. We would point out that these metallic-filament lamps are being entirely produced (including filaments) at the company's own works in Horsell-road, Highbury, London, N., and are not imported. We believe the company is the first English company to manufacture a metallic-filament lamp commercially in this country, and, moreover, the lamp is of British invention.

ELECTRICITY IN HORTICULTURE.

Weak electric currents have been applied to moistened earth in order to determine their effect on plant life, and all the experiments made tend to show that under certain conditions rapid growth results from such applications of electricity. A new use of electricity for obtaining somewhat similar results has been made by Mr. G. Hartman, of Turbine, Ontario, Canada, who converts the electrical energy into heat and applies the heat under a hot-bed for vegetable and flowers. In the comparatively cold climate of Northern Ontario a current of from 15 to 20 amperes at a potential of 110 volts has been found to be sufficient for a hot-bed for a family garden. The heater consists of about 260ft. of No. 12 B. & S. gauge iron wire wound in coils 2in. in diameter. A piece of 1½in. pipe was used in winding the coil, which was afterward cut into seven parts and mounted on porcelain knobs on a piece of asbestos board, the coils being connected in series.

The heater was placed under a rough board frame about 6ft. by 8ft., the floor of which above the heater was covered with about 5in. of earth, two hot-bed sashes being used to cover the top of the frame. Electrical energy was taken from a 110-volt circuit, and, owing to the line losses, the actual current received at the hot-bed last year was 15 amperes at 80 volts. The previous year a current of 18 amperes at 100 volts was obtained, and good results were obtained in both cases. The heat was found to be sufficient to keep the earth always noticeably warm, and in the cold early spring weather tender flowers and vegetables grew rapidly. In some cases the growth was so rapid that the plants were large enough to be set out to advantage were it not for the danger of frost.—*Electrical World.*

PUBLICATIONS RECEIVED.

Transactions of the Manchester Geological and Mining Society, vol. xxx., parts xii.-xv. Published by the Society, Queen's-chambers, 5, John Dalton-street, Manchester.

"L'Usure Anormale des Turbines Hydrauliques," by Julien Dalemont, professor at Fribourg University. Paris: *L'Eclairage Electrique*, 40, Rue des Ecoles. Price, 2fr. 50.

"Principles of Direct-Current Electrical Engineering," by James Barr, A.M.I.E,E., lecturer in electrical engineering, Heriot-Watt College, Edinburgh. 294 illustrations. London: Whittaker and Co., 2, White Hart-street, Paternoster-square, E.C.

Transactions of the Faraday Society, vol. 3, part 3, March, 1908, contains the following communications: "On the Electrolysis of Salt Solutions in Liquefied Sulphur Dioxide at Low Temperatures," by Bertram D. Steele, D.Sc. (discussion); "Note on the Action of Aluminium Powder on Silica and Boric Anhydride," by Frank E. Weston, B.Sc., and H. Russell Ellis, B.Sc.; "Reducing Action of Metallic Calcium and Calcium Hydride upon Metallic Oxides, Sulphides, and Halogen Salts," by F. Mollwo Perkin and Lionel Pratt; "Note on a Series-Parallel Lamp Resistance," by N. T. M. Wilsmore, M.Sc.; "A Physico-Chemical Study of the Complex Copper-Glycocoll Sulphates," by J. T. Barker, B.Sc.; "The Discovery of the Alkali Metals by Humphry Davy: The Bearing of the Discovery upon Industry," by F. Mollwo Perkin, Ph.D. London: The Faraday Society, 82, Victoria-street, S.W. Price 10s. 6d.

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PHYSICAL SOCIETY OF LONDON.

At a meeting of the society held on March 27, Dr. C. V. DRYSDALE exhibited "A vacuum tube apparatus for demonstrating the propagation of alternate-current waves in cables." The apparatus consisted of a wooden stand which supported a helix about 6ft. long, a vacuum tube just above it, and a series of 18 vertical tubes below it. On feeding the helix from a high-frequency resonance circuit nodes and loops of potential and current were simultaneously visible in the two sets of tubes, and these were approximately in quadrature with one another. Experiments were shown in which the frequency of the supply was varied, and the capacity of the helix was altered by introducing an earthed wire inside it. Resistance, capacity, and inductance were also connected successively to the receiving end, and the effects were approximately in agreement with theory.

Mr. W. DUDDELL asked why the points of zero potential were not more clearly marked. Was it due to absorption of energy by the tubes or to the superposition of oscillations with higher frequencies? Had the author used a single long tube with a strip of tinfoil on the outside?

Dr. DRYSDALE, in reply, said that the tubes were filled with CO_2. It was somewhat difficult to ensure their equality, and no attempt had, therefore, been made to use rare gases. Doubtless still better results could be obtained, but the CO_2 tubes were sufficiently bright for most purposes. He believed that the energy taken by so many tubes was the cause of the absence of complete darkness at the nodes, as with a single tube sharper results had been obtained. For this reason the single tube with a strip of tinfoil on the side had not been used.

Dr. C. V. DRYSDALE read a paper on "The Use of Shunts and Transformers with Alternate-Current Measuring Instruments." Owing to the limited range of most alternate-current instruments, shunts and transformers have come into considerable use, but they are liable to cause errors both in magnitude and phase of current. The paper deals with these errors mathematically and experimentally. In the case of shunts the condition for accuracy at all frequencies is that the time constants of the instrument and shunt should be equal, but formulæ are given for multiplying power and phase displacement in other cases. For current transformers the best results are obtained by keeping the magnetising and core loss currents as small as possible. The best uniformity of ratio for different loads is obtained with a non-inductive or leading load, but the lowest phase displacement with a lagging load. Potential difference transformers are much more satisfactory than current transformers, both for ratio and phase displacement. Experimental tests using a wattmeter as indicator approximately confirmed the theory.

Mr. A. CAMPBELL expressed his interest in the thorough manner in which Dr. Drysdale had gone into the question of the use of transformers with measuring instruments. Dr. Drysdale showed that for the special case of constant frequency relatively high inductance does not give the most constant ratio. His (Mr. Campbell's) experiments were not complete enough to settle this point, and he was careful not to dogmatise on the matter. He was glad that Dr. Drysdale had elucidated it.

Mr. A. RUSSELL expressed his interest in the paper. He suggested that the author should take the mutual inductance between the shunt and the instrument into account.

Mr. KENELM EDGCUMBE referred to the fact that the author recommended small core losses, and pointed out that he had seen it stated that in special cases it was possible to improve the ratio and phase errors by increasing the core losses.

Dr. DRYSDALE, in reply to Mr. Campbell, said his praise of the air-core transformer was justified, but in practice instrument makers were forced to use iron for commercial reasons. Similarly, the ring form of transformer was generally impossible, as in practice instrument transformers were used to insulate the observing instrument from high-pressure mains, and considerable insulation between the windings was necessary. The reason why an iron-cored transformer behaved differently to one with an air core chiefly resided in the core-loss current which was not proportional to the magnetising current.

A paper on "Dynamometer Wattmeters" was read by Dr. C. V. DRYSDALE. The author gives a somewhat complete investigation of the theory of the wattmeter, including the effects of shunt inductance and capacity, mutual inductance, eddy currents, wave-form, and of iron. It is pointed out that the theory of the wattmeter is much obscured by the use of the correction factor. On sine wave-forms the true power $\omega = W \cos \phi$, while the reading of the wattmeter

$$\omega' = \frac{R}{I} W \cos(\phi - a) = W \cos a \cos(\phi - a),$$

where W is the apparent power, R and I the resistance and inductance of the shunt respectively, and a the angle of lag in the shunt. This leads to the simple relation

$$\omega = \frac{\omega'}{1 + T^2 p^2} - T p W \sin \phi,$$

where T is the time constant of the shunt and $p = 2 \pi \times$ frequency. In practice $T^2 p^2$ can be neglected in comparison with unity, and hence $d\omega = \omega' - \omega = T p W \sin \phi$, which is perfectly determinate at all power factors. This shows that the correction of a wattmeter should always be applied as a difference, and not as a ratio. It is practically as absurd to apply a correction factor to a wattmeter as to an instrument with a zero displacement. The paper also contains a description of some single and double forms of standard wattmeter and of deflectional wattmeters containing iron. Also of the method of testing wattmeters for various errors and of a phase-shifting transformer for facilitating these tests. Various forms of watt meters and phase shifters were shown in operation.

Mr. W. DUDDELL expressed his interest in the paper, referring especially to the author's remarks upon the application of a correction factor. In some ways he thought a correction factor was preferable to the addition of a zero correction. He was interested in the wattmeters exhibited, which resembled in many features an instrument he had designed some years ago.

Mr. RAYNER, referring to the accuracy of the instruments, asked if Hooke's law held to one part in 500 over a whole turn of the torsion head.

Mr. TINSLEY remarked that the instrument shown resembled those of Mr. Duddell in the mechanical details, because the design adopted was the only practical one.

Dr. DRYSDALE, in reply, said he still maintained that the only rational way of correcting wattmeter readings was by adding a correcting term instead of applying a correction factor. Mr. Beattie's device was unnecessary and of little use, as the inductive coil would not give any indication of the error due to capacity in the shunt, which might be considerable. He had not troubled about astaticism in his instruments as they were for use as standards, and it was easy to eliminate the effect of stray fields. He was surprised and gratified to find that Mr. Duddell recognised the strong resemblance between the wattmeter described in the paper and his own.

INSTITUTION AND SOCIETY NOTES.

Institution of Electrical Engineers.

At the ordinary general meeting held on the 9th inst. the following candidates were elected:

Associate Members.—J. H. Bolam, Corporation Electricity Works, Weymouth; G. W. Cole, Kanan Devan Hills Produce Company, Munnar, South India; A. W. Mandling, 184, Ayres-road, Old Trafford, Manchester; H. E. Morrow, London County Council Paddington Technical Institute, Saltram-crescent, W.; G. D. Nelson, 28, Wood-vale, Forest Hill, S.E.; J. R. Norris, "Fairhaven," Kensington-road, Oldham; Lieutenant A. Rice, R.N., H.M.S. "Good Hope," First Cruiser Squadron; S. Richards, care of Messrs. J. and P. Coats, Limited, 50, Bothwell-street, Glasgow; C. C. Skeates, 18, Wynndale-road, Woodford, Essex.

Students.—G. J. Duckett, Bow-lane, Preston; A. N. Haworth, 88, Raby-street, Moss Side, Manchester; V. M. Levy, Northampton Institute, Clerkenwell, E.C.; C. A. Martin, Godmersham House, St. Albans; T. Y. Porter, 6, Lyndhurst-square, Peckham, S.E.; B. P. Smith, Onslow Hotel, Cranleigh, Surrey.

Leeds Local Section.

At the general meeting of the Leeds Local Section of the Institution of Electrical Engineers held on the 9th inst., Mr. H. E. Yerbury was elected as chairman, in place of Mr. G. D. A. Parr, and Mr. Rogerson vice-chairman, in place of Mr. Yerbury. The following gentlemen were elected as members of the committee: Messrs. W. Emmott, W. B. Woodhouse, J. W. Hame, and J. M. Smyth, in place of Messrs. J. W. Beauchamp, W. Hartnell, S. D. Schofield, and H. H. Wright.

Institution of Civil Engineers.

At a meeting held on the 7th inst. a paper on "The King Edward VII. Bridge, Newcastle-on-Tyne," was read by Messrs. F. W. Davis and C. R. S. Kirkpatrick. In an interesting description of this new bridge, the authors drew attention to the fact that electric power was generated at the contractor's yard for working the air-compressors for the caissons and for driving the whole of the machinery and lighting plant upon the works.

Liverpool and District Electrical Association.

A meeting of the above association was held at the Common Hall, Hackins Hey, on Tuesday evening, April 7, when a discussion on "Electric Incandescent Lamps" was opened by Mr. J. Maxwell. The merits of the respective lamps were gone into in detail, and the point as to what effect the new metallic-filament lamps are likely to have upon central stations was fully entered into, some of the members being of opinion that the effect would be a detrimental one, resulting in a decrease in the

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current consumption, which would not be fully compensated for by the additional consumers likely to be obtained, whilst others were of the opinion that the decreased current consumption would be fully met by increased business.

London County Council School of Lithography.

On Thursday, April 9, Mr. Sherard Cowper-Coles read a paper, entitled "Some Notes on Electrotyping," at the London County Council School of Photo-Engraving and Lithography. The chief features dealt with were the conditions necessary for rapid electro-deposition of copper on the moulds, and the various effects obtained by mechanical and chemical treatment.

THE MUNICIPAL EXHIBITION.

A well-attended meeting of the honorary advisory council of the above exhibition was held at Balfour House, Finsbury-pavement, E.C., on Monday, the 6th inst., when a report was submitted on the progress made to date in organising the various branches of the exhibition. Satisfaction was expressed that a considerable number of representative firms would have attractive exhibits, and also that the undertaking was receiving support and co-operation not only from London borough engineers and councils, who had taken the matter up in a most enthusiastic manner, but a considerable number of provincial councils and officials had shown a practical desire to contribute to the success of the enterprise. Having in view the great amount of interest which has been created recently in connection with the use of X-rays in hospitals, the management have arranged with Mr. Alfred E. Dean to have the apparatus installed and demonstrations illustrating its use carried out at different times each day. Thus the latest development in hospital work will be shown and the public will have the unusual opportunity of seeing the rays in actual use.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Great Harwood.—The Co-operative Society have decided to have their new premises fitted for the installation of electric light.

Sandycroft Foundry Co.—The Great Eastern Railway Co. have placed an order with the above firm for 10 "Cascade" induction motors for driving printing presses.

Accrington.—The Corporation have decided to make application to the Local Government Board for sanction to the borrowing of £7,500 for the purchase of additional electric cable.

Ilford.—The Local Government Board will hold an inquiry on April 23 into the application of the Urban District Council for sanction to borrow £27,000 for electric lighting.

King's Lynn.—The engineer has reported to the committee that since the meeting applications had been received for 54 additional lamps of 8 c.p. or equivalent, making a total of 29,470.

Notice of Dividend.—The *London Gazette* announces that a first and final dividend of 9s. 7d. in the £ has been declared in the estate of H. Wainwright, electrical engineer, George-yard, Barnsley, York.

Maidstone.—The Corporation are seeking sanction to borrow £18,440 for the purposes of their electricity undertaking, and an inquiry will be held by the Local Government Board into the application on April 23.

Dalmuir.—The top of a gasometer at William Beardmore and Co.'s shipyard, Dalmuir, near Glasgow, blew off on Saturday, the explosion creating great alarm and uneasiness for miles around. The workmen had just left work for the day.

Weston-super-Mare.—The Urban District Council have given permission to the Weston-super-Mare and District Electric Supply Co. to light the sea-front at Walliscote-road, and also to install certain electric lights for experimental purposes.

Coatbridge.—On the 8th inst. an alarming explosion occurred within a dwelling-house at Lauriebank-terrace, Dundyvan-road, owing to an escape of gas. The windows were shattered and the curtains set ablaze. Fortunately the inmates escaped injury.

West Ham.—After a discussion on the consumption of gas in the hospital, the House Committee have instructed the secretary to write to the West Ham Corporation electricity department asking for an estimate for laying on electric light for use in the hospital.

Wolverhampton.—The Town Council have passed plans for the erection of workshops and an electric power-house for the Chillington Tool Co. Arrangements have been made with the Council Electricity Committee for supplying electricity from the works of the Corporation.

Darlington.—The total revenue from the electricity supply for the four weeks of March ending on the 28th was £760. 19s. 1½d. The number of units generated for lighting and power during March was 107,652, as against 81,404 during the same period last year, an increase of 26,248 units.

Newcastle-on-Tyne.—The River Tyne Commissioners have agreed to give permission to the Newcastle Electric Supply Co. to lay temporary cables in the bed of the stream until a tunnel can be constructed to contain the cables. The company must exhibit a conspicuous notice, "Electric cables here."

Rawtenstall.—Operations in connection with the Rawtenstall electricity works were commenced on the 9th inst. A start was made at Hareholme, and cables will be laid throughout the necessary districts. It is estimated that this work will cost over £23,000. The contract has been secured by Messrs. Glover, of Manchester.

Walsall.—The Council Electricity Committee have decided to supply electricity on the prepayment system at a rate of 5d. per unit for lighting and 2½d. for other purposes. This is somewhat in excess of the charge usually made, but consumers using prepayment meters will have no meter rents to pay, and will not be required to make any deposit.

Liquidations.—The *London Gazette* announces that the St. Albans and District Electric Supply Co. has been wound up voluntarily and Mr. James McLeod, 101, Finsbury-pavement, London, E.C., appointed liquidator. The Monobloc Accumulator Syndicate has been wound up voluntarily and Mr. H. Newson Smith, 37, Walbrook, London, E.C., appointed liquidator.

Indo-European Telegraph Co.—The directors recommend a dividend for the six months ended Dec. 31 of 17s. 6d. per share, making 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax. They also recommend a special distribution of 15s. per share, free of income tax, out of interest accrued during the year upon investments.

Sowerby Bridge.—The Board of Trade has approved the provisional order promoted by Sowerby Bridge Urban District Council, empowering them to deal with their electrical order (obtained some years ago) by selling it to Electrical Distribution of Yorkshire, Limited. It will now be included in a Confirmation Bill to come before the House of Commons.

Houghton-le-Spring.—At the last meeting of the Urban District Council a letter was read from the Houghton-le-Spring and District Electric Lighting Co. offering to install the electric light in any three of the Council's existing street lamps near to the company's cable for a trial on payment of half the cost, and, if retained, payment in full. The Council, however, decided not to entertain the offer.

St. Annes.—The consumers of electricity now number 643, against 504 a year ago. The tradesmen's association have suggested a reduction in the price of current, and the question is to be considered. A revision of the price charged for traction purposes has also been asked for by the Blackpool, St. Annes, and Lytham Tramway Co., and their request has been referred back for consideration.

Gillingham.—To the last meeting of the Council the engineer reported that the equivalent of 360 8-c.p lamps had been connected with the mains, and that the equivalent of 107 8-c.p. lamps had been disconnected since the last meeting of the committee, making a total of 29,245 equivalent in 8-c.p. lamps with 338 consumers connected, and that applications had been received for the equivalent of 406 8-c.p. lamps.

Pontypridd.—At a meeting of the Electricity and Tramways Committe of the Pontypridd District Council the manager reported that the revenue derived from the electric lighting department for the past four weeks amounted to £620, as compared with £466 for the corresponding period of last year. During the last 12 months 906,755 units of electricity had been generated, or an increase of 33 per cent. over the preceding year.

Northfleet.—The Electric Lighting Committee of the District Council have approved a pattern of lantern to be used by the Gravesend Corporation for lighting the London-road, The Hill, and High-street. They have instructed the surveyor to arrange for a treble lamp to be placed on the Hill at junction of Dover and Springhead roads, and a double lamp in the High-street at the southern end of Granby-road.

Brighouse.—For some months users of the telephone in the Brighouse district have been making complaints as to the inadequate local service, and about three months ago received a promise that some improvement would be effected. As this promise has not been fulfilled the council of the Brighouse Chamber of Commerce have resolved to make a strong complaint to the Telephone Co., and to ask for an immediate improvement in the local service.

Arbroath.—Rapid progress is being made with the erection of the Arbroath electric light works in South Grimsby-street. It is expected that the electric light will be available about the end of June. The company have issued a prospectus. The share capital is £30,000, and subscriptions of £1 each are now being invited for 20,000 shares. An agreement has been entered into with the Town Council for the lighting of the principal thoroughfares of the town.

Maesteg.—A firm of Liverpool electrical engineers have written the District Council stating that they would be glad to assist the Council in regard to exercising their powers under the electric lighting order, and would be prepared to meet the Council at any time to discuss the question. The Council agreed that they would be prepared to meet the firm at any time, on it being clearly understood that the Council did not commit themselves to any liability.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board.—The Board have instructed their engineer to lay a cable along Mottram New-road, Hyde. They have also recommended the Generating Station Committee to accept the tender of Messrs. Willans and Robinson for the supply of a third turbine, subject to the details being to the satisfaction of the chairman and engineer, and to accept the tender of Messrs. Ferranti for a five-panel switchboard.

Bangor.—At the last meeting of the City Council the report of the Lighting Committee showed a decrease of 77,700 in the amount of gas made during the month as compared with the total the corresponding

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period last year. The total amount of gas made up to date this year is 46,498 300, being a decrease of 625,100 upon the amount the same period last year. As to electricity the committee reported that there was an increased percentage of 7·3 of electricity sold during the month. There were now altogether 14,750 lamps connected for electricity.

Burslem.—The report upon the electricity works for the year ending Dec. 31, 1907, shows an income for the year of £3,261. 2s., made up of sale of current £2,858. 9s. 11d., public lighting £300, and meter rents £42. 12s. 1d. The expenditure was £1,223. 8s 4d., which was made up as follows: generation of electricity, £679. 13s. 5d.; distribution of electricity, £46. 6s. 4d.; public lamps, £18. 14s. 7d.; rates, £59. 11s. 5d.; insurance, £12. 1s. 7d.; management expenses, £407. 1s. This gives a gross profit of £2,037. 13s. 8d.

Morley.—The output from the Corporation electricity works for the month ending Feb. 29 was 20,718 units, as compared with 17,822 units the same month of last year, being an increase of 2,896. There were sold to consumers by meter 15,183 units, as compared with 13,274 the same month last year, being an increase of 1,909. The chairman and vice-chairman have been appointed by the Council to consider the tenders and place the order for new transformer. Twelve connecting boxes are to be ordered and placed in Fountain-street and Bridge-street at an estimated cost of about £55.

Middlesbrough.—In pursuance of an arrangement recently arrived at, the Cleveland and Durham County Electric Power Co. has been supplying power in bulk to the Middlesbrough Corporation, the supply having been started three or four weeks ago, and continued without interruption from that time. By this agreement an amicable working arrangement has been concluded between the two parties, whereby the Corporation acts as local distributor, the company supplying power in bulk at a low cost, and being free to directly supply several of the large iron and steel works in the town.

Chichester.—The people of Chichester have been waiting for the advent of electric light for many years, and now at last it is to become an accomplished fact. It is some time since the transfer of the provisional order from the City Council to a company was effected, but it is probable that the light will be installed by the end of the summer. A site has been secured for the works at Stockbridge, and the necessary plant is to be immediately put down. In anticipation of the electric light some of the buildings have been already fitted, but so far have been useless for want of the long-promised electricity.

Brighton.—Important recommendations are made by the Lighting Committee in reference to the future charge for electric lighting and power supply. The 4d. flat rate will not be disturbed, and large consumers are to be specially provided for, but in cases where the charge has been 7d. for the first hour's current and 1d. per unit afterwards the rate will be 6d. and 2d. respectively. Mr. John Christie, the engineer, states that the revision is necessary owing to the increased cost of production, especially in regard to the price of coal. There is also to be an advance in the price charged the town for the street electric lighting, representing a total annual increase of £785 in that item alone.

Cockermouth.—The enterprising company to whom belongs the Oughterside Colliery have gone one step further in making their pit thoroughly up to date by installing electric light in the workings. The work has been carried out by the Corlett Electric Engineering Co., Wigan. The dynamo is of the latest interpole type of Messrs. Corlett, coupled direct to one of Browett-Lindley's high-speed single engines. So far there are 60 lights both above and below ground, and the sidings are illuminated by arc lamps of 260 c.p. The switchboard is the patent of the Electrical Engineering Co., standing 6ft. high and 4ft. broad, mounted with instruments to comply with all the requirements of the latest regulations governing electricity in mines.

Ettingshall. — A serious accident was narrowly averted at Thompson's Boiler Works, Ettingshall, on Friday evening last, by which the lives of between 40 and 50 workmen were endangered. For a month past operations have been in progress to erect a giant electrical travelling crane, and the structure was nearing completion when a portion gave way and the whole fell with a terrific crash into the yard. A warning was quickly given, and fortunately the whole of the workmen engaged below had sufficient time to escape. A number of them, however, sustained bruised limbs in the hurry to get to a place of safety. For some minutes after the crash nothing could be seen owing to the tremendous cloud of dust it sent up.

Bridgend.—The Board of Trade have made and issued a provisional order under the provisions of the Electric Lighting Acts, 1882 to 1890, with a view to the same being included in a Confirmation Bill, about to be introduced into Parliament, to the Urban District Council of Bridgend, authorising them to supply electrical energy for all public and private purposes within the portions of the Bridgend urban district which formerly constituted parts of the parishes of Coity Lower and Daudy, in the rural district of Penybont, added to the Bridgend urban district by the County of Glamorgan (Bridgend, etc) Confirmation Order, 1904, and also within the parishes of Newcastle Higher, St. Brides Minor, Coity Higher, and Ewenny, all in the rural district of Penybont, in the county of Glamorgan.

Whitefield.—At a meeting of the Electricity Committee of the District Council the clerk read a letter from Messrs. J. P. Monks and Co. in reply to his inquiry as to what progress had been made with the lighting order. The firm stated that the company had to satisfy the Board of Trade that they were in a position to carry out the works involved by the transfer of the various orders, and for this purpose it was necessary to show that the required capital was forthcoming. The company informed them that the delay had been caused by the difficulty in the recent state of the money market in arranging for the issue of additional capital on reasonable terms, but that all arrangements had now been concluded for raising a further £150,000, and they believed that all the difficulties were overcome.

Whitehaven.—At the last meeting of the Town Council the electrical engineer reported that the Whitehaven Gas Co. had been somewhat extensively piercing the streets with an iron jumper to seek for leakages of gas, and had caused serious damage to one of the Corporation's electric light distributing mains. The Council instructed the clerk to write the gas company giving them notice to discontinue the practice and to point out the damage. The Council decided to purchase a feeder pillar at a cost of £25. to be placed at the corner of Scotch-street and Lowther-street; and to apply to the Local Government Board for sanction to borrow £1,700 for the following purposes: surface-condensing plant, battery switchboard and boosters, extension of mains, and auxiliary plant at the electricity works.

Electric Colliery.—One of the most important developments in mining which has taken place in the county of Durham for many years was inaugurated on the 9th inst., when Mrs. Austin Kirkup, wife of the chief agent of the Lambton Collieries Co, turned the first sod of the new shaft, and christened the New Winning East Pit, Lumley Colliery, near Chester-le-Street. Mr. Kirkup said that was one of the first collieries in the world, and certainly the first large one, to be worked entirely by electricity. Everything would be done by that means—winding, pumping, hauling, coal-cutting, ventilation, and screening—and no smoke or steam would escape to cause a nuisance to the residents in Lumley Castle, one of the ancestral homes of the Earl of Scarborough. When in full working order the two shafts will deal with from 1,500 to 2,000 tons of coal per day, and about 1,500 persons will find employment either in or about the mine.

Stock Exchange. — Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Tennessee Copper Co.'s 5,000,000dol. capital stock in 200,000 shares of 25dol. each. The committee has also been asked to appoint a special settling day in Cornish Consolidated Tin Mines' further issue of 20,000 ordinary shares of £1 each, fully paid, Nos. 50,001 to 70,000, and Langkat Sumatra Rubber Co.'s 31,000 shares of £1 each, 14s. paid, Nos. 31,501 to 62,500. The committee has appointed April 23 a special settling day in Provincial Tramways Co.'s £175,000 5 per cent. first debenture stock, divided into shares of £10 each, Nos. 1 to 17,500; and have also ordered the undermentioned securities to be quoted in the official list: National Telephone Co.'s further issue of £383,575 deferred stock, and Provincial Tramways Co.'s £175,000 5 per cent. first debenture stock, divided into shares of £10 each, Nos. 1 to 17,500.

Derby.—The new power station in connection with the Corporation electricity works was opened on the 8th inst. The extensions have become necessary in consequence of the increasing demand for electricity for lighting and power by private consumers, and also in consequence of the development of the electric tramway system, which now extends over 14 route miles and 20 track miles. After a tour of inspection of the old and new power stations by the members of the Corporation and their friends, the chairman of the committee presented the mayor with a gold key by which he set in motion one of the two new steam-turbines. The chairman said that at present only two-fifths of the scheme was completed. The two turbines were of 1,000 h.p. each, and the new station would accommodate turbines of 20,000 h.p. The building was plain, good, substantial, and well adapted for its purpose. They were producing electricity which compared favourably in price with the charges in other large towns. Altogether about a quarter of a million had been invested in the undertaking.

Phillips's Monthly Machinery Register.—It will pay all users and buyers of machinery to secure a copy of "Phillips's Monthly Machinery Register" and "Electrical Machinery, Motorcar, and Steam-Wagon Supplement," which has been published since the year 1874. We notice with the current issue that the "Electrical Machinery, Motorcar, and Steam-Wagon Supplement," instead of being strung on the outside of the "Register," is now fastened in the centre of the book, making the journal more complete and convenient. The approximate value of the machinery advertised in this publication at present is £270,000, and it is a first-rate medium for introducing customers who wish to buy, to those who have machinery for sale, and *vice versa*, and is found of practical value to all works managers and engineers throughout the country and abroad. Many bargains are met with, and customers will do well to always keep a copy hung up by them for reference. The proprietor and publisher of the journal is Mr. Charles D. Phillips, M.I.M.E, Emlyn Engineering Works, Newport, Mon., and Gloucester.

Electric Power in Steelworks.—Messrs. Marples, Leach, and Co. advise us that they have been successful in securing the order for the supply, delivery, and erection of a high-tension two-phase alternating-current induction motor for driving two 10in. and one 8in. mills at the works of Messrs. Samuel Osborn and Co., Sheffield. This motor is being wound for the high-pressure distributing mains of the Sheffield Corporation electric supply department at 2,000 volts, two-phase, 50 cycles. This motor is normally rated at 350 b.h.p., but is capable of sustaining very considerable overloads for short periods without injury. It is being provided with wound rotor, brush-lifting and short-circuiting device, by means of which the wear and tear on the brushes and slip-rings is reduced to a minimum. In order to enable the flywheels to take their proper share of the work, the rotor is being provided with a bank of resistances which rotate with the machine, thus allowing a considerable percentage of slip when the load exceeds the normal. This motor is the largest motor which has yet been placed upon these mains, and it is anticipated that very great economy will result in the working of the mill.

Teesbridge Contract.—The British Thomson-Houston Co. have received an order from the Tyneside Electrical Development Co. for an exhaust steam-turbine having an output of 1,500 k.v.a. at 2,875 volts 40 cycles, when running at a speed of 2,400 r.p.m. The turbine

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will be a standard Curtis type, containing two stages, direct-coupled to a three-phase 40-cycle alternator. The steam for this turbine will be supplied from the works of the Teesbridge Iron Co. at atmospheric pressure, and will be condensed by surface-condensing plant of Mirrlees-Watson Co. The condensed steam will be returned to the Teesbridge Co. Provision has been made so that should the turbine not be running at any time it can be isolated from the condensing plant and the condensed steam still utilised for the boiler feed of the Teesbridge Iron Co. The turbine and the generator will be capable of an overload of 1,800 k.v.a The plant had been so arranged that the necessity for the usual foundations are avoided, the condenser being on the same floor level as the turbine itself. The air and circulating pumps will be driven by three-phase 440-volt, 40-cycle B.T.H. motors. The sluice valve between condensing plant and turbine will also be motor operated.

Aston.—Mr. R. H. Bicknell, Local Government Board inspector, attended at the Aston Council House on the 10th inst. to hear an application by the Town Council to borrow £25,213 for the purpose of making extensions to the electrical power station. The town clerk (Mr. Ansell) stated that the loan indebtedness of the borough was £483,301. The rateable value for borough rate was £265,976, and the accessable value for district rate was £219,700. The rates in the £ were 8s., and the estimated population 82,000. Continuing, Mr. Ansell said that up to the present time the Local Government Board had sanctioned loans in connection with the electricity undertaking amounting in the aggregate to £145,125, and the capital expenditure up to date under these sanctions amounted to £134,466. With regard to the application to borrow £25,213, Mr. Ansell said that for some time past the Electricity Committee had had under consideration the question of the necessity of extending the electricity work and plant so as to give effect to the order. The total capacity of the existing plant equalled 2,150 kw., of which 400 kw. was employed in supplying current for the tramways system alone, leaving 1,750 kw. for the public supply service. The Council had applications in hand for 30,753 8-c.p. lamps, bringing the total up to, say, autumn this year to 142,576 equivalent 8 c.p. lamps, or an increase from December, 1907 of 53,976 equivalent 8-c.p. lamps, or 60·9 per cent. In considering the possible maximum demand for the winter of 1908, the Council had taken the actual figures obtained in the winter of 1907, and on the same basis find that the maximum demand which will be made upon the plant for the winter of 1908 will amount to 2,156 kw. It would, therefore, be seen that it would be impossible to meet the next winter demand without a further increase in the capacity of the plant. Having regard to these figures, the committee recommended a scheme for extending the undertaking at a cost of £33,000. The Council had already obtained the Board's sanction to £5,000 on the buildings, £1,687 on one boiler, £1,100 on coal bunkers, making the total sanctioned £7,787, leaving a balance of £25,213, to which the sanction of the Board was sought, but this sum would be varied, reducing it to £25,000. The inspector, after hearing further particulars, proceeded to inspect the works.

TRACTION.

Highgate.—The London County Council have decided to purchase the Highgate-hill cable tramways for £13,000.

Tramway Congress.—The annual tramway congress, to be held at the Franco-British Exhibition, will probably take place on July 3 or 10.

Newcastle-on-Tyne.—The Corporation Tramways Committee have agreed to the relining and renewing of the accumulator cells at the City-road power station at an estimated outlay of £4,000.

East Ham.—The Borough Council have decided to purchase the tramway track in Romford-road, from Manor Park-broadway to Green-street, from the North Metropolitan Tramways Co. for £8,000.

Walsall.—The Town Council are asked to approve a recommendation that the Tramways Committee be authorised to purchase four additional tramcars with top covers of the latest design at an estimated cost of £2,500.

Metropolitan Electric Tramways.—The directors have resolved to take no further steps in the direction of the re-promotion of a surface line from Victoria to the Marble Arch and Cricklewood if the scheme for the tube railway on that route is proceeded with.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways.—At the last meeting of the Board the commercial manager reported that the traffic receipts for the four weeks ended March 14 amounted to £2,653. 13s. 4½d., and that the total receipts to that date from March 31 last were £38,165. 19s.

Blackpool.—The result of the year's working of the trams comes within £230 of the Council's estimate for the year, and the electricity department, notwithstanding that coal had cost fully £1,000 more than last year, has made a profit of £8,500, after paying 6½ per cent. on interest, capital, and sinking fund.

Torquay.—The line of tramway along the Torbay-road, Torquay, is completed, and a very successful trial trip was made with a car on Sunday night, preparatory to the Board of Trade inspection towards the end of the week. Much satisfaction is expressed at the expeditious manner in which the work has been carried out.

Aldershot.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them authorising the construction of light railways in the urban districts of Aldershot and of Farnborough, in the county of Southampton, and in the rural district of Farnham, in the county of Surrey.

Railway Electrification.—The electrified section of the Midland Railway between Morecambe and Heysham Harbour was opened to the general public on the 13th inst., and the novelty of the new service attracted a large number of passengers. The trains consist of a motorcar and two carriages, the motorcar being in the centre.

Heywood.—At the last meeting of the Town Council the chairman of the Electricity and Tramways Committee stated that they had accepted tenders for the proposed extensions of the undertaking. The estimated cost of the work was £9,255. The tenders accepted amounted to £7,615 only, but alterations to the building that would be necessary would add materially to this sum.

Leek and Manifold Light Railway Co.—The annual meeting of the directors and shareholders was held in the Leek Council chamber, Mr. Charles Bill presiding. The report showed that owing to the abnormally wet summer there had been a decrease in the number of bookings by 10,878. The rates for goods traffic were engaging the attention of the directors, and it was hoped that arrangements would eventually be made which would bring about an expansion in this class of traffic. The report was adopted.

Drighlington.—At a meeting of the Urban District Council the clerk read a communication from the Board of Trade in reference to a meeting on the 26th ult. in respect of the application by the British Electric Traction Co. for leave to abandon part of the line authorised under the Morley and Spen Valley light railways order, and stating that the Board had extended the period for the completion of the line to July 14 next in order to afford time for further negotiations with a view to the completion of the uncompleted portion.

Newport.—Councillor Peter Wright has given notice to move at the next meeting of the Newport Corporation for another poll of the ratepayers on the question of a Sunday tram service, and also of Sunday funerals. The question of tramway depreciation has again been under consideration by the Electricity and Tramways Committee of the Corporation, who recommend that before any surplus on tramway revenue account be applied to the relief of rates, a sum averaging £3,000 per annum be paid into the tramways reserve fund.

Morley.—At a meeting of the Town Council on Monday a resolution was confirmed that the Corporation provide the additional plant required to supply power for the proposed tramways, and that the plans and specifications submitted by the borough electrical engineer (Mr. J. E. Ellis) be approved, and that application be made to the Local Government Board for authority to borrow the sum of £7,942 to carry out the work. Application is also to be made to the Local Government Board for authority to borrow the sum of £5,000 for new electric cables.

Halifax.—The Halifax tramways year closed on March 31. The receipts from passenger traffic amounted to £79,000, compared with £75,532 last year. From private cars the revenue was £155 against £172, passengers' luggage £60 against £63, from parcels traffic £1,313 as compared with £1,000, and other receipts were £449 against £356. These figures may need slight adjustment, but substantially they represent accurately the financial results of last year's work. The total revenue is, therefore, £80,977, as compared with £77,126 for the previous 12 months, or an increase of £3,851.

Handsworth.—The Tramways Committee have reported to the District Council that application has been made as directed to the Board of Trade for the appointment of a referee to settle the price to be paid for the part of the tramway company's undertaking authorised by the Birmingham Central Tramways (Extension) Order, 1886, as is within Handsworth, and also the terms of the lease which is to be granted by the Council to the company, if no other arrangements are made. The committee recommend the Council to instruct the clerk to act as solicitor to the Council in the matter.

Putney.—The Fulham Borough Council have decided to sanction the use of the overhead trolley system on the proposed London County Council tramway from a point near Hammersmith-broadway, along Queen-street, Fulham Palace-road, High-street, Fulham, and across Putney Bridge, to a point in Lower Richmond-road. This tramway is already sanctioned under an Act obtained in 1902, but the use of the overhead trolley was expressly forbidden. The Highways Committee of the County Council now proposes to go to Parliament immediately for powers to adopt this system. If carried out, the tramway will enable through cars to be run from Putney to Harlesden.

Luton.—It is stated that Messrs. J. G. White and Co. are prepared to extend the tramway system from Luton to Leagrave and Dunstable if the company can get an extended lease from the Luton Corporation. The possibility of this extension has been hinted at in the Luton Town Council, but whether or not the Corporation would be inclined to extend the lease of the Luton system remains to be seen. A letter was read at the Leagrave Parish Council meeting in which Messrs. J. G. White and Co. stated that when next in Luton their engineer would receive a deputation from the Leagrave and Limbury Parish Councils on this subject. It is suggested that the Dunstable Town Council should also send a deputation to that conference.

Rossendale Valley Tramways Co.—Mr. A. Love, the chairman, presided at the annual meeting of the Rossendale Valley Tramways Co. held in London on Friday, and moved the adoption of the report. The report stated that there had been a decrease in the traffic and other receipts of £47. Owing to extensive repairs to permanent ways the expenditure in that department was much higher than usual. The balance available for distribution was £2,083, which admitted of the usual dividend on the preference shares and 5 per cent. on the ordinary shares, with £500 to reserve. The local authorities had given notice to purchase the tramways, and negotiations were proceeding. The Board had had the undertaking carefully valued by an expert, which had somewhat increased the professional charges. The report was adopted.

Derby.—At the last Council meeting the Tramways Committee reported as follows: The receipts of the Corporation tramways during the four weeks ended March 21, 1908, were £3,052. 3s. 5d., being an increase of £275. 9s. 7d. as compared with the corresponding period

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last year. The committee are of opinion that the electrical tramways should be extended on Burton-road from the present terminus to the borough boundary at an estimated cost of £5 500, and they recommended the Council to empower them to arrange with Mr. G. F. Tomlinson to execute the work in connection with the proposed extension upon his schedule of prices for the Nottingham-road route, subject to a proper deduction being made in respect of the reduced price of materials. The Council is recommended to grant the sum of £124. 15s. 4d. for the purchase from Messrs. Blackwell and Co. of 33½ tons of surplus tramrails.

Pontypridd.—The traffic receipts of the Pontypridd electric cars continue to show a steady increase. The engineer (Mr. Teasdel) presented to the Council last week some interesting comparisons. The Treforest and Cilfynydd route showed an increase of practically £100 over the corresponding period of last year, the figures being £752. 18s. 10d. and £684. 3s. 6d. The Trehafod route showed receipts amounting to £463. 18s. 4d. The average receipts per car mile for Trehafod were 11·52, which was stated to be exceptionally good. Since the opening of the Trehafod section 12 months ago the receipts have increased from £8,718 to £14,503, equivalent to 65 per cent. The members commented on this very gratifying feature, and there is every prospect of the revenue showing a further increase in the near future. In the electric light department there was an increased revenue of £164 as compared with the corresponding month.

Belfast.—A special meeting of the Tramways and Electricity Committee of the Council of the county borough was held on the 8th inst. for the purpose of receiving the directors of the Cavehill and Whitewell Tramways Co. to discuss informally the situation created by the rejection of the Bill for the acquisition of the company's undertaking by the Corporation. The Lord Mayor presided, and Mr. Robert Armstrong (chairman) and Mr. C. H. Dade attended as representing the directors of the company. The proceedings were of a private nature throughout, but various proposals were put forward with a view to a working arrangement being arrived at between the Corporation and the company. After these had been discussed for some time it was finally decided that the company's proposals should be put into writing, and that they should then be submitted to the weekly meeting of the committee, when they will receive careful consideration.

Weston-super-Mare.—The Works Committee reported to the last Council meeting that they had considered plans and sections submitted on behalf of the tramway company for the construction of a proposed alteration to the Birnbeck Pier terminus, and also an application for the approval of the Council to these drawings. A deputation attended on behalf of the local cab and omnibus proprietors to oppose the application of the tramway undertakers, and Mr. Baker, on their behalf, expressed their objections to the proposal of the company, and in appealing to the Council to protect their industry pointed out that the alteration would not remove the most dangerous part of the tramway in this locality, and drew attention to the indifferent manner in which the company catered for the public, particularly during the winter months, and to their neglect to maintain the tramway track in decent order. It was unanimously resolved that the application and plans be deferred for consideration and inspection of the *locus in quo*.

Dover.—At the last meeting of the Tramways Committee the general manager reported receipts as follows: March 28, passengers 37,279, receipts £153. 7s. 7½d.. against £245. 9s. 9d. last year; aggregate April 1 to date, £10,101, against £12,468. For the portion of the week ending April 4, completing the financial year, 12,651 passengers were carried, the receipts being £52. 3s. 6½d., making the aggregate for the complete year £11,053. 8s., against £12,468. For the latter portion of the week ending April 4 (four days) the passengers were 28,094, and the receipts £117. 1s. 7½d., against last year (including Easter week) £276. 3s. 1d. The total for the complete week this year was £169. 8s. 2d., and the aggregate to date £117. 4s. 7½d., against £276. 3s. 1d. last year. Apart from the fact that the corresponding period last year contained Easter week, the general manager said the receipts showed a very encouraging increase, which he attributed to the new notices "Trams stop by request," which had been added to the fixed stopping places.

Cricklewood.—At the Consistory Court of London on the 9th inst. Dr. Tristram, chancellor of the diocese, heard an application from the vicar and churchwardens of St. Peter's, Cricklewood, in the parish of Hendon, for a faculty authorising them to sell to the Middlesex County Council a portion of the churchyard for the purpose of widening the roadway to the extent of 50ft., so as to enable the County Council to construct a tramway line under the powers granted them by the Light Railways Order, 1903. An agreement had been entered into between the County Council and the petitioners by which the Council was to pay a sum of £50 for the land. The learned chancellor, after carefully inquiring as to the probability of noise during the church services, and being assured that the distance of the tramway would be sufficient to prevent any annoyance from that source, said that the scheme was evidently one that would contribute to the convenience of the public, and he granted the faculty as prayed. The money to be paid for the land is to be handed over to the vicar for repairs necessary to the church.

Sheffield.—A number of important tramway schemes are to be completed during the coming summer months, and work is proceeding apace in extending the Hillsborough section to Malin Bridge. Operations were only commenced a fortnight ago, and already they are in a very forward state. The permanent way will be finished a week after Easter, and then the overhead work will be commenced. There is to be a double line to the bottom of Stannington-road with the exception of a short stretch near Messrs. Burgon and Ball's works. The last thing to be done will be to connect the new line up to the Hillsborough route. There are 150 men engaged on the task. When the Malin Bridge section is finished work will be commenced in Leopold-street. The tramlines from the town hall and Bow-street are to be connected. There was a large amount of what is known as "special work" on the Fitzalan-square lines, but there is even more to be done at Leopold-street. Six double junctions (three at each end of the street) and two cross-over roads are to be constructed. It is expected this work will be completed in five weeks. Then the gang of men will go to Ecclesall to extend the tramlines to Ecclesall Church, and after that work at Firth Park will be started.

Cardiff.—Mr. Arthur Ellis, the tramways manager, informed the Cardiff Electrical and Tramways Committee at their last meeting that the income from tramway traffic for the year ending March 31 showed an increase of £3,428, and there was a reduction in wages of £3,684. If they added to that £1,500 from advertisements and £5,500 profit made last year, he anticipated a surplus of £14,113. Alderman Carey (the chairman) pointed out that they had to pay £45,000 in loan charges each year, which was about 43 per cent. of their income. Mr. Ellis said that there would be an increased surplus of about £9,000, and he hoped there would be a considerable reduction in the consumption of stores. A report by Mr. W. Harpur (the city engineer) was read upon the repairs of the tramway tracks in City-road and Cowbridge-road. Mr. Harpur estimated the cost of the repairs to be £850 and £800 respectively, but it was difficult to estimate or specify the works to be done until the ground had been opened out. Mr. Ellis pointed out that the portion of City-road needing attention was in a very bad state, and in view of the summer traffic, which would be heavy, he would like that to be done first. It was resolved to proceed with the repairs suggested without delay, and to take City-road in hand first.

Edinburgh and Leith.—A sub committee of the Tramway Committee of Leith Town Council held a conference with Edinburgh Tramway Committee on the 10th inst. in the City Chambers, Edinburgh, in regard to the proposed extension of the tramways from Leith to Granton. Lord Provost Gibson presided. The representatives of both Corporations went over the various conditions of the proposals, and after a short discussion an amicable settlement was arrived at on all the points of difference. It is understood that the Edinburgh Committee waived the question of feu duty in dispute. It was arranged that the line between Bonnington and Granton should be doubled, but that the line between Granton and Newhaven must be single owing to the narrowness of the road there. Leith agreed to give Edinburgh the same clause regarding the protection of the electric lighting undertaking as they gave with regard to the water and gas. On the ninth clause of the agreement some discussion took place. Under the Tramway Act of 1870 either authority could acquire solely a tramway in its own territory. This did not apply in the case of Pilrig to Bonnington, because that was a mutual line throughout, but in regard to the new lines now proposed part of the road is entirely in Leith—namely, Granton-road—while from Granton-road to Wardie is in Edinburgh. An agreement was arrived at that neither party could acquire the full ownership of these particular parts, but could only become joint owners. Clauses 11 to 15, which form part of what is known as the Pilrig terms, were agreed to without discussion.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Brussels.—Tenders are invited for the equipment of an electricity station at Alsemberg. Tenders by April 28.

Glasgow.—Tenders are invited for cast-iron joint-boxes for the electricity department. Tenders by April 27.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Hungary.—The Municipality invite tenders for lighting Nagykoras by electricity. A deposit of £800 is required. Tenders by May 1.

Hornsey.—The Town Council invite tenders for supply of cable, joint-boxes, and feeder pillar. Tenders to the Town Clerk by April 21.

Madrid.—Tenders are invited by the Public Works Department for the construction of electric tramways in Bilbao. Tenders by April 30.

Buenos Ayres.—Tenders are invited for the construction and working of two sections of the underground electric railway. Tenders by May 1.

Madrid.—The Post and Telegraph Department invite tenders for 35,000 long and 25,000 short telegraph insulator brackets. Tenders by April 27.

Bournemouth.—The Town Council invite tenders for the supply of coal to the tramways generating station. Tenders to the Town Clerk by April 20.

Grimsby.—The Corporation invite tenders for arc lamp lowering gear (Specification No. 63). Particulars from the Borough Electrical Engineer. Tenders by April 24.

Poplar.—The Electricity Committee invite tenders for the supply of switchboards and gear. Particulars from the Borough Eelectrical Engineer. Tenders by April 29.

Hackney.—The London County Council invite tenders for electrically wiring and fitting the tramways car-shed at Mare-street, Hackney, N.E. Tenders by May 12.

Eccles.—The Corporation invite tenders for one Lancashire boiler and superheater and a 210-kw. steam-engine, alternator, and exciter. Tenders to the Town Clerk by April 27.

Manchester.—The Tramways Committee invite tenders for the supply of steel girder rails and fishplates. Particulars from the General Manager. Tenders by April 21.

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Hobart.—Tenders are invited by the Postmaster-General for 200 wall telephones, 800 telephone recorders, and extension of common-battery switchboard. Tenders by May 11.

Tasmania.—The Postmaster-General invites tenders for material for extension of common battery and switchboard, 200 wall telephones, and 800 telephone recorders and cords. Tenders by May 11.

Weymouth.—The Weymouth and Melcombe Regis Corporation invite tenders for the supply of a 300-kw. steam-turbine and extension switchboard panel. Tenders to the Town Clerk by April 18.

Tonbridge.—The Urban District Council invite tenders for the supply and erection of plant at the generating station. Particulars from Mr. W. P. Plunkett, electrical engineer. Tenders by April 22.

Sheffield.—The Tramways Committee invite tenders for the supply of clothing for the tramway employés. Particulars from the General Manager, Tramways Department, Division-street, Sheffield. Tenders by April 23.

Sydney.—The Postmaster-General invites tenders for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators (best white porcelain, large). Tenders by May 20.

Poplar.—The Electricity Committee invite tenders for the erection of a sub-station building at Millwall. Particulars from the Borough Electrical Engineer, Glaucus-street, Bromley-by-Bow. Tenders to the Town Clerk by April 29.

New South Wales.—Tenders are invited by the Postmaster-General for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators, best white porcelain, large. Tenders by May 20.

Govan.—Tenders are invited for the annual supply of stores to the electricity department, including cables, electricity meters, house service fuse boxes, arc lamp carbons, motors, etc. Particulars from the Burgh Electrical Engineer. Tenders by April 27.

London, S.W.—The London County Council invite tenders for 175 double-deck car bodies, swing bolster trucks, and complete electrical equipments for overhead trolley, surface-contact, and underground conduit systems of electric traction. Tenders by May 9.

Haslingden.—The Corporation invite tenders for overhead lines in connection with the electric tramways. Specifications, etc., can be inspected at the office of Messrs. Handcock and Dykes, 1, Victoria-street, Westminster, S.W. Tenders to the Town Clerk by April 25.

Gillingham (Kent).—The Borough Council invite tenders for the supply and delivery of coal to the electricity generating station. Particulars from the Borough Electrical Engineer, Generating Station, Gillingham-road. Tenders to Mr. Boucher, town clerk, by April 27.

Sydney.—The Government Railway Department invite tenders for the supply and installation of about 4½ miles of three-core, high-tension, paper-insulated, lead-covered feeder cable. Particulars from the Electrical Engineer, 51, Phillips-street, Sydney. Tenders by May 4.

Dundee.—The Electricity Committee invite tenders for the supply and erection of water pumping plant and overhead travelling cranes, etc., in connection with the new Carolina Port main generating station. Particulars from Mr. H. Richardson, engineer in-charge. Tenders by April 27.

West Bromwich.—The Town Council invite tenders for the installation of a modern refuse-destroying plant at their electricity works, Black Lake, West Bromwich. Particulars from Mr. Albert D. Greatorex, borough engineer and surveyor, Town Hall, West Bromwich. Tenders by May 9.

Manchester. — The Corporation Electricity Committee invite tenders for the supply of a 10-ton locomotive tipping crane for Stuart-street generating station. Specification, etc., from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders to the Chairman of the Electricity Committee by April 22.

Rawtenstall.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, overhead line equipment, and accessories. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Sillar, and Leigh, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders to the Town Clerk by April 24.

RESULTS OF TENDERS.

Whitehaven.—The Town Council have accepted the following tenders: Phœnix Dynamo Co., battery booster; Whipp and Bourne, battery switchboard; Tudor Co., milking booster.

Belfast.—The Harbour Commissioners have accepted the tender of Dick, Kerr, and Co. to supply about 100 tons of steel girder tramway rails at £6. 14s. per ton, with the necessary fishplates at £8. 4s. per ton, and bolts and nuts at £15 per ton.

Teesbridge.—The British Thomson-Houston Co. have received an order from the Tyneside Electrical Development Co. for an exhaust-steam turbine, having an output of 1,500 k.v.a. at 2,8 5 volts, 40 cycles, when running at a speed of 2,400 r.p.m.

Sheffield.—Messrs. Marples, Leach, and Co. have secured the contract for the supply, delivery, and erection of a high-tension two-phase alternating-current induction motor for driving two 10in. and one 8in. mills at the works of Samuel Osborn and Co., Sheffield.

London.—The Highways Committee of the London County Council recommend for acceptance the following tenders: Hadfield's Steel-foundry Co., special track work, £4,524. 10s; Forced Lubrication Co., shatting brackets, and pulleys, £500. 3s. 2d. (including a provisional sum of £100 for pulleys).

Croydon.—The Corporation have accepted the following tenders for works to be carried out at their electricity works, Factory-lane, Croydon: (*a*) coal and ash conveyor; (*b*) coal bunkers; (*c*) builders' work: Babcock and Wilcox, 30, Farringdon-street, E.C., coal and ash conveyor, £1,154; Weber Concrete Construction Co., Queen Anne's-chambers, Westminster, S.W., coal and ash bunkers, £681. 14s.; St. Pancras Ironworks Co., 171, St. Pancras-road, N., switchboard flooring, £144.

London.—The Highways Committee of the London County Council have accepted the following tenders in connection with the construction of 50 new car bodies: Hurst, Nelson, and Co., car furniture £369. 0s. 9d., 50 sets of sanding gear, movable steps, and lifeguards at £8. 2s. 6d., £3. 12s. 6d., and £4. 5s. a set, 50 sets of window-operating gear at £12. 10s. a set, and sun blinds £292. 10s; United Electric Car Co., 50 sets of brake gear at £4. 19s. a set; Hoskins and Sewell, 50 sets ventilator operating gear at £3 a set.

Derby.—The Tramways Committee have accepted the tender of Edgar Allen and Co., at £350, for special work in connection with the renewal of the junction at the bottom of Babington-lane, and their tender, at £208. 7s., for work in connection with the Nottingham-road car-shed; also the tender of J. Smith and Co., at £270, for the supply of clothing for tramway employés. The committee recommend the Council to grant the sum of £124. 15s. for the purchase of 33½ tons of surplus tramrails from Blackwell and Co.

London.—The London County Council have received the following tenders for installing electric lighting and electrically-driven fans at the Dawes-road, Fulham, and the Hortensia-road, Chelsea, Secondary Schools:

Dawes-road, Fulham.

G. N. Haden and Sons, Trowbridge, London, Manchester, and Birmingham*	£665	0	0
Purcell and Nobbs, 87 and 89, Cleveland-street, Fitzroy-square	678	6	6
Pemberton, Arber, and Co., 8 and 9, Gray's-inn-passage	746	0	0
H. J. Galliers, 32, St. James's street, Brighton	764	0	0
Jenkins and Cawte, Fore-street, Chard	769	0	6
W. G. Cannon and Sons, 107, London-road	870	1	6
G. Weston and Sons, 153, Fenchurch-street	890	0	0
Tilley Bros., 53, Kingsland-road	912	10	6
H. J. Cash and Co., Caxton House, Westminster	940	0	0
V. G. Middleton, Broadway-chambers, Westminster	951	0	0
A. Hawkins and Sons, 125-8, London-road	997	0	0
Sweet Bros., 100-102, Hampstead-road	1,089	0	0
J. Bryden and Sons, 90, Gloucester-road, Queen's Gate	1,182	0	0
G. Benkert, 48, Wilson-street, Finsbury-square	1 270	0	0
R. H. and J. Pearson, 145, Notting Hill-gate	1,542	0	0

Hortensia-road, Chelsea.

G. N. Haden and Sons*	685	0	0
Purcell and Nobbs	689	16	0
Pemberton, Arber, and Co.	771	0	0
H. J. Galliers	770	0	0
Jenkins and Cawte	811	8	8
W. G. Cannon and Sons	867	2	5
G. Weston and Sons	931	15	0
Tilley Bros.	930	18	8
H. J. Cash and Co.	890	0	0
V. G. Middleton	933	0	0
A. Hawkins and Sons	883	0	0
J. Bryden and Sons	1,142	0	0
G. Benkert	1,040	0	0
Efficient Electrical Engineering Co., 87, New Cavendish-street	954	0	0

* Recommended for acceptance.

OPENINGS FOR CONTRACTORS.

ABERCARN—Twenty houses, Trustees of the Gwyddon-road Building Club; 20 houses, Trustees of the Rhyswg-road Building Club.

ABERDARE—Restoring St. Fagan's Church, Rev. R. Jones.

ACCRINGTON—Elementary schools, Boyd-street, Education Committee.

ALNWICK—Housing scheme (£3,000), Urban District Council.

ALTRINCHAM—Extension of public baths (£3,000), Urban District Council.

ARLECDON AND FRIZINGTON—Lighting installation for district (£5,000), Council.

ASKHAM IN-FURNESS—Schoolroom for the Wesleyan Methodists, Trustees.

BALROTHERY—Housing scheme (£42,780), Urban District Council.

BANGOR—Rebuilding Calvinistic Methodist Tabernacle (£4,000), Trustees.

BARNSLEY—Improvements, Carlton Provided School, West Riding Education Committee.

BARTON-ON-HUMBER—Alterations and additions to Constitutional Club premises, Mr. R Maden.

BEAUFORT—Alterations and additions to premises, Partridge-row, Mr. J. Davies.

BILLINGFORD—Church for the local Primitive Methodists. Mr. A. F. Scott, architect

BISHOP'S CASTLE—Secondary school, County Council.

BISHOP'S STORTFORD—Joint secondary school, County Councils of Herts and Essex.

BLACKWOOD—Elementary school (£7,450), Monmouthshire Education Authority.

BOLTON—Presbyterian church, schools, classrooms, etc., Somerset road. Mr. W. B. Rees, architect.

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BOMBAY—Extension of St. George's Hospital (Rs.50,000), Government.

BRADFIELD—Additions, Everington House, Yattendon, Sir A. Rucker; additions, Frilsham House, Sir W. C. Gull; two houses, Tilehurst, Mr. E Mazey; house, Streatley, Mr. H. Saunders; house, Green-lane, Mr. L. Pitney.

BRADFORD—Textile department (£12,000), machinery and equipment (£7 000), in connection with the Bradford Technical College.

BROMLEY—Public convenience, Queen's Garden, Town Council.

BULFORD—Mission hall, Churchwardens South Tidworth Church.

BUXTON—Alterations to The Quadrant, Manchester and Liverpool Banking Co.

CAERPHILLY—Fourteen houses, Lawrence-street Building Club.

CANNAMORE—Extension of the central jail (Rs.21,100), Madras Government.

CARDIFF—Fire brigade station, Cathays-park, Watch Committee.

CHAPELTOWN—Enlargement of Primitive Methodist Chapel. Mr. J. P. Earle, Sheffield, architect.

CHATHAM—Conveniences, etc., Military-road, Town Council.

CHEADLE—Warehouse, etc., Messrs. Pritchards, Limited.

CHESTER—Council school, Egerton-street, Education Committee.

CHOPWELL—Shops, warehouse, etc. Mr. D. M. Spence, architect.

CLONES—Housing scheme (£15,285), Urban District Council.

COTTINGHAM—Six houses, Finkle-street, Mr. H. Whiting; two shops, Mr. Fincheon.

CROWTHORNE—Villa residence, etc, Mr. C J Brake.

CUDDAPAH—Police quarters (Rs.13,235), Madras Government.

DARFIELD—Elementary school, West Riding Education Committee.

DARTON—Eight houses Messrs. R. and W. Dixon, architects.

DEVONPORT—Municipal buildings and offices, Town Council.

DEWSBURY—Wesleyan Sunday school, Hartshead. Mr. E. V. King, architect.

DILTON—Housing scheme (£1,844), Westbury Rural District Council.

DOVER—Two residences, Hardwick-road, Mr. W. D. Redman.

DRIGHLINGTON—Additions to house, Adwalton-lane, Mr. J. Taylor.

DUBLIN—Theatre to accommodate 2,000 people. Messrs. Swanson and Syme, architects.

DUNBAR—Slaughter-house (£1,150), Council.

DUNDEE—House, Blackness-road, Mr. A. Lickley; additions, textile department, Managers, Dundee Technical Institute; alterations, premises, Mr. D. Wallace.

DURRINGTON—Elementary school (£2,567), West Sussex Education Committee.

EAST LOTHIAN—Extension of Western District infectious diseases combination hospital at Haddington (£1,700).

ECCLES—Additional plant at the borough electricity works (£4,000), Town Council.

EDENDERRY—Housing scheme (£4,130), Urban District Council.

EDINBURGH—Improvements at Synod Hall (£500).

EDMONTON—Church of St. Alphege, Lower Edmonton, Ecclesiastical Commissioners.

EGREMONT—Alterations, premises, Market-place, Mr. Suldart.

EVESHAM—Three houses, Northwick-road, Mr. H. Bailey; warehouse, Vine-street, Messrs. White Bros., Limited.

FARINGTON—Enlargement of St. Paul's Church, Ecclesiastical Commissioners.

FORT WILLIAM—Additions to high school. Mr. J. G. Falconer, architect.

FYVIE—Alterations and additions at public school, School Board.

GATESHEAD—Catholic schools, Dunsmuir-grove. Messrs. Lowther and Walker, architects.

GILLINGHAM—Church of St. Luke's, Church Council; three houses, Regent-road, Mr. Hodden; 20 houses, Barnsole-road, Mr. E. J. Hammond.

GILLINGHAM—Elementary school at Hempstead, Council.

GLOSSOP—Council school at Hadfield, £3,850, Town Council.

GUERNSEY—Houses, etc., at Fort Doyle, Harbour Committee.

GUISBOROUGH—Twelve houses, Allison-street, Mr. J. G. Porteous.

HAINBWE (BURMA)—Inspection bungalow (Rs.10 000, for the Public Works Department.

HARTLEPOOL—Operating theatre (£400), Hospital Governors.

HEBDEN BRIDGE—Public library, Literary Society.

HEIGHINGTON — Five houses. Plans passed by Darlington Rural Council.

HERTFORD—County school at Letchworth (£9,000), Herts County Council

HOUGHTON-LE-SPRING—Houses, Gilpin-street, Messrs. Ramsey and Fraser.

HUBLI—Courthouse (Rs.6,500), Bombay Government.

HULL—Alterations and additions, Boulevard Secondary School, Education Committee.

HYTHE—Public convenience in the Grove, Borough Surveyor.

ILFORD—Library and public hall, High-road, Seven Kings, Ilford Urban District Council.

INVERARY—Extensions and improvements to St. Catherine's pier, Town Council

KEIGHLEY—Alterations and additions to clubhouse, Keighley Golf Club.

KIRKBY—Eight houses, Alfred-street, Mr. Ladyman; four houses, Vernon-road, Mr. Stubbins; eight houses, Hodgkinson-road; six houses, Colsden-street, Mr. Tweltidge; house, Nuncargate-road, Mr. Davies; two houses, Skegby-road, Mr. Colledge; two houses, Main-street, Mr. Colledge.

LEEDS—Additions to All Souls' Sunday School, Cambridge-road. Mr. W. P. Schofield, architect.

LEYTON—Enlargement, sorting office, Commissioners of H.M. Works.

LEOMINSTER—Elementary school, Herefordshire County Council.

LISBURN—An annex to the workhouse (£450), Board of Guardians

LIVERPOOL—Additions to workhouse, Smithdown-road, Toxteth Park Board of Guardians

LONDON, N.—Enlargement of Hornsey sorting office, H.M. Commissioners of Public Works.

LONDON, S.W.—Branch post office and meteorological office, South Kensington, Commissioners of H.M. Public Works.

LYNN—Two houses, Chase Estate, Messrs. Seaman and Haverson; house, Sydney-street, Mr. Allflat; four houses, Sir Lewis-street, Mr Dawson.

MAGHERAFELT—One hundred and seventy-nine cottages (£35,790), District Council.

MANCHESTER—Shop extension, Ashton-road, Midland Railway Co.

MANSFIELD—Boys' Brigade drill hall (£3,000), Bolsover Colliery Co.

MARSDEN—Club premises, local Conservative Association.

MELBOURNE—Building for the Melbourne Benevolent Asylum, Cheltenham.

MERTHYR—Elementary schools at Pennydarren and Pant, Education Committee

MERTHYR—Alterations, courthouse, Merthyr Model Homes Syndicate.

MIDDLESBROUGH—Cable for the sub-station (£2,000), Electric Lighting Committee.

MIDHURST—Chapel in connection with workhouse (£500), Board of Guardians.

MILE END.—Asylum accommodation, Essex County Lunatic Asylum.

MIRFIELD—Buildings, Messrs. J. Blackburn and S. J. Benton.

MOFFAT—Extensions to pavilion, etc. (£200), Beechgrove Recreation Grounds Committee.

NEWCASTLE—Twenty-one houses and two shops, Ayton-street; four houses, Delaval-gardens; seven houses, Haldane-terrace; 21 houses, Hampstead-road; 42 houses, Ladykirk-road; seven houses, Wentworth-road. Plans passed by Town Council.

NEWTON ABBOT—Enlargement of elementary school at Highweek, Devon County Education Authority.

NORTHAMPTON—Library (£13,189), Town Council.

PATTUKOTTAI—Government school (Rs.10,000), Madras Government.

PECKHAM, S.E.—Elementary school, London County Council.

PENSTON—Laundry, Grimsargh, Mr. R Mason.

PENWORTHAM—Two houses, Mr. J. Marsden; house, Mr. Seddon.

PENYMAES—Cottage hospital and dispensary. Mr. S. Evans, architect, Mold.

POLSTEAD—Alterations, Council school and teacher's house, West Suffolk Education Committee.

PONTYGRAIGWEN—Ten houses, G. W. Colliery Co.

POOLE—Additions, Normansfield, Forest-road, Messrs. Jenkins and Sons; house, Powell-road, Mr. W. Andrew; house, Pembroke-road, Mr. J. Wellman; motor-house, The Teak House. Messrs. Fogerty and Brunsell; house, Penn Hill-avenue, Mr. A. E. Hoare; house, King's-avenue, Mr. J. F. Watkins; additions, mission hall, Victoria-crescent, Rev. G. C. R. Read; five houses and shops, Commercial road, Mr. Newton; two houses, Rossmore-road, Mr. C. H. Goater.

POOLE—Alterations and improvements to Heatherlands Council School (£214), Education Committee.

POTTERS HEIGHAM—Additions to teacher's house, Norfolk Education Committee.

PRESTWICH — Secondary school (£17,000), County Education Authority.

RATHKEALE—Housing scheme (£40,810), Urban District Council.

RAWTENSTALL—Overhead equipment, Town Council.

REPPS-WITH-BASTWICK—Additions to school, etc., Norfolk Education Committee.

RIBCHESTER—Additions to brewery, Blackburn Brewery Co.; two houses, Mr. J. Barton.

ROCHDALE—Church for the parish of St. Mary's (£10,000), Churchwardens.

ROMFORD—Secondary school, Heath-park site, Urban District Council.

ROTHES—School house at Inchberry (£440), School Board.

RUARDEAN—Alterations and additions to elementary schools, Gloucestershire Education Committee.

SACRISTON—Shops, warehouse, etc. Mr. D. M. Spence, architect.

ST. ALBANS—House, Lancaster-road, Mr. A. C. McKenzie; two houses, Nicholls Farm, Redbourn, Mr. W. Tarry; three houses, Redbourn, Mr. W. Collyer.

ST. ANNES—Residence, St. Annes-road East, Mr. J. Prestwich; four houses, Headroomgate-road, Mr. S. Wilson; two houses, Derbe-road, Messrs. J. Heap and Sons; two houses, Queen's-road, Mr. C. Bluhm; house, St. Thomas's-road, Mr. R. Crighton.

ST. HELENS—Teacher's house at Merton Bank Schools, Parr, St. Helens Education Committee.

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SALTERFORTH—Elementary school, West Riding Education Committee.
SCARBOROUGH—Pavilion, Filey-road, Town Council.
SOUTHAMPTON—Central fire station, Town Council.
SOUTHERY—Two houses on the Ferry Farm. Messrs. Charles Hawkins and Sons.
SOUTHFIELDS—School-chapel (£4,500), local Wesleyans.
SOUTH CROSLAND—Houses, Moor-lane and Armitage-fold, Mr. J. M. Thornton; dye house and shop, Messrs. Thornton, Marsden, and Vickerman.
SOUTH ELMSALL—Elementary school, West Riding Education Committee.
SOUTHPORT — Elementary school, Linaker-street, Education Committee.
STANLEY—Public conveniences, Shield Row, Urban District Council.
STEPNEY, E —Public conveniences, Horseferry Branch-road (£2,000), London County Council.
STOCKPORT—Secondary school, Greek-street, (£13,000), Education Committee.
STOCKPORT—Tramway offices, Mersey-square, Tramways Committee.
SUNDERLAND—Housing scheme, Silksworth and Ryhope (£21,000), Rural District Council.
SWANSEA—Alterations and additions to the National Schools, Oxford-street, Education Authorities.
SWINDON—Ten houses, York-road, Mr. J. E. Bell; house, Fairview, Mr. G. Barker; two villas, Okus-road, Mr. E. Hill; alterations to Carpenter's Arms, Messrs. Drew and Sons.
TARPORLEY—County police station. Mr. H. Beswick, architect.
TEMPLEPATRICK—Alterations and additions to manse, Committee of Presbyterian Church.
TIDWORTH—Mission hall, Churchwardens South Tidworth Church.
TINGLEY—Wesleyan Sunday schools. Messrs. Garside and Pennington, architects.
TOFT MONKS—Alterations and additions to school, Norfolk Education Committee.
TRANENT-House, Bersley-road, Mr. Mitchells; alterations to shop, High-street, Mr. Hood.
TREHERBERT—Alterations and additions to building, Trustees of Libanus Chapel.
TREHERBERT—Five houses, Messrs. Davies and Davies.
TWYNRODYN—Twenty two houses, Twyncynon Building Club.
ULVERSTON—Alterations to premises, Summer-hill, Mr. Altham; cottage, Gummershaw, Mr. Huntingdon; extensions to auction mart, Auction Mart Co.; additions to premises, Lightburn-road, Mr. J. Knight.
WAKEFIELD—Alterations, etc., Outwood Provided School, West Riding Education Committee.
WARDLEWORTH—Church on the site of St. Mary's. Mr. J. N. Cooper, architect.
WARE—Enlargement of girls' grammar school, Urban District Council.
WASHWOOD HEATH—Council school, Leigh-road (£20,172) Education Committee.
WATERLOO-WITH-SEAFORTH — Elementary schools, Urban District Council.
WEST BROMWICH—Elementary school, Hill Top, to accommodate 1,400 scholars, Education Committee.
WEST BROMWICH—Modern refuse destructor at the electricity works, Black Lake, Town Council.
WESTBOURNE—Elementary school, West Sussex Education Committee.
WEST HAM—Extensions to hospital, Hospital Committee.
WEYMOUTH-Secondary school (£9,000), Education Committee.
WHITBY—Secondary school and temporary school, North Riding Education Committee.
WHITCHURCH—Church hall and institute, Churchwardens.
WHITEHAVEN—Alterations to houses, Littledale-lane, etc. Plans passed.
WHITEHAVEN—Alteration of Trinity School buildings, Trustees.
WINCHBURGH—Mission hall, Presbyterian Synod of Abercorn.
WINGATE—Alterations and additions at the Primitive Methodist Church, Trustees.
WORTHING—Enlargement of school of arts (£603), West Sussex Education Committee.
WREXHAM—Regent Hall, Regent-street, Messrs. C. Davies and Co.; three houses, Jubilee-road, Mr. Cafferty; seven houses, Beechley-road, Mr. H. A. Jones; two houses, Erddig-road, Mr. F Oudworth; eight houses, Foster and Cross streets, Mr. Gwilt Cathrall.

COMPANIES' MEETINGS AND REPORTS.

BATH ELECTRIC TRAMWAYS.

The fifth ordinary general meeting of the Bath Electric Tramways Co. was held on Tuesday, Sir Vincent Caillard, chairman of the Company, presiding.

In moving the adoption of the report, the CHAIRMAN said that the receipts for the past year amounted to £41,452, against £42,722 for 1906, the decrease being due to the inclement weather. In the expenses there had been a small increase owing to the higher cost of coal and petrol, with the result that they had a net decrease of £1,526. Their receipts per car mile had decreased by ·115d., but, on the other hand, the receipts per passenger had increased to 1·447d. After payment of the debenture interest and the preference dividend there remained a balance of £2,489, which the Board proposed should be carried forward. The Board did not, on account of the results of the past 12 months, view the future with discouragement.

Mr. A. C. SWINTON seconded the motion, which was carried after some discussion which urged a reduction in the expense of working the system.

ANGLO-ARGENTINE TRAMWAYS.

The twenty-fourth ordinary general meeting of the Anglo-Argentine Tramways Co. was held at Winchester House, Old Broad-street, E.C., Mr. J. B. Concanon (chairman of the Company) presiding.

In moving the adoption of the report and accounts, the CHAIRMAN said the results all round were very satisfactory. The gross profits, after debiting revenue with £65,000 and crediting depreciation renewals fund with that sum, amounted to £365,573, or, roughly speaking, £1,000 per day. Deducting from this figure the interest and sinking fund on debenture stock, the annuity payable to the City Co., dividends on the first and second preference shares, interest payable to the Belgrano Co., sinking fund for the redemption of the preference shares, provision for depreciation on investments, and a dividend at the rate of 8 per cent. per annum on £200,000 of ordinary shares, there was left a balance of £16,734 to be carried forward. He thought he could safely say that the profits for the year 1908 of the Anglo-City system were likely to show a considerable augmentation. Already up to the 1st inst. the gross receipts showed an increase of £30,742, and although about £8,900 of this increase was attributable to the loss of traffic during the strike of their employés towards the end of January last year, in view of the great prosperity of the Argentine Republic, he saw no reason why their receipts and profits should not continue to expand. He was pleased to say that they had had no trouble with their employés since that which occurred towards the end of January last year. Quite recently the Board voluntarily granted an increase of wages to certain of its employés, and no doubt that action would be appreciated by the men, and the additional expenditure would be more than covered by greater efficiency upon their part. With regard to the sums which had hitherto been debited to revenue and credited to the depreciation renewals funds, including the £65,000 set aside out of last year's profits, and after deducting the expenditure on renewals in 1907, they now had a total balance standing to the credit of the paving depreciation fund and the general depreciation renewals fund of £215,979. 12s. 1d. He had intimated at previous meetings that the directors took a very conservative view of this important question. The working of tramways by electricity being, comparatively speaking, a new industry, they naturally gained more experience of the probable life of the permanent way, rolling-stock, etc., as time went on. They proposed, therefore, to submit the question generally to an exhaustive examination towards the end of this year, with the view of arriving at a closer approximation of the figure which should in future be annually charged to revenue under this head. They proposed very shortly to make an issue of £500,000 new debentures. Two hundred thousand pounds of the proceeds of the proposed issue would be applied towards meeting additional capital expenditure for increased rolling-stock, some small extensions, and for other outlays which they had made during the last year or two, and the remaining £300,000 would be applied to the purchase of £300,000 of La Capital Traction and Electric Co. of Buenos Ayres 5 per cent. debentures. This purchase might be regarded as a step towards the acquisition of other tramway undertakings in Buenos Ayres.

Mr. J. R. CORBETT seconded the motion, which was carried unanimously.

APPOINTMENTS VACANT.

Chief Electrical Engineer, Watford Urban District Council. Commencing salary, £250, rising to £400 per annum. Particulars from the Clerk. Applications by April 25.

NEW COMPANIES REGISTERED.

Batang Padang Rubber and Produce Co., Limited.—Registered March 26. Capital, £5,000 in £1 shares. Objects: to acquire grants or leases of certain agricultural land, containing from 700 to 750 acres, near Tapah, and in the Mukim of Batang Padang, in Perak, Federated Malay States (known as Baldwin's Concession), and to carry on the business of planters of indiarubber, guttapercha, balata, gums, coffee, tea, cocoanuts, and other produce, etc. Registered office: 101, Leadenhall-street, E.C.

Accra Rubber Co., Limited.—Registered March 11. Capital, £825 in £1 shares. Objects: to adopt an agreement with W. A. Pritchard, and to carry on the business of planters, cultivators, and sellers of and dealers in rubber, guttapercha, and gums of all kinds. No initial public issue. Table "A" mainly applies. Registered office: 19, Coleman-street, E.C.

Electromotor Equipment Co., Limited.—Registered March 24. Capital, £5,000 in £1 shares (4,500 preference). Objects: to carry on the business of electricians, mechanical and general engineers, workers of and dealers in electricity, motive power, and light, manufacturers of electrical apparatus, etc. No initial public issue.

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Liens Registered.

Consolidated Supply Co., Limited (Electrical Engineers, London).—Issue on March 10 of £875 5 per cent. debentures, part of series created July 18, 1906, to secure £15,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £13,695.

Leicestershire and Warwickshire Electric Power Syndicate, Limited.—Issue on March 16 of £100 6 per cent. debentures, part of series created March 9, 1907, to secure £5,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £850.

J. G. Childs and Co., Limited (Electrical Engineers, Willesden).—Issue on March 17 of £450 and on March 26 of £2,200 6 per cent. debentures, part of series created Feb. 21, 1908, to secure £5,000. Charged on the company's undertaking and property, present and future, except the lands and premises in Hawthorn-road, Willesden Green, charged by a mortgage dated March 3, 1904. No trustees. Total amount previously issued of same series, £2,350.

Micanite Insulators Co., Limited (Walthamstow).—£15,000 5½ per cent. debentures, created March 18 and dated March 26, 1908, have been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Public Undertakings, Limited (Bishop Auckland, etc., Tramways).—A memorandum of satisfaction to the extent of £2,386. 16s. of trust deed dated July 18, 1904, securing £10,000 debenture stock has been filed.

Associated Battery Co., Limited (Westminster).—Issue on March 21 of £1,075 5 per cent. debentures, part of series created Feb. 26, 1908, to secure £2,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

Maxim Electrical Co., Limited (London).—A charge on the company's undertaking and property, present and future, dated April 2, 1908, to secure £500, has been registered. Holders: Barclay and Co.

Yenesei Copper Co., Limited.—Memoranda of satisfaction in full of debentures dated May 30, 1906, securing £1,059, and of a mortgage or charge dated Oct. 3, 1906, securing £1,062. 10s., have been filed. Particulars of £100,000 6 per cent. debentures created by resolution of Feb. 25, 1908, have also been filed pursuant to Section 14 (4) of the Companies' Act, 1900. Property charged: the company's undertaking and assets, present and future. No trustees. £5,000 of above series have been issued.

LEGAL INTELLIGENCE.

ERNEST SCOTT AND MOUNTAIN v. KENT COLLIERIES.

Mr. Muir Mackenzie, official referee, resumed the hearing on Friday last of the action of Ernest Scott and Mountain v. Kent Collieries, the plaintiffs claiming the sum of £3,249, balance of the price of electrical plant and machinery supplied by them to the defendants, and about £1,500 which it was alleged was due on account of a pump supplied, wages paid on behalf of the defendants, goods delivered, etc. The defendants denied liability, and counterclaimed for over £48,000, they alleging that the machinery was not in accordance with contract, and had broken down.

Mr. WILLIAM CHARLES MOUNTAIN, managing director of the plaintiff firm, said on Sept. 12 he received a communication from plaintiffs' representative in charge of the work at defendants' shaft at Dover with regard to the pumping, and he again impressed upon defendants the necessity of lowering another pump into the shaft. It was imperative that in connection with work of such a character there should be a relief pump, because the machinery doing that kind of work required overhauling and careful attention. Care had to be taken that the electrical part of the motor was not unduly heating from any mechanical cause. It was also necessary to examine the pumps' bearings, and to see that all the points were tight. A constant examination of machinery was absolutely necessary. His 25 years' experience told him that 99 per cent. of breakdowns was due to neglect or want of attention. Machinery should be examined at the end of every shift, which should not be more than 12 hours. There was a clause in the Mines Act which provided that all machinery in mines should be examined every 24 hours. Witness took the precaution to send to the defendants a list of instructions which were absolutely necessary, but it would be impossible to carry those instructions out with only one pump.

Cross-examined by Mr. Hutchinson (for the defendants), witness said that it was the duty of the defendants to fix a date for testing the plant in the presence of their expert, and if the tests that Dr. Kapp did arrange for had been carried out it would have saved all the present trouble and litigation. Witness denied that any failure of the machinery was the reason for not making tests. One of the pumps worked for nearly five weeks, which was not contemplated by the plaintiffs, and broke down as a consequence. If there had been any delay after that it was caused by the defendants, who did not carry out the repairs in accordance with plaintiffs' advice and wishes. He never heard that delay through the machinery not working cost £100 a day.

In re-examination by Mr. C. A. Russell, K.C. (for the plaintiffs), witness said that there was a danger of a machine being permanently damaged by standing in the open air for four or five weeks in a damp place like Dover.

The plaintiffs' foreman engineer, who had charge of the work at the defendants' pit at Dover, gave evidence on Saturday with regard to his experience at the shaft. He said that in the presence of several directors of the Collieries Co. he spoke to Mr. Tels about there being only one pump in the shaft, and expressed his surprise that there were not two, as he had understood there were to be. One of the directors told him that they were not able to get a second set in because a second capstan was not ready, and they (defendants) promised to get pulleys for the second pump as soon as possible. Witness came to the work on Aug. 2, 1906, but the capstan and pulleys were not set till the second week in November.

The hearing was again adjourned.

THE RATING OF THE BLACKPOOL AND FLEETWOOD TRAMWAYS.

In the Divisional Court on Friday last Mr. Leslie Scott moved *ex parte* for a rule *nisi* for a mandamus to the justices of Lancashire directing them to make a certain rate on the Blackpool and Fleetwood Tramways Co. Mr. Scott said the rate was quite in order, and when a distress warrant was applied for before the magistrates for the purpose of enforcing payment, the magistrates went into questions of law and fact which they had no right to do, and which could only be dealt with on an appeal to quarter sessions on an assessment. He desired a mandamus directing the magistrates to issue the warrant.

Their Lordships having read the affidavits before the Court, granted the rule.

PRESSURE OF ELECTRICITY SUPPLY.

At North London Police Court on Monday, counsel appeared for the Islington Borough Council to answer 10 summonses taken out by Arthur Wiseman Boreham, on behalf of the Consolidated Supply Co., of Northampton-grove, Canonbury, for failing to supply to the company's works electrical energy at the declared constant pressure of 200 volts, contrary to the provisions of the Electric Lighting Order Confirmation (No. 6) Act, 1893, and to the Board of Trade regulations.

On the cases being called on there was no response on the part of the company.

It was pointed out that the Council had a summons against the company for £25. 11s., balance of account for electricity supplied, and the company had suggested that if the Council would give up their claim they would withdraw their summonses. The Borough Council, however, refused to act on such a suggestion.

The magistrate dismissed the summonses against the Council with £5. 5s. costs, and he made an order on the company to pay the Council's claim of £25. 11s., with 6s. costs.

PROVISIONAL PATENTS, 1908.

APRIL 2.

7261. Improvements in electric timing and recording devices. Frederick Harrison Glew, 156, Clapham-road, London.

7269. Improvements in the electric lighting of motorcars and apparatus therefor. William Heap Holland, 6, Bank-street, Manchester.

7289. Improvements in the regulation of alternating-current commutator machines. Siemens-Schuckertwerke, G. m. b. H., 139, Queen Victoria-street, London. (Date applied for under Section 91 of the Act, April 2, 1907, being date of application in Germany.) (Complete specification.)

7327. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, and Frederick Horton Clough, 83, Cannon-street, London. (Complete specification.)

7328. Improvements in and relating to arc lamps. Allgemeine Elektricitats-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Aug. 2, 1907, being date of application in Germany.) (Complete specification.)

7335. Improvements in electric motor-control systems. Albert Henry Jackson, 22, Southampton-buildings, London.

7337. Improved non-corroding terminal for accumulators and the like. Alfred Ernest Felgate, 10, Queen Victoria-street, Reading.

APRIL 3.

7374. Improvements in insulated railway rail joints. Benjamin Wolhaupter, Palace-chambers, Westminster. (Complete specification.)

7382. Improvements in or relating to electromagnetic circuit breakers for use in connection with electric motor controllers. The Electric and Ordnance Accessories Company, Limited, Robert Frederick Hall, and Max Mueller, 24, Temple-row, Birmingham.

7398. Improvements in apparatus for measuring electrical resistance. Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

7409. Improvements in or relating to switches for electrical purposes. Thomas Joseph Rorke and Edwin Rorke, 7, Southampton-buildings, London.

7434. Improvements in and relating to electric traction and like systems. The British Thomson-Houston Company,

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Limited, 83, Cannon-street, London. (General Electric Company, United States.)

APRIL 4.

7480. Method for testing electrolytic valve cells or the like. Siemens und Halske Aktien-Gesellschaft, 12 Queen Anne's-gate, Westminster, London. (Date applied for under Section 91 of the Act, April 4, 1907, being date of application in Germany.) (Complete specification.)

7490. Improvements in the fixing of insulators to the arms of poles and the like. George Horn, 40, Chancery-lane, London.

7493. Improvements in telephonic transmitters or relays. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, April 5, 1907, being date of application in United States.) (Complete specification.)

7494. Improvements in wireless signalling. Reginald Aubrey Fessenden, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, April 5, 1907, being date of application in United States.) (Complete specification.)

7507. Improvements in or relating to electrically-heated tools. John Oerlly and Charles Frederick Dudley, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, April 6, 1907, being date of application in United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on April 23.)

1907.

4313. Dynamo-electric transmission of power. Haydon and Williams.

7642. Filaments for incandescent electric lamps. Lake. (Parker Clark Electric Company.)

7712. Electro-pneumatic track channelers. Lake. (Ingersoll Rand Company.)

7828. Devices for feeding tubular or like articles to machines which work upon said articles. British Thomson-Houston Company. (General Electric Company.)

8036. Electrodes for the evolution of ozone from oxygen or atmospheric air. Craig.

8153. Electric motor-control systems. British Thomson-Houston Company. (General Electric Company.)

10071. Supports for the filaments of incandescent electric lamps. British Thomson-Houston Company. (General Electric Company.)

11032. Lightning arresters. Hirst and Leoscher.

13044. Insulators for telegraph, telephone, and like wires. Webb.

17147. Electrically-operated fountains. Southam. (Date applied for under International Convention, Aug. 4, 1906.)

17781. Electric arc lamps. Jones.

17783. Electromagnetic reversing coupling. Meyer.

17972. Manufacture of electric incandescent lamps having filaments made from a plastic mass. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, Aug. 28, 1906.)

18033. Locking apparatus for locking electric light glow lamps to holders. Bodell.

18406. Electric switches. Ewart.

19027. Electrolytic process for the preparation of indigo dyes. Uhaumat. (Date applied for under International Convention, Aug. 28, 1906.)

19975. Apparatus actuated by the passage of trains to control railway points or signals. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

21623. Electric striking mechanism for timepieces. Moller.

22745. Telephone exchanges. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

24135. Alternating-current commutating electric machines. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Nov. 1, 1906.)

25832. Insulated railway rail joint. Wolhaupter.

25833. Insulated railway rail joint. Wolhaupter. (Date applied for under International Convention, Dec. 6, 1906.)

26531. Receiver arrangement for wireless telegraphy. Ges. für drahtlose Telegraphie. (Date applied for under International Convention, Dec. 3, 1906.)

26647. Electric alarm clocks. Palmer.

26925. Method of ensuring insulation of the current-conducting parts of high-tension magneto-electric sparking apparatus. Unterberg and Helmle.

28212. Electrical locking apparatus for railway signals. Hoffe and Jelfs.

1908.

328. Electric motors. Lertourné. (Date applied for under International Convention, Jan. 10, 1907.)

468. Maximum demand electrical meters. Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.)

519. Electrical heating apparatus. Trumpler. (Date applied for under International Convention, Feb. 1, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price
	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	½-⅝
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	11/16-3/16
—— Ordinary, Nos. 1 125,000	1 ..	3/16-5/16
British Aluminium Co., Ordinary, 2 001-40 000	5 ..	3⅝-4¼
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4¼-4⅜
—— "A" 6 per cent. Cum. Pref., 1-20 000	5 ..	4¼-4⅜
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾ 4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	100 103
—— 5 per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	97 100
British Insulated and Helsby Cables, Ord., 1-100 000	5 ..	6¼-6⅜
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	92-97
British Westinghouse Elec. and Manuf. 10 per cent. Pref., 275 001-475 000	3 ..	⅛-⅞
—— 4 per cent. Mortgage Debenture Stock	100 ..	45 50
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2 ..	0-¼
—— Non. Cum., 6 per cent., Pref.	2 ..	3/16-7/16
—— 4½ per cent. 1st Debenture Stock	100 ..	77-80
—— 4½ per cent. 2nd Debenture Stock	100 ..	63-66
Callender's Cable, Debentures	100 ..	106-108
—— Ordinary	5 ..	10¼-1 ¼
—— 5 per cent. Pref.	5 ..	5⅜ 5¼
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	7/16-9/16
Crompton and Co.	3	1 11/16-1 15/16
—— 5 per cent. Debentures	100 ..	92-95
Dick, Kerr and Co., Ordinary, 1.250 000	1 ..	1¼-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼ xd
—— 4½ per cent. Debenture Stock, Red.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-98 261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1¼-2¼
—— 5 per cent. Debentures	100 ..	85-87 xd
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112.100	2 ..	1-1¼
—— 7 per cent. Cumulative Pref.	2 ..	1¼-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	64-66
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock Red	100 ..	—
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅞-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	87-90 xd
W. T. Henley's Telegraph Works, Ordinary	5 ..	10¼-11¼
—— 4½ per cent. Preference	5 ..	4⅜- ½
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15¼-16¼
—— 4 per cent. Debentures	100 ..	98-100 xd
National Electric Construction Co., 1-170,000	1 ..	7/16-11/16
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	31-33
—— 4 per cent. Bonds	100 ..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9

Electric Lighting and Supply.—

Name.	Amount paid.	Last price
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅝-5¼
Bournemouth and Poole, Ordinary	10 ..	10¾-11¼ xd
—— 4½ per cent. Cum. Pref., 7 501-15 000	10 ..	10-11
—— 6 per cent. Cum. Second Pref., 15 001-22,500	10 ..	10½-11
—— 4½ per cent. Debenture Stock, Red.	100 ..	100-103
Bromley (Kent) Electric Light and Power Co	5 ..	4⅝-5¼
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	96-99
Brompton and Kensington, Ordinary	5 ..	7¼-8¼
—— 7 per cent. Preference	5 ..	6¾-7⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-50,000	5 ..	6¾ 7¼
—— Nos. 80,000-100.000	5 ..	6⅝ 7¼
Cambridge Electric Supply Company. £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	94-98 xd
—— 7 per cent. Cum. Pref. Stock	$100 ..	106-110¼ xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅝ 4¼
—— 4½ per cent. Cum Pref., 1-80.000	5 ..	4-4½
—— 4 per cent. Debenture Stock, Red.	100 ..	96 99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	4-4¼
—— ditto (1903) 40,001-80.000	5 ..	4⅜-4⅝
Chelsea Electricity Supply	5 ..	3¼-3⅜
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	9¾-10⅛ xd
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼ xd
—— 5 per cent. Debenture Stock	100 ..	123-126
—— 4½ per cent. 2nd Deb. Stk. Red.	100 ..	101-104
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10.001-50,000	5 ..	3-3¼
—— 5 per cent Preference, 1-50,000	5 ..	4¼-4⅜
County of London Elec. Supply, Ordinary	10 ..	7⅝-7¾
—— 6 per cent. Cum Pref.	10 ..	10⅞-11¼ xd
—— 4½ per cent. Debentures Prov Certs. All pd., Red.	100 ..	108-109
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	97-100
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	¼-⅜
—— 6 per cent. Cum Pref.	5 ..	¼-1¼
—— 4½ per cent. First Mort. Deb.	100 ..	58-63
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15 750	— ..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-2⅜
—— 5 per cent Debenture Stock, Red.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	91-94
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4¼-5 xd
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	4⅝-5⅜ xd
—— 4½ per cent. First Deb Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	6¼-6⅜ xd
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	96-99
Isle of Wight Elec. Lt. and Pwr. 4½ p.c. Db. Stk., Red	100 ..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	⅛-¼
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	7¾-8¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	97-101 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4½-5
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100 ..	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red (Prov. Certs.), all paid	100 ..	92-95
Metropolitan Ordinary, 100 001- 00,000	5 ..	5-5½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	107-111
—— 4½ per cent. Cum. Pref.	5 ..	4⅜-5⅛
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	£5 90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1 000	— ..	75-77 p.c.
Mexican Light and Power Co., Capital Stock	$100 ..	49-51
—— 5 per cent 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	84-86
Midland Electric Power Dist., 4½ p.c 1st Mort. Deb.	— ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	5⅞-6⅛
—— do., 57,010-75,000	5 ..	5⅞-6⅛
—— do., 75,001-87,500 (issued at 22 prem., 16s. paid	5 ..	6¼-6⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5¼-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5 ..	5¼-5⅜ xd
Notting Hill Electric Lighting	10 ..	11¼-12¼
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅜ 6¼
—— 4 per cent. Debenture Stock	100 ..	93-96
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1 ..	⅛ 1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red.	100 ..	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5 ..	4⅜-5⅛ xd
—— 6 per cent. Cum 2nd Pref., 1-15,000	5 ..	4⅜-5⅛ xd
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	⅛-1⅛
—— 4 per cent. Debenture Stock	100 ..	70-74
South London Ordinary	5 ..	2⅜-2⅝
South Metropolitan Electric Light and Power, Ord.	1 ..	⅝-¾
—— 7 per cent Cum Pref.	1 ..	1⅛-1⅜
—— 4½ per cent 1st Mort. Deb.	100 ..	99-102 xd
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7⅛-8½
—— 7 per cent. Pref.	5 ..	6½-7
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1⅜ 2⅛ xd
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	1⅞-2⅜ xd
—— 4½ per cent. First Mort. Debenture Stock, Red.	100 ..	£7 90 xd
Westminster, Ordinary	5 ..	7¼-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	5-5½

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5 ..	6-6¼
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,037 ..	5 ..	8⅛-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	129-132
Auckland Elec Trams., 5 p.c. 1s Mor. Deb. Stk., Red.	100 ..	104-107
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref. shares, 1-10,000	10 ..	—
—— 5 per cent Deb., Red., 1 600	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	½-⅝
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1 ..	13/16-15/16
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100 ..	93-96
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10 ..	9½-10¼
—— 4½ per cent. Deb. Stock, Red.	100 ..	94½-95⅛
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3¾-4⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜ 5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd. ..	100 ..	97-101
British Columbia Electric Railway Co., Ord Def.	100 ..	132-135
—— Ord. Pref.	100 ..	110-114
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	105 109
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	101-104
—— 4½ per cent. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord. 1-300 000 & 60 001-90 000	10 ..	1⅛-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	4-4½
—— 5 per cent. Perpetual Debenture Stock	100 ..	93½-96½ xd
—— 4½ per cent. 2nd Deb. Stock	100 ..	72-76
Bueno Ayres and Belgrano Trams	5 ..	4⅝-4⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅝ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4⅝ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110-116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	96-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	97-101 xd
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	92-95
Calcutta Tramways, Ord., Nos 1-137,610	5 ..	5⅜-6⅛
—— 5 per cent. Cum. Pref., Nos. 1 70,000	5 ..	5-5⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	102-106
Cape Electric Tramways, Nos. 1-480,000	1 ..	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4⅜-7⅛
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	98-101
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5 ..	5 3/16-5 7/16
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	100-104
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	89-93
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos 1-60,000	10 ..	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12¼-13¼
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	95-98 xd
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	81-86
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14¼
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30 001-60,000	5 ..	⅞-1⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £286,500 2nd Mort. Deb. Stock	— ..	—
—— £83,430 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	⅞-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1 ..	⅞-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	90-95

Name.	Amount paid.	Last price.
	£	£
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	6-7
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	80-85
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red. 1-1,635	$1,000 ..	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-61,636 and 23,436 26 000	5 ..	4½ 5
——½ per cent 1st Mort. Deb Stock, Red.	100 ..	85-90 xd
Metropolitan Elec Trams., Defd., 1,000,001-1 314 016	1 ..	1/16-3/16
—— 5 per cent. Cum Pref. 500,001-1,000 000	1	⅜-½
—— ½ per cent. Deb. Stock, Red.	100 ..	85-88
Mexico Trams. Co., Gen. Cons. 1st Mort 50-year 5 per cent. Gold Bonds	— ..	82½-84½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con. Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34 001-74,000	5 ..	½-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8½-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mit. Deb. Stk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 1-245.000	1 ..	¼-⅜
—— per cent. Cum Pref., 300,001-545 000	1 ..	¼-⅜
—— per cent. Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary, 1-24 912	10 ..	4½-5
—— per cent. Cum. Pref., 1-10,000	10 ..	9½-10¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5 ..	5⅛ 5⅝
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100 ..	127-132 xd
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-11,000	$500 ..	96½-97½ p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅞-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100 ..	78 82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red. 1-1 600	100 ..	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5 ..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3-3⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	73-76
—— 4 per cent. Pref.	100 ..	82-84
—— " " deferred	100 ..	53-56
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid) ..	100 ..	100-103
City and South London, Consolidated Ordinary	100 ..	39-41
—— 4 per cent Debenture Stock	100 ..	101-104
—— 5 per cent. Pref. Stock '91	100 ..	113-116
—— " " " '96	100 ..	112-115
—— " " " '01	100 ..	110-113
—— " " " '03	100 ..	106-109
Liverpool Overhead, 5 per cent. Pref.	10 ..	10-10¼
—— Ordinary, 1-50 000	10 ..	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent. Profit-sharing Secured Notes	— ..	40-44
—— Deposit Receipts	— ..	40-44

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs., Red., within 1-1,068	100 ..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28.000 and 53,001-78,000	$1 000 ..	85 87
Anglo-American Telegraph Co., Ordinary	100 ..	55-58
—— 6 per cent. Preferred Ordinary	100 ..	98½-100½
—— Deferred Ordinary	100 ..	13¼-13⅜
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	98½-101¼
Chili Telephone Co., 1-44 000	5 ..	7-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	85-88 xd
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	7¼-8½
—— 10 per cent Preference, 1-6,000	10 ..	16-17
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-3½ xd
—— 10 per cent. Cum. Preference	5 ..	8½-9½ xd
—— 4½ per cent. Debs., 1-600	50 ..	99½-102½
Direct United States Cable Co.	20 ..	13⅜-14⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	98½-101¼
Eastern Extension, Australasia and China, 1-300,000	10 ..	12¼-13⅜
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	99-102
Eastern Telegraph Co., Ordinary Stock	100 ..	130-135
—— 3½ per cent. Preference Stock	100 ..	84-87
—— 4 per cent. Mortgage Debenture Stock	100 ..	101-104
Great Northern Telegraph Co. (of Copenhagen)	10 ..	31-33
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100 ..	99-101
Indo-European Telegraph Co.	25 ..	54-57
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1 ..	7/16-9/16
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	1 ..	¾-1
National Telephone, Preferred	100 ..	107-109
—— Deferred Stock	100 ..	108-110
—— 6 per cent. Cum. First Pref.	10 ..	10-12
—— 6 per cent Cum. Second Pref.	10 ..	10-12
—— 5 per cent. Non Cum. Third Pref.	5 ..	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	97½-99½
—— 4 per cent. Deb. Stock, Red.	100 ..	101¼-103½
Oriental Telephone and Electric Company	1 ..	1 5/16-1 9/16
—— 6 per cent. Cum. Pref	1 ..	1¼-1½
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6-6¼
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅜-5⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10¼
West Coast of America, 1-30.000 and 53,001-53,008	2½ ..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	98 101
West India and Panama Telegraph Co., Ordinary	10 ..	17/32-21/32
—— 6 per cent. Cum. 1st Preference	10 ..	8¼-9
—— 6 per cent. Cum 2nd Preference	10 ..	8¼-9
—— 5 per cent. Debs., Red., 1-800	100 ..	100-103
Western Telegraph Co., 1-207,930	10 ..	13¼-13⅜ xd
—— 4 per cent. Debenture Stock, Red.	100 ..	99-102

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	April 8	1,223	1,250	- 27	- 1,654	27½	27½	May 31	72,605	17,676 000	1,529.682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 11	211	237	- 26	—	8	8	,, 15	15,283	3,603,783	378,834	·97	9·28	1,917	5 35
Baker Street and Waterloo Ry.	,, 11	2 980	2,390	+ 600	+11,374	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 12	1,022	960	+ 82	- 27	43·53	43·53	March 31	55,408	11 696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 4	6,351	6,536	— 172	—	56½	56½	,, 31	18,557	5,752,098	215,345	·87	16·2	8,228	—
Blackburn Corporation	,, 8	1,000	985	+ 45	- 901	25·80	25·80	,, 25	54,951	10,089,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 9	584	1 662	-1,078	—	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	,, 12	2,2 4	2,035	+ 209	- 386	42	42	March 31	111 294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 8	1,489	1,622	- 133	- 1,254	23¼	24½	,, 31	83,663	13,503,010	1,765,068	1·48	11·37	2,860	7·28
Bradford Corporation	,, 4	4,3 0	6 354	-2,074	—	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 12	756	795	- 39	- 110	17·191	17·191	,, 31	50,652	10,759,210	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 10	4 583	4,701	- 1·8	—	53½	51½	,, 31	266,769	66,902,257	6 178,886	—	—	—	—
Burnley Corporation	,, 11	1,177	1,118	+ 59	—	19½	19½	,, 31	62,699	11,967,4.8	1,206,830	1·31	12 48	5,825	8·21
Burton Corporation	,, 12	244	263	- 18	- 20	9¼	8½	,, 31	15,576	3,383,527	421,317	·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	April 11	155	161	- 6	+ 27	8·5	8·5	Dec. 31	10,254	2,780 699	350,417	—	—	—	7·96
Central London Railway	,, 11	5,914	6,127	- 213	- 2,003	6	6	,, 31	349,298	43,057,597	1,279 698a	1·85	62·29a	55,357	5·44a
Charing X, Euston, & Hamp. Ry	,, 11	3,700	—	—	—	7½	6½	—	—	—	—	—	—	—	—
City and South London Railway	,, 12	3,140	2 988	+ 152	+ 5,536	9	6½	A June 30	88,456	10,048.780	—	—	—	—	—
Colchester Corporation	,, 1	165	315	- 150	—	8	8	*March 31	10,588	2,457,853	720,788	·87	7·47	1,401	6·12
Cork E. T. and L. Company	,, 9	438	444	- 5	- 471	15½	15½	Dec 31	25,032	5 966 364	891.978	—	6·74	—	4·78
Croydon Corporation	,, 10	1,269	—	—	—	12 c	12 c	March 3	62,065	13,514,9 8	1,102 408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 10	243	240	+ 3	- 70	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Mar. 28	153	245	- 92	- 2,367	4½	4½	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	April 10	102	102	+ 6	- 48a	6½	6½	—	—	—	—	—	—	—	—
Dublin U.T.	,, 10	4 811	4,959	- 148	+ 586	54½	48½	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 8	1,144	1 195	- 51	—	22	22	May 1*	57.672	15 554 905	1,162 792	·878	1·9	4,352	7·3
East Ham Corporation	,, 11	814	8.5	- 1	- 223	14	14	March 31	47,140	15,049,240	1,052,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 4	17,640	18 956	-1,316	+16,161A	177½	169	May 31	387,381	221,063,088	20,350,367	95	0·47	5,035	5·21
Gloucester Corporation	,, 1	215	421	- 186	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	,, 11	5,385	3,910	+1,475	+21,916	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,896	18,893,242	1,624,275	—	1·52	—	5·65
Huddersfield Corporation	Mar. 21	1,443	1,471	- 28	+ 3 269	35½	35	,, 31	81,196	15 252,150	1.804.745	1 52	0 79	2,770	5·32
Hull Corporation	April 11	2 3 5	2,1 4	+ 180	- 630	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	Mar 14	391	414	- 23	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	April 8	129	116	+ 11	- 61	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 8	280	215	+ 35	—	7½	7½	May 15	13,702	4,640,618	466,919	6·2	7·55	1,723	4 95
Lancashire United Tramways	,, 8	1,222	1,150	+ 172	- 185	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 4	6 244	8 198	-1,954	- 1,452	96½	96½	March 31	327,794	73,024,853	7,358,185	1 06	10·69	3,352	5 58
Leicester Corporation	,, 11	2,120	2,116	+ 4	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 4	10,801	11,797	- 996	- 2,944	104	104	Dec. 31	563.793	122,094,528	12,115 934	1 108	1 17	5,421	7·75
Liverpool Overhead Railway	,, 12	1,763	1,367	— 5	- 169A	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	Mar. 28	31 025	30,235	+ 790	+242,623	98	98	March 31	1378,014	314,227 090	30,130 997	1·05	10 98	—	8 56
Lowestoft Corporation	April 4	138	207	- 69	—	3½	—	Sept. 30	11,079	2,622,922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 9	164	103	+ 61	—	3½	2	March 31	5,913	1 186.566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 11	14,161	12 997	+1 164	+ 32	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7 03
Metropolitan District Railway	,, 11	8,702	7.897	+ 805	+15 787	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 12	15,520	15.416	+ 114	+ 2,709	23½	23½	June 30	637,794	87,639,334	—	1·39	—	—	—
Nelson Corporation	,, 11	120	123	+ 7	—	2¾	2¾	March 31	7,709	2.035,300	203,203	86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 11	3,671	3.785	- 114	- 2,237	59⅛	57½	,, 31	210,491	45,536,468	4,263,174	1·11	11 85	3,560	6·04
Newport (Mon.) Corporation	,, 4	695	804	— 199	- 1 9	14½	14½	,, 31	32,421	7,760.403	772 753	1 03	10 01	1.525	6·87
Oldham Corporation	Dec. 8	1,805	1,744	+ 61	+ 4,550	35½	35½	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·239
Portsmouth Corporation	Mar. 28	1,460	2,086	— 626	—	28½	28½	,, 31	98,911	20.668 825	2,199,823	1·15	10 79	—	—
Reading Corporation	Dec. 5	567	555	+ 9	- 788	13½	13½	,, 31	32,661	8,130,179	918,825	·96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	April 6	4,392	4,414	- 22	- 1,897	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 12	5.447	5,053	+ 394	- 2 226	64½	65¾	March 25	276,807	73.966,299	6,804,656	·898	9 767	4,174	5·94
Southampton Corporation	Mar. 25	841	849	- 7	+ 3,335	18	18	,, 31	49,185	9,437,396	1,143,085	1 25	10·71	—	7 7
Southend-on-Sea Corporation	April 8	295	299	- 3	- 230	9	9	,, 31	20,076	4,431,728	390,578	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248 656	—	9 464	—	4·849
Sunderland Corporation	,, 12	1,087	1,213	- 126	- 871	20	20	,, 31	72,396	17.483 132	1,575,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 9	217	187	+ 30	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 13	756	728	+ 28	— 411	12 68	12·43	‡ ,, 31	42,810	8,312,592	850,906	—	11·53	—	—
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19.204	4,965 286	429 785	—	10 724	1,989	6·35
West Ham Corporation	,, 9	2,050	2,076	- 25	— 1,102	14·7	14 7	,, 31	122,881	35,202,836	2,566,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 8	769	751	+ 18	+ 302	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·095

‡ 905-6 figures. 1907-8 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. A Half-year's figures

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THE INDIAN INSTITUTE OF SCIENCE.

The foundation of the Indian Institute of Science is now certain, and the institute is assured of a large annual income, so that its programme need not be restricted. It is to the late J. N. Tata, a Parsi merchant and millowner, that the institute owes its inception. He acknowledged the great help science had been to him in establishing the cotton industry in Bombay by allotting a large part of his property to the establishment of an institute of science. The income from this property was at first calculated at £8,333 per annum, but it has now appreciated in value. Then also he recognised that expert advice was needed to start the undertaking on the right lines, and Sir William Ramsay was invited to India to assist in the determination of the character of the scheme. Prof. Masson, of Melbourne, and Colonel Clibborn, of Rurki College, also helped by preparing tentative plans and estimates of cost. The location of the institute has also been a matter for serious consideration, and finally another pioneer of science in India—the Maharajah of Mysore—took up the matter strongly. It was he who, on the advice of his late enlightened Dewan, Sir Seshadri Iyer, established the Cauvery power scheme (*Electrical Engineer*, Oct. 31, 1902), by which the power running to waste over the Cauvery Falls was transmitted 100 miles to the Kolar goldfields. The engineering work on this scheme was placed in the hands of Major Lotbiniere, who had Lieutenant (now Captain) Hunter as resident engineer. The success of the scheme from an engineering point of view has been complete, but it is dwarfed by the economic advantages accruing to all concerned. The cost of power on the goldfields was reduced enormously by a tariff which even then was sufficient to wipe out the capital cost of the power plant in five years. Hence the Mysore State now possesses an income from this scheme free of all capital charges. It is a suitable acknowledgment of the proved value of science that the Maharajah should assist the Institute of Science as he has done. His gifts to this institute include a free site at Bangalore, where the climate is temperate and most healthy, and also an annual grant of Rs.50,000 (about £3,333) and £33,330 towards the building fund. After these princely gifts the Government grant of £5,833 comes as an official approval of a scheme from which India should reap great advantage. Dr. Morris W. Travers, F.R.S., has for the last eighteen months been director of the institute, and a staff is already being formed at Bangalore. We see from a description in the *Times* that the chief work of the institute will be the establishment of departments of pure and applied science, and students who have passed through the Indian universities will be trained so that they may apply science to the Indian arts and industries. It will be in no sense a "trade school." Though there will be no undergraduate side at present, it is expected that this may ultimately become a necessity, as has been the case with some post-graduate institutions in America. Even as it is, most of the Indian students entering the institute will first have to go through a course of practical instruction before commencing research. Private workers requiring accommodation for the purpose of investigating new products or processes, or actuated by a desire to carry out scientific research, will be received. Six departments are to be established, each with a professor and assistant professors. The director will occupy the chair of pure chemistry, and a professor of applied chemistry has already been selected. In view of the importance of vegetable products in India, there will also be a chair of organic chemistry. The nearness of the great Cauvery power works,

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from which a supply of electricity at high tension will be obtained, has led to the decision to open a department of electrical technology. There will also be a chair of bacteriology, and, though the sixth department has not yet been finally decided on, it may be a chair of metallurgy or electro-metallurgy. A large sum is being allotted for the creation of a library. Probably sixty students will be admitted to the institute in the first two or three years, and a few students in chemistry may be at work by the end of the present year, when temporary laboratories will become available. Our success as rulers of India has been due chiefly to the fact that we have developed the resources of the country, and, perhaps, the civil engineer has in this been quite as important as the statesman. We trust that this Institute of Science will help forward the great work of converting the great resources of Nature in India to the use and convenience of man.

WORKS MANAGEMENT.

The larger questions, such as have a direct and perceptible bearing upon the output in engineering works, are continually cropping up for discussion before the various technical and engineering societies. Every advantage is taken of these discussions (which are, after all, the result of practice and experience) for effecting some cheapening in the cost of production, and improvements suggested in machinery and processes are adopted, whenever practicable. Indeed, no one hesitates about scrapping expensive plant in favour of improved types which give better results, and prove themselves indispensable for the maintenance of efficiency in the works, and no question of cost will prevent the equipping of a factory with the most modern plant, and its staffing with the most capable men. But, just as in almost every sphere of human affairs, the larger questions loom with such continued prominence that minor questions are often completely obscured or, at all events, they are not regarded in their true perspective. Small details in the management of engineering workshops may superficially appear to be of little consequence, and are, therefore, neglected. Further consideration, however, shows that they are not at all to be regarded lightly. A very useful study of modern methods in practice in engineering workshops is embodied in the paper which Mr. Eustace Thomas, B Sc., recently read before the Manchester Local Section. That paper should serve as a valuable incentive to the study of modern methods in practice, especially when we bear in mind that it was prepared after visits to works engaged in widely different manufactures, where the details of organisation were gone into at great lengths. Mr. Thomas disclaims any pretence to elaborating a system of works organisation, and merely gives a record of some impressions received. It should also be mentioned that his interest being chiefly among small work, much of what he has to say refers particularly to this. He deals with the general principles by which economy may be obtained in engineering works. It is agreed that the manual worker should not have any unavoidable head work to do. Mr. Thomas states that the workman in every case should have a drawing or even a sketch to work to, fully dimensioned. As to the duties of foremen, Mr. Thomas classifies these as : (*a*) clerical or administrative, such as giving out work, seeing there is no delay caused by waiting for material, watching the efficiency of the workmen, planning to get work executed to time ; and (*b*) technical—*i.e.*, the consideration of methods, tools, and jigs for executing work, for overcoming difficulties, for reducing cost of production, etc. The most modern tendency seems to be give the foreman function (*a*) to carry out, but Mr. Thomas thinks that the foreman must be technical enough to know if matters are not going rightly, and in such cases get an expert tool fitter to study them out and do what is required. This seems essentially the right system. The shop will not work efficiently unless each man feels that the foreman is always about and vigilant. Equally, he cannot possibly worry out technical matters sufficiently if he is subject to constant interruption through his duties under function (*a*), and it is better to put on a man who can give the work undivided attention. Mr. Thomas's paper deals with a number of small points, all of which are of supreme importance in the efficient management of engineering works.

THE ELECTRICAL INDUSTRY IN THE UNITED STATES.

The cloud of uncertainty which has been hanging over the United States for so long, and gradually growing more threatening, is now passing away, and it may be said that the worst of the financial storm which has caused not a little damage in the industrial world has passed. Readjustment and recuperation seem well under way, and unless labour troubles should retard the improvement or monopolies of capital interfere to keep up prices at too high a level, it is expected that before many months have passed business will be on a safer and more normal basis. It is reassuring to learn from one of the leading of our contemporaries that among the electrical companies several bright symptoms are noticeable. The General Electric and Westinghouse interests report good orders and a fuller tide of activity in their shops. Large contracts for traction cars are being given out, and others impend. The New York Edison Company reports that its February business was equal to that of the same month in 1907. The Bell telephone system is resuming construction work that will run to £10,000,000 this year, and the other week forty-nine new independent telephone companies reported, twenty-six of which had a total capital of £144,000. The purchases of copper on electrical account are growing again, and resumption of transmission enterprises is noticeable. It is apparent that the general tone is very much improved in the electrical field, and that there are good reasons for an increase of cheerfulness on the part of our Transatlantic cousins. Further evidence of the brightening of the American industrial outlook is available in the report on the trade of the United States for the year 1907 by Mr. Seymour Bell, British commercial agent in the United States. Mr. Bell reviews calmly and shows us in a clear light the peculiar situation in 1907, with its financial panic, scarcity of labour, suspension of manufactures, and other disturbing factors. The electrical industry is not specifically dealt with in this report, but its importance as a factor in the industrial development of the country is clearly discernible. Particularly is this the case with the textile industry. During the past few years the Southern States have been considerably in advance of the Northern in the construction of new mills. Large sums of money are being spent in obtaining power to generate electricity for driving the mills. Many of the Southern mills are situated far from rivers, and the electricity is brought in some cases as far as twenty-five miles from some central generating station. These generating stations have been a great incentive to mill building. The power is supplied cheaply, and anywhere within a radius of fifty miles of the station is considered a suitable site for a mill.

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FRANCO-BRITISH EXHIBITION.

The announcement by the Institution of Electrical Engineers that the proposed electrical section at the Franco-British Exhibition, which is to be opened next month, could not be carried out will have come as a surprise to those who were not acquainted with the difficulties which the organising committee had to encounter. The idea of a co-operative exhibit between the supply companies and the manufacturers was, indeed, an excellent one, and if it had been possible to give it effect, the co-operative gas display—notwithstanding the tremendous efforts that are being made to render it effective—would have received a decided set-back. At the same time, the public—for whose benefit these lighting displays were to be arranged—will be deprived of an instructive object lesson in the art of illumination and the economics of lighting through the failure of the electrical exhibit. Still, whatever is—is, and no amount of regret or complaint will alter the state of affairs. Let us recognise the immensity of the task undertaken by the organising committee and bear in mind the relatively brief space of time it had at its disposal for the accomplishment of that task, then we will appreciate the propriety of their decision to drop the scheme. This, however, should by no means preclude individual manufacturers from exhibiting if they consider it in their interests to do so. Moreover, the great Manchester Exhibition to be held in October next will afford the opportunity of making amends for the Shepherd's Bush failure, and we hope that every section of the industry will concentrate their efforts upon making that exhibition the success it deserves to be.

HEATING OF VENTILATED AND ENCLOSED MOTORS.*

BY WILSON HARTNELL, MEMBER.

The evolution of the continuous-current electric motor during the last 15 years has resulted in a gradual decrease in size for any given output without loss of efficiency. The smooth ring wound armatures have been replaced by slotted drum wound. The clearance between the pole-face and the armature is now comparatively very small and the armature notches are wide, necessitating laminated pole-faces. The length of the armature is shorter in proportion to its diameter. In consequences of these changes the magnetic flux in the air-gap has been raised from, say, 4,000 lines per square centimetre to 10,000 or 12,000. At the same time the ampere-turns on the magnets have been decreased and the magnetic leakage reduced to, say, one-fourth to one-fifth of that of the old ring wound motors. The carbon brushes are now run sparklessly in, or nearly in, the middle position, unaffected by reactance voltage or by large field distortion. The modern four-pole motor is at a disadvantage, compared with the old two-pole motors with copper brushes, in respect of dissipating the heat produced in working. The heat produced in the armature and shunt winding is no greater than of old. The heat produced by losses in the teeth and armature discs is serious with a dense magnetic flux in the air-gap, and can only be kept within reasonable bounds by a moderate surface speed of armature. The heat due to the carbon brushes is considerable with low voltages. With a surface speed of 1,500ft. per minute the loss due to friction, and the loss in volts between the carbon and copper, may easily be equal to from 1½ to 1¾ watts per ampere per brush. The heat thus produced can only be dissipated as follows: (1) by heating the motor itself; (2) by radiation; (3) by conduction to a flow of cool air—that is, by ventilation.

It is impossible to separate these cooling effects by ordinary observation, but some assistance may be given by the following table, which shows for a series of motors an assumed average weight, cooling surface, and loss of watts. These data are founded on an actual set of standard motors. There are also tabulated the square inches of cooling surface per watt; the time the motor would require for a rise of 72deg. F. (40deg. C.) in temperature, assuming that no heat escaped elsewhere; the cubic feet of cool air per minute that would be required to prevent the rise of temperature exceeding 72deg. F., also assuming that the escaping air were heated 36deg. F., and that no heat escaped elsewhere. The relative change of these values, as the size of the motor increases, may be seen from Fig. 1. From this it may be inferred that the heating of the motor itself is of practical value when a motor works intermittently, as in a crane or a hoist, say, not running more than 20 minutes per hour fully loaded.

TABLE I.

Size of Motor. H.P.	Assumed Loss in Watts at Full Load.	Area of Enclosed Motor in Square Inches.	Cooling Surface per Watt lost	Cubic Feet of Air per Minute the Watts lost could raise 36° F.	Weight of Motor.	Minutes in which the lost Watt could Heat the whole Motor 72° F.
3	380	1,000	2·6	31	300	113
5	580	1,300	2·2	47	470	100
7½	770	1,600	2·1	63	550	102
10	960	1,850	1·9	79	660	98
15	1,200	2,300	1·8	102	1,000	118
20	1,460	2,650	1·7	120	1,300	128
30	1,900	3,250	1·6	157	1,900	144
40	2,380	3,850	1·5	196	2,500	150
50	2,980	4,300	1·4	244	3,100	140
60	3,570	4,700	1·3	292	—	—
75	4,400	5,100	1·2	360	—	—
100	5,700	5,700	1·0	470	—	—

Radiation.—It will be seen that the cooling surface per watt of motor under 5 h.p is nearly double that of motors over 50 h.p. The difference in the effectiveness of the cooling surface is far greater. For the hotter air inside the larger enclosed motor is near the top, the bottom of the motor remaining markedly cooler, and, therefore, the radiating surface less active. Also the magnet case may be three or four times as thick in the larger motor, rendering the escape of heat of the metal proportionately less. Thus, although 2·5 to 2·0 square inches of radiating surface per watt lost may suffice for small enclosed motors, considerably more would be necessary to keep, say, a 50-h.p. enclosed motor equally cool. In order that radiating surfaces be most efficient they must be opposite to cool surfaces, as all surfaces radiate heat in all directions. If there be a steam or gas engine or wall of a boiler-house near the motor, the effective radiation on that side of the motor will be partly neutralised although the intermediate air may be cool. When an enclosed motor is required of more than, say, 3 h.p., the usual means of obtaining the requisite cooling surface is to take a motor of larger size and reduce the output, the armature current being reduced—and, therefore, the armature reaction—and also the flux density in the air-space and ampere-turns in the poles. This reduces the heat due to losses in the copper, and still more the heat due to core losses. By such means the total heat losses are reduced until the cooling surface per watt of the large motor is sufficient for the diminished outputs. This, however, makes a costly motor for continuous working, even for moderate powers; a 20-h.p. motor wholly enclosed may give 10 h.p. at a passable temperature, but a 30-h.p. motor would scarcely give 15 h.p. for the same temperature rise. A more economical arrangement for an enclosed motor is to place an open motor that may be fully loaded under a thin sheet-iron cover with ample inspection doors. This has been found convenient and satisfactory in flour mills, the case, though merely resting on the floor, being practically dust-proof and inexpensive. The cover must be roomy because the heated air remains in the upper part of the cover, the lower part remaining cool, and, therefore, ineffective as a heat radiator. Examples of open motors working satisfactorily fully loaded, placed in large covered recesses below the ground floor, and also enclosed in what might be compared to large, roomy wooden cupboards, are to be found in our clothing factories, many of which are driven by electric motors throughout.

* Paper read before the Institution of Electrical Engineers.

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Ventilation.—The cubic feet of air required to keep the temperature rise below 72deg. is probably not less than the quantity tabulated—viz., about nine cubic feet per horse-power per minute for the smaller motors under 10 h.p., and about five cubic feet per horse-power per minute for motors over 30 h.p. Experience shows that large open motors working to their full load can, by the aid of ventilation and radiation, be kept within the limits of 72deg. But when wholly enclosed they can only be kept cool by forced draught. From rough estimation it seems that at least double the quantity of air per minute is then required. Electric motors, viewed in regard to their means of cooling, may be divided into eight classes: (1) Entirely open, having their bearings usually on a bed-plate which carries the magnets: Suitable for large motors, say over 100 h.p. (2) Protected open, the bearings carried by open covers at each end of the magnet case: This is the ordinary modern motor, say from 100 h.p. to 2 h.p. (3) Enclosed ventilated: The same as No. 2, but with the openings covered by wire net or perforated metal. These are used in factories where the open motor is assumed to be less safe. If the mesh be not less than four per inch the ventilation is not much interfered with, but if the mesh be much less, not only is the ventilation much impeded, but the wire-work is apt to become choked with dust and fluff, and the safety of the motor endangered. (4) Same as No. 2 or No. 3, but with a forced ventilation by means of a fan on the armature and a diaphragm or its equivalent to divide the fan suction from the delivery: This is necessary in an exceptionally warm place. (5) Totally enclosed: These are required for special purposes, and usually necessitate a considerable reduction in the output. (6) Covered motors: The same as No. 2 fully loaded, but covered by a roomy thin sheet-iron case, practically dust-proof, with openings for oiling and inspecting the brushes, the pulley standing outside the case. (7) Open covered motors: The same as No. 6, but with a smaller cover made wholly or in parts of fine wire netting. The large area of wire-work prevents the tendency of any draught to cause the fine mesh to get clogged, and the motor fully loaded would be as cool as if unenclosed. This is specially adapted to textile mills where floating fluff is found. (8) Totally enclosed, but with forced ventilation like No. 4: This is necessary (*a*) when the motor is working in fumes very injurious to the motor, fresh air being sucked into the motor from a pure source through a pipe and discharged near the motor; (*b*) when the motor may be surrounded by inflammable gases, as sometimes in mines, the same air being circulated again and again through the motor and a cooling arrangement. Total enclosure with forced ventilation has been used to cool very large dynamos, cool air being drawn from outside the dynamo house and hot air discharged also outside.

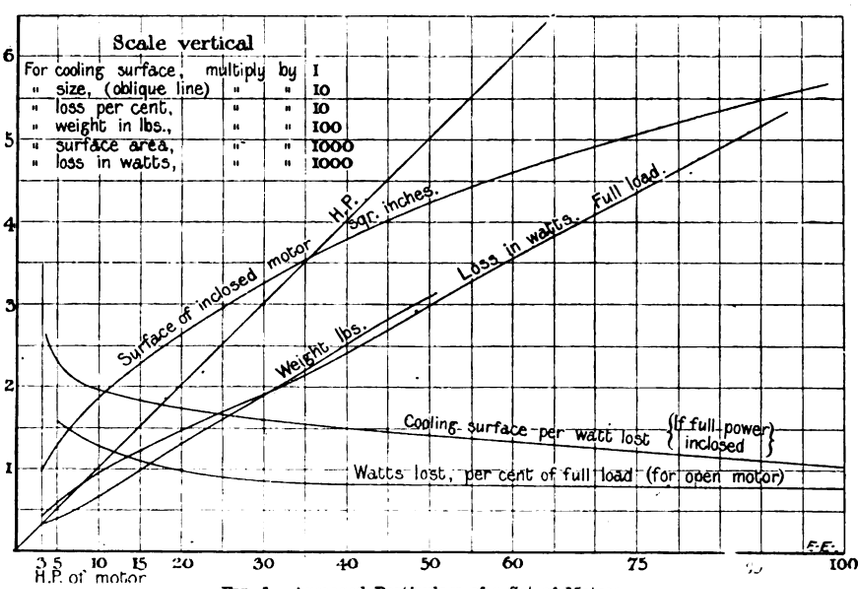
Scale vertical
For cooling surface, multiply by 1
" size, (oblique line) " " 10
" loss per cent, " " 10
" weight in lbs., " " 100
" surface area, " " 1000
" loss in watts, " " 1000
H.P. sqr. inches.
Surface of inclosed motor
Loss in watts. Full load.
Weight lbs.
Cooling surface per watt lost (if full power) inclosed
Watts lost, per cent of full load (for open motor)
H.P. of motor
E.E.

FIG. 1.—Averaged Particulars of a Set of Motors,

The examples given in Table II. of the rise of temperature in motors open and enclosed are taken from records of ordinary tests in the workshop. The motors were of the usual type with decarbonised steel cases and laminated poles, the induction in the poles being from 13,500 to 14,500. In most of the tests the motors drove another motor running as a dynamo whose current helped to drive the motor. Full particulars were taken every half-hour besides occasional temperature observations. All these are omitted so as to confine attention as briefly as possible to the rise of temperature. The rise in temperature with the same motor with the same load in a given time is usually greater when the temperature of the atmosphere is higher. The rise in the temperature of the commutator in a given time under similar conditions can be considerably varied by differences of pressures, width, and quality of the carbons, the best results being determined by experiment. All the above motors had four poles. The particular figures of these tests apply only to the motors tested, but they are in general agreement with tests of other motors. They

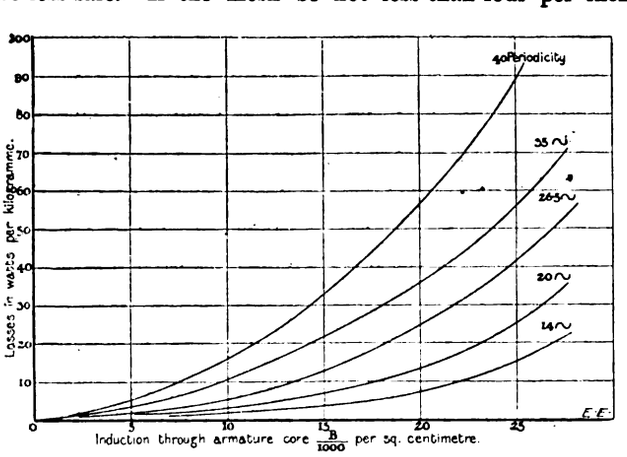

FIG. 2.—Iron losses in C, 500 armature at different periodicities. Discs thickness 26 S.W.G. (*i.e.*, Standard Wire Gauge = 18 mils) = 0·45 millimetre. They are coated with "Insuline" and rest on the shaft. Weight of armature core, 81 kilogrammes. Weight of armature teeth, 21 kilogrammes. Mean section through teeth under pole-face section through core = 0·7.

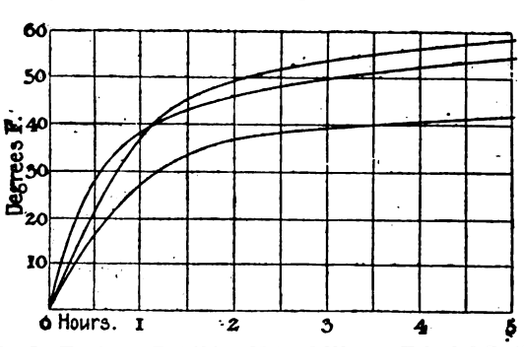

FIG. 3.—Heating on Test 60-h.p. Motor, 1,000 revs, Unloaded, Partly Open.

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show the reduced power permissible, if a motor be totally enclosed and continuously loaded. Below 3 h.p the loss of power may be inconsiderable. But a 20-h.p. open motor when totally enclosed is but little more than equal in power to a 10-h.p. open motor. In the above table it is shown that a 50-h.p. open motor could only give 21 h.p. with a permissible temperature of commutator. To obtain the minimum temperature with the reduced output the winding had been specially arranged. In short, whilst the power of a modern open motor is chiefly a function of its magnetic flux, when totally enclosed the power becomes a function of the area of its casing, considerably influenced, however, by its environment—that is, by the exchange of radiated heat with its surroundings or the motion of the surrounding air.

TABLE II.

Standard		As Tested					Rise of Temperature Deg. Fahr.				
Horse-power.	Revolutions.	Horse-power.	Revolutions.	O = Open. E = Enclosed.	Volts.	Hours on Continuous Test.	Air.	Field Coils.	Armature.	Commutator.	
3	1,250	3·00	1,080	O	220	6	68	24	25	20	
3	1,250	2·25	800	E	220	6	65	45	47	48	
3	1,250	2·20	780	E	220	10	64	56	75	71	
5	1,100	5·00	800	O	220	6	70	53	56	46	Mean test of 4 motors.
—	—	5·00	842	O	220	9	63	49	47	37	
10	900	10·40	925	O	220	5½	55	58	54	51	
—	—	10·40	853	O	220	9½	67	43	53	55	
—	—	5·00	760	E	120	6	70	59	56	51	Mean test of 3 motors.
20	800	20·00	800	O	220	6¼	63	49	47	35	
—	—	10·50	695	E	120	6	71	86	74	73	Mean test of 2 motors.
40	750	28·00	361	O	105	4½	70	65	70	80	
50	600	50·00	1,050	O	120	8	66	48	69	46	Mean test of 2 motors.
—	—	20·50	455	E	120	6	70	40	56	65	
—	—	20·50	447	E	120	6	73	51	57	82	

The increased heating due to totally enclosing a large open-type motor is strikingly shown by the following experiments, and incidentally the increased iron losses due to high speed. The motor was designed for 60 h p. at 1,000 r.p.m. in the magnet case of a 50-h.p. motor at 600 r.p.m. The ventilating slots around the periphery of the end covers were at first closed. This had been proved greatly to interfere with the ventilation of a large motor, because a cylinder of hot air collects around the inside of the motor although both ends are open. The armature was open, the usual type, diameter 410mm. Slots 48, size 12mm. by 30mm. The discs (which had the usual core holes) rested on the shaft 4 diameter. The magnetic flux was reduced about 15 per cent. as compared with the standard for 600 r.p.m. The armature was at first driven by belt from another smaller motor, and the amperes noted. On running the armature, fully wound, but with the magnets only excited, it was at once noticed that the increase of current on the small motor due to exciting the magnets of the 60-h p. was much more than anticipated, and that the armature rapidly heated. A series of progressive tests was then made to determine the iron losses. The results are shown in Fig. 2. These curves can only be approximate representations of the true iron losses, as they include other losses which could not be measured. A similar armature, but unwound, was substituted, and the tests for heating repeated with the same results. The stampings were by Messrs. Sankey with "Insuline" paint on them. The unwound armature was stripped and rebuilt, the stamping equally spaced by 10 sheets of tracing paper. On again testing there was no noticeable improvement. The armature discs were again removed, bored, and fixed on a gunmetal bush, the end plates for supporting the end winding were turned thinner, and the cylindrical part for supporting ends of the windings were made shorter and thinner. The end plates were also separated from the stampings by paper discs. This made a slight improvement. After two hours' run with air at 60deg F. the rise of temperature in the slots was 54 and in the centre of the core 66.

The heating being evidently due to the discs themselves, Messrs. Sankey were written to and they sent their curves for the iron losses, which gave no calculated agreement with facts. Finally, the armature was rebuilt with Stalloy stampings and tested unwound, but with the slots filled with wood and the magnets excited. The results are shown on Fig. 3. The rise of temperature in two hours was 8deg. F. less than before, showing a slight advantage over ordinary stampings. The armature was wound and a fan fitted to the end of the armature to circulate the air inside. It was then tested as a totally enclosed motor with a load of 58 h p for three hours, with the following results: rise of commutator, 111deg.; fields coils, 88deg. It was again tested totally enclosed for eight hours, but with a stop of eight to ten minutes every hour (after the first four hours) to take temperatures. Load, 59 h.p. The final temperature rises were (air at 70deg. F.): commutator 170, armature 149, field coils 125, air inside 105. Particulars of the rise in temperature are shown in Fig. 4. It will be noticed that there was not much increase of temperature after the first four hours, but the temperatures then were impracticable. The fan was then removed and the motor ran at 59 h.p. as an open motor for eight hours

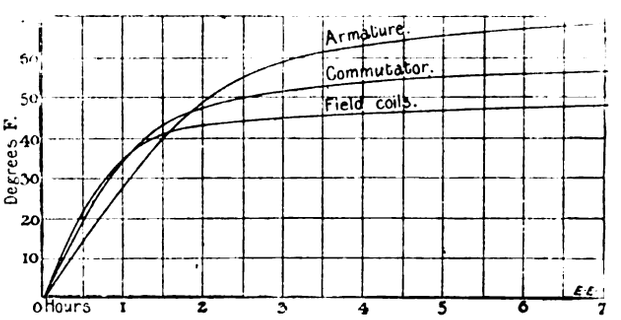

FIG. 4.—Heating on Test 59-h.p 1,080 Open Motor.

with the ventilating slots on the periphery of the end covers also opened; the final temperature rise with the air at 62deg. to 69deg. was: commutator 58deg., field coils 48deg, armature 68deg. F. It will have been noticed from Table II. that the 50-h.p. motor totally enclosed at about 450 r.p.m. keeps reasonably cool with 20·5 h.p. This power probably would be the working limit at standard speed. The cooling surface of the totally enclosed motor per watt lost should be apparently not less than 3½ to 4 square inches; but this depends on outside ventilation. On long tests the temperatures have often been known to go down after three or four hours, due apparently to draughts caused through opening doors.

The heating of the armature at high speeds beyond that given by the usual formula may be in part explained by the formula being founded on experiment that might be indicated by curves, whereas curves indicating the flux changes in the teeth and armature would show a greater

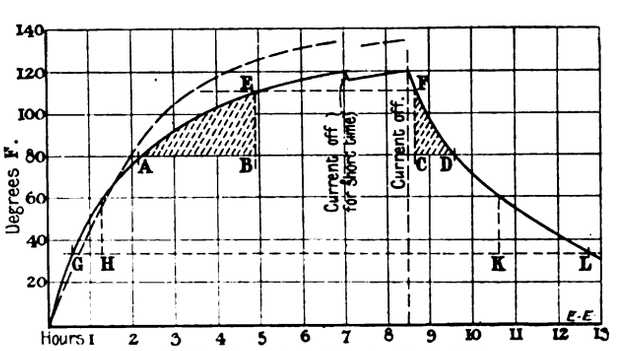

FIG. 5.—Heating and Cooling of a Magnet Coil.

maximum and far greater rapidity of change at parts of a complete period. Many measurements of temperature have been taken at intervals of one to two hours, necessitating stopping the motor tested for five to ten minutes. On attempting to plot curves from these measurements showing the rise of temperature, it was obvious that there was a fall of temperature during each interval, especially in small motors, rendering the results of the test useless for the purpose intended. The convex curve (Fig. 5) shows the gradual rise to a maximum temperature of an overloaded field coil of a dynamo (without an armature) and the concave curve the shorter interval of time to reduce the higher temperature after the current is cut off. Thus in this curve if any line A B C D be drawn A B represents the time required to rise to a particular temperature B E (measured outside the coil) and C D the

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time to cool. For the higher temperature which illustrates practical work C D is small compared with A B. The dotted line shows the average internal temperature calculated from the reduced current as the temperature rose. The coil was fully exposed to the air, and it was noticed that the temperature between the coil and the magnet ring was the same as outside the magnet ring near the pole. In enclosed motors the outside of the case may at times be 20deg. F. cooler than the magnet coils inside.

The great advantage of intervals of light or no load in the cooling of loaded motors may be roughly judged from Fig. 6, which explains why heavy overload can be borne with intermittent work without undue heating, as in crane motors. This advantageous cooling with intermittent loads can only be obtained when there is a considerable difference of temperature between that of the air and the highest permissible of the motor. If the air be very warm, so that this difference is comparatively small, the motor gets hot in less time than it cools. It will be seen on Fig. 5 that G H is less than K L. It has often been noticed how a comparative small opening in a metal cover or (Class 6) enclosing an open motor would reduce the temperature. If the escaping air had a temperature of 72deg. F. only one-sixth the quantity given in table would suffice to carry off one-third of the heat, and if the velocity were only 2ft. per second a moderate opening would suffice. It may be noticed that there is no such thing as a gas-tight motor, even if the shaft worked through a stuffing box. The expulsion of, say, 15 per cent. of the enclosed atmosphere when it was heated, and the entry of the same amount of gaseous air from the outside on cooling, would cause the average condition of the atmosphere

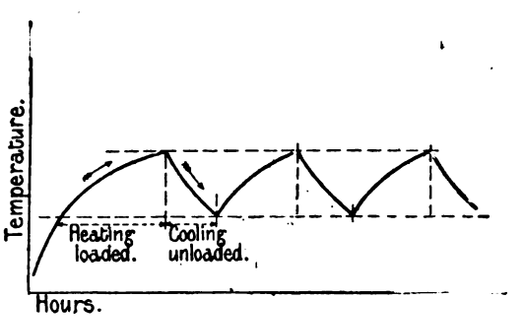

FIG. 6.—Intermittent Load.

outside and inside soon to be similar. To enclose a motor tightly to keep out noxious gases is a delusion. Time forbids any detailed account of experience with the various ways of protecting motors. In an explosive atmosphere they must be totally enclosed, and strong enough to withstand an internal explosion as made by the author for a mine some 18 years ago.

Experience with open motors exposed to various noxious chemical fumes shows that although the motor's appearance may be spoiled and soldered joints affected, yet the motors last so long that it is better to let them wear out and buy new ones rather than put up with the troubles from enclosing them. In the author's opinion, the reasons given for totally enclosing any but very small motors (Class 5) are usually mistakes. In the case of insurance risk they tend to defeat the object in view. In nearly every place where power is required for manufacturing, open motors may be used and easily protected against the real or supposed dangers of its particular environment. Enclosed motors with a current of air forced through them either by means of a fan or chimney may be considered as open motors so far as heating is concerned. In order that a continuous-current motor may give the least trouble, it is important that the arrangement be such as to keep the commutator as cool as possible, and *vice versâ*. The conclusion is that totally enclosed motors (Class 5) are under great disadvantages, and in general their use can be avoided.

River Plate.—The petition submitted last year to Congress by Messrs. Fontenelle and Co. for a concession for an electric tramway from Alsina and Pozos to the new Liniers slaughter yards, and then on to Liniers, Ramos Mejia, and San Justo, has been favourably reported on by the National Railway Department.

THE MANAGEMENT OF ENGINEERING WORKSHOPS.*

BY EUSTACE THOMAS, B.SC.

The subject of this paper was chosen as affording a valuable incentive to the study of modern methods in practice, and not merely as proposed on paper. By the courtesy of a number of gentlemen—to whom the author's grateful acknowledgments are due—visits were paid to works engaged in widely different manufactures, and the details of organisation and of the "paper" used were gone into at great length. The results of the author's impressions are presented after much thought with the desire that they may provoke useful discussion and interchange of ideas on a subject which is yet far from its full development.

Variety of Systems of "Paper."—The amount of "paper" necessary for handing on instructions and keeping records and costs varies greatly, being very large in some works and quite small in others. There seems to be no generally adopted system, and the same result is often achieved in quite different ways. It is impossible in a paper of this character to compare these systems in detail, and it is proposed rather to deal with the general principles and common objects of such systems.

General Shops and Specialised Shops.—Most of the shops visited, which had an efficient modern organisation, were specialised shops where the work was almost wholly standard, and non-standard work was discouraged. Such shops often reach a wonderful degree of efficiency and simplicity. The organisation of a general shop, where changes are frequent and much material is built to special order, is immensely more difficult, and efficiency is frequently much less. While this fact is usually recognised, such general shops exist in large numbers. As people really come to realise the difference at its full value, such general shops must diminish in number. And if it is possible to run such a shop efficiently, it should be easily possible to run a specialised one; hence, much of what follows will be stated with the general shop in mind. In one of the works visited there were two quite separate establishments, in one of which meters were manufactured, and in the other switchgear. The one was specialised, the other general. The simplicity of the one when compared with the other brought the matter home to the author's mind in the most convincing manner. To give these impressions some pretence of an orderly arrangement, the author has grouped them under the following heads: (I.) separation of head work and manual work and development of routine; (II.) handling and distribution of material—waste; (III) labour efficiency—day, piece, and premium systems; (IV.) cutting and non-cutting times; (V.) execution of work to time.

I.—Separation of Head Work and Manual Work.

The general principle is that the manual worker should not have any avoidable head work to do. It is generally agreed that the workman in every case should have a drawing, or even a sketch, to work to fully dimensioned—that is, that the workman should have only manual work, and all head work should be done by the draughtsman or designer.

List of Material.—On the same principle a complete list of material should be prepared in the office, containing every single detail that may be required. The application of the rule is frequently carried out imperfectly. In one works every part of the gear was detailed in a printed specification with catalogue numbers, except the bolts, nuts, split-pins, and other small store parts used in erection. Incidentally, erection was day and manufacture premium work. In hundreds of works the material is still requisitioned from the drawing by the foreman or the workman without a list. In every case where the list is not prepared beforehand or is incomplete the workman becomes a head worker, and he is usually a very inefficient and expensive one. Moreover, a list *must* be got out by someone, and if this is done in the works it will have to be thought out and written out every single time that the job repeats itself. The certain result is preventable expense and loss of time. The list should be prepared in the office even if

* Paper read before the Institution of Electrical Engineers.

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only one article is to be made, but in such form that it may be readily available for any future work.

List of Operations.—A still further application which is only seldom made, and only in the most advanced shops, is that there should be provided also a list of operations in every case where a new workman might possibly be in doubt. This applies particularly in some classes of switch work. Otherwise the foreman must give these instructions every time the work is given out, which implies preventable waste of time. He may forget or the man may do so, and that means imperfect work or waste of work and material. If the job is given to a new man, the advantage is particularly great; but even if the same man gets the job his memory is not to be trusted. This is particularly the case where less skilled or boys' labour is used.

List of Tools, Jigs, etc.—There are the same arguments for this list as for the last. It saves head work, defects of memory, and consequently great waste of time, and makes it easy for the foreman to have the tools collected in advance by the labourer who collects material, and deposited ready on the man's bench or machine before he requires them.

Duties of Foremen—The same principle deserves the most careful consideration in defining the duties of foremen. These may come under two heads: (A) clerical or administrative: such as giving out work, seeing that there is no delay caused by waiting for material, watching the efficiency of the workmen, planning to get work executed to time, etc.; and (B) technical: methods, tools, and jigs, for executing work, for overcoming difficulties, for reducing cost of production, etc. Probably in most existing shops these two functions are combined, a foreman's clerk being often provided to assist function (A) and tool fitters to assist (B). In some highly organised modern shops visited the foreman was chiefly occupied with function (B), but the conditions were usually rather special. The most modern tendency seems to be to give the foreman function (A) to carry out. In regard to (B), he must be technical enough to know if matters are not going rightly, and in such case set an expert tool fitter to study them out and do what is required. This seems to the author essentially the right system, especially when day work is going on. The shop will not work efficiently unless each man feels that the foreman is always about and vigilant, and this is impossible if he attempts to study out technical points. Equally, he cannot possibly worry out technical matters efficiently if he is subject to constant interruption through his duties under function (A), and it is better to put on a man who can give the work undivided attention.

Human Element.—It is of essential importance to recognise that all employés are only human, and, therefore, liable to slack, liable to forget, and liable to neglect or to alter certain of their duties, unless these are defined and a check frequently taken. In one works the responsible organiser stated that he had to be constantly on the look-out to see that routine duties were not neglected, and to nip in the bud numerous "improvements" on the system by individuals which would render it unreliable. In another case one of these "improvements" was discovered while the author was walking round to examine the working of the details of the system.

Routine and Red-Tape.—The best way to minimise these difficulties is to have a sufficient amount of red-tape or routine, and to have the routine for each man written out. A sufficient amount of red-tape is really essential, and also cheap, for it assumes that the work follows a well-worn and accustomed track. And, on the other hand, it is to be remembered that discretion allows indiscretion, and the latter is costly out of all proportion.

Routine Books.—A routine is useless unless kept up by constant supervision. It is here that systems most frequently work badly. The best way of preventing this that the author knows of is to have a routine book for each man who has routine duties—this to have columns ruled off for days or weeks. Each day or each week a tick or a date is put in the appropriate column to signify that that duty has been attended to, or to show the date to which that duty has been brought up. All these routine books go to the manager at a stated hour each week, and he can glance through a large number in a very short time

Weekly Inspection.—In the same way each week at a fixed hour the manager should walk round the works, and all books used should be laid out in readiness. A glance at the latest pages will show if these are being entered, posted, etc., as intended, or if an "improvement" is being made. The packing-case records, as an example, often repay this trouble. At the same time any difficulties can be brought up for solution. In this way the manager has his own routine, and should observe it as rigidly as he requires his subordinates to observe theirs.

Summaries and Abstracts—In some of the works visited all sorts of summaries and abstracts were prepared, which, if periodically inspected and acted on, would probably be more than worth their cost In some cases, however, they certainly were not regularly examined. In such cases they are worse than useless, for they cost money needlessly, and they convict the management of slackness which will certainly be reflected through the works. If used, it is worth while to have quite a number of these summaries, as long as their collection is made a mere mechanical matter not requiring skill or any but cheap labour. The general principle is always to diminish head work, eliminate memory, and leave no excuse for forgetfulness or omissions, but all the time to make it easy to detect defects just as soon as they arise.

Application to Clerks' Work.—In one works the human element is recognised in a curious manner. In the costing work forms have been prepared so as to eliminate writing as far as possible, and against each space are set full instructions for filling in Moreover, additions and subtractions are done by a simple slide rule invented by the manager. This makes these operations merely mechanical, and the feeling of tiredness that is liable to set in near the end of the morning or afternoon is not expected to have so detrimental an effect as usual.

Inspection of Costs.—It is of little use recording comparative costs if they are not looked at Where kept on cards, it is easy to place all cards on which entries have been made in a separate drawer each day. The manager can then inspect these quickly each day before they are put into their respective places.

II.—Handling and Distribution of Material.

Lists of Material.—Material must be booked, and this means that someone must write out a list of it. It is far the best way to do this in the office, even if only one article is required, and to preserve in this way a uniform routine system. But the same list, if prepared with thought for standard work, can serve several important purposes, plenty of copies being prepared and distributed: (*a*) The storekeeper marks it for material in stock or to order. (*b*) The stores issue goods from it to the foreman's auxiliary stores without further requisition. (*c*) The foreman can check by it all material at any stage. (*d*) The drawings having been cut up into as many parts as there are pieces or groups of pieces to be made, a copy of the list is also cut up and pieces attached to the divided-up drawings for the workmen's use. (*e*) On a further copy, against each item is marked the time by which it must be completed, in order that the whole of the work may go through to the date desired. Each shop foreman must have his own copy marked. (*f*) A copy goes to the cost department. The work can be priced against this list in advance if required, and actual issues and returns can be checked against it. If any one of these functions is omitted, delay, waste, or other trouble will follow, and the importance of the list is sufficiently obvious.

Arrangement of Lists.—Where work is executed in different shops it is of assistance to subdivide the list accordingly. Any assembled parts which may be used for other work are best given separate lists, as they may be manufactured for stock. It is convenient to submit the pencil list to the foreman, and to arrange in the order of importance of execution. It is quite easy to do this, and it saves time and thought to the foreman ever afterwards. If several parts are given out together (as is regularly done in switch work) these can be grouped together, if this is attended to on the pencil list at first.

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Catalogue Numbers.—It is well worth while to devise a system of catalogue numbers to cover all single pieces. A numerical system is very simple. An examination of a large number of drawings will enable all pieces to be divided up into a sufficient number of classes. Thus capstan rod work might be classed as 27, and it could be subdivided into sub-classes 27-1, 27-2, 27-3, and so forth. These class numbers are the numerators, and serial numbers are used as denominators. A separate card is made out for each piece, and reference is entered to every drawing or job on which used. The uses are numerous: (*a*) This catalogue number appears on each drawing and on each list of material against each piece. (*b*) It facilitates comparison of costs. (*c*) It facilitates estimation by the ease of reference to all other pieces at all like it. (*d*) It facilitates standardisation by making it easy for any draughtsman to see what has been done before, and to use something already made if possible. (*e*) Patterns are marked with this number and stored in trays or spaces marked with the class number. This often saves new patterns by making reference easy to all existing ones. (*f*) The stores are arranged as far as possible to follow this classification. The system is not nearly so difficult to put into operation as might at first be thought, and has obvious advantages.

Auxiliary Stores.—The percentage of time lost through waiting for material is always greater than appears casually. The orderly progress of the work through the shop may also be disturbed and the whole time programme disarranged. It is probably well worth while to let the foreman have an auxiliary stores under his own control, with plenty of easily accessible shelves. All material for an order is delivered here and sorted out in a space prepared for it. With each lot is placed the drawing and even the job ticket. Any partially completed work is returned to the same spot to await assembly. Special tools and jigs can also be collected with the material, and all given out together. With this system the foreman can see at a glance how the work stands, whether he is short of material, etc. It is advisable to have plenty of tins of suitable sizes to contain small screws, parts, etc., so that these may be easily handled and not be mixed.

Shop Drawings.—These consist of pieces of cardboard carrying that part of the drawing required for any one piece or group of pieces given out to one man only at a time. On the same card is the list of material, cut off the general list, the list of operations, and the list of tools, gauges, jigs, etc. The separate cards are numbered serially and usually kept together. Those required for a job are distributed in the auxiliary stores in the space allotted. There should be some material to each card, if all material has been collected. The above refers, of course, to such of the work as is small enough.

Losses, Scraps, etc.—If a rigid rule is made that small material shall always be returned to the stores when any part of the work is completed or is stopped from any cause, there will be fewer losses, and the man concerned may be made responsible. Incidentally, it will check the giving out of too large jobs and the changing from one job to another before the first is complete. The work should be checked at each stage for accuracy and number of pieces, and any scraps should be dealt with and recorded, and orders for replace parts at once attended to. All scraps and defects in workmanship should be entered on the job ticket and in a report book which goes before the management. In one works a weekly return is made of: (*a*) materials scrapped through fault in the material; (*b*) labour wasted through fault in the material; (*c*) labour wasted through faulty workmanship; (*d*) material wasted through faulty workmanship; (*e*) cost of putting any jobs right if that is possible. A slip cut off a duplicate of this return is pasted on to the cost card, and defects of workmanship are entered each week against the man on a special card giving his record for the half-year. This system has been working for some years, and it is considered that the saving which has resulted much more than pays the cost of the clerical work.

Inspection at Each Stage.—There is no doubt that this pays for itself even in such work as switch work. It is a sort of police system, and if relaxed trouble is liable to creep in at once It is not very usual or systematic in many general shops, and particularly with such work as switch work.

Too Large Stock Orders.—Where both special or general work and stock work are going on together, it is easy to break off a stock job. This is always disadvantageous, and to avoid it: (*a*) stock jobs should not be too large; (*b*) work should be done on as few stock jobs as possible at one time, concentrating on these as many men as are available. In this way no stock job need last long, and the liability to break off or to finish a part only of the order is consequently diminished. This matter needs emphasising. Nearly all foremen have a natural inclination to get a large number of orders in hand at once, all progressing slowly and, perhaps, frequently hung up. If this is stopped there will certainly be less total labour used, and the orders will all be completed in less time.

III.—Labour Efficiency.

Day Work versus Piece or Premium Work.—If a number of shops are visited in succession, some working on day work and some on piece or premium systems, the difference impresses itself most strongly. With piece or premium work there is not only a brisker air about, but also the author seemed always to notice a more cheerful atmosphere. Probably the reason is that with either the piece or premium system the man feels that he is working for his own benefit. The following are some disadvantages of daywork, especially in general shops: The men slack off as soon as the foreman's vigilance relaxes at all. Some men regard it as a matter of principle to make jobs last as long as possible with a view to increasing employment. The men are quite content to wait for material. The handling of material by the foreman is always less efficient. Costing is uncertain and unsatisfactory. Some advantages of premium or piece work are: Each man has an interest in the work. The men press the foreman to give efficient delivery of material, and the foreman is thus placed between two fires. Each job must have careful consideration before being committed to a price or time which may be hard to change. Each job makes the estimation of new work easier. The foreman has more time to plan his jobs, and is better able to estimate for and keep correct promises of completion. If the assemblers are on piece or premium work, they draw attention themselves to any inaccurate manufacture of parts coming to them.

Day Work to have Time and Price Estimated.—In cases where day work seems necessary, it should be insisted on that a price and time are estimated for each job, even although these are not made known to the men. The actual price and time must be compared later with this estimate. The effect is to force attention to all day-work jobs, and in some measure to bring about the other advantages enumerated under premium and piece work. But, further than this, it must eventually make the foreman desire to get piece or premium work in where he has been accustomed to give out day work, for if a price has to be given in any case it is easier for him if it is given to the man outright and the man is working with him to keep the time down. The simplicity, comfort, and general advantage of piece or premium work cannot be sufficiently proclaimed. So much so, that where appreciated every manager of a general shop will find means to introduce it to a much greater extent than is at present common.

Premium Work.—It was well known that with piecework a man seldom attempts to earn more than about time and a quarter, for fear of getting the rate cut. This caused an uneasy feeling in the employers that they were not getting the best efficiency, and it was hoped by the introduction of the premium system that this difficulty would be got over, a promise being made that the time allowed should not be altered unless a new method were adopted. In fact, the masters hoped that they might be able to relax some of their vigilance, and that the men would of their own accord do their best in their joint interests. Such a golden vision was not likely to be realised. The men know quite well that if they make too much premium a new method will always be found. The author has been amused to find that the managers of some of the works visited have declared that the rate was never cut. Their responsible

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assistants, however, have usually acknowledged, on being pressed, that practically the same result was obtained by this plan of "finding a new method." The practical result is that the premium system, after all, requires just as much vigilance as the piecework system. It has the disadvantage of requiring rather more book-keeping, and of rather more difficulty in adjusting the price when a mistake has been made. If there had never been any cutting, the older firms would have been placed at considerable disadvantage as compared with newer firms, and would find that they had been pioneering for such newer firms, who are enabled to take advantage of the improvements effected and set shorter times to start with. In actual practice, however, it is probable that the greater proportion of the rates fixed, especially in large machine work, are pretty correct, and there is not perhaps so much scope for any undue bonus to be earned.

Expert Check on Times Set.—Where it is considered that the best results are not being obtained the author is convinced that the only way to improve matters is to have enough expert men who are paid well, and can be relied upon to work in the employer's interest. Such men, for example, may act as rate fixers. One or more of them can work on such of the jobs as seem to require checking, and they will advise on any changes that seem likely to be profitable. In particular they seek economy in "non-cutting" times. It seems very desirable that the rate fixers should keep their hands in in this way, otherwise some stagnation is probable. Also if some system of remuneration for improvements they effect can be introduced, it will probably yield a very profitable return.

IV.—Cutting and Non-Cutting Time.

On small work especially the proportion of non-cutting time is sometimes very great. In a certain rather tricky job a very experienced rate fixer set the following time: cutting, 16 minutes; changing tools, 10 minutes; gauging, 20 minutes; setting up and fixing, 30 minutes. This, of course, was not quite an average job, but in particular the item for gauging is to be noticed.

Gauging.—There happened to be a number of surfaces to machine, and each to exact dimensions. "Gauging" included the actual measuring and the successive short cuts necessary to get down to the exact depth for the final cut. A little thought will show how antiquated and wasteful are the ordinary methods of doing this. A cheap gauge or micrometer is badly required which will tell in a second or two to ordinary men just how far they are off the final dimension, and then means are required to set the tool forward just that amount. Micrometer heads on lathe screws are useless without the micrometer or gauge for showing how much remains to be taken off. The introduction of some cheap device of this sort will easily effect an appreciable percentage economy.

Changing Belts.—With belt-driven machines and cone pulleys the speeds usually change in not less ratio than 1·75 to 1 or even 2 to 1. In the latter case we shall on the average be working at just three-quarters of the correct speed, and the cutting time is increased one-third. This is a very serious loss, and argues strongly the advantage of a gradual speed change device; also of some cheap speed indicator to be applied to the work and show instantaneously the rate of cutting. But in an even simpler way losses constantly occur. It is usually not quite easy to change from one speed to another, and the tired man in particular will not take the trouble to speed up and down as often as perhaps he should. One large firm doing very accurate work provides a handle which automatically shifts the belt by pressure to right or left. There is no doubt the cost of this has been repaid many times.

Quick-Change Drill Chucks.—A quantity of work comes under the radial or single spindle drill, and requires fairly frequent change of drills. Quick-change drill chucks, which enable the grill to be changed instantaneously without stopping the spindle, may easily save anything from 10 to 50 per cent.

Setting Work in Jigs.—In small and thin work the cutting time is often very little, and the setting and handling of the jig may be a large percentage of the whole. In one shop where the work was all repetition, and large numbers of very expensive jigs were used, the foreman estimated, at a rough guess, 25 to 75 per cent. of non-cutting time, a multiple spindle drill being used, and very good jigs.

Picking-up Tools.—In one very accurate and tricky job, requiring a number of operations to be performed from the same setting, and requiring a number of tools in successive use, the author was impressed with the small cutting time, and also with the loss in finding and picking up the exact tool required. A large block, having exactly as many holes as tools and gauges, and with these arranged in suitable groups, will save its cost many times over. A careful study of this particular job enabled the time required for it to be halved, with considerably greater satisfaction in the character of the work turned out, and all by attention to these small details. The above details will sufficiently emphasise the point that there is a large field open at present for improvement to reduce the non-cutting time as well as the cutting, and that employers may often profitably take obvious opportunities of economising which lie ready to their hands instead of looking abroad for new tools.

Visiting Consultants.—In America, and in a few cases in this country, visiting consultants are called in to examine the works, its lay out, its organisation, and to suggest improvements. Such men must have an experience which no one attached to a single works can possibly attain to, and should be able to exercise it without breach of confidence. In any single concern there must be some tendency to stagnation, and there seems as good reason for the visiting consultant as for the visiting auditor, whose services are now regarded as essential, and taken as a matter of course.

V.—Execution of Work to Time.

In a general shop having many small jobs in hand at once it requires a very clever foreman to give times of completion of all work in hand which he can adhere to, and yet not have too much labour employed. The author has devised a special indicator for the purpose, which gives the foreman a bird's-eye view of the work in hand and of the capacity for work. It requires that time shall be estimated on all work in detail, whether on the day, piece, or premium systems. One or more suitable boards are laid out with horizontal grooves to represent the different men in classes according to employment, wages, etc.; some spare grooves are also allowed to each class. Vertical lines are drawn to scale to represent hours, days, and weeks. Fairly narrow strips of card are cut off for each job, of length equal to the number of hours estimated, and marked with the job number and date by which completion is required. These are then set up in the grooves, always to the left of the date marked on them. If there is more work in hand than capacity in men, some cards must go into the spare grooves. The card to the left in each groove is always the job in progress at the time with that man, those to the right being arranged in the order of present urgency. They can be reshuffled later as altered circumstances may seem to require. Thus the foreman or manager can see at a glance what work is likely to be late, what is the present capacity for new work, stock work, etc., what jobs are hanging, and where it is desirable to take on or discharge men. The material labourer can also see what materials, tools, etc., are likely to be required soon, and get them ready. The cost of keeping up is small, and amply repaid by the advantages.

In conclusion, the author would recapitulate a few of the points which stand out most strongly before him: (*a*) Make it unnecessary for the workman to think or remember what can be committed to writing, and he might forget. (*b*) Some red-tape is necessary and cheap. Remember that discretion may also mean indiscretion. (*c*) Use routine books arranged for easy weekly inspection. (*d*) Give every piece made a carefully chosen catalogue number, and use this everywhere. (*e*) Provide an auxiliary stores for each foreman where there is much small work. (*f*) Make use of the list of material in the numerous ways suggested. (*g*) Drawings should be divided up, and each detail given a list of operations and tools. (*h*) Get as many men as economically possible on to each order in progress, and so have as few in hand at any one time as possible, and finish each quickly. (*i*) Check standard jobs by expert

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labour, and reward improvements made. (*j*) Insist on an estimate of the time required for each day-work job. (*k*) For the sake of comfort, as well as for economy, displace day work as much as possible. (*l*) Keep the attention directed to the "non-cutting" losses, especially with small work. (*m*) Keep the whole of the work under general view by means of a suitable foreman's indicator.

It should be pointed out again that this paper is merely a record of some impressions received, and does not pretend to be a system of works organisation; also that the author's interest being chiefly among small work, much of what has been said must be taken particularly to refer to this.

HIGH-SPEED ELECTRICAL MACHINERY.*

BY GERALD STONEY, B ENG., MEMBER, AND A. H. LAW, B.ENG., ASSOCIATE.

(*Concluded from page 557.*)

A further advantage of coils thus wound and protected is the permanence of the balance of such rotors. Formerly with unprotected coils the windings had to find their own place as they were squeezed up by the centrifugal force, by the sliding of the insulation along metal surfaces more or less smooth. Thus the insulation was sometimes damaged, and perhaps one or two coils went further up than others, thus throwing the rotor out of balance. On running again other coils would move slightly, and so the balancing process had often to be repeated several times before a stable condition was reached. With the metal cases the coils take up their final position at once and stay there, and it is a common occurrence for a rotor to go straight up to 25 per cent. over speed the first time it is turned round without requiring any further balancing.

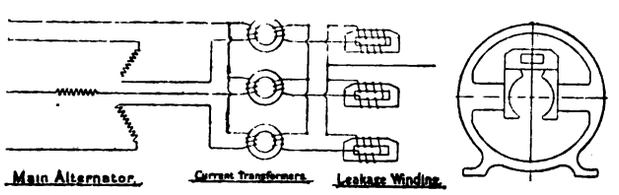

FIG. 11.—Diagram of Connections. Leakage Winding.

In the case of large rotors the pole-tips are made to slide over a tee-shaped projection on the rotor body, and the coils are wound separately in coil cases and slipped over the poles before the pole-tips are put on.

In selecting material for high-speed work it is particularly necessary that it should be of the best, and it is most desirable not to obtain high tensile strengths at the expense of the ductility of the material. It is rather tempting to do this, since a design can often be materially improved and cheapened by using a large diameter and high peripheral speed, while the factors of safety can be kept high *on paper* by using such material, but it is on the ductility that we rely for properly distributing the stresses between the various parts, while material of too great hardness may easily be cracked or flawed accidentally either during construction or afterwards. As in the case of continuous-current machinery, one object is to get the maximum output at the highest speed possible. The strengths of the materials limit the diameter and length of the rotor, and, therefore, both the available flux and ampere-turns. This again limits in the stator the output for a certain inherent regulation. If, however, any method of compounding the alternator to improve the regulation is adopted, much larger outputs can be obtained from a given carcase. Many methods of doing this have been proposed, but most of them depend on either commutating a portion of the alternating current or causing certain parts to become saturated as the load increases, or by varying the effective resistance of the winding on the exciter magnets. The first is objectionable on account of the trouble given by commutators, the second since the compounding will vary with varying voltage, and the third is generally too slow to allow for rapid changes of load. A method of compounding has recently been brought out (see Parsons's and Law's patents 24,141/05 and 13,712/07) which avoids these difficulties.

The exciter is provided with an alternative path for the magnetism in parallel with the armature, which we call a "leakage path." This "leakage path" is provided with a winding, which is in series with the stator winding, and as the alternating current in this rises it chokes back the magnetism, or, in other words, increases the magnetic resistance of the leakage path. Thus more flux goes through the armature, and, therefore, the voltage of the exciter rises and compensates for the tendency of the main voltage to drop. In a three-phase alternator there is generally one leakage path in each phase, and if the primary current is at high voltage a current transformer is generally used. These leakage paths are easily adjusted for any desired amount of compounding, or for any power factor. Fig. 11 shows diagrammatically this arrangement fitted to the exciter of a turbo-alternator, and Fig. 12 gives the comparative regulation on varying load with and without the leakage path in action.

The authors have in this paper endeavoured to trace out the progress of the high-speed dynamo from its first inception by Mr. Parsons in 1884, and to show the difficulties that had to be met at each step before turbo-dynamos and alternators could claim their present commanding position.

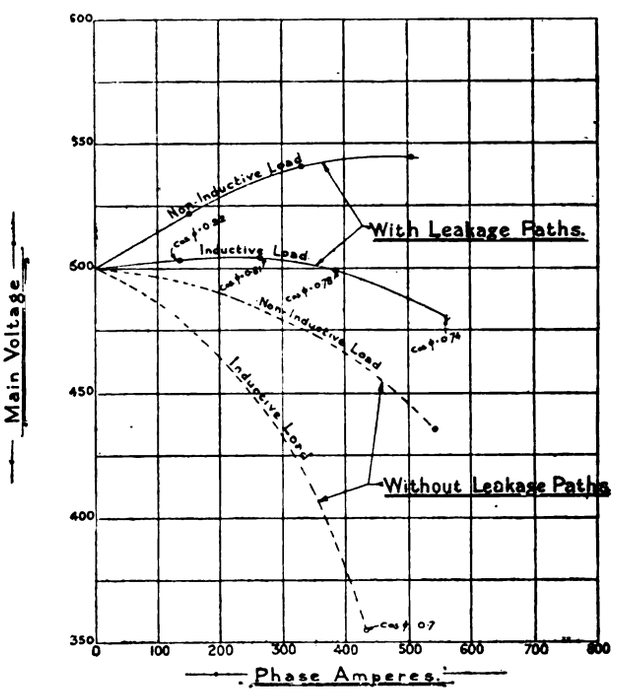

FIG. 12.—450-kw. Turbo-Alternator Voltage Regulation Putting on Load. Rheostats unaltered.

They have also tried to describe briefly some of the more important features of the modern types and to show the principles on which they have been constructed. As regards the future, it is hardly possible that progress will be quite as rapid as it has been in the past, but it is certain that still larger turbo-units will be built both for direct and for alternating current, and in their design many problems will be encountered which will demand the highest skill of the scientist and the engineer.

DISCUSSION.

Prof. SILVANUS P. THOMPSON expressed his indebtedness to the authors for their interesting paper, which did not profess to be more than an account of the highly successful doings of one firm—that of Messrs. Parsons. He had analysed some data relating to modern machines in order to find out what progress we had made in the last 20 years in the utilisation of materials, and he had found that the tendency was in favour of smaller machines in proportion to their output. Taking as the basis of his comparison the diameter of the machine multiplied by the armature core and divided by the output in kilowatts, he found that in 1884, in the case of a small continuous-current 8-kw. machine, the average coefficient of size in proportion to output was 2·4. In 1889 the average coefficient had gone down to 2·1, and in two recent examples of 750-kw. and 1,000-kw. machines the coefficient had gone down to 0·917 and 0·828. It would be seen that for continuous-current machines the output was now about

* Paper read before the Institution of Electrical Engineers.

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three times as much in proportion to the size of the armature. The figures for alternators were still more striking. In 1889, in the case of a 75-kw. single-phase machine the ratio was 3. A little later, a machine of 105 kw. had a ratio of 1·76. In 1894, a machine of 350 kw. had a ratio of 2·8, and between 1894 and 1896 a 1,000-k.v.a. machine had an improved ratio of 1·73. The 4,000-kw. machine made at Carville, and shown in Fig. 9, had a ratio of 0·64. Thus it would be seen that the ratio had gone down more than one-fifth. He claimed that a firm that could do this in the years between 1889 and 1903 had made a remarkable advance. With regard to the comparison of winding between the ring armature and the drum type, Prof. Thompson thought the argument should be reversed. The given thing was the number of segments, and not the number of conductors. For a given number of segments the Gramme armature had twice the number of conductors, and it was, therefore, worse than the drum. This appeared to be acknowledged by the authors, who in another part of the paper referred to the greater self-induction of a Gramme winding. He supposed the argument referred to bipolar machines. As to the use of smooth-cored armatures on continuous-current machines, which appeared to be still preferred to the slotted cores, the reason appeared to be that of better commutation. He thought, however, that there must be another reason. If slotted armatures were used with slots of the usual size, the frequency of charge of the magnetism as the teeth moved in and out must be deleterious, and eddy currents would be set up in the pole-pieces. This was a reason why teeth should be avoided in machines of this type. It was difficult to understand the authors' statement that the method used by Messrs. Parsons and Co. as to getting rid of the time lag by using no iron commutating pole, for it seemed to him that sudden changes of load would equally affect the current in the armature and series winding. He admired the method of compounding through the exciter of the alternator which was described in the paper.

Mr. E. J. Fox (Messrs. Willans and Robinson, Limited) said that when his firm first took to the manufacture of steam-turbines some four or five years ago they had great difficulty in finding electrical firms to supply them with generators for coupling to the turbines. He was sorry in a way that the authors had confined their attention to smooth-core and corrugated commutator direct-current machines. Though machines of this type were doing some good work they were far from finality, and the smooth-core and corrugated commutator would have to give way to the toothed core and carbon brushes if direct-current machines were going to compete with reciprocating engines. He referred to the direct-current dynamos with slotted cores which Willans and Robinson were developing in this country, and the commutation in which was excellent. Messrs. Brown-Boveri were now experimenting with a machine designed for working entirely with carbon brushes. Their idea was to support the commutator in such a way that as the bars heated up expansion took place endways, and prevented bulging at the periphery. With regard to alternators, he agreed with the authors' adoption of the salient-pole type of machine. The authors advocated compounding, but he thought it was better to use an ordinary alternator with the complications of compounding, and a Tirrell regulator if necessary.

Mr. W. Parker (Messrs. Siemens Bros. Dynamo Works, Limited) added a few remarks on the history of the direct-current machine in general. He was surprised to find that the authors still advocated the antiquated construction of the smooth-core armature and metal brushes where commutation difficulties were extremely severe. He was convinced that future users would insist on carbon brushes and slotted armatures. The real difficulty in designing direct-current turbines was excessive heat from the commutator, and if carbon brushes were used on high-speed machines it was necessary to employ artificial cooling. He then described the method of cooling adopted by his firm, which was by means of axial holes in the segments of the commutator with a fan attached to the shaft for inducing a current of air through the holes. By this means the temperature could be kept down to about 40deg. F. and the density of the brushes to 45 amperes per square inch. He had very little doubt that the best construction for large direct-current turbo-units was a combination of commutating poles with compensating windings.

Dr. R. Pohl (Phœnix Dynamo Manufacturing Company, Limited) agreed with previous speakers that the smooth-core armature would have to give way. He thought field distortion would by no means be eliminated with over-compensating windings. In Parsons machines the field distortion was kept down by the smooth core and large air-gap, but it would be found that by concentrating the over-compensating winding in the neutral zone the slotted core with the very much smaller air-gap would give better results. The winding of the coils of the alternating-current machines in hermetically sealed cases was novel, but he would like to have a further description of the winding of these coils. He did not see how the slipping of the coils in the cases was prevented. He congratulated Mr. Law on his ingenious idea of the leakage path method of compounding, but he doubted whether this idea would be a commercial success in practice. Fig. 12 showed that an enormous flux must pass through that leakage path, and the leakage path would have to be about three as large as an ordinary exciter; then there would be the additional expense of a choking coil and current transformer.

Mr. F. H. Clough (British Thomson-Houston Company) criticised the authors' statement that the salient pole was the preferable one, more especially for high speeds. With a well-distributed stator winding the effects of higher harmonics could be very nearly eliminated, and there was an even distribution of flux. In order to keep down the density in the centre, it was necessary to make the pole-tips flat. He described some machines with a modified cylindrical type of rotor which his company were making.

Mr. Miles Walker (British Westinghouse Electric and Manufacturing Company) confined his remarks to the salient *versus* the cylindrical windings, and expressed the opinion that the latter would survive on account of the larger output which it could give from a given amount of material. With cylindrical winding it was possible to work the copper 50 per cent. higher than with salient winding. He sketched on the board a type of construction giving enormous outputs for very small sizes. In one case it was possible to get 60,000 ampere-turns with a rotor about 20in. in diameter, so that distributed winding looked very promising for the future.

Mr. H. M. Hobart thought that the reason we had not yet obtained success with continuous-current turbo-dynamos was that we were going contrary to fundamental laws. On the other hand, we were working in accordance with these laws in the case of alternating-current machines. Slow speed was the best for direct-current types. The turbine did not show up very well in comparison with the reciprocating engines for steam consumption below 1,000 kw.

Mr. A. H. Law, in replying to the discussion, dealt only briefly with a few of the points raised, and reserved his full reply for the *Journal*. As to the relative advantages of smooth cores and slotted armatures, Messrs. Parsons were relying on experience of both types. He admitted that exceptionally good results had been obtained recently with large two-pole smooth-core machines with distributed compensating winding, but they were loth to change at this moment. The probability of some form of carbon brush had in all cases been kept in view, and in all the machines designed by Messrs. Parsons sufficient surface was provided to enable the carbon brush to be used, and the change would involve very little expense. He submitted that if a dynamo could be made with brass wire brushes, they should adopt that form of construction for the moment, and when the ideal carbon brush came along, it would then be time to consider a change. As to leakage path, it was true that the exciter magnets had to be somewhat larger, but the only thing that was affected was the iron in the magnets, and the iron in the magnets was a very small proportion of the cost of the alternator. He said there was no time lag in the exciter magnets with the leakage path compounding.

CONTRACTORS v. MANUFACTURERS AND CENTRAL-STATION SUPPLY COMPANIES.

BY AN ELECTRICAL CONTRACTOR.

There has long been a bone of contention between electrical contractors, manufacturers, and central-station authorities as to who shall hold the field in supplying the wants of electric light users, and it is not at all unlikely that with the increased application of business-getting methods of a vigorous nature by all parties, this trouble will not be diminished but increased in the future.

It should be said at the outset that such antagonistic relations do not exist in the electrical trade only, but will be found in the selling of most articles of commerce of the present day. Manufacturers and wholesale dealers are daily assuming the *rôle* of retailers, and tending to oust the middleman from the market. Prices are so cut and competition is so keen that the extra 2½ per cent. allowed to the retailer is being eagerly grasped by the wholesale dealer. The middleman is on the horns of a dilemma: if he obtains the sole agency in any one district for a certain manufacturing house, he is sure to be restricted from trafficking in similar goods supplied by prominent rivals of that firm. The natural result is the sending by that rival house of a representative into the district with under-cutting prices and having the advantage of the direct-dealing opposition. In this way the agency becomes a white elephant. Again, a prospective customer may invite

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a quotation for a certain article, the contractor will go to the trouble and time of quoting to the requirements given, and the customer will promptly make use of this to invite a further quotation from the manufacturer direct; with the result that he gets a quotation at the same or, perhaps, a lower price, and the chances are that the contractor who has originally quoted is passed over. Still, again, there is the pernicious custom at the present day for one firm to place an order with another as a *contra* deal. An order is offered to one firm in return for this firm taking an equivalent value of goods from the offerer, and such a method cuts out any legitimate agency work such as could be taken by a contractor.

There appears to be at the present time absolutely no etiquette in the dealing of many of the manufacturing and wholesale houses in whatever branch of industry we may look, inasmuch as the policy appears to be simply to acquire all the business possible under any conditions and any price as long as there is the barest margin of profit. Some firms are willing even to sacrifice the profit in order to get a footing under the hope that later on a benefit will be reaped on repeat orders. With such inducements held up to the consumer to deal direct with large houses, it is hardly to be wondered at that the contractor is ignored and scarcely gets the fringe of the trade. Of remedy there appears to be very little; each section is fighting for the topmost place, and unity, even along the excellent lines suggested by Mr. Northcote, appears to be out of the question. For example, cablemakers have united apparently with the view of keeping up prices, with the result that by the free-trade policy of this country foreign makes of cables are being taken up by the reliable English houses, and only as English-made cable is brought down to a similar figure will it be possible to compete at home. The point that it is desired to emphasise is that manufacturers should not combine for big profits, but rather in order to see that the proper basis of buying and selling and representation is observed. One could scarcely conceive it possible for extra profit to be derived by means of having a traveller hawking goods round every town: his expenses must undoubtedly swallow a good portion of the extra profit. Such work can be well left to the local contractor, who is on the spot all the time, and willing to look after the business properly, if he does not have the cream of it taken away from him, but when a manufacturing firm is willing to do business with any man in the street the local contractor is forced to give up the chase, and this leads the manufacturer on to still widen and increase his energies and expense.

As shown by the above, the contractor has a very uphill fight in retailing manufactured goods, but it is possible to show that he is further handicapped in installation and repair work, which ought to be a flourishing part of his business. Just as plumbers and other classes of tradesmen have to obtain proper registration before undertaking their work, so there ought to be a system of guarantee in the electrical trade. Instead of this, any small ironmonger or jerry wireman can pose as an electrician, and that inferior contractor can undercut the legitimate trader, and thus materially curtail the second source of his revenue. On the top of this comes the electricity supply authority, whose principal aim is to sell current, and in so doing adopts every available means. Supply authorities have the advantage that consumers are more willing to put their trust in them than the contractors, and if the supply authorities play a sweeping game they can always wipe out the poor struggling contractor.

It must not be imagined that this article is a piece of special pleading for the contractors. There are many that deserve to be extinct. But the honest capable man is undoubtedly a fine auxiliary to both the manufacturer and supply company, and ought to be encouraged. Of the jerry wireman enough has been said in the past to consign him to outer darkness, and he may be responsible to a large extent for the present state of affairs. Many supply authorities can look back with sorrow on lost units due to the heavy charges and bad work of this type of contractor. They would gladly have made defects good at their own expense rather than have lost a consumer and part of their reputation, therefore when faithful consumers came to them and pleaded for the supply authority to take over some work which the jerry wireman has attempted several times and failed over, there was naturally a great tendency on the part of the supply authority to adopt an attitude of suspicion towards electrical contractors generally unless such men unreservedly bow to the authority. So much of the lighting authority's business depends upon efficient installation in the first instance. At the same time the contractor is very hard pressed by the fact that so much capital is arrayed against him in a competition which should not really arise. The supply authorities and contractors both have the option of taking up a hire-purchase or deferred-payment system of selling goods, but it will be found in practice that it is only the supply authority who will hire without further prospects of effecting a sale. The reason is not far to see; there is not one contractor in a hundred who could afford to capitalise his business to the extent required for such a system. If the supply authority be a corporation, unless the hire-purchase system is based on sound finance as to repairs, maintenance, depreciation, and unless with such provisions the offer appears worth consideration by a consumer, then with a contractor already in the field prepared to sell all apparatus required at a reasonable price, it would appear that the corporation electricity department was pursuing a risky and even a thoroughly bad policy. Motors may possibly be a good subject for a hire system, but accessories—such as radiators, arc lamps, fans, etc.—will either have heavy depreciation or will accumulate in number by reason of returns and new consumers from time to time wanting something different, so that a loss is almost inevitable, and to make up this on the cost per unit for current is a case of "change for a shilling with a charge made for effecting the change." Until such time as the electrical trade settles down to have its work carried out by recognised and registered men, its sales effected by authorised agents, and authorised in the full meaning of the word, and the contractor recognises his responsibility and properly fulfils and carries out his part in a manner satisfactory to all concerned, it would appear that the present friction will be maintained between three parties whose broad interests should be absolutely identical.

THE JUNIOR INSTITUTION OF ENGINEERS.

Through the munificence of Mrs. Frank R. Durham, a bursary of the value of £25 per annum, to be called, after the chairman of the institution, the Durham bursary, is about to be announced to the members and associates, of whom those between the age of 20 and 22 will be eligible to compete by writing a thesis on some technical subject chosen by the candidate. The first award will be made in October, and competing theses must be in the hands of the secretary at 39, Victoria-street, Westminster, not later than Sept. 1 next.

At a recent meeting of this institution, the chairman, Mr. Frank R. Durham, A.M.I.C.E., presiding, a very interesting paper on "Automatic Fire Extinction as applied to Factories" was read by Mr. Geo. T. Bullock (vice-chairman), A.I.E.E., chief surveyor to the Union Assurance Society. The history of the subject was first lightly touched upon, and reference made to the types of sprinklers known as the Parwalee, Vulcan, the early Grinnell, Witter, Draper-Hetherington, Walworth, Titan, Galloway, Mayall, and Hudson; whilst those of the modern types, the Grinnell, Witter, Titan, Hoffman, etc., were subsequently dealt with. The essential conditions of a successful installation were fully described, and the points of buildings where special protection was needed were enumerated. Questions relating to water supplies were entered into, including town mains, elevated gravity tank, private reservoir, pressure tanks, pumps, and automatic injector apparatus. Considerations relating to the spacing of sprinklers were introduced. Areas of supply and distribution pipes, valve connections, both of the wet and dry type systems, pressure gauges, alarm gong, and other important branches of the subject were treated, and in conclusion the author gave some valuable statistics showing the effect of automatic fire-extinguishing apparatus in actual operation. The paper was excellently illustrated in the text, and a number of specimens of sprinklers were exhibited. An animated discussion ensued, in which Messrs. J. H. Pearson, C. W. Pettit, G. C. Allingham, Jas. Spiller, J. O'Brien, B. E. D. Kilburn, F. D. G. Napier, A. W. Marshall, Jas. Sheppard, A. J. Simpson, J. W. Johnston, L. T. Healy, J. W. Nisbet, R. H. Parsons, L. F. de Peyrecave, and Ridley took part; and the proceedings closed with a vote of thanks to the author.

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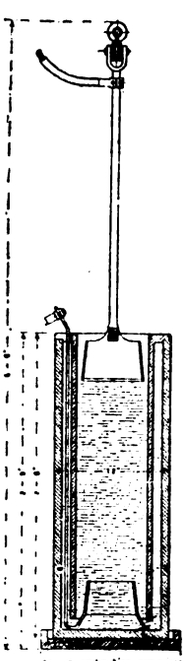
CONSTRUCTION OF RESISTANCES.

The resistance for an electrical circuit is, perhaps, one of the oldest problems presented to engineers, and it is yet one which is being from day to day the subject of modifications and improvements.

Several factors enter into the construction of commercial resistances, such as are used for motor shunts, theatre dimmers, and resistance control of power circuits generally. One of the principal is, of course, cheapness, but this should not be pushed too far, as experiments with cheap and nasty makes of resistance coils—made of, say, iron-wire spirals, suspended simply in the air and heated by the passage of current to a ripe redness—has proved in the past that a little money spent on the initial installation meets with exceeding great reward in the absence of further trouble. On the other hand, many of the laboratory resistance materials are too expensive for ordinary use. Another point should be ease of accessibility for repair, and in this connection many of the sealed-in devices consisting of oxidisable metals encased in vitreous enamel lie open to considerable objection. The question of bulk is an important one in places such as central stations, where economy of space is a consideration, and uniformity and reliability of



80 AMP. JAR.

FIG. 1.

construction with regard to insulating properties is also a most desirable point.

This article does not intend to deal with the whole subject, but to introduce one or two of the more modern forms of applications of long-standing devices, in order to show how a little care in construction can bring an otherwise crude appliance to a state of considerable perfection. We can take, for example, the liquid resistance. It is within the experience of most engineers that a temporary liquid resistance is one of the most exciting forms of apparatus to be met with on a power circuit. The writer can remember a set of tubs which were rigged up for the test of a 2,000-volt alternator suddenly becoming not only inoperative, but rather interesting, from the fact that the high-tension end developed a large leak, which put the whole arrangement to earth and created a good display of fireworks. Those also who have had experience with the extraordinary properties of common salt when deposited in a liquid resistance, can appreciate the subtleties which underlie the employment of such rheostats. An interesting form of liquid resistance, however, which appears to have reduced this makeshift device to a really scientific apparatus is the liquid resistance of Messrs. Moy and Bastie, which is illustrated herewith. In this resistance the error of putting any holes in the side or base of the container has been scrupulously avoided, with the result that, as there are no joints, there is no possibility of liquid leaking out. The lower electrode is made in the form of a truncated cone, over which, when all resistance is cut out, the upper electrode fits. By this arrangement there is no possibility of settlement, which always forms in liquid resistance, causing imperfect contact between the electrode. Both terminals are placed at the top of the jar, so that a series of pots may be placed comparatively close together. The moving electrode is provided with a flexible conductor covered with rubber insulation, and the whole arrangement can be placed on an insulating oil tray. Corrosion and electrolytic action are by this device put out of the question.

Turning now to the ordinary iron-wire resistance, great objection has been raised to the employment of iron on account of its liability to oxidisation and its high coefficient of expansion under heat. It is, however, a very cheap material to use, and, provided that the current density is not too high, there is no reason why it should not be employed. Some firms adopt the use of an alloy of iron with rarer metals, giving the wire a higher specific resistance and slightly less tendency to oxidisation. The great trouble with an iron resistance is its bulk, and this is overcome in modern forms of iron resistance by means

FIG. 2.

of winding the spirals very closely together. An arrangement for doing this by the above patentees is shown in the second illustration. A very thin metal tube provided with terminal bands at each end has a thread both on its inside and outside surfaces. The iron wire on the outside is kept from contact with the tube by thin asbestos, and no amount of heat expansion caused by the ordinary passage of current causes sufficient expansion to allow adjacent turns to touch each other. Rapid radiation of heat takes place, and each unit spiral is mounted on a pair of porcelain insulators. For alternating-current circuits the tube is split to avoid eddy currents.

Another type of modern resistance coil made by Messrs. Bray, Markham, and Reiss, Limited, consists of a thin steel tube split along its axis with its edges bending inwards. It is first of all coated with two layers of a very hard enamel, which will not soften except under white heat, and above this is placed another coat of a softer enamel which softens at a red heat. Both these enamels have, as far as possible, the same coefficient of expansion as the steel. The tube while being wound with the wire is kept slightly compressed, and, when wound, the outer pressure of the tube keeps the wire taut at all ordinary temperatures. When wound a current is passed through the wire until it obtains a bright-red heat, which just renders the outer coat of enamel plastic, the wire then sinking in and

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forming a groove for itself, thus preventing adjacent turns from coming in contact. The wire is fastened at each end of the unit to connecting lugs, and, if necessary, tapping lugs can be wound in at a required point on the tube in order to divide up the resistance to suit different conditions. The insulation of the enamel is such that 500 volts can stand between the wire and tubes, while with the method of mounting the units by means of porcelain holders the complete resistance will stand a voltage of 2,000 alternating between the wire and frame. The question of corrosion often arises where resistances are subjected to damp or steamy atmospheres, and it is in such locations that the enamel-covered resistances show to their best advantage. Satisfactory results, however, can be obtained by using nickel-iron or other alloys which have very little oxidisation at ordinary temperatures.

CARTRIDGE-TYPE FUSES.

(Contributed.)

This class of auxiliary apparatus has had in recent years an extended and important use. Every installation, whether simple or complex, is protected by some device for automatically opening the circuit under an abnormal condition dangerous to the apparatus connected therewith. The fuse is the most elementary form of device for this purpose, and in its simplest construction is a comparatively inexpensive one. The earliest type of fuse, which is still in general use, is the "link" or "strip" type, and consists of a strip of wire or other fusible metal, like lead alloy, soldered to copper terminals, these latter fitting under binding screws or wing nuts on suitable fuse blocks, an example being shown in Fig. 1.

Fuse blocks were originally made of wood, which material is now superseded by slate or porcelain. The objectionable features attending the blowing of link fuses when mounted in the open are the flashing and the spraying of molten metal, so that fire risk led to their being enclosed in cabinets. There is also danger to the lives of switchboard attendants, especially if numerous fuses are mounted on the front of a board. Obviously, should the attendant close the switch when a short-circuit or heavy overload exists on the line, he may be blinded by the flashing or burnt by the flying particles of molten metal as the fuse blows. The effect of this increases directly as the capacity and voltage of the fuse. These link-type fuses cannot be accurately rated on account of the exposure of the fusible strip. Also their current-carrying capacity may be materially changed when they are connected to very large or very small terminals, or touch any neighbouring object, say the fuse base.

To overcome the above-mentioned drawbacks to the open-link type of fuse, the enclosed or "cartridge" type was developed, which is free from flashing and the expulsion of molten metal. Also the cartridge fuse can be more accurately rated, is noiseless in its action, and is less affected by exterior conditions. A blown cartridge fuse may be withdrawn from a live circuit with safety, and a new cartridge inserted in a minimum of time. The "cartridge" fuse consists essentially of one or more fusible strips enclosed in a strong fibre tube, at the ends of which terminals are provided for connecting the strip with the fuse-block jaws. This tube—in fuses of recent construction—is lined with a thin sheet of asbestos paper to protect it from the heat and arcing occurring in its interior, and to prevent the fibre from being burnt, so that numerous refillings can be made. This is an important factor, as there is a wide difference between the charge for refilling a fuse and its first cost.

Surrounding the fuse metal, and in most cases completely filling the tube, is a material composed of some insulating substance such as sand, whitening, plaster of Paris, etc. This filling is usually powdered or granular, and serves the threefold purpose of absorbing the heat generated within the strip, of retaining the molten particles—either by uniting chemically with them or by simply extracting the heat therefrom—and of destroying the continuity of the line of molten metal, thus opening the circuit. Zinc is the most commonly used metal for the fuse strip, as it more completely volatilises at a comparatively low temperature, and its vapour is more easily

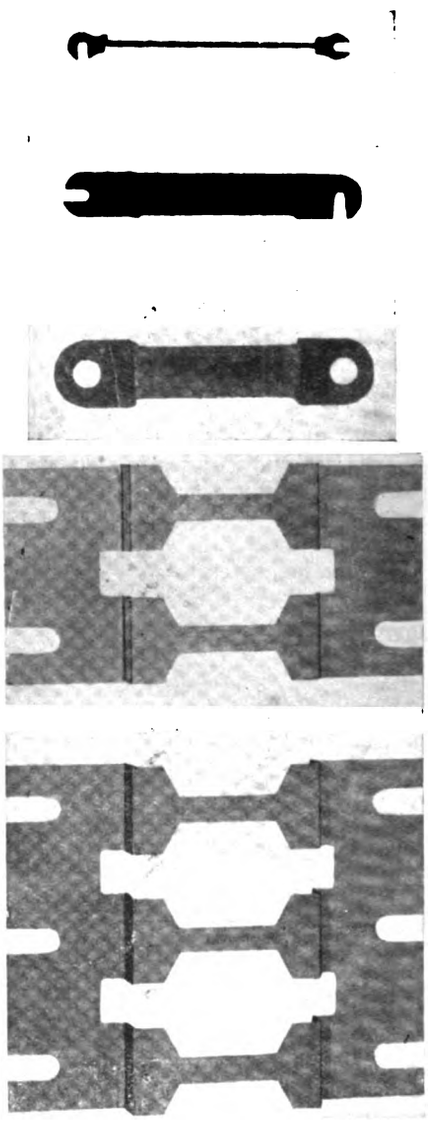

FIG. 1.—Line of Aluminium and Composition Open Link Fuses.

absorbed by the filling material. These zinc strips are usually cut away or made weaker at the centre, so as to

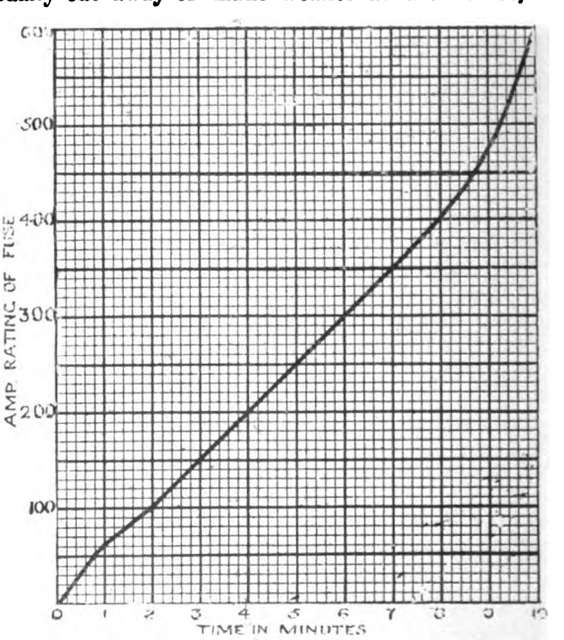

FIG. 2 - Curve showing time required for National Standard Enclosed Fuses to blow out at 50 per cent. overload. Fuses cold at start.

centralise the arc and keep it away from the terminals. The cutting away or notching of this strip is a considerable factor in the time element of the blowing of the fuse, in the

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temperature at full load, etc. The end caps of the fuse have usually drilled or sawn holes, which permit free exit of the gases generated at the time of blowing. These holes have until quite recently tended to produce a condition which has, in a number of cases, subjected this type of fuse to severe criticism of its action, as moisture has crept into the interior and been retained by the absorbent nature of the filling. This difficulty is done away with by covering the holes with a thin piece of glazed paper, which serves to exclude moisture while still retaining the ventilating features, as any gases generated in the interior easily rupture the paper.

FIG. 3.—Cartridge Fuse, 60 amps. at 250 volts.

FIG. 4.—Fuse Base and Spring Clip Contacts for Front Connection.

The general construction and arrangement of all types of cartridge fuses is very similar, but until recently no question in electrical engineering has received so little attention in this country as the one of fuses. It has been left to our

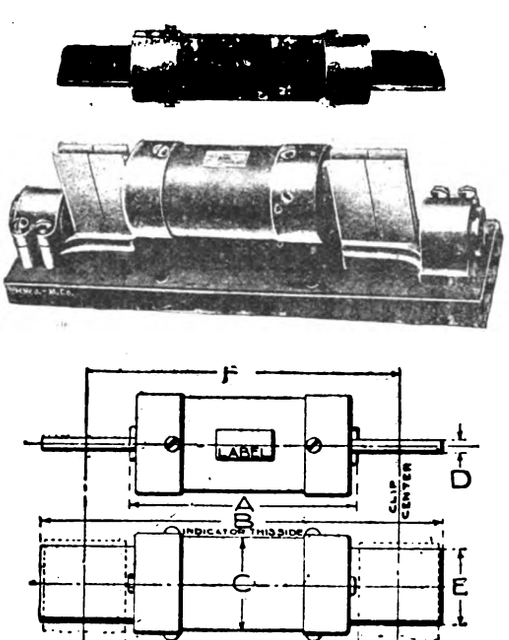

FIG. 5.—Cartridge Fuse with Knife-Jaw Contacts.

competitors abroad to perfect the cartridge type of fuse. Manufacturers of fuses in America have had to comply with the stringent conditions laid down periodically by the Electrical Committee of the National Board of Underwriters. Now, however, complete lines of cartridge fuses are being developed here by many firms, each make differing in dimensions. A committee formed in May, 1905, is at present adopting standard requirements for cartridge fuses, as it is evident that the standardisation of fuses is necessary, though one need scarcely enter here into the question of why this is so. The difficulty of obtaining renewals—as the fuses of corresponding capacities of different makes differ in dimensions — and the non-uniformity of rating has led to much confusion. Certain makers rate their fuses at about a maximum carrying capacity, while others rate them 20 per cent. lower. The cartridge fuses made in accordance with the national electric

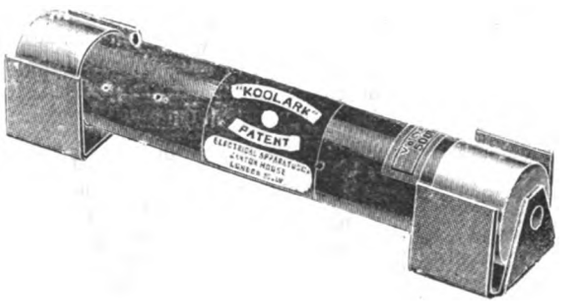

FIG. 6.—"Koolark" Enclosed Fuse.

code of America, and termed national standard fuses, are interchangeable for all fuse blocks of corresponding capacity. The standard fuses are rated to carry a 10 per cent. overload indefinitely, and to blow at 25 per cent. overload. The curve in Fig. 2 shows the time required for national

FIG. 7.—"No-ark" Fuse.

standard enclosed fuses to blow at 50 per cent. overload, the fuses being cold at the commencement of the test.

Fig. 3 illustrates a cartridge fuse having a capacity of 60 amperes at 250 volts made by the British Westinghouse Company. Fig. 4 shows its porcelain fuse base and spring-clip contacts for front connection. This company in the smaller sizes (up to 60 amperes capacity) supply cartridge fuses with phosphor-bronze spring clips fitting into spring jaws. In the larger sizes (61 to 600 amperes capacity) the circuit connection is made by means of knife-blade contacts and jaws of hard-drawn copper, which arrangement (see Fig. 5) ensures good surface contact, while preventing unnecessary heating of the fuse. Fig. 6 illustrates the "Koolark" enclosed fuse. It is claimed in this type that perfect results can be obtained only by instantaneous cooling and the immediate condensation and absorption of

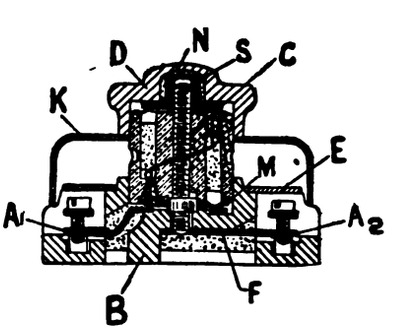

FIG. 8.—Section through a SP Fuse.

FIG. 9.—Section through SP Cartridge and Base of Fuse.

any gases generated at the blowing. The cooling is effected by inserting one or more glass vessels containing a special cooling fluid close to the strip. Under ordinary overload conditions the "Koolark" fuse breaks the circuit without the aid of this cooling fluid, but under short-circuit conditions the pressure and heat of the gases generated instantaneously break and melt the glass vessels, and the fluid contained therein permeates the filling, condensing the gases, thereby relieving the pressure and extinguishing the arc. The well-known "No-ark" fuse is illustrated in section in Fig. 7.

Messrs. Siemens Bros. manufacture a fuse which differs considerably from the ordinary, and resembles the Edison plug type of fuse used in America (see Fig. 11). Fig. 8

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shows a cross-section of their class "S.P." fuse. The fuse wire is of *silver*, and is embedded in a special sandy material, which in turn is enclosed in the porcelain body of the cartridge. A thin wire in parallel with the fuse strip is exposed in a recess in the cartridge, and indicates the condition of the fuse at any time. The vertical spindle, S, fixed to the porcelain base, B, passes through the cartridge, C, which is pressed against the metal ring, M, in the base by cap, D. The path of the current can be readily seen. Protection against the circuit being provided with too heavy a fuse is afforded by varying the number of nuts on the spindle (see Fig. 9)—three nuts being used for a 15-ampere cartridge—as the depth of the cylindrical recess in the lower part of the cartridge varies with the capacity.

FIG. 10.—External View of HP Cartridge.

Fig. 10 is a view of their class H.P. cartridge, no special cap D being required.

One of the objections to the frequent use of cartridge fuses is the difficulty in determining when a fuse is blown. Cases have been known where pumps operated at a distance have stood idle for hours through the non-action and unreliability of the "indicator." A common type of indicator is that formed by the heating of a thin resistance wire brought out for a short distance on the case beneath the label. This wire is in parallel with the fuse strip, and indicates by burning the label. The "bull's eye" indicator is more distinct, and is formed by the shunt wire passing

FIG. 11.—Edison Plug Fuse.

through a small quantity of explosive, which ejects a red disc when the fuse is blown.

ELECTRIC LOCOMOTIVE PERFORMANCE.

Calculations of train resistance and performance of electric motive equipment are made with a considerable degree of certainty. It is well understood that the design of electrical apparatus is no longer laid out on lines which admit of guesswork as to ultimate efficiency and practical results. But it is interesting to compare the calculations made in course of design with the results of tests made susbequently in actual service, disclosing at a glance the measure of agreement between theory and practice. Such a parallel study is given by Malcolm MacLaren in the *Electric Journal*, a Westinghouse publication, taken from tests made on the equipment of the New York, New Haven, and Hartford Railroad on its electric zone near New York City; and it is quoted in abstract here to show the degree of accuracy with which an electric service may be predetermined.

It is usual in preliminary calculations of train performance to simplify the work by substituting for the irregular profile of the road a uniform grade equal to the average grade between terminal points. If curves are not sufficiently severe to require slow-speed running the effect of these is also averaged, and, instead of figuring out each individual run for a train making frequent stops, the service is studied by a single typical run equal in length to the average distance between stops. Some discretion has to be used in applying this method, as it would not hold good over too wide limits, but with proper precautions it will give accurate results.

By applying this method to a study of the local service on the electrified zone of the New York, New Haven, and Hartford, it was found that the average grade between Mount Vernon and Stamford is a little less than $\frac{1}{10}$ per cent. The average distance between the stations is 1·65 miles, the individual runs varying from 0·4 of a mile to 2·62 miles. The curves do not materially affect the speed of the local trains, and they need not be considered. From a series of tests made upon trains operating in regular service, the running time from Mount Vernon to Stamford for 200-ton trains, when the time between station stops averages 45 seconds, is found to be $47\frac{1}{3}$ minutes, and from Stamford to Mount Vernon $48\frac{2}{3}$ minutes. The typical runs in the two directions were calculated, using an accelerating current equal to the average obtained in the tests, and taking a braking rate and period of coasting to correspond as closely as possible to the values obtained in service. The running times as obtained in this way were $47\frac{1}{2}$ minutes from Mount Vernon to Stamford and 49

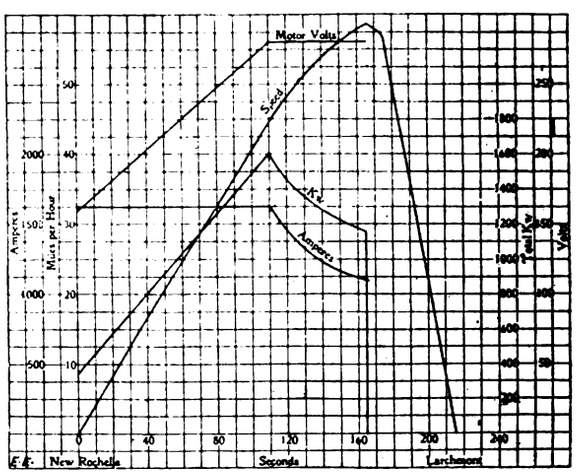

FIG. 1.—Calculated Electric Locomotive Performance, New Rochelle to Larchmont.

minutes from Stamford to Mount Vernon. The calculated and measured values for heating current and power consumption showed equally close agreement.

The theoretical studies of individual runs, as made during the preliminary calculations, also check closely with results obtained from tests on the locomotives in service. The calculated and test performance, respectively, of a locomotive when hauling a 296-ton train between New Rochelle and Larchmont, a distance of a little over two miles, are shown in the diagrams (Figs. 1 and 2). On comparing these curves it will be found that during acceleration the speed curves are practically identical up to 40 miles per hour. At the higher points the calculated speed is slightly higher than the test speed, apparently because a lower train resistance was assumed than that actually obtained. The net result of this error is to make the calculated time of the run three seconds shorter than the actual, or 216 seconds instead of 219 seconds. To facilitate the calculation it was assumed that the voltage is increased uniformly during acceleration instead of by steps, as actually occurs with unit switch control. This accounts for the difference in the character of the voltage, current, and power curves in the two cases. No appreciable error, however, is introduced by this assumption. The square root of the mean square current per motor, which determines the heating of the apparatus, was 1,210 amperes measured and 1,200 amperes calculated. The power consumption for the run, including the transformer losses, is 66·5 watt-hours per ton-mile measured and 64·2 watt-hours per ton-mile calculated.

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The power required for this run, while fairly low for such a service, is higher than that usually obtained on the New Haven system. The reason for this is that the current was held on up to the time of applying the brakes, whereas it is usual to allow considerable coasting.

The diagram Fig. 2 further shows the remarkable steadiness of the line potential. The tests show that even at the extreme end of the line, 18 miles from the power-house, the line drop does not amount to 10 per cent. at the time of heavy traffic. This run is characteristic of the performance of the locomotive when hauling these heavy trains. The starting

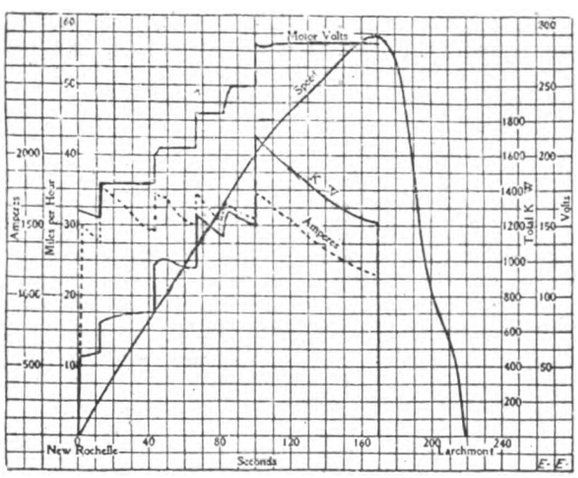

FIG. 2.—Results of Actual Test, Electric Locomotive from New Rochelle to Larchmont.

currents which are used daily are from 50 to 75 per cent. in excess of the normal full-load current, and in addition to this a motor voltage of over 25 per cent. above the normal is frequently applied. This latter possibility is of special interest, and is one of the unique features of the single-phase system. It is well known that with a direct-current motor the armature losses rapidly increase with the increase of voltage. This is not necessarily the case with the single-phase motor. Advantage of this was taken during the development of the New Haven locomotives, and the transformers and control were arranged to give two over-voltage running points. On account

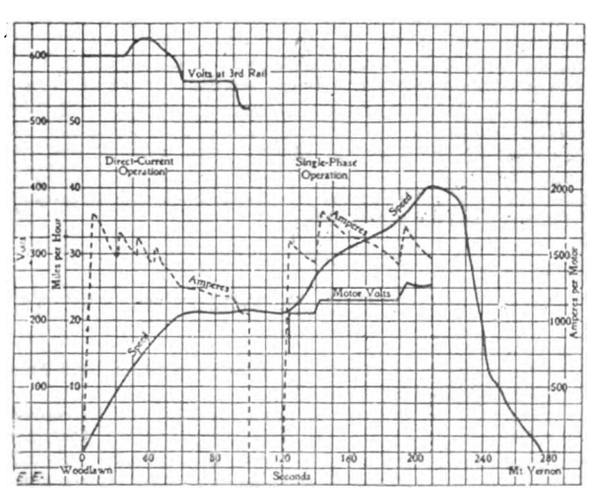

FIG. 3.—Performance of Electric Locomotive on N. Y., N. H., and H. R. R. from Woodlawn to Mt. Vernon.

of the large over-load capacity of these locomotives they are able to haul 300-ton trains on the shorter runs out from New York, whereas the maximum weight of train which the locomotives were guaranteed to haul on the local service was 200 tons. The principal function of the higher voltage points is to enable these heavier trains to be operated without loss in schedule speed and to provide a liberal margin for making up time in case of delays.

The performance of the same locomotive on the run from Woodlawn to Mount Vernon is shown in the accompanying illustration (Fig. 3), in which section the transition from direct to alternating current is made. It may be seen that the time required for passing from one system to the other is only 20 seconds. The speed of this particular train was checked by the signal at Woodlawn, so that the transition point was passed at comparatively low speed. The change from direct to alternating current, and *vice versâ*, is ordinarily made when running at 40 or 50 miles per hour.

It should not be assumed from the above that the operation of trains can be reduced to an exact science, or that the time for any run and resulting load upon the apparatus can always be predetermined within the limits indicated above. There will often be incidental delays due to various causes, such as high winds, signal stops, and variations in time of stops at station, so that in selecting an equipment for a given service this fact must be recognised and proper allowance provided for making up time in case of delays. The examples which have been given, however, show that if the conditions of operations are specified the actual performance of an electrical equipment on a given service can be predetermined with considerable accuracy, and in most cases this can be done without making very elaborate calculations.—*Railway and Engineering Review.*

THE PREVENTION OF ELECTRICAL FIRES IN COLLIERIES.

The increased use of electricity in underground working of collieries is producing a new class of preventive devices, designed more especially to overcome the risk of explosive gases. Colliery cables, for example, have to be specially armoured in order to prevent their breakage at any time by the falling in of the workings, while electrical manufacturers are now making special lines of hermetically enclosed switches and fuses, so designed that tampering with them by unauthorised persons is impossible. This is generally secured by means of encasing the switches in cast iron in such a way that the covers can only be removed by means of a special key when the switch is opened, and arrangements are made in the interlocking that the switch cannot be closed before the case of the gear is also closed, locked, and the key withdrawn. The same precautions are taken with regard to the fuses, these being hermetically sealed, and all apparatus of the switch fuse type in which contact must be made while the enclosing covering is open are carefully avoided. A very good example of the type of apparatus which is now being put upon the market in order to meet these special conditions is the combined switch fuse and ammeter encased in iron put upon the market by the Allgemeine Elektricitäts-Gesellschaft, Berlin, for colliery purposes. In this case the main switch must be opened before the key can be inserted which operates the lock on the case. The fuses are of the plug-socket type, having different sized sockets for the different strengths of fuses, so that no over-fusing can be successfully attempted. In this way no circuit can be reconnected to the supply after a breakdown until the cover has been securely placed in position and the key withdrawn, and the only conditions under which a fuse will blow are those favourable to the suppression of any flash due to the melting of the wire. This principle is carried further in dangerous mines by the exclusive use of enclosed motors where the supply is of the direct-current type, and of the adoption of the squirrel-cage induction motor type, if possible, without slip-rings and starting resistances, where the supply is laid down on the three-phase alternating current system.

The question of lighting the mine is a more difficult one. The old-fashioned Davy lamp is being to a considerable extent superseded by a system of electric lighting mains and the use of electric lamps, but this modern arrangement is not without its danger, inasmuch as an incandescent lamp is an extremely fragile thing, and should a filament get crossed there is a likelihood of an explosion in the cap, causing trouble if the gases surrounding it at the time constitute an explosive mixture. Moreover, the run of lighting leads, consisting of ordinary rubber-covered cable on porcelain insulators, is liable to damage owing

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to falls from [the roof or even from accidental contact in the passage of tubs, etc. There is, therefore, a considerable amount to be said in favour of the older practice of using hand lamps, whose flames are protected from the explosive mixture by means of fine gauze. The difficulty which was experienced in the relighting of the lamps can be, however, overcome by electrical means; formerly it was necessary whenever a lamp became extinguished to carry it to the surface, inasmuch as the Mines Regulations preclude the carrying of matches or other fire-igniting devices of such a nature down the mine, even when the mine is regarded as safe. An electric igniter, however, which can pass within the metallic gauze is suitable for lighting the miners' lamps, and by using portable electric batteries in conjunction with these the loss of time entailed in taking lamps to the surface is avoided. An electric igniter was introduced many years ago by Mr. Wm. Best, whose reformed methods in the treatment of safety lamps in mines are generally adopted throughout the kingdom. Trouble, however, has occasionally been experienced by the accidental short-circuiting of the battery terminals when the cells were being sent out of the mine for recharging purposes, and a recent patent under the name of John C. Best adds a further item to the list of safety devices for the use of electricity in mines. A device is adopted whereby both terminals of the battery are simultaneously and automatically locked up in an insulated condition at the instant that the connecting wires to the igniter are withdrawn from the battery, and this safety terminal or connection, which consists of casing of the conductor with an insulator having a rectangular slot which allows for depression of the key of the conductor to within terminal distance, contact being secured by moving the conductor, will readily apply to all similar cases where safe means of completing and breaking an electric circuit is needed, such as in the case of portable motors, safety wall plugs, and the like.

Fortunately, the use of electricity in mines does not appear from Home Office returns to have directly caused any noticeable increase of mine accidents due to explosion, and this is probably due to the large amount of care which has been expended in the proper provision of safety devices for avoiding the initial spark which can set fire to the explosive mixtures often found in mines. This, coupled with good ventilation, which is secured easily and efficiently by electrical means, is probably a factor in preserving the lives of many thousands of men engaged in this hazardous occupation.

SURGES AND OSCILLATIONS ON TRANSMISSION SYSTEMS.

In a paper recently read before the New York Electrical Society Mr. Ernest J. Berg discussed the various phenomena in the nature of surges and oscillations met with in high-tension transmission systems. He discussed the subject under the heads of instantaneous abnormal voltages and currents due to energy stored electromagnetically and electrostatically; surges caused by grounds; surges due to arcing grounds; statics caused by grounds; abnormal voltages caused by triple-frequency E.M.F. in transformers, and corona effects. The electromagnetic and the static energy stored in a circuit were compared to the mechanical energy stored in a moving body. It is no more possible to change the current or voltage of an electric system than it is to change the speed of a flywheel without supplying or consuming energy. If the current in an inductive circuit could be interrupted instantaneously, the voltage would rise to infinity, and if capacity is present there will be a corresponding current flow. On the interruption of the current the electromagnetic energy is converted into electrostatic energy, and this in turn is reconverted into electromagnetic energy, causing current flow. Where there is no resistance in the circuit the current would flow indefinitely, but since there is always resistance present the energy is dissipated in heat and the oscillations finally cease.

The phenomena associated with grounds on one of the transmission wires or with temporary emergency transformer connections were explained. When one transmission line is grounded, "static" appears at the switchboard, at the generator, and in general in the secondary network, and the instruments, transformers, motors, and generators are liable to be damaged thereby. A ground on a high-potential line usually causes considerable disturbance on telephone lines. Mr. Berg pointed out that with certain transformer connections a triple-frequency E.M.F. is induced in the transformer which, although not affecting the voltage between the lines, affects the potential stresses of the windings against ground. These E.M.F.'s, however, are not incidental to high voltages, but are of much more importance in high-voltage systems due to the usually lesser margin in insulation. Arcing grounds are always more destructive than positive grounds since they involve a train of oscillations, the circuit being made and interrupted with great frequency. The stresses caused by such grounds depend much upon the transformer connections.

Experiments have proved that with parallel conductors air insulation breakdowns and corona effects appear at a potential gradient of 100,000 volts per inch at atmospheric pressure. With rubber or varnished fabric corona takes place at higher voltages than in air. It was shown to be practically impossible to insulate a wire of small gauge for very high voltages. Corona manifests itself in a glow, and among other effects it turns small wires black, while larger ones remain bright. It is thought that the formation of nitric acid is an accompaniment of the corona.

ELECTROBUS RUN TO BRIGHTON.

Electric traction seems to be the solution of the motor-omnibus problem. The only omnibus in London which is at once unobjectionable and commercially successful is the electrobus, and on Easter Sunday its value as a road vehicle was further demonstrated by its being run from London to Brighton on one charge of the battery. This, for so large and heavy an electrical vehicle, is an unprecedented feat. The 'bus, entirely British built by the Electric Vehicle Company, of West Norwood, was delivered to the Brighton and Hove Omnibus Company, which, in common with many other provincial corporations and omnibus companies, have had their attention directed to this form of public service automobile by the character of its operation in the Metropolis, and in this fact is foreshadowed an important and possibly a wide development of electric road traction without rails. The London electrobus is operated at an inclusive cost of 9d. per car mile, and its receipts have averaged over 13d. per car mile during nine months of service. These results are mainly due to its remarkable freedom from breakdown, for in upwards of 100,000 miles of travel the Electrobus Company has not experienced one serious delay. The importance of this immunity becomes apparent when it is remembered that the cost of a day's "hold up" in London service is estimated to involve a loss of £5. 18s. 2d.

THE AMERICAN BELL TELEPHONE SYSTEM.

The annual report of the American Telephone and Telegrap Company has just been issued.

At the close of the year a valuation based on the replacement cost of the existing plant, without any allowance for franchises or for unearned increment, showed £97,659,200. Against this there were outstanding obligations of the American Telephone and Telegraph Company and its associated companies, including capital stock at par in the hands of the public, of £110,987,800. These companies also had cash on hand, quick assets, and investments of £20,214,800, so that the obligations against the plant were only £90,773,000, or £6,886,200 less than its appraised value.

The business has shown a constant gain during the year, and at the close there were 3,839,000 stations connected to the system, with a total of 8,610,592 miles of wire. The total number of exchange and toll calls for the year was about 5,997,000,000. During the year £10,584,000 was added to construction, and in the past eight years £70,367,131 has been so added. Of the stations connected 755,316 belong to other systems than the Bell. There was a total gain during the year of 768,340 stations. The number of exchanges and branch offices is 5,108, an increase of 219, with a total of 88,274 employés.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE FUTURE OF THE TELEPHONE SERVICE.

SIR,—Mr. Bennett declares for the bludgeon, and he knows which weapon best suits his style. It would not be edifying to follow him further into the field of personalities, but in thinking the "design" of apparatus and the "construction" of exchanges more important than knowledge and experience of the real problems of commercial telephony he raises a point worthy of a few words of comment.

"The bearing of an observation lies in the application thereof." An engineer who insists on designing methods and apparatus inferior to those which are standard, either ignoring that this may be sacrificing future efficiency to mere cheapness, or doing it merely for the sake of doing something different, is comparable, I think, to the man who is his own lawyer. A fair example of what such "design" Mr. Bennett prides himself on leads to is furnished by some of the municipal switchboards, which have the two plugs of a pair on different shelves; the result is to encourage operating errors through the use of two plugs of different pairs, thus effectively separating two lines instead of connecting them.

It is because Mr. Bennett claims this sort of thing—and this is only one of many unpractical things done in municipal telephone work—as an improvement over modern methods that telephone men do not take him seriously. If you compare your own description of the new exchange of the National Telephone Company at Gerrard-street (published, oddly enough, in the same issues as Mr. Bennett's elegant letters) with descriptions published a few years ago of the various municipal exchanges, you will see the wide gulf which exists between the municipal telephone work, with all its special "design," and serious telephone engineering.

Another illustration of the greater value of practical knowledge and experience compared with paper design is afforded by Glasgow. The "design" for Glasgow was first produced in 1897, and was a totally unpractical scheme, such as a person without experience in the working of large telephone systems might be expected to put on paper. At the Glasgow telephone inquiry in 1897 I pointed out the fundamental errors of the scheme. Principles and experience were scoffed at, and in 1900-1901, when the scheme was proceeded with, the call-wire system and other eccentricities were superimposed on an unseaworthy craft which started crank from the designer's yard. The result was the practical failure which is common knowledge. The capital cost per subscriber was twice what was estimated, and even then the Glasgow Corporation had to sell out to avoid further large expenditure for reconstruction. I estimate that when the reconstruction has been done by the Post Office the Glasgow system will have cost not far short of £500,000. It looks as if home-made "design" may prove a good deal more expensive in the long run than standard practice. If reasonable attention had been paid to the existing state of the telephone art when the Glasgow system was started, and if the Glasgow Corporation had known something of the requirements of telephone organisation on a large scale, the system might easily have been a great success.—Yours, etc.,

HERBERT LAWS WEBB.

TELEPHONE RATES.

SIR,—The leading articles in your paper concerning the telephone rate question and the contributions of Mr Webb and Mr. Bennett have been read and discussed with a deal of interest on this side of the water. It is a matter of history that the great development of telephony in this country dates from the introduction of what is termed "the measured-rate" system of charging for telephone service. In the whole of my experience I have never met any telephone engineer who would defend what you refer to as a "flat rate." I was, therefore, surprised to see the statement of Mr. Bennett to the effect that the various municipalities that operated telephone systems could and did make money at a low flat rate. I happen to be familiar with the telephone service that was given by the municipality of Glasgow. I can only describe it as being outrageously bad. Moreover, the system was planned on such hopelessly out-of-date lines that in a few years the amount of money that would have been needed to care for depreciation and reconstruction would have reached an alarming amount. I have a recollection of reading somewhere that the Post Office Telephone Company has already been obliged to spend a large amount of money in remodelling the plant. I do not agree with Mr. Webb that the message is the true unit of cost in the telephone business. It is evident that some subscribers will talk for three minutes, others for six minutes; also the length of the line over which the conversation is held would be six miles in some instances and three in others. This being so, clearly the true unit of cost must be the message, time, mile—corresponding somewhat to the passenger mile—which is the accepted unit of cost of a street car system. So that, in drawing up a schedule of rates to calculate the cost of giving service, not only must the number of messages per subscriber be estimated, but the distance the messages are to be carried and the length of time during which the circuit will be in use must be figured out. There is no doubt whatever that the flat-rate system of charging for telephone service narrows and restricts the development. The rates are fixed to cover the cost of giving service to the largest user, consequently they are high for the moderate user and either exorbitant or prohibitive for the small user. With a carefully-graded measured rate all subscribers would pay in proportion to the use they made of the service. To show how this method of charging will permit persons of small means enjoying telephone service, I would mention that 30 per cent. of the subscribers of the Chicago Tele-

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phone Company have telephone service at a guarantee of only 2½d. per day.

From a service standpoint all operating telephone engineers agree that it is absolutely impossible to give as good service with a flat rate as with a measured rate. When the same charge is made regardless of whether the 'phone is used little or much, very often the instrument is at the disposal of the office boy or borrowing neighbour, and the line is kept so busy with outgoing calls which are often frivolous and unnecessary that it is almost impossible to get connection with the line. This is the chief cause of that bugbear of all telephone users, "the busy signal." On the other hand, even a small charge per message dispenses with all borrowing and unnecessary calls. Moreover, seeing that under a measured service rate the revenue of the telephone company depends upon the number of completed calls, they will naturally endeavour to keep up their service to a high standard, supply increased line facilities to large users, and, in fact, do all in their power to increase the number of effective calls. With the flat rate there is no such incentive, as any increase in the calling rate means increased operating expenses and reduced profit.

This question has been discussed very thoroughly in this country. Without exception every telephone commission that has investigated this subject has reported as being absolutely in favour of a measured rate and entirely opposed to a flat rate. It seems to me that, judging from your leading articles, you approve of the principle of the measured rate, but object to the cost per message which it is sought to establish. What is a fair rate per message ought not to be a difficult matter to determine.—

Yours, etc., WALTER F. BURGISS,

Assistant Engineer, Chicago Telephone Company.

CORRECTION.

SIR,—I notice in your issue of Feb. 28, under the heading of "Business Notes," a paragraph referring to the reorganisation of the electric scheme at Cape Town. As there is no such reorganisation anticipated at Cape Town, I shall be glad if you will insert a correction in your next issue. I presume the paragraph refers to the proposed alterations to the lighting system at East London.—

Yours, etc. WALTER F. LONG,

City Electrical Engineer, Cape Town.

CENTRAL-STATION PUBLICITY.

It is interesting to follow the campaign which enterprising managers of electricity undertakings are conducting with a view to enticing customers to their businesses. Central-station managers awakened somewhat late in the day to the advantages of organised propaganda in the midst of their respective areas of supply. But those who have determined to seek for their product the same publicity that an up-to-date manufacturer or business man seeks for his wares, have found the practice decidedly beneficial. It would seem that in the relatively small towns, outside the reach of the Metropolis, but centres of industrial activity, there is a unique opportunity for carrying on a vigorous propaganda among likely consumers of current for lighting, power, and other purposes, whilst there the results of such a policy can be better gauged than in larger places, where in some cases there is a certain amount of competition between two or more electricity supply companies, and consequently there is not that clear and direct rivalry between electricity and other forms of power.

We have frequently drawn attention to the publicity methods of different stations, and on more than one occasion have drawn attention to and commented favourably upon the various methods adopted at Loughborough by the capable and energetic chief of the Corporation electricity department—Mr. Walter H. Allen. His method of propaganda, when directed to the general public, has not lacked that originality and effectiveness which the idea must have to allure lighting and heating customers. For manufacturers and power users generally another method of propaganda must be adopted. Hard facts alone will attract, and none but concrete results will convince. Mr. Allen has just issued a pamphlet which demonstrates clearly the comparative cost of running a manufacturing or other plant under precisely similar conditions when driven by a steam-engine, supplied with steam from a boiler close by; a gas-engine, supplied with the town supply of coal gas; and an electric motor, supplied with the town supply of current. A number of examples are given, all of which show what a considerable saving is effected by the electric motor.

But Mr. Allen does not rely solely upon the printed pamphlet. If that fails to bring a reply, he proposes to issue a series of three follow-up letters at different dates. The first letter accompanies the pamphlet, and calls attention to its contents. The second letter will be sent about 14 days later (if no reply has been received in the meantime) again drawing attention to the pamphlet), and offering the recipient help in the consideration of the matter. The third letter, which will be sent about six weeks after the date of the first communication, will read as follows: "We venture to once again approach you on the question that we wrote you about some six weeks ago—*i.e.*, electric driving. Doubtless you have read our pamphlet setting forth our arguments in favour of electric motors, and the comparative cost of running different kinds of plant, and in that case we are surprised we have not heard from you, because we are satisfied that having read the pamphlet, and studied the figures, you could not fail to be convinced of our ability to be of beneficial service to you. We are, therefore, inclined to think that there must be some detail upon which you are not satisfied, and we should be extremely glad if you would give us the opportunity of disposing of that difficulty. Thanking you in anticipation of an early reply."

This commendable enterprise should result in greatly extending the business of the Loughborough undertaking.

THE DEFORMATION OF THE VOLTAGE CURVE OF ALTERNATORS WHEN LOADED.*

BY HERR E. SIEDEK.

In all synchronous generators there is, theoretically, a phase difference of 90deg. between the voltage curve and the flux curve. If, therefore, the current is in phase with the voltage—*i.e.*, with non-inductive load—it will act as a demagnetising force on one half of the pole and as a magnetising force on the other half. The flux from one half of the pole is reduced, and that from the other half is increased. If the saturating effect of the increased flux at one pole-tip is neglected—as it may generally be—the flux per pole as a whole will not be altered. When the current is lagging or leading the result is different. Thus, if the current lags 90deg. behind the volts, the maximum current in the coil will occur at the same instant as the maximum flux through the coil, and the armature ampere-turns will act demagnetisingly on the field, but the action is symmetrical, and no distortion of the flux takes place. If the current leads 90deg., the effect is similar, except that the armature ampere-turns help the field ampere-turns instead of opposing them. The voltage drop of the machine is intimately connected with these actions. With non-inductive load the voltage change—neglecting the resistance effect—is a minimum. With the lagging current there is a much more considerable drop, whilst with the leading current there is a voltage rise with rising load—in fact, the machine may even be able to excite itself. As regards the effect on the shape of the voltage curve the three cases are again different. Since $E = -\frac{d\phi}{dt}$, where E is the voltage and $\frac{d\phi}{dt}$ is the rate of change of flux through the coil, the distortion of the flux due to the non-inductive current must produce a corresponding unsymmetrical distortion of the

* Abstract of an article in *Elektrotechnik und Maschinenbau*, April 5, 1908.

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voltage curve. With the lagging or leading currents no unsymmetrical distortion occurs, but only a general weakening or strengthening of the voltage—the curve being flattened in the former case and peaked out symmetrically in the latter case. In practice the circuit is never wholly inductive or wholly conductive, and in such cases the effect can best be considered by splitting up the current, and with it the ampere-turns, into a power component in phase with the volts and a wattless component lagging or leading by 90deg. The former component distorts the field, and, therefore, the voltage curve, whilst

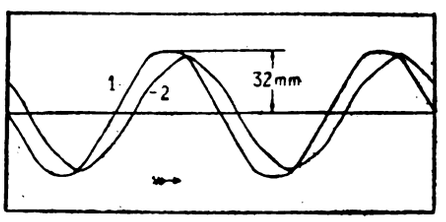

FIG. 1.

the latter only acts as a general weakening or strengthening effect. The above effects refer more especially to single-phase machines. In the case of multiphase machines certain additional peculiarities have to be considered, as is shown below.

The following experiments were carried out for the purpose of studying these effects. They were made on a small alternator having a revolving ring armature with external radial magnet poles. The armature was arranged for single, two, and three phase currents. In all cases the oscillographic records were taken from the voltage per phase. Fig. 1 shows the open-circuit voltage: (1) as

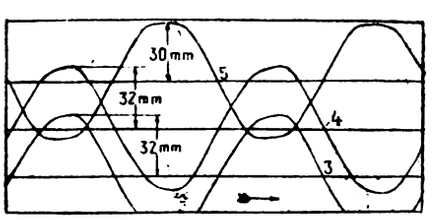

FIG. 2.

single-phase machine and (2) as three-phase machine. The greater flatness of the single-phase curve is accounted for by the fact that the polar arc forms a smaller proportion of the width of the band of winding belonging to a phase for the single-phase than for the three-phase case. The measured voltages were 56·5 for the single-phase and 49·5 for the three-phase, and these figures bear approximately the correct theoretical relation to one another. Fig. 2 shows the voltage curves when loaded as a single-phase machine: Curve (3) being for a non-inductive lamp load of 115 2 volts 50·5 amperes, Curve (4) for a similar load of 116 volts 90 amperes, and Curve (5) for an induc-

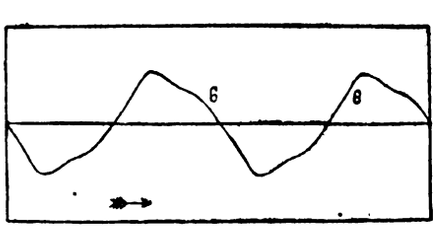

FIG. 3.

tive load of 114 volts 81 amperes, with a power factor of ·14. It will be seen that Curves (3) and (4) show the characteristic depression at one side of the maximum point and the elevation at the other side, whilst Curve (5) shows no appreciable variation from the shape of the no-load curve, but there is a general reduction in height. In Fig. 3 is shown the corresponding curve for a capacity load of 16 5 volts, 91 amperes, and power factor ·666. The low voltage in this case was necessitated by the high transformation ratio of the transformer used to change the available condensers. The high power factor is accounted for by the presence of this transformer. Consequently the curve shows the effect of both a power component and a wattless component of the current.

Turning next to the question of multiphase generators with balanced load, the effects are less marked than with single-phase machines, because the neighbouring phases partly cancel out one another's effects In Fig. 4 I., II., and III. indicates the armature windings of an ordinary three-phase alternator. The phases are taken as non-

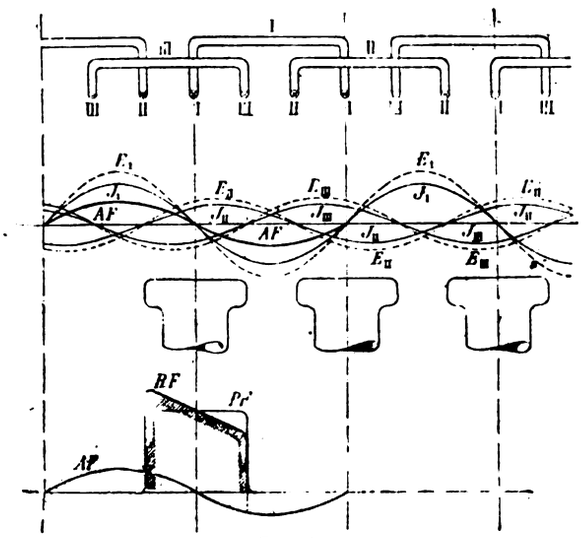

FIG. 4

inductively and equally loaded, and the instant is chosen when the current in phase I. has its maximum value, and phases II. and III. have currents of half this value. The Curves J_1, J_2, and J_3 represent either the space distribution

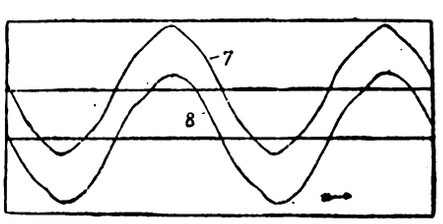

FIG. 5.

(assumed sinusoidal) of the ampere-turns of the three phases, or the space distribution of the fluxes due to these ampere-turns. These fluxes are in phase with the phase voltages E_1, E_2, and E_3 respectively. The distorting effect of iron saturation has been neglected. The thick line curve, A F, represents the resultant armature ampere-turns, and it will be seen that this is only half as great as the ampere-turns of phase I. alone (Curve J_1). The effect

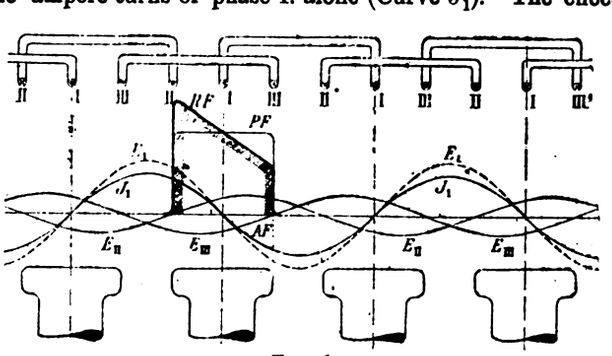

FIG. 6.

on the flux distribution of the pole is, therefore, a distorting one, as in the case of the single-phase machine, but the distortion is less in amount. With capacity or inductive loads the same holds good—viz., the effect is of the same nature as with single-phase machines, but less in amount.

If only one phase of a three-phase machine is loaded, the effect on the voltage curve of that phase is naturally exactly the same as in the case of a single-phase machine. Thus Fig. 5 show the no-load voltage per phase (7), and the distorted voltage curve produced by a non-inductive load of 114 volts 91 amperes in that one phase only (8). It is interesting to consider the effect of such an unbalanced

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load on the voltage curves of the other phases. The conditions for this case are shown in Fig. 6, where I is the (non-inductively) loaded phase and the instantaneous flux distribution over the pole is shown by the shaded line. It will be noticed that the effect of the flux distortion on the voltage of phase I. is exactly the same as for the single-phase machine, but that the elevated left-hand peak of the flux will have a much more marked distorting effect on phase II. than on phase III. This fact is confirmed by the oscillogram in Fig. 7. Curve (15) is the voltage of the loaded phase I. (113 volts 71 amperes), and

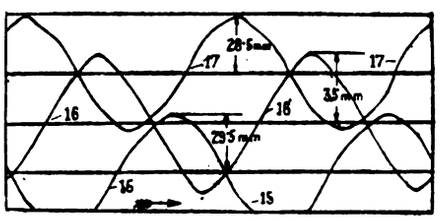

FIG. 7.

is the most deformed. Curve (16), for which the current of the loaded phase is a leading one, has a strongly elevated maximum (118 volts), whilst curve (17), for which the current in the loaded phase may be said to have a lag, is slightly depressed at the top (112 volts). The effects are, in fact, well explained by considering that the three-phase voltages have a 120deg. phase difference, so that a non-inductive load on one phase affects the voltage of that phase just as in the case of a single-phase machine, whilst towards the phase lying behind in space—*i.e.*, ahead in phase—it behaves as a strongly lagging current in this

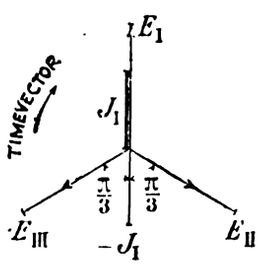

FIG. 8.

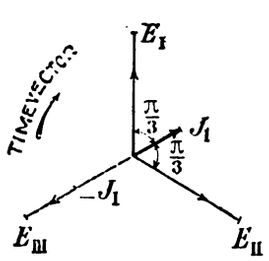

FIG. 9.

phase and towards the other phase (lying ahead in space) as a leading current in this phase. Consequently the effect is to distort the voltage of the loaded phase, but only to elevate or depress the voltage curves of the other two phases.

The effects can also be studied by means of vector diagrams. Thus Fig. 8 refers to the non-inductive loading of phase I. by current J_1, and shows that the current lags by 60deg. relatively to phase III. and leads phase II. by 60deg. Fig. 9 shows the case of a load of J_1 amperes in phase I. lagging by 60deg. behind the volts of

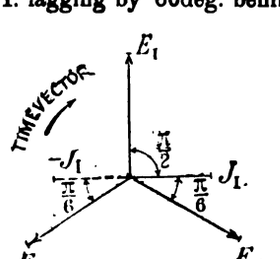

FIG. 10.

phase I. Here the current is in phase with the volts of phase III. and leads the volts of phase II. by 60deg. Fig. 10 is for a wholly inductive load, J_1, on phase I. Here the current lags 30deg. relatively to phase III. and leads phase II. by 30deg. The effects for capacity loads are similar but with reversed angles. These diagrams show that large phase differences exist between the current in the loaded phase and the voltages of the other phases, and that these angles vary with the particular nature of the load.

The theoretical deductions made above are based on the consideration of an ordinary coil-wound alternator whilst the tests were carried out on a distributed ring winding. The close agreement between the two shows that the actual arrangement of the armature winding has little to do with the result.

A SATISFACTORY FORM OF HIGH RESISTANCE.

Mr. G. W. Stewart describes a new form of high resistance for laboratory work in the *Physical Review*. The use of a transparent lacquer called "Zapon" in the shop of the laboratory of the University of North Dakota directed the writer's attention to its possible combination with carbon in the formation of a permanent high resistance. The lacquer consists of soluble cotton dissolved in certain mixed solvents, the chief ingredient of which is amyl acetate. When dry there is left a film of pyroxyline which is elastic, is not subject to ordinary changes in temperature, does not evaporate, does not crack, and is a good insulator. These characteristics are extremely important and suggested to the writer that if lampblack were mixed with this lacquer and spread with a brush upon an insulator, a permanent and yet high resistance might be obtained. Experiment has proven this to be the case. The commercial "Germantown" lampblack and the lacquer known as "Zapon L" were used in the experiments.

The resistance is obtained by spreading the mixture of lampblack and zapon upon an insulating surface. The conductivity of the films thus produced can be easily regulated by the amount of lampblack used and the thickness to which the lacquer is spread with the brush. By trial the writer secured a variation in resistance from 3,000 ohms to 3,000,000 ohms with a film approximately 3mm. long and 2mm. wide. In order to control the range in constructing high resistances, mixtures with varying proportions of lampblack can be kept on hand. In some experiments resistances as high as 40,000 megohms are desired. With a film similar to the one just mentioned, it would be possible to secure this enormous resistance by a strip 0·2mm. wide and 4m. long. Doubtless films of less conductivity can be secured readily, thus making the length required more easily obtainable. A further convenience is that the process of making the films is simple and easy of execution, requiring no special apparatus whatever. The forms in which the resistances can be made are unlimited, and can be determined by the purpose for which the resistance is intended. Thus far the writer has experimented only with hard rubber as a base for the lacquer, and the different forms in which the rubber is readily obtainable means great convenience in the construction of such resistances. It should be stated that the sample of zapon used will not cling very satisfactorily to a very smooth surface—unroughened glass, for example.

Without any special care as regards ageing the resistances are found to be fairly constant—*e.g.*, variations not exceeding 3 per cent. in five months—and, doubtless, ageing by baking would bring such films to a practical steady value at once. With careful connection between the terminals and the film the resistance was independent of variations in the applied voltage in the ratio of 10 : 1 or more. As would be expected, there is a variation in these carbon resistances with the temperature. A number of observations were made through small ranges of temperature, and the results show a variation of from 0·1 to 0·15 per cent. per degree Centigrade. Of course, this figure will depend somewhat upon the base employed for the film, and, consequently, must be determined for each arrangement. The permanence of the film of pyroxyline, the fact that it can be subjected to ordinary ranges of temperature without cracking or deteriorating, would indicate that properly constructed resistances would give satisfaction for an indefinite time. Furthermore, resistances of a few megohms might easily be enclosed in sealed tubes in order to obviate any variations due to moisture. It is believed, therefore, that this note suggests a form of high resistance which is both convenient and reasonably permanent, subjected only to very slow changes in resistance with time, and which will prove especially satisfactory where very high resistances of thousands of megohms are desired.

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THE RELATION BETWEEN IRON AND COPPER IN TRANSFORMERS.

Mr. M. Kawara in a recent article in the *Electrical World* gives an interesting set of curves indicating the variations

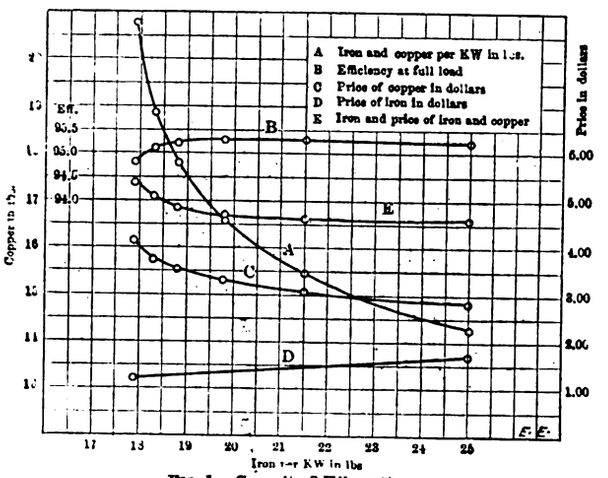
A Iron and copper per KW in lbs.
B Efficiency at full load
C Price of copper in dollars
D Price of iron in dollars
E Iron and price of iron and copper
Eff.
Copper in lbs.
Price in dollars
Iron per KW in lbs.

FIG. 1.—Capacity 2 Kilowatts.

in cost of material of small transformers of a particular type, with variations in the relation of weight of copper to weight of iron. The transformer is of the rectangular frame core type, and the cross-section of the core is square.

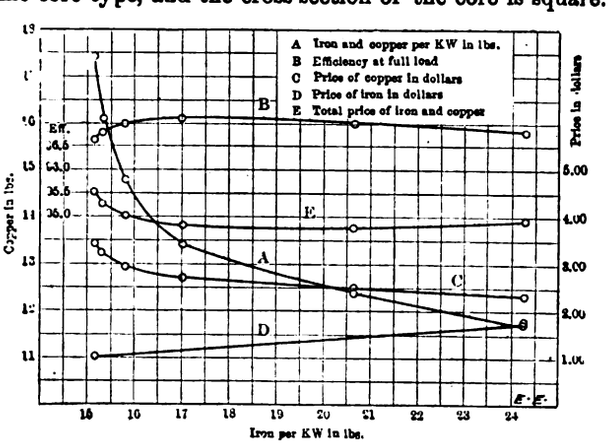
A Iron and copper per KW in lbs.
B Efficiency at full load
C Price of copper in dollars
D Price of iron in dollars
E Total price of iron and copper
Eff.
Copper in lbs.
Price in dollars
Iron per KW in lbs.

FIG. 2.—Capacity 4 Kilowatts.

Five sizes of transformer are analysed—namely, 2, 4, 8, 16, and 32 kilowatts. In each of these cases the mass of iron per kilowatt, or, to a modified scale, the total mass of iron used, is plotted as abscissa and the corresponding

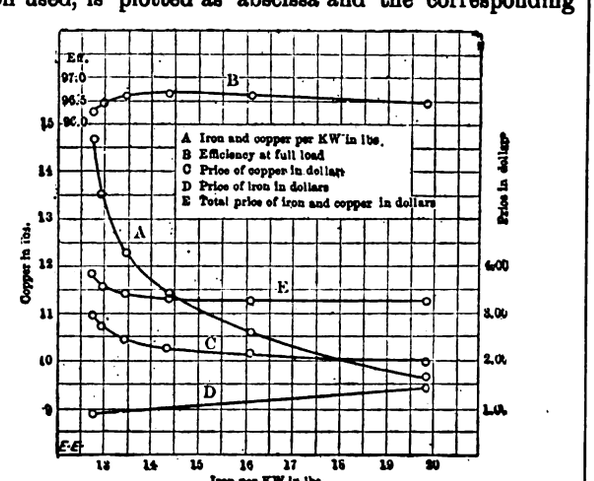
A Iron and copper per KW in lbs.
B Efficiency at full load
C Price of copper in dollars
D Price of iron in dollars
E Total price of iron and copper in dollars
Eff.
Copper in lbs.
Price in dollars
Iron per KW in lbs.

FIG. 3.—Capacity 8 Kilowatts.

mass of copper and other properties of the apparatus are plotted as ordinates.

The curves indicate that there is a rapid deduction in the weight of copper for a given size of transformer as the iron is increased, and that the total cost of iron laminations and copper taken together is nearly constant through a considerable range in the weight of iron as selected. We may increase the iron 50 per cent. and not change the total cost of iron and copper more than, say, 6 per cent. in some of the cases presented. There will be a certain relation of iron to copper for minimum cost, and also another relation for maximum efficiency. The curves from I. to VI., inclusive, have for data the amount of necessary copper per kilowatt, the price of copper, of core lamination, the total price of copper and iron, the full-load efficiency, and the lamination iron per kilowatt.

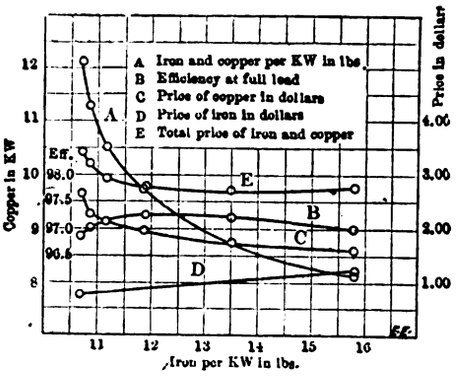
A Iron and copper per KW in lbs.
B Efficiency at full load
C Price of copper in dollars
D Price of iron in dollars
E Total price of iron and copper
Eff.
Copper in KW
Price in dollars
Iron per KW in lbs.

FIG. 4.—Capacity 15 Kilowatts.

The assumptions made in calculating the curves of Figs. 1 to 6 are as follows:

Total number of flux $N = \sqrt{\frac{80 \times \text{KW.} \times (10)''}{4 \cdot 44 \times 60}}$

Number of cycles per second	60
Flux density in core	50,000
Current density in windings	1,500 cir. mils per ampere
Copper space ÷ winding space	=0·40
Copper loss per pound of iron	1 watt
Core loss per pound of iron	1 watt
Primary voltage	2,200
Mean length per turn	$4 \times \left(c + \frac{a}{2}\right)$
Insulation between laminations	10 %
Secondary voltage	220

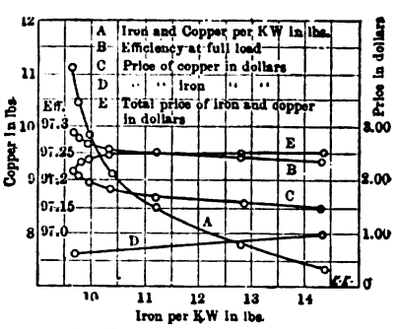
A Iron and Copper per KW in lbs.
B Efficiency at full load
C Price of copper in dollars
D " " Iron " "
E Total price of iron and copper in dollars
Eff.
Copper in lbs.
Price in dollars
Iron per KW in lbs.

FIG. 5.—Capacity 24 Kilowatts.

Where a and c have the meanings as indicated in Fig. 8: primary voltage, 2,200; secondary voltage, 220. Further, the core type of transformer with square core was assumed (Fig. 8). The shape of the winding space ($a \times b$) was

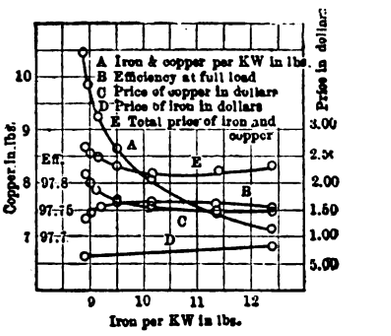
A Iron & copper per KW in lbs.
B Efficiency at full load
C Price of copper in dollars
D Price of iron in dollars
E Total price of iron and copper
Eff.
Copper in lbs.
Price in dollars
Iron per KW in lbs.

FIG. 6.—Capacity 32 Kilowatts.

varied from that of square to narrow rectangle, keeping the product $a \times b$ constant. In calculating the full-load efficiency, the copper and core losses only were taken into consideration. The price of laminations was taken at seven cents (3½d.) per pound, and that of copper at 20 cents (10d.). Therefore, smaller machines are shown in a more favourable light than in actual cases.

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The copper-iron curves are very nearly hyperbolic. As *b* (Fig. 7) is increased, the length of the core also increases, and consequently the core loss becomes larger, but, at the same time, the mean length of the windings decreases, and hence the copper loss also decreases. These facts are clearly brought out. It is to be noted that the point of the highest efficiency falls very near to the point of the lowest cost of material. This is a very fortunate coincidence for the manufacturers and users of transformers. However, the writer found that in small transformers the point of the lowest cost is far from the desirable dimensions.

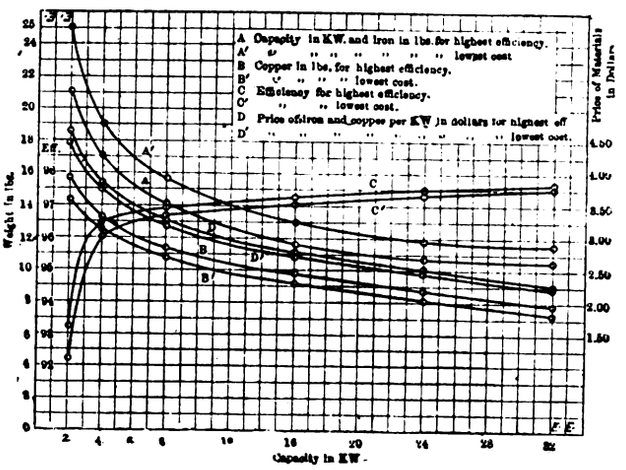

A Capacity in KW. and iron in lbs. for highest efficiency.
A' " " " " " " lowest cost
B Copper in lbs. for highest efficiency.
B' " " " lowest cost.
C Efficiency for highest efficiency.
C' " " lowest cost.
D Price of iron and copper per KW in dollars for highest eff
D' " " " " " " lowest cost.
Eff.
Weight in lbs.
Price of Materials in Dollars
Capacity in KW.

FIG. 7.—Comparison of Curves

For instance, in 2-kw. transformers *b* is about eight times *a* at that point under the assumed conditions. The highest efficiency point comes a little nearer to the practical dimensions, as *b* is four times that of *a* at that point. In larger ones, both the lowest cost point and highest efficiency point lie inside of the practical dimensions, and the points come nearer together as capacity goes up. Of course, the lowest cost point shifts as the relative prices of copper and iron change. Hence the cost curves must be revised from time to time.

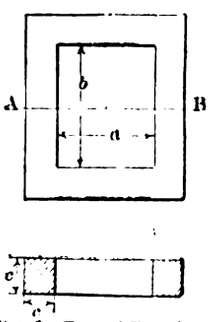


FIG. 8.—Type of Transformer.

The curves of Fig. 7 were drawn from the six preceding ones. The meanings of the curves are clear without any explanation.

FORTHCOMING EVENTS.

TUESDAY, APRIL 28.

Faraday Society.—At 8 p.m., the Library of the Institution of Electrical Engineers, 92, Victoria-street, S.W., "The Planimetrical Analysis of Alloys," by Prof. A. K. Huntington and Mr. C. H. Desch; "The Interaction of Aluminium Powder and Carbon," by Mr. F. E. Weston and Mr. H. Russell Ellis; "Technical Electrochemistry in Russia," by Prof. N. Piltschikoff.

Royal Institution.—At 3 p.m., "The Development of the Modern Steam Turbine and its Application," by Mr. Gerald Stoney.

WEDNESDAY, APRIL 29.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., at Finsbury Technical College, Leonard-street, City-road, E.C., "Radio-Telegraphy," by Messrs. Marvin and Smith.

THURSDAY, APRIL 30.

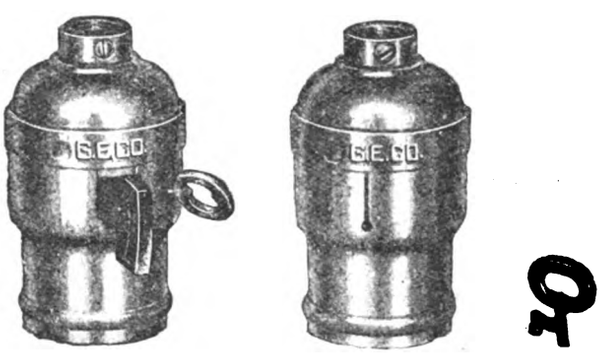
Institution of Electrical Engineers.—At 8 p.m., Kelvin lecture, "Lord Kelvin—His Life and Works," by Prof. Silvanus P. Thompson.

FRIDAY, MAY 1.

Royal Institution.—At 9 p.m., "The Scientific Work of Lord Kelvin," by Prof. J. J. Larmor.

LOCKING SOCKETS TO PREVENT THEFT OF LAMPS.

While the theft of current from electric lighting companies by dishonest meter connection, etc., has received considerable attention, comparatively little has been said of another source of trouble of a similar nature—viz., the stealing of incandescent lamps from their sockets. Central stations whose policy it is to make free renewals find that there is a continual demand for new lamps without the exchange of burned-out lamps being offered in return—factories, hotels, and public buildings are often mulcted by their employés and patrons. The majority of the lamps are probably stolen for use by the thieves, but several instances have been uncovered where a regular trade



Locking Socket with Key.

was carried on in the second-hand lamps. The advent of high-efficiency filaments, with the greatly increased value of the lamps, has given this traffic much more importance in central-station economics, and the device shown in the accompanying illustrations has been perfected to protect the companies from this loss.

In appearance, the locking socket is similar to the ordinary key or keyless socket, the only difference being a small keyhole. The screw shell in the socket, however, swivels freely until it is locked by a key inserted in the keyhole. To place a lamp in the socket or to remove one from it, it is necessary to lock the interior shell by use of the key before the lamp can be screwed in or out. As the lamp turns freely at all other times, it will not be broken by a person thinking it is merely stuck in the shell and trying to force it out. The locking mechanism is safe and simple, and with the exception of the locking feature the socket has all of the characteristics of the ordinary socket and can be installed in the same manner—either on bracket, chandelier, or as a pendant socket. It differs from other burglar-proof devices by being left unlocked, the key being used only to hold the inside shell rigid while the lamp is being inserted or taken out. The socket is made by the General Electric Company, Schenectady, N.Y.—*Western Electrician.*

MERIDIAN TIME BY WIRELESS.

In a communication presented last week to the French Academy of Science by M. Bouquet de la Grye, it was proposed to establish on the Eiffel Tower a wireless telegraph station for the purpose of communicating Greenwich or Paris time to every ship in the world equipped with wireless apparatus. By prearranged signal either noon or midnight would be indicated, and ships would thus be able to regulate their chronometers. The proposal has already been accepted by the French Government, and experiments will first be undertaken in communicating with French ships in the Atlantic and the Mediterranean. It is proposed to send the hour of midnight according to Paris time, this being preferable to noon owing to less liability to local disturbance.—*Electrical World.*

PUBLICATIONS RECEIVED.

"TELEGRAPHIC SYSTEMS AND OTHER NOTES," by Arthur Crotch. London: Charles Griffin and Co., Limited, Exeter-street, Strand, W.C. Price, 5s. net. A plain and concise description of the main systems in use in practical telegraphy, profusely illustrated.

The Post Office Electrical Engineer's Journal. Vol. I., part 1, April, 1908. London: H. Alabaster, Gatehouse, and Co., 4, Ludgate-hill, E.C. Price, 1s. A new quarterly journal, the scope of which is explained by the title. The first number contains articles contributed by members of the Institution of Post Office Electrical Engineers and by Post Office officials of the United Kingdom connected with telegraphs and telephones.

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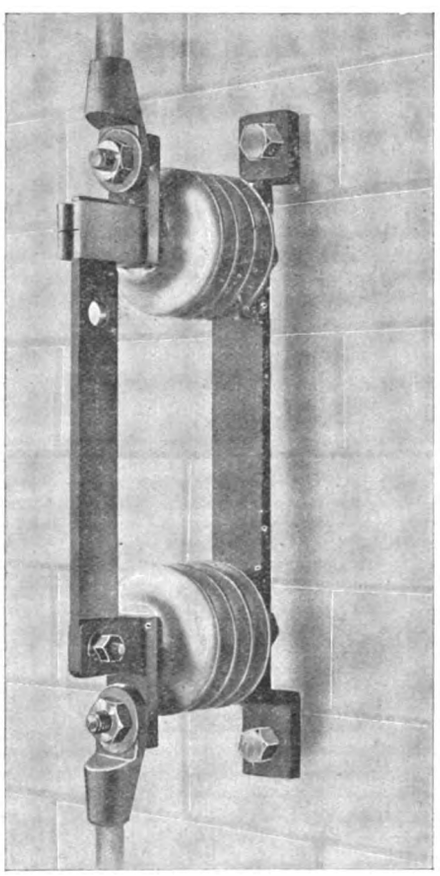
ISOLATING SWITCHES.

A useful accessory for high-tension switchboards and equipments is shown on the attached illustration. These, in common with other productions of the kind from Messrs. Reyrolle and Co., of Hebburn-on-Tyne, are well finished and of excellent workmanship. The switches can be supplied all ready fixed on a suitable iron strap, or they can be supplied without the strap in cases where customers prefer to fix the isolating switches on existing panels or boards.

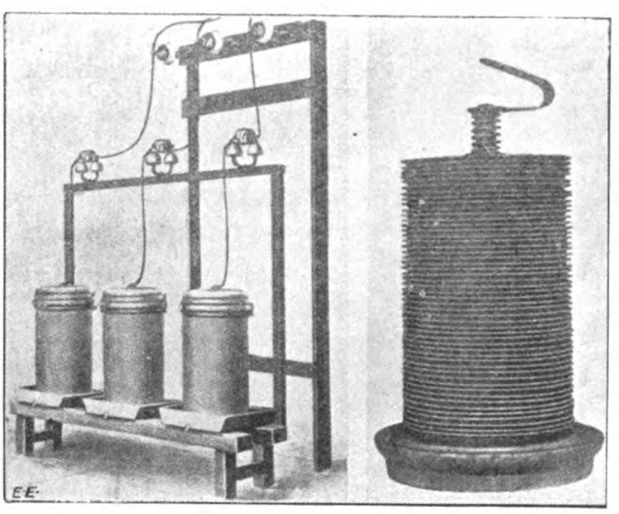


In view of the proposed Home Office regulations, which stipulate that it should be possible to isolate all parts of a switchboard for cleaning purposes, inspection, etc., the switches should be of much interest to our readers. They are, of course, intended to be fixed in places where they can be safely operated by means of a long insulated pole furnished with a suitable hook at the end. These switches are being supplied for all pressures up to 12,000 volts.

ELECTROLYTIC LIGHTNING ARRESTERS.

As the result of experiments covering a number of years, the Westinghouse Electric and Manufacturing Company has developed the electrolytic lightning arrester shown in the accompanying illustrations. It consists of a number of aluminium plates pressed into tray form so that when set one within the other, separated by small insulating washers, they may be built into a column capable of withstanding high voltages and still retain the safety-valve characteristics of a single plate. These columns are made in two sizes, one for voltages between 4,000 and 7,500, the other for voltages between 7,500 and 15,000. The columns are enclosed in substantial stoneware jars. The jars may be mounted one upon the other to form arresters for any desired voltage. A gap on the line side of the electrolytic elements, which will withstand the normal voltage of the system, breaks down with over-voltage and permits the surge to discharge through the electrolytic units.

The electrolyte is dissolved in pure water and poured into the top of the arrester unit. It thus fills the first tray and runs over into the second and so on through the column, the surplus escaping through a hole in the bottom of the containing jar through the next jar, if there be more than one, to the pan at the bottom. The electrolyte fills only the trays and not the jar, so there is no opportunity for the current to pass except from tray to tray. Each unit when placed in the pan or on another unit automatically makes contact. The electrolytic solution causes a very thin film to form on the aluminium plates. This film has an apparent resistance of very high value when moderate voltages are impressed upon it, but when the voltage reaches a certain value it breaks down in myriads of minute punctures, making almost a short-circuit.



As soon, however, as the voltage is reduced again the punctures seal up at once, and the original high resistance reasserts itself. These arresters are arranged for installation either indoors or out, as suits the convenience of the user.—*Electrical World.*

APPOINTMENTS VACANT.

Premium Pupil. Apply, Electricity Works, Canterbury. See advertisement.

Premium Pupil, Shrewsbury Corporation Electricity Works. Applications to Mr. C. M. Johnston, engineer and manager. See advertisement.

Chief Electrical Engineer, Watford Urban District Council. Commencing salary, £250, rising to £400 per annum. Particulars from the Clerk. Applications by April 25.

LEGAL INTELLIGENCE.

UNDERGROUND ELECTRIC RAILWAYS OF LONDON.

Mr. Henry Terrell, K.C., appeared before Mr. Justice Warrington in the Chancery Division on the 15th inst. and said he desired to make an application in a matter of great importance and very great urgency. He asked for the appointment of a receiver and manager in the matter of the Underground Electric Railways Co. of London in the action between Messrs. Speyer Bros., the well-known bankers, on behalf of themselves and all other persons holding secured temporary loan notes and profit-sharing secured notes of the defendant company as plaintiffs and the company and the London and Westminster Bank defendants. Counsel said the company was incorporated in 1902 with a capital of £5,000,000, all of which had been issued. In 1903 the company issued what were called profit-sharing secured notes to the amount of £7,000,000, which were secured by a trust deed. These notes would become due on June 1 next. Subsequently they issued £300,000 of an intended issue of £400,000 of securities called secured temporary loan notes. The due date of these notes was May 15, and under the circumstances they were now presently payable. The company, said counsel, had carried out the electrification of the Metropolitan District Railway, and the construction of the three most recent tube railways. The assets of the company consisted of very large holdings in the capital and in the debenture issues of these four railway companies. They also had a large holding in the London United Tramways. The secured temporary loan notes were secured by a scrip certificate. The first lot for £7,000,000 were secured by trust deed, and the trustees of that deed were the London and Westminster Bank, who desired that a receiver should be appointed in both the case of the profit-sharing secured notes and the secured temporary loan notes. It was perfectly clear that the secured temporary loan notes were now payable, and it was also clear from Messrs. Speyer's certificate that they anticipated a difficulty. The plaintiffs had large holdings in both classes of securities. The assets

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of the company consisted of a very large holding in the railways he had mentioned, and subject to mortgages they were entitled also to what was known as the power-house, which supplied all these railway companies with motive power. Proceedings by a creditor were threatened, and if these were taken the work of the power-house might be stopped, and consequently the railways would be stopped, and the result would be a very serious position. The company had a scheme, which was advertised that day with the consent of Messrs. Speyer, whereby it was intended to raise by prior lien debentures all the moneys necessary for the cash requirements of the defendant company, and also to pay off the temporary loan notes and to enable the company to carry on its business on a sound basis. But in the meantime, and pending the carrying out of the scheme, it was essential that a manager and receiver should be appointed in order that in the interests of everybody there should be no possibility of any stoppage of any part of this great undertaking. They proposed that Sir George Gibb, vice-chairman and managing director of the company, should be appointed receiver and manager.

His Lordship granted an order appointing Sir George Gibb, on behalf of the holders of the profit-sharing secured notes, as receiver of assets comprised in the trust deed, and on behalf of the secured temporary loan notes as receiver of the company generally, and as manager of the company.

COMPANIES' MEETINGS AND REPORTS.

MARCONI'S WIRELESS TELEGRAPH.

The annual report and statement of accounts of Marconi's Wireless Telegraph Co. for the period ending Sept. 30, 1907, states that the building up of the business has been attained with a capital issue of 384,190 shares, with the profits which have been allotted to capital account, and by financial engagements amounting in all to £94,263. 15s. 6d. at Sept. 30 last. Attention is called to the credit side of the balance-sheet, on which appear the important share interests in the subsidiary enterprises of the nominal value of £2.394.106. 10s., which are, together with the patents, set out in the balance-sheet at only £242,966. 9s. 10d. It is not possible at present to make a precise valuation of these assets, but some idea of their value to this Company may be gauged by the fact that our holdings represent more than 50 per cent. of the whole issued capital of these companies. These items include practically the whole of the £200,000 share capital of the Marconi International Marine Communication Co., representing the Marconi wireless exchange of messages at sea. When the Marconi patents were originally acquired in 1897, communications could only be sent a distance of two miles, but, as the result of the work on development since that date, communications can now be sent 2,500 miles. In all the Company owns over 550 patents. The British Admiralty are paying £5,000 per annum for a term of years for the right of using the system. With reference to Transatlantic communication the report states: On the basis of the improved Irish-Canadian service and of the contemplated English-American service, working the four stations at 12 hours a day at an average net wireless rate of 4d. a word, and at a speed of 20 words a minute, a net revenue (after deducting working expenses) approaching £150,000 per annum is capable of being earned by these four stations. The maritime service is progressing most satisfactorily, the North Atlantic being covered by a network of wireless communication. The number of steamers using the Marconi international organisation of ship and shore stations has again increased. The net receipts by the Marconi International Marine Communication Co. and its associated companies from this source are: 1905, £13,065. 10s. 4d.; 1906, £27,500. 16s.; 1907, £37,935. 13s. 7d. As to intercommunication, the report states that on the establishment of the above organisation the expenditure was necessarily large, and it has been productive of most promising results, but the very success of our efforts in this direction led to foreign intervention. After recounting matters in connection with the recent convention, the report goes on as follows: The directors have been carefully considering the course the Company should now adopt. They remain convinced that the working of wireless telegraphy at sea—that is to say, between moving points—can only be efficient if controlled by one central organisation, and in their opinion the rules adopted by your Company and the commercial organisation which it has established afford the best means for ensuring this efficiency and practicability. But the majority of the Governments do not share this opinion, and this being the case your directors are compelled to take the view that it would be wise for this Company's business interests to consider how it may best be found practicable to modify the policy hitherto pursued by the Board, and believe that with mutual goodwill and regard to respective interests arrangements may be arrived at not only satisfactory to the Governments concerned, but also remunerative to the Marconi Companies, who have invested so large an amount of capital in the establishment of this present wireless organisation.

The Company owns a fully-equipped factory adequate to cope with the expanding demand for instruments and installations. Over 500 wireless stations have already been equipped by the Company, and the number is constantly being added to. Considerable orders are received each year from the British Admiralty and foreign Governments for wireless telegraph apparatus and accessories. It is proposed to increase the capital of the Company to £750,000 by the issue of £250,000 preference shares of £1 each. The proceeds of the new issue will serve to pay off the Company's engagements to bankers and others. There would then remain, in the opinion of the directors, an amount sufficient to carry on and extend the business of the Company, to complete the long-distance stations, to provide these with the necessary land-line facilities, and to enable the Company to deal with the orders already received and likely to be obtained.

BRITISH ALUMINIUM.

The report of the British Aluminium Co. for 1907 states that the profit for the year transferred to appropriation account is £120,482. There has to be deducted for debenture stock and debenture interest £28,514. Expenses of issue of new capital in 1907, amounting to £7,427, have been written off, and there has been appropriated in reduction of the cost of the Company's temporary factory at Kinlochleven £10,764 (the last-named two sums, amounting together to £17,991, have been applied in accordance with the debenture stock supplemental trust deed in purchasing and cancelling debenture stock). There thus remains available £73,975, of which it is proposed to write off for depreciation £20,000, leaving £63,975. To this has to be added the balance brought forward, £34,548, making a total available of £88,523. The directors now recommend a final dividend at the rate of 7 per cent. on ordinary shares, making 7 per cent. for the year, and out of the balance then remaining available £8,986 has been utilised in purchasing and cancelling 2,196 funding certificates of £5 each at cost, leaving to be carried forward £36,502. In comparison with 1906 there has been a decline in profits, which during the preceding five years had shown continuous expansion. This may be attributed to the slump in copper last July, and to the resulting demoralisation in the metal markets generally. Not only did prices decline sharply, but there was a severe contraction in the demand for all metals for several months subsequently. There has been no recovery in the price of aluminium, so the metal has been taken into stock at a much lower price than in previous years. Customers, however, have latterly been ordering much more freely, and an improving demand may now be counted on. The temporary aluminium works at Leven only commenced producing during the last week of December, and those at Stangfjord in January last, so that the Company derived no advantage from them during the year. Progress continues to be made with the development of the permanent power scheme at Kinlochleven, but the Board are much disappointed at having to state that there is now no prospect of any power being derived from this prior to the summer of next year, when the various sections of the work should be completed to enable the production of aluminium to be started. The erection of the village of Kinlochleven has been much advanced. The development of the Orsieres power scheme is being proceeded with, and a contract has been entered into for the construction of the first portions of the hydraulic section of the works. The construction of the Martigny-Orsieres Railway, which was commenced last year, is proceeding satisfactorily. The first 8 km. are well in hand, and will shortly be ready for the rails to be laid. The next six are just being begun; and the Company, having undertaken to complete the line, will proceed with the remaining 6 km. as soon as the detailed plans have received the Government's approval. Towards meeting the large capital expenditure which these extensions entail, issues have been made of 40,000 "1908" conversion shares of £10 each, 39,070 of which have been subscribed, and of 20,000 "A" 6 per cent. preference shares of £5 each, all of which have been taken up.

DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION.

The report of the Dudley, Stourbridge, and District Electric Traction Co. for the year ended Dec. 31, 1907, states that the gross receipts for the year amounted to £46,254. After deducting all expenses chargeable to revenue, including repairs and maintenance, and placing £2,000 to renewals account, there remains £11,898. Deducting the dividend on the preference shares accrued to Dec. 31, 1907, and adding the balance of £1,050 brought forward from last account, £7,948 remains available for allocation. The directors propose to place to sinking fund £1,000, to depreciation and reserve £1,000, to pay a dividend at the rate of 5 per cent. per annum on the ordinary shares, and to carry forward £949. The amount available for distribution is apparently less than in 1906, owing to the directors having decided to charge a larger amount to renewals account before arriving at the balance rather than appropriating it after ascertaining the balance. Expenditure on capital account during the year has amounted to £532, being principally in respect of payments of balance on the new siding at Kinver and the extension of the Amblecote car-shed and sub-station. As stated in the last report, the Corporation of Dudley appealed to the House of Lords against the decision of the Court of Appeal on the special case as to the basis for the purchase of light railway No. 5. The House of Lords decided against the Company. The effect of the decision is that the Company will receive £16,028 less than had the railway been purchased under the Light Railways Act, but the rent to be paid under the lease will be correspondingly reduced. Efforts are now being made to complete the sale, and to settle the terms of the lease. It is proposed to enter into an agreement with the Birmingham and Midland Co. and the Shropshire, Worcestershire, and Staffordshire Electric Power Co. to sell to the power company the generating stations at Hart's Hill, Amblecote, and Lye. As a condition of the sale of the generating stations, arrangements will be made for obtaining a supply of power from the Shropshire company at favourable prices. Arrangements for the management of all the tramways in the Black Country by the joint committee, referred to in the last report, have continued to work satisfactorily, and the agreement with the other companies operating in the district has been continued for a further period. In order to obtain to the fullest extent the benefit accruing from the management of the Company's tramways by the joint committee, an

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agreement has been entered into with the other companies for the erection of suitable workshops and car-sheds in a central position at Tividale. The basis of the agreement is that each company shall pay a rent calculated on the number of cars owned by each company on Jan. 1, 1907. The right of user of the car-sheds is secured to each company on the same basis, and all repairs carried out are executed at cost price. The directors consider that by this arrangement the cost of heavy repairs will be considerably reduced. The Company has joined the British Electrical Federation, which has been formed by various electric traction and lighting companies for the purpose of co-operation and joint action in matters of common interest. The parcels and goods traffic service has been further developed during the year with good results. The gross receipts amounted to £607 and the expenses £511, leaving a profit of £96.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS.

The report of the Wolverhampton District Electric Tramways for 1907 states that the total revenue for the year amounted to £25,125. After deducting all expenses chargeable thereto, including debenture interest, repairs, and maintenance, and providing £1,000 for the renewals fund, there remains a profit of £2,622. Adding to this amount the sum of £544 brought forward from the previous account, there is an available balance of £3,166. The directors recommend that there be placed to depreciation and reserve fund £500, and after paying a dividend at the rate of 1½ per cent. per annum on the ordinary shares, there remains to be carried forward £269. In view of the fact that £9,086 will be received from the Dudley Corporation as the purchase price of the tramways in Dudley, hereafter to be leased to the Company, the directors have not thought it necessary to set aside any amount to sinking fund in this account. The capital outlay during the year amounted to £1,135, and was chiefly in respect of the equipment of rolling-stock with the Lorain equipment to enable the through services into Wolverhampton to be effected. In connection with the tramways in Dudley, the arbitration proceedings have now been completed and negotiations are taking place as to the terms of the lease to be granted by the Dudley Corporation. On the completion of the purchase £9,086 will be received from the Dudley Corporation as the price of this Company's lines in Dudley. The Company has joined the British Electrical Federation, which is formed by various electric traction and lighting companies for the purpose of co-operation and joint action in matters of common interest. The Company has continued to benefit during the past year from the operation of its tramways as part of the system worked by the Birmingham and Midland Tramways Joint Committee. An agreement has been entered into with the other companies of the joint committee for providing a central car-shed and repair shop at Tividale for the execution of repairs, etc., on the basis of each company paying a rent proportionate to the number of cars owned on Jan. 1, 1907. The parcels and goods traffic service has given satisfactory results during the past year, and there has been a considerable increase in the number of parcels handled.

ORIENTAL TELEPHONE AND ELECTRIC.

The report of the Oriental Telephone and Electric Co. for the year ended Dec. 31, 1907, to be presented at the meeting on the 29th inst., states that, including £1,035 brought forward from Dec. 31, 1906, and after deducting interim dividends of 3 per cent., paid Nov. 1 last on both the preference and ordinary shares, and making the necessary provision for redemption of the debenture stock and other charges as shown in the net revenue account, the amount to be dealt with is £15,839. The directors now recommend a final dividend of 5 per cent. (free of income tax) on the ordinary shares, making 8 per cent. for the year, transferring to reserve account £3,500, and carrying forward £1,873. The directors regret to have to record the death on the 24th ult. of their esteemed chairman, Sir Auckland Colvin, who occupied that position for 10 years, rendering most valuable services to the Company during that time. The changes in the Company's own systems by means of underground cabling have now been completed, but extensions to the scheme as originally laid out have become necessary. The increased business anticipated in last year's report, as a consequence of these important alterations, has made itself felt, and all the chief exchanges show an improvement for the year. At Rangoon, land had to be purchased for a new sub-exchange, which has since been constructed and is now in working order. In Mauritius the Government has under consideration a scheme whereby it is hoped that the scope of the Company's business will be extended to the whole of the island. The Indian local companies have declared the same dividends as for the year 1906—namely, the Bengal Telephone Co. 5 per cent., and the Bombay Telephone Co. 6 per cent.—and the amounts have been included in the revenue account. The Telephone Co. of Egypt has declared a dividend of 10 per cent. for the year on both its preferred and deferred shares, which has also been brought into the account. That company is engaged on further extensions as well as on work connected with adapting the freehold premises they purchased in Cairo in March, 1907, to the company's requirements. The telephone trunk lines between Cairo and Alexandria and Cairo and Tantah continue to be well patronised by the public and by that company's exchange subscribers. Installations of additional provincial telephone lines for the Government of the Khedive are still in progress, and it is anticipated that this branch of the company's business will take still further extensions. The Ministry of Public Works in Egypt granted to that company last year an authorisation for the installation of telephone lines in the province of Fayoum, in Upper Egypt, for a period of 35 years from Dec. 17, 1907. Work in connection with it is now in progress. To provide the means to carry out these contracts, the directors of the Oriental Telephone and Electric Co. have taken up a further 8,000 preferred shares of £5 each in the Telephone Co. of Egypt. The China and Japan Telephone and Electric Co., at Hong Kong and Kowloon, has also had a prosperous year subsequent to the reconstruction of its system, and proposes to declare a first dividend shortly on its ordinary shares.

BABCOCK AND WILCOX.

The report of Babcock and Wilcox for 1907 states that the net profit for the year amounted to £309 769, to which has to be added the balance brought forward—£25 895—together £335,664 The directors now recommend a dividend of 8 per cent. on the ordinary shares and bonus of 4 per cent., both free of income tax, placing to reserve fund £100,000 and to the dividend equalisation fund £25,000, leaving a balance to be carried forward of £38 664. The extensions of the works referred to in last year's report have been completed and are in working order, and have enabled the increase in the business during last year to be dealt with. The volume of orders on hand at Dec. 31, 1907, and carried over for execution in 1908 was considerable.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION.

The report of the Kidderminster and District Electric Lighting and Traction Co. for 1907 shows a total capital expenditure to Dec. 31, 1907, on account of buildings and plant for electric supply of £50,798, an increase of £5,023, which is chiefly due to the installation of the new 500-kw. generating set and auxiliary plant. The gross receipts, including the amount receivable from the Kidderminster and Stourport Electric Tramway Co. for dividend on the shares held by this Company, amount to £9,388, which, added to £687 brought forward, makes £10,075. After deducting the expenses (including debenture stock and loan interest), amounting to £5,861, there remains £4,214. The directors propose to carry to depreciation and renewals fund £750, to debenture and loan redemption reserve £500, to dividend on cumulative preference shares for the year 1907 £1,500, and a dividend at the rate of 2½ per cent. per annum on the ordinary shares, leaving to be carried forward £289. After the above appropriation has been made, the balance of the sums reserved to date out of revenue by this Company and the tramway company for the purposes shown in the accounts is £6,394. The gross receipts of the Kidderminster and Stourport Electric Tramway Co. for the year ended Dec 31, 1907, amount to £6,334, being a decrease of £18 as compared with 1906, and the expenses to £3,268, an increase of £67. The profit on the year's working is £3,066, which, added to the balance of £39 brought forward, makes a total of £3,105 at the credit of profit and loss account. This amount has been applied as follows: to reserve and renewals fund £500, to dividend at the rate of 4½ per cent. on 5,720 shares £2,574, leaving to be carried forward £31. The demand for electrical energy for lighting and power purposes continues to increase satisfactorily. The number of Board of Trade units sold in 1907 was 1,042,204, as compared with 705,841 during the preceding year, while the profit from the electrical supply business shows an increase of £794. The new 500-kw. generating set was first run on load on Nov. 24 last, and, owing to its efficiency being higher than that of the older machines, a further substantial reduction in the costs per unit generated should be obtained during the current year.

ELECTRIC TRACTION OF HONG-KONG.

The report of the Electric Traction Co. of Hong-Kong for the year ended Dec. 31, 1907, to be submitted at the meeting on the 29th inst., states that the result of the year's working, after paying debenture interest and all other charges, shows a profit of £5,950, which, added to the amount brought forward, makes a total of £6,530. Of this sum the directors have placed to the reserve for depreciation and renewals £6,000, raising that fund to £12,000; the balance of £530 it is proposed to carry forward. Steady progress has again been made during the year, the receipts having amounted to £42,705, as against £41,063 for the previous year, an increase of 4 per cent. The Board regrets, however, that owing to the very large loss sustained in respect of subsidiary coinage amounting to £4,400, representing over 16 per cent. of the total working expenses, the profit has again been adversely affected. In the latter part of last year a committee was appointed by the governor to inquire into the subsidiary coinage question, with the object of advising as to what remedial measures could be taken. The committee have presented a report, from which it appears that they are divided in their opinions as to the best solution of the difficulty. Unless some definite step is taken at an early date to mitigate the evil, the Board will have to consider the question of raising the fares charged, a step which they are unwilling to take except in self-defence. The application to the Stock Exchange for an official quotation for the debentures, referred to in the last report, has been granted.

PRIMITIVA GAS AND ELECTRIC LIGHTING.

The report of the Primitiva Gas and Electric Lighting Co. of Buenos Aires for 1907, to be presented at the meeting on the 28th inst., states that the balance of revenue account and the interest received from the German Transatlantic Electricity Co. amount to £105,348; transfer fees totalled £72, making a total at the credit of profit and loss account £105,420, to which has to be added the balance brought forward, £16,612. Interest paid on debentures absorbed £22,828; interest, discount and commission, London expenses, fees of directors and trustees, income tax, etc., £9,101; two

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dividends each of 2s. 6d. per share (free of income tax) paid respectively on July 31, 1907, and Jan. 31, 1908, on the issued preference shares and making reserve for dividend on those still to be issued required £40,000; interim dividend of 2s. 6d. per share (free of income tax), paid on Oct. 31, 1907, on the ordinary shares, £10,000; and the amount placed to general reserve account, £6,221, leaving a balance of £33,881. The directors recommend that a final dividend of 4s. 6d. per share (free of income tax), making a total distribution of 7 per cent. for the year, be declared on the ordinary shares, which will leave £15,881 to be carried forward. The directors regret to have to report the death of their esteemed colleague, Mr. Joseph Kincaid.

RIVER PLATE ELECTRICITY.

The report of the River Plate Electricity Co. for 1907, to be submitted at the meeting on the 27th inst., states that the revenue account, after providing for debenture interest and all depreciations, shows a credit balance of £17,290, which, with £5,301 brought forward, makes a total of £22,592. The directors recommend paying a dividend of 6 per cent. for the year upon the ordinary shares, and an addition to the general reserve of £4,000, carrying forward to the credit of next year £5,410. The above appropriation to reserve will raise that fund to £14,000. At La Plata the change over from the old to the new system of supply was completed early in the year, and has resulted in a substantial expansion of the Company's business, while considerable economies have been realised from the use of the new and modern machinery.

ANGLO-MALAY RUBBER.

The report of the directors of the Anglo-Malay Rubber Co. for the year 1907 states that the crop of rubber amounted to 224,778lb. dry, against an estimate of 150,000lb. dry and 100,019lb. in the previous 14 months. This is a satisfactory output, considering the fact that the number of trees tapped was only 68,236, and the average yield per tree works out at just over 3½lb. of dry rubber. Including 91 acres felled but not planted in 1906, 470 acres were planted with Para rubber during the year, and 120 acres were felled and burnt to be planted up early in 1908. This completes the programme of extensions, with the exception of a few odd acres to round off blocks, which are to be planted in 1908. The rubber yield for 1908 is estimated at 325,000lb. The cost of tapping and curing should be capable of reduction. The directors recommend a final dividend of 10 per cent. on the capital as paid up on Dec. 31, 1907, which, with the 10 per cent. interim dividend paid in October, makes 20 per cent. for the year. A sum of £3,350 is carried forward, after reserving £500 for possible commission to the staff in the East.

COLOMBO ELECTRIC TRAMWAYS AND LIGHTING.

The directors of the Colombo Electric Tramways and Lighting Co. recommend a dividend of 4 per cent. (8s. per share), free of income tax, for the past year, to place £5,111 to reserve and renewal fund, from which £13,000 has been taken to write down the track renewal account, £1,000 to extinguish the mains and plant improvement account, carrying forward £935.

NEW COMPANIES REGISTERED.

Flintshire Silver-Lead Mines and Spelter Works Co., Limited. Registered April 10 by L. A. Graham, Regent House, Regent-street, W. Capital, £50,000 in £1 shares. Objects: to search for, extract, procure, and treat minerals and transform same into lead, zinc, silver, and other products; to acquire and work silver-lead, lead, zinc, and other mines, mining rights, and lands containing metals of any kind, and to carry on the business of lead and general miners, prospectors, explorers, proprietors of smelting and spelter works, etc. Registered office: 32, Great St. Helens, E.C.

Liens Registered.

Buenos Ayres and Pacific Railway Co., Limited —An acknowledgment of indebtedness under seal, dated April 1, 1908 (supplemental to a trust deed dated May 28 and an acknowledgment of indebtedness dated Oct. 11, 1907), to secure £1,000,000 4½ per cent. consolidated debenture stock, has been registered. Property charged: the company's undertaking and assets, ranking *pari passu* with £2,000,000 4½ per cent. consolidated stock, but subject to the first and second 5 per cent. debenture stock Trustees: Earl of Coventry, 1, Balfour-place, Park-lane, W., and Lord Stanley, 36, Great Cumberland-place, W.

British Westinghouse Electric and Manufacturing Co., Limited.—A trust deed, dated March 27, 1908, to secure £300,000 6 per cent. prior lien debentures, has been registered. Property charged: specifically—the company's lands and works at Trafford Park, Manchester, with fixtures, fixed plant, and machinery thereon (subject to certain rent charges, rights, and obligations) ranking in priority to trust deeds dated Feb. 18, 1902, Aug. 31, 1903, and Aug. 2, 1904, securing £1,462,500 debenture stock; as a floating security—the company's general assets, present and future, including uncalled capital, ranking in priority to the said trust deeds. The company may not create any mortgage or charge ranking in priority to or *pari passu* with the present debentures upon its materials, supplies, apparatus in course of manufacture or on consignment, finished products, loose machinery, plant, tools, dies, equipments, patents, or goodwill. Trustees: Merchants' Trust, 63, Cornhill, E.C.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Redditch.—The District Council have decided to apply for a loan of £1,500 in connection with the electric supply undertaking.

Beckenham.—The Education Committee have decided to have the electric light installed in the Alexandra Schools at an estimated cost of £225.

Shirebrook.—The Shirebrook Colliery Co. have accepted the offer of the Council to light the model village by electricity at 35s. per lamp per annum.

Taunton.—The Corporation Electricity Committee report that the connections to the mains during the past quarter were equivalent to 620 8-c.p. lamps.

Aberystwyth.—The Council have decided to invite tenders for the lighting of the electric lamps in North-parade and Chalybeate-street with 16-c.p. lights during the whole night.

Kingussie.—The cost of the proposed electric lighting scheme is estimated at £3,000. The Town Council have agreed to leave the matter over for the consideration of the members.

Montreal Light, Heat, and Power Co.—The directors have declared a dividend of 1½ per cent. on the paid-up capital stock, being at the rate of 6 per cent. per annum for the quarter ended April 30 last.

Newport.—The Town Council have agreed to confer with the Swansea and Cardiff Corporations with a view to taking joint action to oppose the Bill promoted by the South Wales Electrical Power Distribution Co.

Paisley.—Among the applications last month for the supply of electric light was one from the Y.M.C.A. for their new institute in High-street for 754 lights of 8 c.p. each, and one from the Wesleyan Methodist Halls, Smithhills (shops and halls), for 802 lights.

Aberdare.—The District Council have resolved to proceed with the electric lighting of the town, and have instructed their clerk to engage an expert, etc., to report to the Council thereon. The Council have decided not to oppose the South Wales Electric Distribution Bill.

Ayr.—The Town Council have unanimously agreed to adopt a minute of the Lighting Committee to proceed with the extension of electric undertaking at a cost of £15,050, to apply for an extension of the lighting area, and for further borrowing powers to meet the outlay.

York.—A Local Government Board inquiry has been held into the application of the City Council for sanction to the borrowing of £25,285 for the purposes of the electricity undertaking. In order to provide time wherein to prepare certain particulars, the inspector has adjourned the inquiry until June 2.

Yarmouth.—The Council have instructed the town clerk to submit to the Finance Committee the desirability of recommending the Council to make application to the Local Government Board for sanction to the Corporation obtaining a loan of £1,000 for public lighting mains, and a loan of £1,000 for low-tension mains.

Dundee.—The question of the coal contracts for the electric station occupied the attention of the members of the Electricity Committee at their last meeting. It was arranged that the engineer should test four different qualities of coal, each for a week, and report to the committee, who will have regard to the results when the contracts come to be fixed.

Foleshill.—At the last meeting of the Board of Guardians tenders were received for lighting the isolation hospital by various methods, and the Council decided in favour of the hospital being lighted by electricity, the current to be obtained from the Newdigate Colliery. The surveyor was instructed to obtain the necessary information for the next meeting.

Wednesbury.—The Local Government Board have sanctioned the borrowing of £8,000 by the Town Council for laying down an independent electric plant. A few small items, amounting altogether to £93, have been disallowed. The Corporation expect to be ready in a few months to supply electric energy for power and light purposes throughout the borough.

Hammersmith.—The Borough Council have decided that in all streets where low-tension mains have been or shall be laid electric lamps are to be substituted for gas lamps for the purpose of public lighting, the annual charge for the same, including supply of current, lamp-posts, fittings, and maintenance, not to exceed the amount which the Council now pay for gas lamps.

Lowestoft.—There are connected to the Corporation mains 868 consumers, representing 44,213 8-c.p. lamps. During the past month 19 new consumers, representing 675 8 c.p. lamps, were connected, including five motors. The Local Government Board have sanctioned the borrowing by the Council of £940 for the purposes of free wiring, and, in view of the popularity of the wiring scheme, another loan of £1,000 is to be sought.

Johnstone.—The Strathclyde Electrical Co. directors having refused to make further concessions to the Town Council, the town clerk has been instructed to write the Board of Trade fully narrating the whole of the negotiations which had taken place between the Town Council and the Strathclyde Electrical Co., and to ask the Board of Trade to refuse the Strathclyde application unless they are willing to grant an obligation as desired by the Town Council of Johnstone.

Walsall.—The total number of consumers supplied from the Corporation electricity works on March 31 last was 536, as compared with 499 at the same date last year. During the past month the total units

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generated at the station were 185,162 as compared with 168,188 for the same period last year. The total output from the main generators was 180,578 units, as compared with 163,138 for the same period last year. The total units registered on the meters were 103,424, as compared with 92,539 units for the same period last year.

Dudley.—The Town Council are seeking the sanction of the Local Government Board to the borrowing of £4,630 for providing additional cables. The working of the electrical undertaking for the four weeks ending Feb. 22 showed the number of units generated: trams, 79,931 (corresponding period last year, 84,570); private lights, 45,003 (45,263); private motors, 34 552 (36,289); public lights 13,609 (12,841); station use, 3,396 (4,067)—making totals of 176,491 and 183,030. There were connected to the mains the equivalent of 40,570 8-c.p. lamps; total consumers, 344; motors, 111—amounting to 760 h.p.

Bournemouth.—The new electric lift, erected by the Corporation on Bournemouth East Cliff, was opened on Thursday week by Lady Meyrick, wife of Sir George Meyrick, in the presence of the Mayor and Corporation and a large assemblage of the general public. The lift, which has cost between £300 and £400, affords access to and from the eastern end of the new Undercliff Drive. After the ceremony, Sir George and Lady Meyrick and other guests were entertained at luncheon at East Cliff Hall by Mr. and Mrs. Merton Russell Cotes, and later they inspected the pictures, curios, and art treasures which Mr. and Mrs. Cotes are presenting to the town.

Alyth.—The telephone wires, poles, etc., have been erected throughout Alyth, and all that is wanted now is connection with the outside world. It is understood that the non-completion of the connection is due to a misunderstanding between the Post Office and the railway company. The Post Office authorities, it is alleged, claim the right to erect the necessary poles on railway ground by a former agreement. The railway company deny the existence of such a right, but say permission would be readily granted if asked for. So between the demanding and the asking, the public, who are waiting, are denied the privilege which the neighbourhood possesses.

Blackpool.—Mr. W. A. Ducat, Local Government Board inspector, held an inquiry on the 16th inst. at the Blackpool Town Hall into an application by the Corporation for sanction to borrow £5,000 for the purpose of extending the electricity supply mains. The Town Clerk said the extension was made necessary by the increase in the number of consumers. In 1893 there were 30 consumers, and the capital of the works was £26,000. At present there were 1,250 consumers, and the capital was nearly £200,000. Mr. Furness, the electrical engineer, said the net profit on the undertaking showed a remarkable increase. In 1903 it was £2,352; in 1904, £2,270; 1905, £5,900; 1906, £6,120; and last year, £8,229.

Institution of Electrical Engineers.—At a meeting of the Institution of Electrical Engineers (Glasgow Section), held in the rooms, 207, Bath-street, on the 14th inst., a paper, entitled "Polyphase Induction Motors: the Choice of Type," was read by Mr. George Stevenson. Prof. Baillie, Heriot-Watt College, Edinburgh, presided. The lecturer said his paper was based on experience gained in the conversion of various classes of machines from steam to electric driving, with special reference to the question of simplicity in the motor and starting gear in connection therewith. Practically the only trouble he had had with polyphase motors during five years' experience had been due to slip rings and their accessories. But one advantage of the slip-ring machine was the ease with which its speed might be regulated. In conclusion, he ventured to affirm that electrical engineers in general were too apt to attempt a solution of each and every problem by electrical means and without sufficient consideration of the case in its mechanical aspects. Lantern slides, illustrative of the application of motors to textile work, were shown.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Charing Cross, West-end, and City Electricity Supply Co.'s provisional certificates (25 per cent. paid) for £301,630 4½ per cent. debenture stock. The committee have also been asked to allow the following securities to be quoted in the official list: Charing Cross, West-End, and City Electricity Supply Co.'s £109,500 4½ per cent. debenture stock; Manx Electric Railway Co.'s further issue of 3,140 5½ per cent. cumulative preference shares of £5 each, fully paid; Mexico Tramways Co.'s 300,000dol. additional first mortgage 50-year 5 per cent. gold bonds; Sao Paulo Tramway, Light, and Power Co.'s 6,000 additional shares of 100dol. each of capital stock; and Urban Electric Supply Co.'s further issue of £75,000 4½ per cent. first mortgage debenture stock. The committee have appointed April 28 special settling day in Cornish Consolidated Tin Mines' further issue of 20,000 ordinary shares of £1 each, fully paid, Nos. 50,001 to 70,000; Langkat Sumatra Rubber Co.'s 31,000 shares of £1 each, 14s. paid, Nos. 31,501 to 62 500; Sumatra Para Rubber Plantations' 20,000 vendors' shares of £1 each, fully paid, Nos. 50,001 to 70,000; and United Motor Cab Co.'s 25,406 vendors' preferred ordinary shares of £1 each, fully paid, Nos. 180,003 to 205,413. The committee have also ordered Sumatra Para Rubber Plantations' 20,000 vendors' shares of £1 each, fully paid, Nos. 50,001 to 70,000, to be quoted in the official list.

TRACTION.

Lowestoft.—The total receipts from the Corporation trams from Oct. 1 to March 24 amounted to £3,962. 18s. 3d., as against £3,803. 4s. 9d. for the corresponding period last year.

Brighton.—The Town Council have asked the engineer to report on the resolution of the overseers of Preston Council calling attention to the necessity of providing a tramway service between the Aquarium and Preston village.

Leith.—The electric tramway receipts for last week amounted to £486. 6s. 2d., an increase of £22. 2s. 3d.

Madras Electric Tramways (1904).—The traffic receipts for the fortnight ending April 15 amounted to Rs.18,861, against a total of Rs.16,820 for the corresponding period of 1907.

Anglo-Argentine Tramway Co.—The profits of the tramways for 1907 amounted to £335,325, out of which the directors recommend a dividend of 8 per cent., carrying forward £16,734.

Buenos Ayres and Belgrano Electric Tramways Co.—The receipts for the week ending April 15 were £3,941, against a total of £3,938 for the corresponding period of last year.

Yarmouth.—The takings on the Yarmouth and Gorleston systems for the year were £20,480, a decrease of £975. On the Caister section, which has not been in operation quite a year, the receipts were £3,474.

Coulsdon.—The Warlingham Parish Council have asked the Coulsdon Council to join in an application to the S.E.R. to persuade the latter to run a series of rail cars between Purley and Caterham with suitable halting places between the present stations, also between Purley and Chipstead.

Rochester.—Major J. W. Pringle, R.E., inspector from the Board of Trade, inspected the new tramway lines through the High streets of Rochester and Strood, to Strood-hill and Frindsbury-hill, on the 16th inst. He was accompanied by the mayor, the chairman, and several members of the Corporation Tramways Committee, as well as officials of the Chatham and District Light Railways Co., who are leasing the lines.

New Light Railway.—The final portion of the Waltham Cross and Enfield light railway, which has been constructed by the Middlesex and Herts County Councils, was opened on the 17th inst., cars running from the Eleanor Cross at the former town to Finsbury Park, and being largely patronised. The system has been leased to the Metropolitan Electric Tramways, Limited, with whose lines it is connected at Lower Edmonton.

Newport.—The reports of the borough engineer and tramways manager upon the question of depreciation of the tramways permanent way, rolling-stock, etc., have been considered by the Corporation Electricity Committee, and on their recommendation the Council have resolved that before any surplus on tramways revenue account is applied to relief of rates a sum averaging £3,000 per annum is to be paid into the tramways reserve fund.

Rio de Janeiro Tramway, Light, and Power Co.—The company have concluded arrangements with some leading banking houses in Paris and Brussels for placing £1,750,000 (one-half) of the issue of new 5 per cent. debentures, £400,000 of these debentures having been paid in full. A public issue of £900,000 will be made simultaneously in Paris and Brussels on May 12, and the balance, £850,000, of the above amount reserved for Paris and Brussels, will be offered in the autumn.

Holland.—A concession has been granted by the Dutch Government to the Amsterdam and North Holland Electric Tramway Co. to construct and operate a system of electric railways in Holland. The system comprises about 50 km. of route running from Amsterdam North through Zaandam to Krommenie, from Zaandyk to Wyk-aan-Zee, and Wormerveer to Purmerend. The Amsterdam and North Holland Electric Tramway Co. have entered into a contract with the Holland Development Co., 278 Herengracht, Amsterdam, to construct the entire system.

Halesowen.—Messrs. Lees, Butterworth, and McDonnell, the parliamentary agents acting on behalf of Mr. E. H. Grove, the clerk to the Halesowen District Council, on Saturday issued notices that the Board of Trade have made and issued a provisional order under the provisions of the Electric Lighting Acts, 1882 to 1890, with a view to the same being included in a confirming Bill about to be introduced into Parliament to Mr. George Balfour, electrical engineer, of London, authorising him to supply electrical energy for all public and private purposes within the rural district of Halesowen. It is now anticipated that during the present summer the work of providing electric tramways will be commenced.

West Bromwich.—Mr. James Clark resumed the inquiry on the 15th inst. at the Law Courts, West Bromwich, concerning the death of James Latham, who died in the hospital on March 8 from the effects of injuries received on Feb. 20 in the tram smash near Tividale. Evidence was given by Rowland Brown, engineer to the company, to the effect that in his opinion the wheel of the car collapsed before it left the line, and the manager of the tramways company, Mr. Cramp, said they had been unable to discover the cause of the collapsing of the wheel. The Coroner said he had received a private letter from Colonel Yorke, Board of Trade inspector, and his opinion as to the cause of the overturning of the tram was not in conflict with the evidence given that day. The jury returned a verdict of "Accidental death." They considered no one was to blame, but added that the wheels and the cars generally should be properly tested and examined much more often.

Manchester.—The Tramways Committee of the Manchester Corporation have had under consideration their estimate of expenses and receipts for the current year. The record for the year just ended is considered highly satisfactory. The committee anticipate an income of no less than £813,662, as compared with £769,188 (approximate) received this year, and they expect to be able to hand over £60,000 to the city fund in relief of rates. This is £5,000 more than was handed over last year, and is in addition to £4,100 for interest and sinking fund charges in connection with the widening of the streets around the Royal Infirmary secured by the purchase of the infirmary site. Last year the committee estimated for no profits from the parcels department, but the department has actually produced an

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income of £1,240, and the committee expect to receive £1,500 from the working of the department next year. Capital expenditure for next year on new cars, sheds, etc., is estimated at £78,000, as against £44,453 spent last year.

Underground Electric Railways Co. of London.—The scheme of readjustment of the Underground Electric Railways Co. of London is now published. It is prefaced by a recommendation of the Advisory Committees of London and Amsterdam. The traffic which can be secured by the carrying companies affords, it is claimed, ample scope for remunerative enterprise. If, therefore, competition is kept within fair and prudent limits, as there is every reason to hope that it will be, it is inconceivable that the situation of the carrying companies will not gradually improve. The main features of this scheme may be summarised as follows: the company will deposit and pledge an additional £3,500,000 (nominal) tube shares and the equity of the power-house with the London and Westminster Bank, the trustee for the noteholders, and issue as detailed below: £1,000,000 prior lien 5 per cent. bonds, due Nov. 1, 1920, for cash requirements; £3,000,000 4½ per cent. bonds, due Jan. 1, 1933; £5,200,000 6 per cent. income bonds, due Jan. 1, 1948. The noteholders are asked to exchange their notes as to 40 per cent. nominal value into 4½ per cent. bonds, and as to 70 per cent. nominal value into income bonds at par, the exchange taking place as and on Dec. 1, 1907.

Wemyss.—The directors of the Wemyss and District Tramway Co. have issued their second annual report. In their first report the directors had barely five months' working to speak on, there was the element of novelty in the service to swell the receipts, but the utility of the system may be fairly judged from the results of the past year. The monthly average of £1,022 is increased to £1,092, and the receipts for the year are £13,111. To the Wemyss Coal Co. for power £1,726 was paid, the operating expenses ran to £3,006, the repairs and maintenance to £1,029, interest on mortgage debenture stock £1,252, and the sum of £1,500 was carried to form a depreciation reserve fund. The parcels department showed a net profit of £33. Advertising on cars yielded £153, and a total net profit of £1,866 is shown. Four new cars and two baggage vans have been provided, a large extension made to the car-shed, and a signalling system installed. With the operations going on in connection with the new dock at Methil and the general briskness of trade in the district the directors anticipate an increase in the receipts for the current year. Some time ago the company came to an arrangement with the Kirkcaldy Corporation for mutual running on both systems, and so far this has proved a mutual benefit. To the Kirkcaldy Corporation it means the conversion of a losing concern into a flourishing department, and the Wemyss Co. also derives profit out of it. In 1907 the passengers carried totalled close on 1,705,000, but during the last three months there is a gain of 63,000 passengers on the corresponding period.

Worcester.—At the annual meeting of the Worcester Electric Traction Co. the report of the directors was submitted, showing that the capital expenditure to Dec. 31 last was £115,969, of which £122 was expended during 1907. The total revenue for the year amounted to £15,100. After deducting expenses chargeable to revenue, including repairs, maintenance, and debenture stock interest, and adding balance available from last account, £548, there remained £4,631 for allocation. Of this £1,000 was placed to depreciation and reserve fund, £3,150 applied to payment of 4½ per cent. dividend on the 14,000 ordinary shares, and £481 carried forward to next account. The directors reported an arrangement with the Worcester City Council, by which the Council undertakes to maintain the whole of the permanent way for the sum of £450 per annum during a period of seven years from Jan. 1, 1907. Mr. W. L. Madgen, M.I.E.E., who is chairman of the Kidderminster electric light undertaking and a managing director of the British Electric Traction Co., has joined the Board since last year, and Mr. H. R. Arnold retires. The other directors are Messrs. H. S. Day (chairman), W. G. Bond, and J. A. Lycett. The accounts for the year showed that the cars and 'buses belonging to the Company carried 2,987,453 passengers, or 60,139 less than in 1906; average traffic receipts per passenger 1·15d., an increase of ·03d.; average expenditure per passenger 0·84d., an increase of ·06d.; proportion of expenses to receipts 73 per cent., an increase of 3 per cent. The profits for the year were £4,083, or £321 less than in 1906; the total receipts being £15,100, or £81 less. Reduction in receipts, it should be stated, is a common feature of the balance-sheets of tramways and cognate undertakings, owing to the persistent wet weather during months when traffic is usually heavy. The power and running expenses exceeded those of 1906 by £39, and the expenditure for repairs and maintenance increased by £179. The administration and general expenses, £1,298, included £317 for rates and taxes.

PERSONAL.

Mr. Gillingham, who has acted as chief inspector of the Hammersmith and City Railway for the past 49 years, has been presented with a gold-mounted umbrella by the guards and conductors working the electric trains over the service on his retirement.

Sir Charles Petrie, chairman of the Liverpool Tramways Committee, has been presented by the tramway employés with a painting depicting a night tramway scene at the pierhead as a token of the esteem in which he is held.

The Swindon Corporation have increased the salary of Mr. A. Dimmack, the electrical engineer, from £200 to £250 per annum.

Messrs. William McGeoch and Co., of 28, West Campbell street, Glasgow, Birmingham, and London, advise us that they now represent the Credenda Conduits Co., of Birmingham, for their C.C.C. conduit fittings and accessories for Scotland. Messrs. McGeoch hold large stocks, and are in a position to give immediate delivery of orders entrusted to them.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Brussels.—Tenders are invited for the equipment of an electricity station at Alsemberg. Tenders by April 28.

Glasgow.—Tenders are invited for cast-iron joint-boxes for the electricity department. Tenders by April 27.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Hungary.—The Municipality invite tenders for lighting Nagykoras by electricity. A deposit of £800 is required. Tenders by May 1.

Queensland.—The Postmaster-General invites tenders for battery glassware, etc., battery material and chemicals. Tenders by June 1.

Madrid.—Tenders are invited by the Public Works Department for the construction of electric tramways in Bilbao. Tenders by April 30.

Buenos Ayres.—Tenders are invited for the construction and working of two sections of the underground electric railway. Tenders by May 1.

Madrid.—The Post and Telegraph Department invite tenders for 35,000 long and 25,000 short telegraph insulator brackets. Tenders by April 27.

South Australia.—The Postmaster-General invites tenders for telephone material, telephone instruments, and telephone switchboards. Tenders by June 3.

Grimsby.—The Corporation invite tenders for arc lamp lowering gear (Specification No. 63). Particulars from the Borough Electrical Engineer. Tenders by April 24.

Poplar.—The Electricity Committee invite tenders for the supply of switchboards and gear. Particulars from the Borough Eelectrical Engineer. Tenders by April 29.

Hackney.—The London County Council invite tenders for electrically wiring and fitting the tramways car-shed at Mare-street, Hackney, N.E. Tenders by May 12.

Eccles.—The Corporation invite tenders for one Lancashire boiler and superheater and a 210-kw. steam-engine, alternator, and exciter. Tenders to the Town Clerk by April 27.

Hobart.—Tenders are invited by the Postmaster-General for 200 wall telephones, 800 telephone recorders, and extension of common-battery switchboard. Tenders by May 11.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Tasmania.—The Postmaster-General invites tenders for material for extension of common battery and switchboard, 200 wall telephones, and 800 telephone recorders and cords. Tenders by May 11.

Wigan.—The Corporation invite tenders for the supply and installation of a heating apparatus at the Pemberton car-sheds. Particulars from the Electrical Engineer. Tenders to the Town Clerk by April 27.

Sydney.—The Postmaster-General invites tenders for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators (best white porcelain, large). Tenders by May 20.

Poplar.—The Electricity Committee invite tenders for the erection of a sub-station building at Millwall. Particulars from the Borough Electrical Engineer, Glaucus-street, Bromley-by-Bow. Tenders to the Town Clerk by April 29.

New South Wales.—Tenders are invited by the Postmaster-General for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators, best white porcelain, large. Tenders by May 20.

New South Wales.—Tenders are invited by the Postmaster-General for eight tons wire, hard-drawn copper (400lb. per mile), 1½cwt. tape binding, copper (200lb. per mile), 1,300 insulators, best white porcelain, large. Tenders by June 10.

Govan.—Tenders are invited for the annual supply of stores to the electricity department, including cables, electricity meters, house service fuse boxes, arc lamp carbons, motors, etc. Particulars from the Burgh Electrical Engineer. Tenders by April 27.

London, S.W.—The London County Council invite tenders for 175 double-deck car bodies, swing bolster trucks, and complete electrical equipments for overhead trolley, surface-contact, and underground conduit systems of electric traction. Tenders by May 9.

Haslingden.—The Corporation invite tenders for overhead lines in connection with the electric tramways. Specifications, etc., can be inspected at the office of Messrs. Handcock and Dykes, 1, Victoria-street, Westminster, S.W. Tenders to the Town Clerk by April 25.

Gillingham (Kent).—The Borough Council invite tenders for the supply and delivery of coal to the electricity generating station, Particulars from the Borough Electrical Engineer, Generating Station, Gillingham-road. Tenders to Mr. Boucher, town clerk, by April 27.

Sydney.—The Government Railway Department invite tenders for the supply and installation of about 4½ miles of three-core, high-tension, paper-insulated, lead-covered feeder cable. Particulars from the Electrical Engineer, 51, Phillips-street, Sydney. Tenders by May 4.

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Victoria.—Tenders are invited for the following for the Postmaster-General's Department: 2,800 jacks, in strips of 20; 1 mile 64-wire switchboard cable; 50 3-conductor cords, 7ft. long, for "B" boards; 96 3-part plugs, and 66 listening and ringing keys. Tenders by June 9.

Dundee.—The Electricity Committee invite tenders for the supply and erection of water pumping plant and overhead travelling cranes, etc., in connection with the new Carolina Port main generating station. Particulars from Mr. H. Richardson, engineer in-charge. Tenders by April 27.

West Bromwich.—The Town Council invite tenders for the installation of a modern refuse-destroying plant at their electricity works, Black Lake, West Bromwich. Particulars from Mr. Albert D. Greatorex, borough engineer and surveyor, Town Hall, West Bromwich. Tenders by May 9.

Glasgow.—The Corporation invite tenders for the supply of (1) main cables; (2) small cables and wires; (3) electricity meters; and (4) arc lamp carbons, for a period of 12 months from May 31. Particulars from the Electrical Engineer. Tenders to the Town Clerk by April 27. See advertisement in last issue.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors, 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

London, E.—The Poplar Electricity Committee invite tenders for supply and erection of various switchboards and gear at their electricity works and sub-stations. Particulars from the Borough Electrical Engineer, Glaucus-street, Bromley-by-Bow. Tenders to Mr. Leonard Potts, town clerk, Council Offices, High-street, Poplar, E., by April 29.

Rawtenstall.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, overhead line equipment, and accessories. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Sillar, and Leigh, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders to the Town Clerk by April 24.

Adelaide.—The Postmaster-General of South Australia invites tenders for 1,000 tons of steel rails, 80lb. per lineal yard; 1,000 tons steel rails, 60lb. per lineal yard; 2,300 tons steel rails, 50lb. per lineal yard; 68 tons steel fishplates for 80lb. rails; 67 tons steel fishplates for 60lb. rails; 159 tons steel fishplates for 50lb. rails. Tenders by May 19.

Rawtenstall.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, overhead line equipment, and accessories. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Sillar, and Leigh, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by May 4. See advertisement in last issue.

Clacton.—The Urban District Council invite tenders for the supply of two 25-kw. 500-volt dynamos. Two existing 100-volt Taunton machines, which can be viewed on application to the Engineer, Electricity Works, Clacton-on-Sea, to be taken in part payment. Also for additions to the switchboard. Tenders to Mr. G. T. Lewis, clerk to the Council, by April 29. See advertisement in last issue.

Rio de Janeiro.—Tenders are invited for the supply of new lighting apparatus and accessories for the lighthouse on Raza Island. Tenders will be opened on June 2 in the Ministry of Marine (Secçao de Pharóes) at Rio de Janeiro. No deposit is required. Further particulars may be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Antwerp.—The Consul-General at Antwerp announces that a copy of a specification has been issued by the Municipal Authorities of that city in connection with a call for tenders for supply and fixture of two electric lifts in premises belonging to the Municipality in the Place de Meir, Antwerp. Tenders to M. le Bourgmestre de la Ville at the Hotel de Ville, Antwerp. Deposit, 1,000fr. (about £40). Tenders by April 30.

RESULTS OF TENDERS.

Yarmouth.—The Town Council have accepted the tender of Cory and Son for 600 tons of Pleasley hard coal at 15s. 3d. for the electricity works.

Nelson.—The tender of Carter and Co., Nelson, has been accepted for electrically fitting the new Council school in Badshaw-street, Nelson.

Bradford.—The Corporation have accepted the tender of Bolckow, Vaughan, and Co., Middlesbrough, for the supply of 1,000 tons of steel girder rails.

Portsmouth.—The tender of S. Cooper, of Bournemouth, has been accepted for electric lighting of the New South Parade Pier for the sum of £1,060.

Birmingham.—The Corporation have accepted the tender of E. J. Jennings, West Walls, Westgate, Newcastle-on-Tyne, for the purchase of the whole of the generating sets, direct-current transformers, balancers, etc., which until recently formed their generating plant at the Dale End Station.

Tasmania.—The following tenders have been accepted for the Postmaster-General's Department: British Insulated and Helsby Cables, Melbourne, one mile cable, paper-insulated, lead-covered, £507. 10s. 9d.; Mauri Bros. and Thomson, Sydney, 200 tons 3in. cast-iron pipes, £9. 19s. 4d. per ton.

Western Australia.—The Postmaster-General has accepted the following tenders: Splatt, Wall, and Co., Perth, 80 accumulators, £75; O. Haes, Sydney, one voltmeter, £2. 19s., and two ammeters, £5s. 5s.; Siemens Bros., Sydney, two knife switches, £1. 10s.; A. Bray, Subiaco, 20 telephone cabinets, £13. 5s. each; British Insulated and Helsby Cables, Melbourne, telephone cable.

Derby.—Messrs. G. Robson and Co., Eclipse Engineering Works, Sheffield, have received an order from the Corporation for one of their "Eclipse" patent portable electric track grinders.

Leek.—The Urban District Council have received the following tenders for engine, dynamo, and other foundations and extensions to their generating station buildings in Station-street, Leek:

S. Salt, Leek	£1,797 4 3
T. Grace, Leek (recommended for acceptance)	1,597 15 9

Whitchurch.—The following tenders have been received for the wiring, etc., of the Ty-Clydd Mental Hospital, Whitchurch, for the Visiting Committee:

Price, Friend, and Co., St. John's-square, Cardiff (accepted)	£31 15 0
A. G. Arnold and Son, Newport	27 12 0
T. C. Moore, Griffiths, and Co.	39 15 0
W. A. Baker and Co.	34 15 0

Victoria.—The following tenders have been accepted for supplies to the Postmaster-General's Department: Lawrence and Hanson, Sydney, 500 bells, magneto extension, 8s. 10d. each, 300 switches, extension, for two metallic circuits, £1. 1s. 11d. each; British Insulated and Helsby Cables, Melbourne, 1,000 cords, 2-conductor, for metallic circuits, 10½d. each; India Rubber, Gutta Percha, and Telegraph Works Co., Melbourne, 6,000 yards cords, single conductor, 13s. 6d. per 100 yards, 2,000 fuses, 3d. each, 2,000 fuses for Commonwealth telephones, 3½d. each, 2,000 lead strips and attachments for Meidinger main battery, 2½d. each; J. Bartram and Son, King-street, Melbourne, 200 conversers for wall telephones, with cord, plug, and jack complete, £1. 1s. 1½d. each, 1,000 ear-pieces for receivers, 1s. 0½d. each, 4,000 fuses and holders, 5d. each; R. B. Hungerford, Sydney, 1,000 indicators, A type, 100 ohms resistance, 2s. 7d. each, 500 jacks, metallic circuit, 1s. 1d. each; J. A. Newton and Co. Proprietary, Melbourne, 2,000 insulators, 50 section switches, with three plugs for each, 1,500 incandescent glow lamps, 16 c.p., 110 volts.

OPENINGS FOR CONTRACTORS.

ABERDARE—Workmen's dwellings (£10,000), Town Council.

ABERHAFESP—Elementary school, Montgomeryshire Education Committee.

ACCRINGTON—Electric cable (£7,500), Town Council.

ASHBOURN—Four houses, Mayfield-road, Mr. A. Key.

ASHBURTON—Two villas, Lurgecombe Cross, Mr. A. Warren.

ASH VALE—Elementary school, Surrey Education Committee.

ASTON—Infirmary, Slade-road, Board of Guardians.

ATHERSTONE—Gymnasium, grammar school (£300), County Education Committee.

AYR—Enlargement of Newtownhead School (£2,850), Ayr School Board

BAKEWELL - Plans passed by Urban District Council for 28 houses.

BALLIEBOROUGH—Housing scheme (£45,010), Urban District Council.

BALLYVAGHAN—Housing scheme (£29,808), Urban District Council.

BALROTHERY—Housing scheme (£42,780), Urban District Council.

BANNOCKBURN - House, bakery, etc., Newmarket, Mr. J. E. Muirhead.

BEECLES—Stables and stores, Ingate-road (£462), Town Council.

BEVERLEY—Public-house, Holm Church-lane, Messrs. Moars and Robson.

BLAENGARW—Two houses, Mount Pleasant, Mr. P. J. Thomas.

BRADFIELD—Two houses, Tilehurst, Mr. H. Saunders; house, Streatley, Sir Robert Mowbray; house, Green-lane, Mr. L. Pitney.

BROADSTAIRS—House, Wrotham-road, Mr. W. James; shop and house, Belvedere Estate, Mr. J. Pope; houses and shops, York-street, Mr. T. J. Wardell.

BUCKLYVIE—Additions to public schools.

BURSLEM—Elementary school, Education Committee.

BUXTON—Alterations, premises, Manchester and Liverpool Banking Co.

CANNING TOWN, E.—Houses, Upperton-road and house, Selby-road, Mr. B. Selby; office, Barking-road, Messrs. F. and T. Thorne; building over annealing kilns, City Glass and Bottle Co.

CARDIFF—Congregational church (£2,500).

CARLISLE—Turkish baths (£1,985), Town Council.

CARLTON—Enlargement of Council school, West Riding Education Authority.

CEFNCOED—Elementary school, Montgomery Education Committee.

CHESTER—Public conveniences, Northgate-street and Grosvenor-road, Town Council.

CHESTERFIELD—High school, Derbyshire Education Committee.

CHICHESTER—Secondary school, Stockbridge-road, County Education Committee.

CHURWELL—Tannery and buildings, Messrs. W. L. Ingle, Limited.

CLOWNE—Caretaker's house and additions to school Cresswell, United Methodist Church Trustees; two houses, Duke-street, Mr. W. Dawes; four houses, Rotherham road, Mr. J. C. Turner; house, Neale-street, Mr. J. Seston; two houses, Gray-street, Mr. G. Jenkinson; three houses, North-road, Mr. F. J. Hutchings; eight houses, High-street, Mr. English.

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CLONES—Housing scheme (£18,497), Urban District Council.
CWMBELLAN—Elementary school, Montgomery Education Committee.
DARFIELD—Elementary school, West Riding Education Authority.
DISLEY—Parish church, Furness Vale.
DUDLEY—Electric cable (£4,630 , Town Council.
DUNSHAUGHLIN—Housing scheme (£31,058), Urban District Council.
DUNSTABLE—Eight houses, Cross-street, Messrs. Wood and Son.
EALING—Secondary school (£16,000). Town Council.
EASTBOURNE—Wesleyan church (£13 600).
EDENDERRY—Housing scheme (£4,130), Urban District Council.
EDINBURGH — Rebuilding Baptist chapel, Rose-street (£4,000), Trustees.
ENNISKILLEN—Housing scheme (£35,790), Rural District Council.
EXETER—Gymnasium and additions to infirmary, Devon and Exeter Boys' Reformatory.
FENNY STRATFORD—Eight houses, Park-road, Mr. Yirrell; house, Park-road, Mr. Tranfield.
FOLESHILL—Elementary school (£6,500), Warwickshire Education Committee.
FOREST GATE — Additions, workshop, Chaucer-road, Mr. M. W. Hudson; alterations and additions, industrial school, Forest-lane, Messrs. F. and T. Thorne; three houses, Romford-road, Mr. Chambers.
GARSTON—Congregational church.
GERIZIM - Elementary school, Montgomery Education Committee.
GWAUN-CAE GURWEN—Fifty houses, Gwaun-cae-Gurwen Colliery Co.
HADDINGTON—Post office, Commissioners of Public Works.
HANLEY—Improvements, public baths (£2,500), Town Council.
HARDINGHAM—Primitive Methodist chapel, Mr. J. Cook-Rees.
HARPENDEN—Houses, Tennyson road, Mr. Bourne.
HARROGATE—Extensions to Royal Baths (£12,000), Town Council.
HINCKLEY—Infirmary, Board of Guardians.
HOLMER GREEN—Enlargement of Council school (£1,500), Mr. C. H Townsend.
HUCKNALL—Plans passed by Urban District Council for 16 houses.
HULL—Enlargement of Boulevard Secondary School. Education Committee.
ILFORD—Public electric lighting (£27,000), Urban District Council.
INCE—Roman Catholic church, Parish Priest.
KAIMES—House, Mr. J. Couper.
LANDPORT—Sailors' and soldiers' home (£11,800).
LEAMINGTON—Alterations, secondary school, Town Council.
LINTHWAITE—Two houses, Ingfield. Mr. E. Cock; 11 houses, Cowlersley-lane, Mr. Pearson; 23 houses, Jovil, Messrs. Lunn and Kaye; six houses, Smithriding, Mr. W. Hayes.
LLANDINAM—Elementary school, Montgomery Education Committee.
LLANDRINDOD WELLS—Public conveniences (£1,200) and refreshment kiosk (£800), Town Council.
LLAWRYGLYN — Elementary school, Montgomery Education Committee.
LLIDIARTYWAEN—Elementary school, Montgomery Education Committee.
LOCHORE—Elementary school, Ballingry School Board.
LOWESTOFT—Four houses, Royal-avenue, Messrs. A. and B. Chadd; alterations and additions, 1, Kirkley-villas, London-road South, Mr. W. H. Adamson; workshop, St. Peter's street, Mr. F. Wright; smoke-house and store, Mariners'-street, Mr. E. Wisker; wash-houses, Gordon-road, Messrs. Howes Bros.
LUDLOW—Two houses, Bronfield Castle, Mr. H. E. Whittaker.
MAIDSTONE—Extensions to electricity department (£18,400), Town Council.
MARYHILL—Extension to Possil Park School, Maryhill School Board.
MAULEDD—Elementary school, Montgomery Education Committee.
MELLINGTON—Elementary school, Montgomery Education Committee.
MERTHYR—Workmen's dwellings (£7,650), Town Council.
MERTHYR—House and café near recreation ground, Mr. C. M. Davies.
MITCHELSTOWN—Housing scheme (£11,390), Urban District Council.
MONK BRETTON—Twelve houses, Burton-lane, Mr. E. W. Dyson.
MORLEY—Plant at Corporation electricity station (£7,942), electric cables (£5,000), Town Council.
MORPETH—Housing scheme (£5,500), Town Council.
NORTH ANSTON—Congregational schools, Local Trustees.
NORTH BIERLEY—Board-room (£1,100), Guardians.
NORWICH—Boiler-house (£535), Board of Guardians.
NOTTINGHAM—Extensions, Barridge-road school (£7,200) and Bosworth-road schools; elementary school, Trent Bridge (£24 200), Nottingham City Council.
NUNEATON—Public slaughter-house (£1,800), Town Council.
OAKENSHAW—Villa, Mr. A. T. Verity.
PAISLEY—Additions, works, Macdowall-street, Messrs. A. F. Craig and Co.; alterations, public-house, Lawn-street, Mr. S. Young; additions, nurses' home, Royal Alexandra Infirmary, Mr. P. Coates; engine shop, Laighpark, Messrs. T. White and Sons; stables and stores, Clark-street, Mr. J. Picken.
PLAISTOW—Addition, office, Meredith-street, Messrs. Newell and Lusty; toy factory, Credon-road, Mr. R. B. Martin.
POOLE — Additions to house, Normansfield, Forest-road, Messrs. Jenkins and Sons; houses, Powell-road, Mr. Walter Andrew; house, Pembroke-road, Messrs. Smart and Wyeth; house, Bury-road, Mr. J. H. Brewerton; house, Penn Hill-avenue, Messrs. James and Son; house, Cheltenham-road, Mr. J. Day; house, Kingston-crescent. Mr. P. Coates; house, King's-avenue, Mr. J. F. Watkins; lodge and stables, Alington-road, Messrs. Chinchen and Co.; house, Munster-road, Mr. T. E. Grimes; house, Banks-road, Mr. H. Whitcombe; house, Woking-road Mr. W. G. Crane; five houses and shops, Commercial-road, Messrs. James and Sons; pair of houses, Rossmore-road, Mr. E. E. Clarke; house, Cranford-road, Mr. C. H. Goster.
PURDYSBURN—Asylum (£85,000), Belfast City Council.
RATHDOWN—Housing scheme, Urban District Council.
RATHKEALE—Housing scheme (£40,810), Urban District Council.
RAWMARSH—Isolation hospital, West Riding County Council.
ST. ANNES — Motor garage, St. Andrew's-road, Mr. T. Eaves; residence, St. Annes-road East, Mr. J. Prestwich; two pairs of houses, Headroomgate-road, Mr. S. Wilson; pair houses, Derbe-road, Messrs. J. Heap and Sons; house, Queen's-road, Mr. T. Hedges; houses, Queen's-road, Mr. C. Bluhm; house, St. Thomas's-road, Mr. R. Crichton.
SALFORD—Public baths, Derby-road, Town Council.
SALTERFORTH—Elementary school, West Riding Education Authority.
SANDAL—Six houses, Gordon-street, Messrs. Massie and Holdsworth; 25 houses, Elm Tree-street, Messrs. Massie and Co.
SAVILE TOWN—House, Hilcrest-road, Mr. P. A. Hinchcliffe.
SHORTLANDS—Congregational church (£2,480).
SILVERTOWN—Additions, premises, Messrs. Brunner, Mond, and Co.
SKIPTON—Public library, High-street, Town Council.
SMALL HEATH — Special school, Little Green-lane, Birmingham Education Committee.
SLOUGH—House, White Hart-road, Mr. A. Keen; public-house, Salt-hill, Messrs. Nevill, Reid, and Co.; house, Victoria-road, Mr. A. Woolsey.
SOLIHULL — Extensions, grammar school, Warwickshire County Education Committee.
SOUTH ELMSALL—Elementary school, West Riding Education Committee.
SOUTHPORT—Public conveniences, Hesketh Park, Town Council.
STAYLITTLE—Elementary school, Montgomery Education Committee.
STOCKTON—Six houses, Rokeby-street, Mr. W. Little; two houses, Allendale-road, Mr. W. Wier; 24 houses, Stavordale-road, Mr. A. J. Cooke.
STOURBRIDGE—Elementary schools, Wollaston-road (£7,000), District Education Committee.
STRATFORD (ESSEX)—House, Litchfield-avenue, Mr. G. Chambers; additions, boiler-house, Chandos-road. Mr. G. W. Beale; sugar warehouse, Carpenter's-road, Mr. P. K. Allen; bottling store, Leytonstone-road, Mr. W. E. Trent.
SWANSEA—Building (£3,000), Cambrian Cold Storage Co.
SWANSEA—Alterations, National Schools, Oxford-street.
TAMWORTH—School, Warwick Education Authority.
THORNABY—Fifteen houses, Victoria-road, Messrs. Sidgwick Bros.; eight houses, Ellerburn-street, Mr. E. Harrison.
TICKHILL—House, Church-lane, Mr. E. Clarkson.
TIPPERARY—Housing scheme (£47,182), Urban District Council.
TOLWORTH—Parish hall, Churchwardens, St. Matthew's Parish.
TORQUAY - Post office, Fleet-street, Commissioners of Public Works.
TOXTETH PARK—Extensions to workhouse, Board of Guardians.
TREHERBERT—Five houses, Messrs. Davies and Davies.
TWERTON—Elementary school, Somerset County Council.
TWICKENHAM—Secondary school (£6,000), District Council.
ULVERSTON—House, Gummershow, Mr. Huntington.
URLINGFORD—Housing scheme (£14,927), Urban District Council.
WANDSWORTH, S.W.—Public convenience (£1,100), Town Council.
WARE—House, Standon-lane, Mr. F. Howard.
WELHOLME—Extensions to school (£7,220), Grimsby Town Council.
WEST HAM—House, Haig-road, and three houses, Brock-road, Mr. B. Selby; cricket pavilion, Messrs. Leeds and Elves.
WESTON—Enlargement of elementary school, Cheshire County Council.
WEYBRIDGE—Police station (£3,700), Commissioners of Public Works.
WHITEHAVEN—Extensions to electricity plant (£1,700), Town Council.
WHITSTABLE—House, Nelson-road, Mr. T. W. Porter.
WICKHAM — House, Sunniside, Mr. W. Murray; house, Mr. R. Appleby.
WISBECH—County hall and public offices (£6,000).
WOLVERHAMPTON—Workshops and electric power-house, Chillington Tool Co
WORTHING—Extensions, Swandean Hospital (£3,000), Town Council.
WRABNESS—Wesleyan chapel and school.
YARMOUTH—House, 64, Southtown, Mr. A. B. Castle; two houses, Hamilton road, Mr. J. Harper; iron workshop, Southgates-road, Mr. Gus Lee, jun.; bakery, Suffolk-place, Co-operative Society; warehouse, 31, Wolseley-road, Mr. Naunton; four houses, Harley-road, Mr. J. Eastoe; six houses, Clarence-road, Gorleston, Messrs. J. and R. Chaston; warehouse, North-road, South Denes, Mr. N. Suffling; fishing premises, Middle-road, South Denes, Mr. Jarvis.
YORK—Extensions to electricity undertaking (£25,285), City Council.

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PROVISIONAL PATENTS, 1908.

APRIL 6.

7565. Improvements in current-conducting wire terminals. Walter Vernum, Beechwood-gardens, Caterham Valley, Surrey.

7569. Improvements relating to electric accumulators or secondary batteries. Emil Henry Hungerbuhler, 37, Essex-street, Strand, London.

7571. Improvements in and relating to field magnets for dynamo-electric machines. Alfred George Brookes, 55, Chancery-lane, London. (Cushman Electric Company, United States). (Complete specification.)

7586. Electrically-operated signals for railroads. Helena Jenett Jones, 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, May 13, 1907, being date of application in United States.) (Complete specification.)

7593. Improvements in watertight holders for incandescent electric lamps. Ernest Gustav Byng and Charles Edward Gunner, 71, Queen Victoria-street, London.

7614. Improvements in rewirable electric enclosed bridge fuses. Herbert Henry Berry, 78, Upper Thames-street, London.

7621. Improvements in alternating-current electric motors of the repulsion type. Ateliers Thomson-Houston, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, April 6, 1907, being date of application in France.) (Complete specification.)

APRIL 7.

7644. Improvements in apparatus for restricting the maximum current passing in electric circuit. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

7645. Improvements in charging for electricity supplied. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

7646. Improvement in electric meters for limiting the amount of electrical energy which may pass through a circuit to a predetermined quantity. William Fennell and William Pagden Perry, 68, Dudley-road, Tipton, Staffs.

7668. Improvements in electrical methods of transmitting power in a variable and flexible manner. William Beaumont Parker, 116, Shepherds-lane, Leeds.

7670. Improvements in safety cut-outs for use in connection with the overhead wires of electric traction systems. Alfred Edward Dixon, 24, Temple-row, Birmingham.

7674. New or improved means for attaching shades and reflectors to incandescent electric lamps. Charles William Dawson, 30, Park-row, Leeds.

7711. Improvements in or connected with conduits for electric leads or cables. George Gladman Sarney, Birkbeck Bank-chambers, Southampton-buildings, London.

7719. Improvements in or relating to valves. The Brush Electrical Engineering Company, Limited, William Chilton, and John McKenzie Newton, 46, Lincoln's-inn-fields, London.

7720. Improvements in or relating to elastic fluid pressure turbines. The Brush Electrical Engineering Company, Limited, William Chilton, and John McKenzie Newton, 46, Lincoln's-inn-fields, London.

7721. Improvements in or relating to turbines. The Brush Electrical Engineering Company, Limited, William Chilton, and John McKenzie Newton, 46, Lincoln's-inn-fields, London.

7730. Improvements in telephone relays. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

7740. Improvements in or connected with globe galleries for gas-burners, electric lamps, and the like. Samuel Mundler, 4, South-street, Finsbury, London.

7747. Improvements connected with high-tension magneto-ignition apparatus for internal-combustion engines. Chambers Motors, Limited, and Alexander Marcus Patton, 18, Southampton-buildings, London. (Complete specification.)

7750. Improvements in electric locomotives. Ernest Cummings Ketchum, 31, Bedford street, Strand, London. (Complete specification.)

APRIL 8.

7800. Improvements in electric reciprocating tools. Allen Frederick Carver, 65, Chancery-lane, London. (Complete specification.)

7822. Improvements in connection with electric lamps and their circuits. Henry William Handcock, Alfred Herbert Dykes, Charles Henry Stearn, and Charles Fred Topham, 47, Lincoln's-inn-fields, London.

7844. Improvements in and relating to electric motor controllers. The British Thomson-Houston Company, Limited, Hammond Charles Hastings, and William Leonard Wise, 83, Cannon-street, London.

7811. Improvements in the controlling of electric motors. Sir W. G. Armstrong, Whitworth, and Co., Limited, and Frank Harlaw, 24, Southampton-buildings, London.

7845. Improvements in and relating to alternating electric current motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

APRIL 9.

7853. Improvements in connectors for electric conductors. Albert Morgan, 14, Hindsley-place, Forest Hill, London.

7854. Improvements in electrical machines. Joseph Platt Hall, 17, St. Ann's-square, Manchester.

7865. Electric incandescent lamp wrapper. Francis Harrison, 14, Ossian-road, Stroud Green, London.

7886. Improvements in or applicable to electric meter systems. Nalder Bros. and Thompson, Limited, Henry William Handcock, and Alfred Herbert Dykes, 139, Queen Victoria-street, London.

7905. Improved means for attaching telegraph, telephone, and other wires or conductors to insulators or other supports. Ernest William Gover, 8, Quality-court, Chancery-lane, London. (William McIlwaine Robinson, Transvaal.)

7910. Improvements in pyrometers or thermometers of the thermo-electric or electrical resistance type. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

7916. Improved automatic electric switch. William Herbert Smith and Adolph Aufholz, 4, South-street, Finsbury, London.

7923. Improvements in or relating to electric furnaces. Hans Nathusius and Westdeutche Thomasphosphatwerke Gesellschaft mit beschrankter Haftung, 111, Hatton-garden, London. (Application for patent of addition to No. 7188/08.) (Complete specification.)

7930. Improvements in and connected with electrical ignition devices. Carl Ebner, 6, Lord-street, Liverpool. (Application for patent of addition to No. 28738/07.) (Complete specification.)

7941. Improvements relating to electric brakes. Percy Stuart Turner, Westinghouse Building, Norfolk-street, Strand, London.

7943. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

APRIL 10.

7944. Automatic frog for overhead trolleys. William Gray, 61, New-street, Erdington, Birmingham.

7954. Improvements in and relating to the covering and fire-proofing of electric wires, firemen's dress, and the like. Robert Sutherland Wiseman, 96, Buchanan-street, Glasgow.

7961. Improved telephone bridge for measurements of ohmic resistances, not affected by the inductance of such resistances. Aage S. M. Sörensen, Sedburgh, Whitley Bay, Northumberland.

7964. Improved apparatus for rendering sanitary telephone compartments and the like. Thomas Thorne Baker, 7, St. James's-avenue, Cricklewood, London.

7969. Dynamo worker for bicycles, motorcars, and other vehicles. John Mabbett and Joseph Herbert Alpass, Market place, Berkeley, Gloucestershire.

8013. Improvements in telegraphically transmitting signals by means of a perforated strip. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

8017. Improved process for the manufacture of an insulating material. Hans Branco and Gustav Gumpert, 7, Southampton-buildings, London. (Complete specification.)

8018. Improvements in and relating to ampere-hour meters. Wilhelm Meyerling, 27, Chancery-lane, London. (Date applied for under Section 91 of the Act, Aug. 7, 1907, being date of application in Germany.) (Complete specification.)

APRIL 11.

8065. Improvements in dynamo-electric machines also applicable as rotary electric transformers or motor-generators. Crompton and Co., Limited, James Colquhoun Macfarlane, and Harry Burge, 55, Chancery-lane, London. (Complete specification).

8093. Improvements in and relating to electrical heating. Edward Charles Robert Marks, 18, Southampton-buildings, London. (John Roberts, Natal.)

8097. Improvements in and relating to wireless telegraphy. Alessandro Artom, 7, Southampton-buildings, London. Date applied for under Section 91 of the Act, April 11, 1907, being date of application in Italy.) (Complete specification.)

8101. Improvements in cooling the commutator of a dynamo-electric machine. Siemens Bros. and Co., Limited, and Claude Martineau Toplis, Birkbeck Bank-chambers, South-

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ampton-buildings, London. (Application for patent of addition to No. 7255/06.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on April 30.)

1906.

26560A. Electrically-operated locks and fastenings. Burns. (Date applied for under Rule 13, May 21, 1907.)

1907.

539. Production and maintenance of interrupted electric arcs of high frequency. Ruhmer.

3215. Method of effecting Hertzian telephony and apparatus therefor. Ruhmer.

5194. Electrical ignition apparatus for use in internal-combustion engines and for other purposes. Postans.

7687. Method and means of radio-telegraphy and radio-telephony. Webb.

7941. Electric arc lamps. Bevis and Angold.

7941A. Electric arc lamps. Bevis and Angold. (Date applied for under Rule 13, April 5, 1907.)

7959. Electric automatic fire alarms. Howson.

8183. Alternating-current dynamo-electric machines. Mershon.

8364. Receivers for wireless telegraphy. Ges. für drahtlose Telegraphie. (Date applied for under International Convention, April 10, 1906.)

8563. Process for the manufacture of metallic illuminating bodies adapted for electric incandescence lamps. Deutsche Gasglühlicht Akt.-Ges. (Auer Ges.). (Date applied for under International Convention, Aug. 30, 1906.)

8641. Joints between incandescent electric lamp filaments and leading-in wires or supports. British Thomson-Houston Company. (General Electric Company.)

8903. Electric lampholder applicable for motor carriages and the like. Davis.

9868. Electro-magnetic circuit breakers. Electric and Ordnance Accessories Company and Hall.

11381. Electrical messenger call and order installations. Siemens Bros. and Co. and Grimston.

11850. Electric sign switches. Botting and Botting.

12402. Mechanism for operating magneto machines. Griffin.

12420. Dynamo-electric machinery. Lancashire Dynamo and Motor Company and Stansfield.

12907. Electrical counting and indicating gear. Newitt.

12960. Receiving apparatus for wireless telegraphy. Marconi's Wireless Telegraph Company and Franklin.

14150. Electrical signalling apparatus. Moore and Powles.

16383. Electric light carriers or fittings. Appleyard and Quiggin.

16489. Manufacture of a plastic mass from tungsten compounds. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, July 21, 1906.)

16513. Apparatus for cooling electric machinery. Wise. (Mailloux.)

17655. Arc lamps. Heys. (Scott Electrical Company.)

17686. Space telegraphy. Stone. (Date applied for under International Convention, Aug. 3, 1906.)

18045. Inverted repulsion electric motors. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Aug. 15, 1906.)

21087. Diaphragms or tympans for phonographic and telephonic apparatus. Coombs.

21408. Detectors for wireless telegraphy. Thompson. (Ges. fur drahtlose Telegraphie.)

22259. Controlling locks for the well-doors of electric lifts. Etchells.

22349. Electric switches or controllers. Etchells.

23709. Dynamo-electric machines. Underwood and Smith. (Date applied for under International Convention, Oct. 27, 1906.)

23756. Electric fans. Diehl and Becker. (Date applied for under International Convention, April 22, 1907.)

24212. Electrical indicating or recording targets. Johnson. (Felten und Guilleaume-Lahmeyerwerke Akt.-Ges.)

24702. Automatic electrical fire-alarm systems. Rennert.

25187. Bathing tubs for the treatment of the human body by the application of electric currents. Braun.

26530. System of radio-telephony. Ges. für drahtlose Telegraphie. (Date applied for under International Convention, Dec. 19, 1906.)

1908.

559. Electric lamps for miners' helmets and the like. Dräger and Dräger.

879. Socket shells suitable for holders for electric lamps. Hubbell.

2676. Holders for electric incandescent lamps. Loebl and British Ever Ready Electrical Company.

7041. Production of powerful interrupted electric impulses of high frequency. Ruhmer. (Date applied for under Rule 13, Jan. 8, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-⅝
—— Ord., 1,125 000	1	..	¼-⅜
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	11/16-13/16
—— Ordinary, Nos. 1 125,000	1	..	3/16-5/16
British Aluminium Co., Ordinary, 2 001-40,000	5	..	3⅝-4⅛
—— 7 per cent. Cum. Pref., 1-40 000	5	..	1⅜-4⅞
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4⅞-5⅜
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3⅞-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	103-104
—— 5½ per cent. Loch Leven Deb. (Reg.). Red., 1-3,000	100	..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¼-6⅝
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	£4 93
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275,001-475 000	3	..	½-⅞
—— 4 per cent. Mortgage Debenture Stock	100	..	45 50
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	3/16-7/16
—— 4½ per cent 1st Debenture Stock	100	..	77-80
—— 4½ per cent. 2nd Debenture Stock	100	..	63-66
Callender's Cable, Debentures	100	..	105-106½
—— Ordinary	5	..	10¼-11½
—— 5 per cent. Pref.	5	..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1 11/16-1 15/16
—— 5 per cent Debentures	100	..	92-95
Dick, Kerr and Co., Ordinary, 1 250 000	1	..	1¼-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Edison and Swan United, "A" Shares, 1-99 261	3	..	¾-1
—— "A" Shares, 01-017,139	5	..	1½-2¼
——	100	..	85-87
—— 5 per cent. Debentures	100	..	78-81
—— 4 per cent. Deb. Stock, Red.	2	..	¼-½
Electric Construction, Nos. 1 to 112 100	2	..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	100	..	64-68
—— 4 per cent. Perp. 1st Mort. Deb	1	..	3/16-5/16
Electrolytic Alkali Co., Ordinary, 1-202,218	100	..	—
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	10	..	7⅜-8¼
General Electric Company (1900) 5 per cent. Cum. Pref.	100	..	87-90
—— 4 per cent. 1st Mort. Deb. Stock	5	..	10¼-11½
W. T. Henley's Telegraph Works, Ordinary	5	..	4-⅜
—— 4½ per cent. Preference	100	..	106-108
—— 4½ per cent. Debentures	10	..	15¼-16½
India Rubber, Gutta Percha, and Telegraph Works	100	..	98-100
—— 4 per cent. Debentures	1	..	⅜-⅝
National Electric Construction Co., 1-170,000	10	..	10-10¼
Parker, Thos., Limited, Ordinary	5	..	—
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	12	..	30½-32½
Telegraph Construction and Maintenance	100	..	100-103
—— 4 per cent. Bonds	10	..	8-9
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000			

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4⅝-5¼
Bournemouth and Poole, Ordinary	10	..	10¾-11⅛
—— 4½ per cent. Cum Pref., 7 501-15 000	10	..	10-11
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	10¼-11
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105
Bromley (Kent) Electric Light and Power Co.	5	..	4¼-5 xd
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-99
Brompton and Kensington, Ordinary	5	..	7¼-7½
—— 7 per cent. Preference	5	..	6¾-7⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6¾-7¼
—— Nos. 80,000-100,000	5	..	6⅝-7⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13¼
Canadian General Electric Co., Common Shares	$100	..	97-101
—— 7 per cent. Cum. Pref. Stock	$100	..	106½-108½ xd
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3⅝-4⅛
—— 4½ per cent. Cum Pref., 1-80,000	5	..	4¼-4⅝
—— 4 per cent. Debenture Stock, Red.	100	..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	4-4½
—— ditto (1903) 40,001-80,000	5	..	4⅜-4⅝
Chelsea Electricity Supply	5	..	3¼-3⅜
—— 4½ per cent. Debentures	100	..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9¾-10½
—— 6 per cent. Cumulative Pref.	10	..	11¾-12¾
—— 5 per cent. Debenture Stock	100	..	123-126
—— 4½ per cent. 2nd Deb. Stk., Red.	100	..	101-104
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Corfu's Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3-3¼
—— 5 per cent. Preference, 1-50,000	5	..	4¼-4⅜
County of London Elec. Supply, Ordinary	10	..	7¼-8¼
—— 6 per cent. Cum. Pref.	10	..	11¼-11½
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	107-110
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	98-101
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	¾-⅞
—— 6 per cent. Cum. Pref.	5	..	1-1¼
—— 4½ per cent. First Mort. Deb.	100	..	57-62
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	74-77 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2¼-2⅜
—— 5 per cent. Debenture Stock, Red.	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	91-94
Folkestone Electric Supply, Ord., Nos. 1-10 000	5	..	4¼-5
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	4¾-5¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-13,000	5	..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	95-98
Isle of Wight Elec. Lt. and Pr., 4½ p.c. Db. Stk., Red.	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	3/16-5/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	7¼-8¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	97-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5	1-1¼
—— 6 per cent. Pref.	5	4½-5
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	90-95
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	88-92 xd
Metropolitan Ordinary, 100,001-200,000	5	4⅜-5¼
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4⅜-5¼
—— 3½ per cent. Mortgage Debenture, Red	100	85 90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1 4,000 ($1 000	—	76-7 p.c.
Mexican Light and Power Co., Capital Stock	$100	49-51
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	—	83-85
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57 009	5	5⅛-5⅛
—— do., 57,010-75,000	5	5⅛-5⅛
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	5⅛-5⅛
—— 5 per cent., Pref., 1-57,009	5	5⅛-5⅛
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5⅛-5⅛ xd
Notting Hill Electric Lighting	10	11¼-12¼
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5⅛-5⅛
—— 4 per cent. Debenture Stock	100	93-96
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	⅞-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red.	100	96-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5	4⅛-5⅛
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅛-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¼-1¼
—— 4 per cent. Debenture Stock	100	70-75
South London Ordinary	5	2⅜-2¾ xd
South Metropolitan Electric Light and Power, Ord.	1	⅞-1
—— 7 per cent Cum Pref.	1	1⅛-1⅜
—— 4½ per cent 1st Mort. Deb.	100	99-102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7¼ 8¼
—— 7 per cent. Pref.	5	6¼-7
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1⅜ 2¼
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1-2¼
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	87 90
Westminster, Ordinary	5	7¼-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅜-5¼

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,00	5	6¼-6⅜
—— 10 per cent. Non-Cum. 2nd Pref., 2:0,008-80,007	5	8-8¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	130-135
Auckland Elec. Trams, 5 p.c. 1st Mor. Deb. Stk., Red.	100	104-107
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10 000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-100,606	1	⅛-⅜
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	⅛-⅜
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	93-96
Blackpool and Fleetwood Tramroad	10	13¾ 14⅜
Bombay Elec. Supply and Trams Co, 6 per cent. Cum. Pref.	10	9½-10⅜
—— 4½ per cent. Deb. Stock, Red.	100	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5	3¼-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¾ 5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd	100	98-102
British Columbia Electric Railway Co., Ord Def.	100	132-135
—— Ord. Pref.	100	110 114
—— 5 per cent. Cum. Perpetual Pref. Stock	100	106-110
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £240 each	40	99-102 xd
—— 4½ per cent. Vancouver Power Deb.	100	101-104
British Electric Traction, Ord. 1-300,000 & 60 001-90,000	10	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10	4-4¼
—— 5 per cent. Perpetual Debenture Stock	100	90-95
—— 4½ per cent. 2nd Deb. Stock	100	72-76
Bueno Ayres and Belgrano Trams	5	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	95-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	97-101
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	92-95
Calcutta Tramways, Ord., Nos 1-137,610	5	6-7
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5	5-5⅛
—— 4½ per cent. 1st Deb. Stock, Red.	100	102-106
Cape Electric Tramways, Nos. 1-480,000	1	5/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4½-5
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	97-100 xd
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5¼-5½
—— 4 per cent. Deb. Stock, Red. 1985	100	99-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	89-93
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos 1-60 000	10	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60 000	10	12¼-13¼
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	95-98
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	81-86
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	⅞-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/16-⅛
—— 5 per cent. "A" Deb. Stock	100	87-91
—— 6 per cent. "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10-10¼
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296,500 2nd Mort. Deb. Stock	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1¼
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	90-95

Name.	Amount paid.	Last price.
	£	£
London United Trys. (1901), 5 per cent. Cum. Pref.	10	⅝-7⅛
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	80-85
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Stnkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 23,436-25,000	5	4¼ 5
——4½ per cent 1st Mort. Deb Stock, Red.	100	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314 016	1	1/16-3/16
—— 5 per cent. Cum Pref., 500,001-1,000 000	1	⅜-½
—— ½ per cent. Deb. Stock, Red.	100	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	85½-86½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 20-yr. Con. Mort Bonds, 1926. 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10 000 and 34,001-74,000	5	½-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mtt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1	½-⅝
—— per cent. Cum. Pref., 300,001-545 000	1	½-⅝
—— per cent. Debenture Stock	100	93-96
Provincial Tramways Co., Ordinary, 1-24,912	10	4⅜-5¼
—— per cent. Cum. Pref., 1-10,000	10	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5	5⅛-5⅝
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	122-133
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-12,000	$500	86-88 p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅞-1⅛
—— 4 per cent. Deb Stock, Red. 1940	100	78-82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5	3-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100	75-78
—— 4 per cent. Pref.	100	83-85
—— " " deferred	100	54-57
—— 4 p.c Deb. Stock (Prov. Scrip Certs., fully paid)	100	100-103
City and South London, Consolidated Ordinary	100	39-41
—— 4 per cent Debenture Stock	100	101-104
—— 5 per cent. Pref Stock '91	100	113-116
—— " " " '96	100	112-115
—— " " " '01	100	110-113
—— " " " '05	100	106-109
Liverpool Overhead, 5 per cent. Pref	10	10-10¼
—— Ordinary, 1-50 000	10	3¼-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1 700	—	94-96
Underground Electric Railways of London, 5 per cent. Profit-Sharing Secured Notes	—	39-43
—— Deposit Receipts	—	39-43

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1 000	85 87
Anglo-American Telegraph Co., Ordinary	100	55-58 xd
—— 6 per cent. Preferred Ordinary	100	98½-100½ xd
—— Deferred Ordinary	100	15½-14
Anglo-Portuguese Telephone Co., 5 per cent 1st Mort. Deb. Stock, Red.	100	98½-101¼
Chili Telephone Co., 1-44 000	5	7-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	84-87
Cuba Submarine Telegraph Co., Ordinary, 1-16 000	10	7⅛-8¼
—— 10 per cent Preference, 1-6 000	10	16-17
Direct Spanish Telegraph Co., Ordinary	5	3¼-3½
—— 10 per cent. Cum. Preference	5	8¼-9
—— 4½ per cent. Debs., 1-600	50	99½-102½
Direct United States Cable Co.	20	13½-14 xd
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	99-101
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	100-102
Eastern Extension, Australasia and China, 1-300,000	10	12⅞-13⅜
—— 4 per cent. Mort. Deb. Stock, Perp	100	99-102
Eastern Telegraph Co., Ordinary Stock	100	130-135
—— 3½ per cent. Preference Stock	100	84-87
—— 4 per cent. Mortgage Debenture Stock	100	101-104
Great Northern Telegraph Co. (of Copenhagen)	10	31¼-33½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100	99-101
Indo-European Telegraph Co.	£5	55-58
Marconi's Wireless Telegraph Co., Nos. 256,128-384,190	1	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	1	¾-1
National Telephone, Preferred	100	107-109
—— Deferred Stock	100	108-110
—— 6 per cent. Cum. First Pref.	10	10-12
—— 6 per cent Cum. Second Pref.	10	10-12
—— 5 per cent. Non Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	98-100
—— 4 per cent. Deb. Stock, Red.	100	101½-103½
Oriental Telephone and Electric Company	1	1⅛-1⅜
—— 6 per cent. Cum. Pref.	1	1¼-1⅜
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5	6-6¼
—— 5 per cent. Cum. Pref., 1-40,000	5	4⅛-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	98-101
West India and Panama Telegraph Co., Ordinary	10	9/16-11/16
—— 6 per cent. Cum. 1st Preference	10	8¼-8⅜
—— 6 per cent. Cum 2nd Preference	10	8⅛-9
—— 5 per cent. Debs., Red., 1-800	100	101-104
Western Telegraph Co., 1-207,930	10	13¼-13⅜
—— 4 per cent. Debenture Stock, Red.	100	99-102

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	April 15	1,214	1,209	+ 5	− 1,362*h*	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 18	246	222	+ 21	—	8	8	,, 15	15,283	3,603,789	378,834	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 13	2 720	2,480	+ 240	+11,614	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 19	1,006	930	+ 76	+ 46	23·53	23·53	March 31	55,408	11,686,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 11	6 295	5,275	+1,020	—	55½	55½	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 15	997	961	+ 36	− 858	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12·64	2,309	8·02
Blackpool Corporation	,, 16	520	453	+ 67	− 1,013	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	,, 19	3,010	2,0 0	+1,000	+ 614	42	42	March 31	111 294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 15	1,483	1,496	− 13	− 1,267	29¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 11	4,279	3 884	+ 395	+ 407	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 19	9.0	739	+ 171	+ 60	17·191	17·191	,, 31	50,652	10,759,310	1,798,505	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 17	4,778	4,781	− 3	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 17	1,612	1,154	+ 458	—	19¾	19¾	,, 31	62,699	11,967,488	1,205,830	1·31	12·48	5,825	8·21
Burton Corporation	,, 19	268	254	+ 14	+ 702	9⅛	8½	,, 31	15,676	3,383,527	421,317	1·07	8·87	1,718	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	April 11	155	161	− 5	+ 27	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 13	6,994	6,236	- 1,242	- 3,245	6	6	,, 31	349,298	43,057,897	1,279,698*a*	1·85	62·29*a*	55,357	35·22*a*
Charing X, Euston, & Hamp. Ry	,, 18	3,190	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 19	2,853	2 836	+ 22	+ 5,619	9	6¼	*h* June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 15	160	177	− 17	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 16	444	445	+ 1	− 43	15½	15½	Dec. 31	25,032	5,966,364	891,998	—	6·74	—	4·78
Croydon Corporation	,, 10	1,269	—	—	—	12 *c*	12 *c*	March 31	62,065	13,514,918	1,502,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 17	207	237	+ 70	—	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	Mar. 28	153	245	− 92	− 2,367	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	April 17	132	100	+ 28	− 20*h*	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 17	4 802	5,120	− 318	+ 380	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	,, 8	1,144	1 195	− 51	—	22	22	May 1[5]	57,672	15,554 905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	,, 11	814	8 5	− 1	− 225	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 11	17,459	17,059	+ 401	+16,562*h*	177½	169	May 31	387,381	224,063,088	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 15	240	235	+ 5	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	,, 18	4,930	4,020	+ 910	+25,856	9¼	9	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	,, 31	77,996	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	Mar. 21	1,443	1,471	− 28	+ 3 269	35½	35	,, 31	81,196	15 252,150	1,804,745	1·22	10·79	2,770	5·92
Hull Corporation	April 18	2 4 9	2,215	+ 264	− 356	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	Mar 14	391	411	- 23	—	10½	10½	,, 31	26,499	6,586,754	645,117	·89	9 58	2,225	6 5
Ilkeston Corporation	April 15	123	117	+ 6	− 57	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 8	280	215	+ 35	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1,73	4 95
Lancashire United Tramways	,, 15	1,153	1,077	+ 82	− 94	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 11	6 124	5,683	+ 441	+ 1,082	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5·58
Leicester Corporation	,, 11	2,120	2,116	+ 4	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 4	10,801	11,797	− 996	− 2,944	104	104	Dec. 31	563,793	122,094,528	12,115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 12	1,762	1,367	— 5	− 169*h*	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 4	31 879	33,850	-1,971	+249,780	98	98	March 31	1378,014	314,227 090	30,130 297	1·05	10 98	—	8·56
Lowestoft Corporation	,, 18	171	138	+ 33	+ 71	3½	—	Sept. 30	11,009	2,622,922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 9	164	103	+ 61	—	3¼	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 18	15,521	13 345	+2 176	+ 2,244	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 18	8,102	8 042	+ 60	+15 847	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 19	14,115	15 005	- 890	+ 1,819	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 13	189	122	− 67	− 125	2¾	2¾	March 31	7,309	2.035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 11	3,671	3 785	− 114	− 2,237	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 11	629	597	+ 32	− 167	14½	14½	,, 31	32,421	7,760,403	772.753	1 03	10 01	1,525	6·87
Oldham Corporation	—	—	—	—	—	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·259
Portsmouth Corporation	Mar. 28	1,460	2,086	− 626	—	28½	28½	,, 31	98,911	20,668.825	2,199,823	1·15	10 79	—	—
Reading Corporation	—	—	—	—	—	13½	13½	,, 31	32,661	8,130.179	918,825	·95	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	April 13	4,177	4,208	− 31	− 2,028	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 *c*	4·78 *c*	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7·01
Sheffield Corporation	,, 12	5,447	5,053	+ 394	− 2 226	65¼	65¾	March 25	276,907	73,966,299	6,804,656	·898	9 767	4,174	5·94
Southampton Corporation	Mar. 25	841	849	− 7	+ 3,335	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	April 15	286	283	+ 3	− 227	9	9	,, 31	20,076	4,431,728	390,578	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 19	1,214	1,245	− 31	− 903	20	20	,, 31	72,396	17,483.132	1,535,425	1·006	11·261	3,687	6·37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 16	230	167	+ 63	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 13	756	728	+ 28	− 411	12 68	12·43	‡ ,, 31	42,810	8,312,592	850,906	—	11·53	—	—
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,965 296	429 785	—	10 724	1,989	6·95
West Ham Corporation	,, 9	2,050	2,076	− 25	− 1,102	14·7	14 7	,, 31	122,881	35,502,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 15	742	770	− 28	− 327	20	20	,, 31	43,823	9,276,023	966,133	—	10 886	2,159	6·096

* 1905-6 figures. 1907-8 figures. † And 98 miles of interlacing track. *a* Train mile. *c* Miles of route. ‡ Half-year's figures

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TIME LIMITS.

Politics do interfere with trade, and there is no getting away from the fact. Unfortunately, again, the interference is almost always very damaging, very often altogether ruinous. In the electrical industry the time limit has been a canker-worm constantly eating out the vitals of trade. The unctuosity that maintains a licence confers a value is the utilisation of that half-lie which is so difficult to explain, but it is a lie, nevertheless, and those who in the first place put it forward know as used with intent to deceive it is a lie. Certainly, the man who obtains a licence for electrically lighting a given area does obtain something of value, so does the promoter who obtains an "option." The value, however, of licence or option before any work has been commenced is one thing; the value of the concern after work and brains have been exercised upon it is another thing, and if a time limit is imposed suddenly where no time limit was before the value becomes problematical. The Government is endeavouring to impose a time limit where none was before, and if this is to be done in one thing, why not in another? The imposition of time limits is bad from every point of view except one—that of the rogue and thief. What, really, does the time limit mean to any industry? It differs somewhat in its incidence according to the undertaking being one wherein there will be free competition or of the character of a monopoly. In the former case the capital must be arranged to be returned within the time limit, and the interest obtained will be governed by the ordinary conditions of trading. In the latter case the capital must similarly be arranged for, and the interest obtainable will probably be restricted because of the monopolistic character of the undertaking. These statements assume the time limit known at the inception of the undertaking. It seems to us, then, that the imposition of a time limit increases the price of the productions of the undertaking by the amount necessary to redeem the capital within that time limit. If our view of the case is correct, buyers have to pay more than they need to because of the limit. This is just what is taking place in almost all electrical work. Municipalities have to repay capital; private concerns have also to arrange for capital return when the time limit is reached. No doubt something may be said for such a system, but the something comes from the pessimist, not from ordinary business working. The cotton mill and the coal mine take their chances against other cotton mills and coal mines, and try to so conduct business that the return for capital expended is enough to repay capital, not in a defined limit, but within a time determined by all the conditions of trade. Ordinarily a small return for capital expended means a long limit of life to the undertaking; a high return means a short life. These are natural laws. We refer to the question just now because the time-limit idea is extending. It is to be made more oppressive in another industry. Where is it going to stop? We have always had a very strong feeling as to the hardships of those who first invested in electrical undertakings. Much money was lost under a short time limit, and the trade suffered incalculably; a longer time limit allowed development in favoured places, but even this curtails much work that might well be undertaken.

TRANSATLANTIC WIRELESS TELEGRAPHY.

The annual report of Marconi's Wireless Telegraph Company, Limited, for the period ending Sept. 30, 1907, has been issued, and must be looked upon from two points of view. The commercial man, looking at the balance-sheet only, will find that the company has returned no

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interest to its shareholders, and that these have invested some £400,000 in the company. The balance-sheet shows that nearly £100,000 more has been raised by loan. There is not a clear statement in the report as to the income of this company or of that of the subsidiary companies connected with it. It is obvious from the accounts that more capital must be obtained for the commercial development of the large system of wireless telegraphy which the company has built up, and hence the proposed issue of £250,000 preference shares with a cumulative dividend of 7 per cent. per annum. It is not reasonable, however, to judge the company by the results obtained to date, and one should consider rather the success of the pioneering efforts of Mr. Marconi and the Board of directors. The company was incorporated ten or eleven years ago, soon after Mr. Marconi had introduced his system for transmitting signals by etheric waves. Now there are land stations available for transmitting these signals spaced at intervals round the coasts of Great Britain, the United States, Italy, and other countries. The present report gives a list of one hundred and thirty-nine ships equipped with Marconi apparatus from and to which signals can be sent. The commercial value of the ship-to-shore communication it is difficult to gauge, but the income last year reached £37,975. The Admiralty, again, make extensive use of the Marconi system, and acknowledge the value of his work by a substantial royalty. Last, but by no means least from a scientific point of view, is the fact that Transatlantic signalling by etheric waves is an established fact. Commercial messages have been sent across the Atlantic from Clifden in Ireland and Poldhu in Cornwall, and from the stations at Glace Bay in Canada and Cape Cod. The full report of a lecture delivered by Mr. Marconi on this subject before the Royal Institution we are reproducing elsewhere in this issue. In it, it is frankly admitted that there have been pioneer troubles. We have evidence from rival experts in the States that commercial messages are being regularly transmitted. In view of this, the commercial outlook of the company seems promising, and we are by no means sure that the company will lose from the Berliin Convention. As the report states, "the directors remain convinced that the working of wireless telegraphy at sea—that is to say, between moving points—can only be efficient if controlled by one central organisation, and in their opinion the rules adopted by your company and the commercial organisation which it has established afford the best means for ensuring this efficiency and practicability. But the majority of the Governments do not share this opinion, and this being the case your directors are compelled to take the view that it would be wise for this company's business interests to consider how it may best be found practicable to modify the policy hitherto pursued by the Board, and believe that, with mutual goodwill and regard to respective interests, arrangements may be arrived at not only satisfactory to the Governments concerned but also remunerative to the Marconi Companies, who have invested so large an amount of capital in the establishment of this present wireless organisation." We trust that with the spread of wireless telegraphy the public gain will be accompanied by an adequate return both to the inventors of the various systems and to those who have financed the pioneering work.

ELECTRICAL ENTERPRISE IN SPAIN.

It is not a very difficult matter to draw the attention of the British manufacturer to opportunities for business abroad. Relatively, few of these opportunities, however, fructify, and charges of lack of business enterprise are in consequence heaped upon the heads of British manufacturers. But the reason for our non-success is not far to seek. In too many cases the opportunities which are publicly advertised only exist in the minds of those over-sanguine guides who profess to see in the success of the enterprise of some other country outside its own borders an opportunity which British enterprise has missed; in other cases the nature of the business and the circumstances attending it are such as to deprive British enterprise of the spoils. Then, again, foreign enterprise presupposes that the firms engaged therein are financially sound, and that their stability has been secured by prosperous home markets. Taking a general survey of the leading British electrical manufacturing companies one would hardly assert in full confidence that this is the case, and the wonder is that, in view of all the circumstances, reasonable headway has been made. It must not be thought that because little mention is made of British enterprise abroad that, therefore, it does not exist. There are, indeed, cases of British houses building up a solid business in all the leading countries, while indications are not wanting to show that Englishmen are interesting themselves in the undeveloped resources of these countries. In a very exhaustive account of the present commercial conditions of Spain by Mr. S. P. Cockerell, commercial attaché to the British Embassy at Madrid, which the Foreign Office has just issued, it is pointed out that English manufacturers and financiers might with advantage turn their attention to electrical engineering in all its branches. On this Mr. Arthur Jackson, vice-consul at Madrid, an expert on the subject, supplies a special and valuable memorandum. There were in Spain in 1901, he points out, only 861 electric power stations, of which 651 were for public lighting and 210 for private lighting. Since then the number of power stations has increased considerably. Mr. Jackson adds that the use of electricity in its multiple and other applications has also increased and become more general, but there is still a vast field for further industrial developments, as the supply of power which the country affords is far from exhausted. The last statistical returns (1904) showed that there were 1,165 stations in the country. Of these, 692 generated continuous current, the total output being 47,533·83 kw.; 232 single-phase alternating current, output 15,673·55 kw.; 70 bi-phase alternating current, output 7,213·22 kw.; 137 three-phase alternating current, total output 25,089·48 kw.; and 21 "mixed" stations, having a total output of 6,440·44 kw. Most Spanish towns of any importance have a fair service of public and private lighting. But business in this line is not by a long way yet exhausted, and, as the report shows, there are yet a considerable number of towns, some of them of importance, which are not yet supplied with electric lighting. The Spanish market for electrical material and machinery is almost exclusively in the hands of Germany, Switzerland, France, the United States, and Belgium. There has been an increase in the construction of electrical fittings and machinery at home, and with the protective tariff this new industry may yet develop into an important one. A suggestion contained in the report certainly deserves attention. "Manufacturers sometimes combine to appoint an expert to visit and report on their line of trade in foreign countries," says Mr. Cockerell, "and I would venture to suggest how advantageous it might be for the British electrical trade if the Institution of Electrical Engineers or some representative combination of British manufacturers took steps to have an investigation made by someone acquainted with Spain into the great openings which this country undoubtedly affords.

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THE INSTITUTION.

In another column will be found the Institution Council's list of candidates for nomination to fill the vacancies on the Council caused by the retirement, under the rules, at the end of the session, of the president, two vice-presidents, five members of the Council, one associate member of the Council, and the hon. treasurer. Mr. Mordey is the president-designate, in succession to Colonel Crompton (who is filling with such marked success the vacancy caused by the death of Lord Kelvin), and we are sure that this nomination is one which will meet with the heartiest approval in every branch of the profession. Of Mr. Mordey's pioneering work in electrical engineering, of his services to the Institution, and of his general popularity we need not speak here, for these are too well known. The new nominations for the Council represent the many sides of electrical science and industry, and each of the five gentlemen whose names are now submitted stand well in the forefront of the various interests. With the inclusion of Major O'Meara's name, the traditional association with the Post Office is maintained.

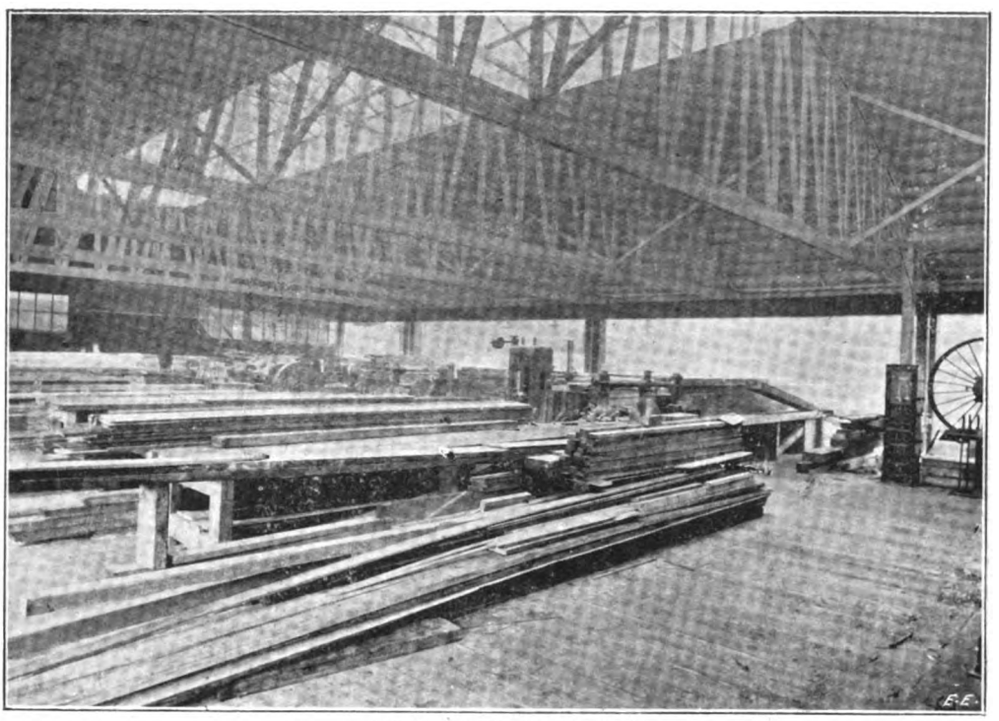

FIG. 1.—General View of Sawmill.

THE SAWMILLS OF MESSRS. J. AND W. BELLHOUSE.

The sawmills and timber sheds of Messrs. J. and W. Bellhouse, Miles Platting, Manchester, form an interesting example of the modern application of electric motors to the driving of wood-working machinery. The sawmills are situated on the banks of the Bridgwater Canal, and were established in 1792, so that the firm can claim to be one of the oldest in the trade. Up to July of last year they had depended for their motive power on a steam-engine and lines of over-

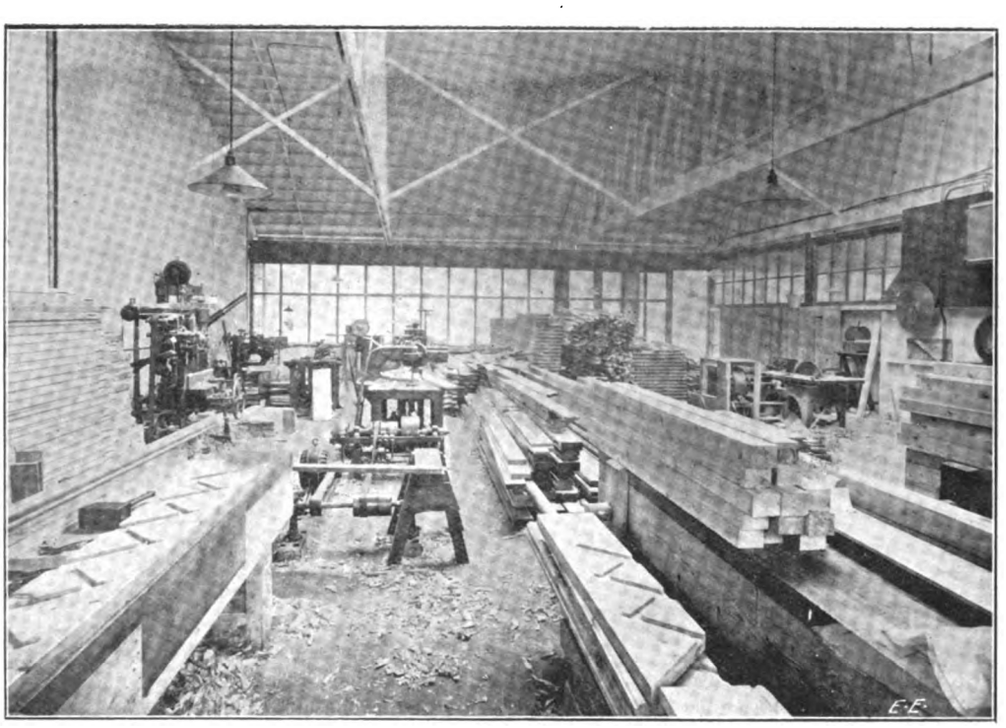

FIG. 2.—Joiners' Machine Shop Spindle Housing Machine driven by a Westinghouse 5-h.p Motor in the immediate foreground, and a Chain Mortising Machine driven by a Westinghouse 7½-h.p. Motor immediately to the left.

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head shafting, with belts therefrom to the various machines. During the past few years the firm have been fully convinced of the many advantages to be gained by the adoption of electricity as the motive power, but owing to the capital represented by their steam-power plant they were reluctant to make the change over.

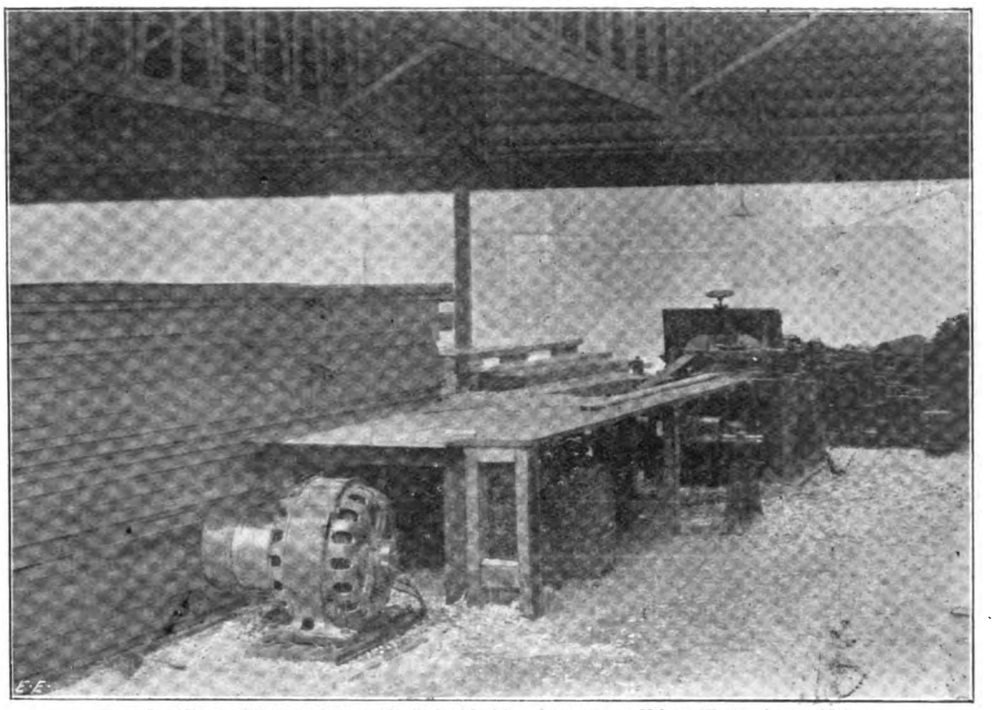

FIG. 3.—12in. by 4in. Four-Cutter Moulding Machine driven by a 20-h.p. Westinghouse Motor.

In July of 1907 a disastrous fire burnt the mills to the ground, and the steam plant was destroyed. Recognising, as they had done for some time, the superior advantages of the electric drive, they at once provided that their new sheds should have a complete electrical installation. The result is a thoroughly up-to-date equipment, with all machines individually driven by electric motors and the whole factory electrically lighted. The plan of driving each machine by its own motor has many advantages over the more common method of "group driving." Perhaps the chief advantages of the system are its economical use of power and its flexibility, the former being due largely to the fact that the motor may be switched out of circuit without interfering with the other motors and machines in any way, and so all losses occurring in the motor for its particular machine are obviated. With the group driving of machines the stoppage of one leaves the shafting still running, the losses continue to take place in the steam-engine until it and all the machines are stopped. The flexibility of the electric motor system as applied to the operation of industrial works is an important feature which all users of electric motors agree is not obtainable in other drives.

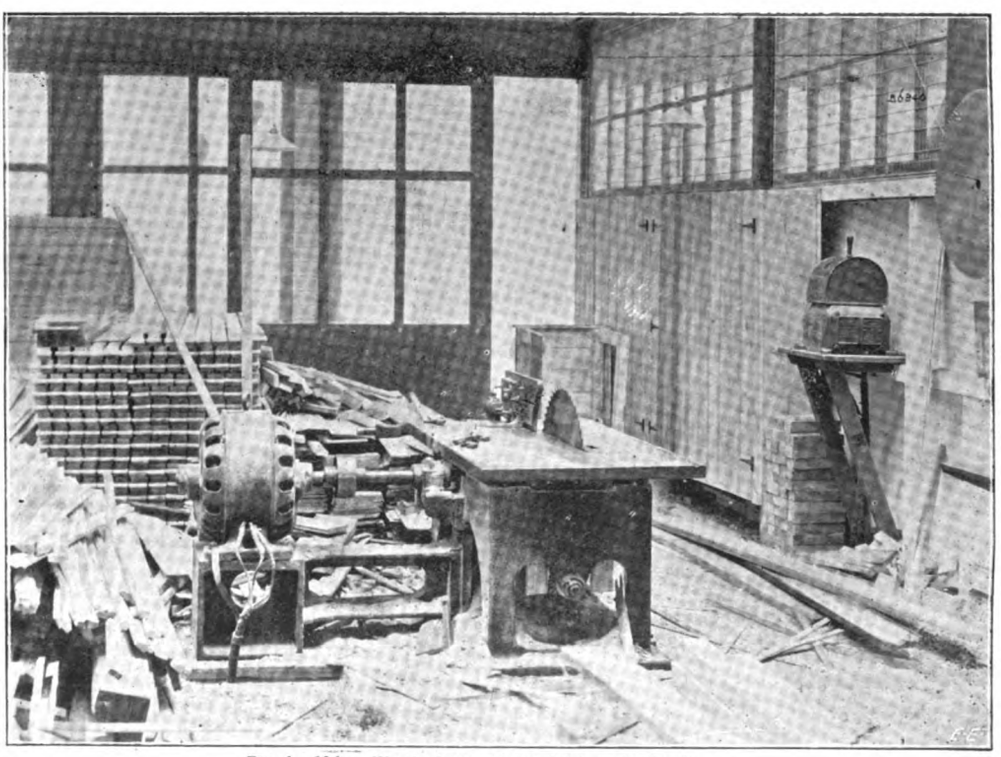

FIG. 4.—10-h.p. Westinghouse Motor driving Circu'ar Saw.

Messrs. Bellhouse's mills consist of two sheds or buildings, one of which is the joiners' shop (containing no machinery), the other building containing the sawmill and joiners' machine shop, the former section being merely a shed open at the sides, the latter being entirely enclosed. Fig. 1 shows a general view of the sawmill, and Fig. 2 a general interior view of the joiners' machine shop. A com-

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parison of these pictures with similar pictures of shops using steam-engines and shafting for the driving of the saws and other timber-working machines will show the

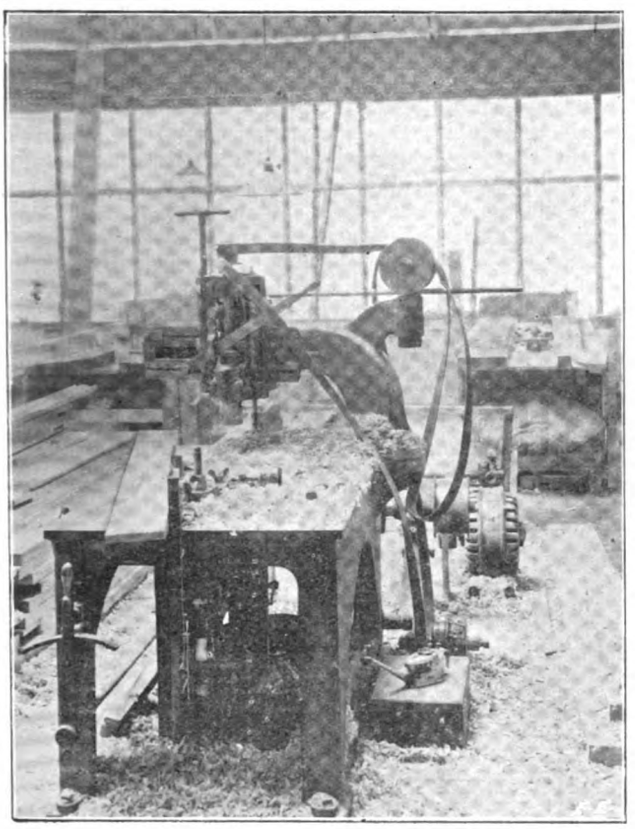

FIG. 5.—5-h.p. Westinghouse Motor driving a Spindle Housing Machine.

marked improvement effected by the absence of shafting from the walls. The abolition of long lines of shafting also means that there is no necessity to make the walls of such heavy and solid construction, thus effecting an economy in the building cost which would amount to a considerable sum in a large plant.

capacity of the motors installed exceeds 280 h.p., the sizes ranging from 1 h.p. to 50 h.p. The squirrel-cage induction motor is essentially a constant-speed machine, so that in some cases where several speeds are required the motor is connected to the machine through countershafts, with different sized pulleys for obtaining the necessary range of speed. The motors are very simple, and in the case of the larger sizes are started by means of auto-starters (one of which can be seen on the bracket to the right of the circular saw in Fig. 5), the handles of which are first moved to the starting position, when a reduced voltage is applied to the motor. On moving the handle from the starting to the running position (which is done as the motor attains a fair speed) the full voltage is applied to the stator of the motor, which will then run up to its full speed. In the case of motors below 5 h.p. an ordinary knife switch is frequently all that is necessary for starting up, the motors being put straight on to the line.

The high-tension feeders of the Manchester Corporation are brought into the private sub-station, which contains two 250-kw. Westinghouse three-phase reducing transformers and a Ferranti three-panel enamelled slate switchboard. The transformer reduces the voltage to 420 volts, at which pressure the motors are operated, and the switchboard contains the necessary switching and recording apparatus for controlling and recording the current supplied to the motors. A distributing switchboard is installed in the sawmill for recording the power consumption of and for controlling the various sections of the plant.

The sawmill contains several large-size wood-working machines, each being driven by its own motor. Fig. 3 shows a 20 h.p. motor driving a 12in. by 4in. four-cutter moulding machine. In addition to these there are several other large and important machines in the same shed, including a 12in. by 5in. four-cutter moulding machine (35-h.p. motor), two self-feeding circular saws (30-h.p. and 35-h.p motors respectively), 24in. by 6in. deal thread machine operated by a 15-h.p. motor, a log band-saw machine driven by a Lancashire Dynamo and Motor Company's 50-h.p. motor, the carriage being operated by one of the same company's 7-h.p. motors (part of the machine is shown to the right in Fig. 1), a cross-cut saw (10-h.p. motor), and a tool grinder operated by a 2-h.p. motor. One portion of the sawmill is partitioned off for saw sharpening and setting, and contains a circular-

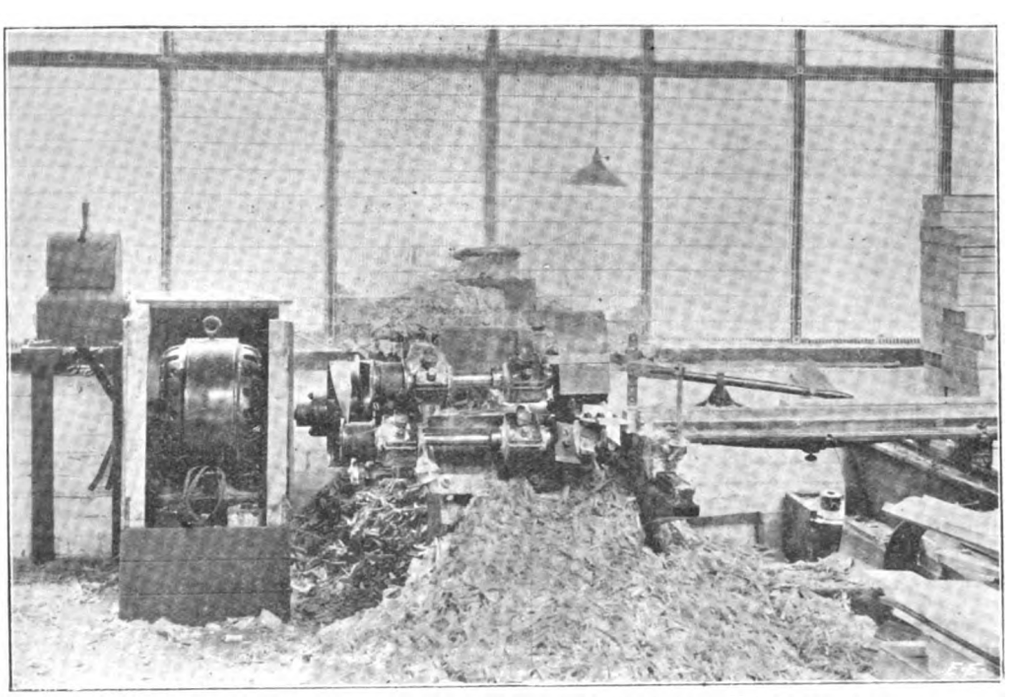

FIG. 6.—Tenoning Machine driven by 10-h.p. Westinghouse Motor.

The contract for the supply of the electric motors was placed with the British Westinghouse Company, the motors installed being of their alternating current, three-phase, squirrel-cage, induction type, except in one or two cases where motors of the Lancashire Dynamo and Motor Company's make were supplied with the machines. The total

saw sharpening machine and a band-saw sharpening machine, each being driven by its own 1-h.p. motor. The motors for the cross-cut saw, self-feeding circular saws, 12in. by 5in. moulding machine, and the deal thread machine, are all in the cellar beneath the shed, the belts being taken up through holes in the floor. This has the

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decided advantage of leaving the working floor comparatively free from obstructions. The joiners' machine shop contains several smaller machines, comprising a circular saw driven by a 10-h.p. motor (Fig. 4), chain morticing machines driven by a 7½-h.p. motor, jacker, dovetailing, and automatic grinding machines, each with its own 3-h.p. motor, spindle housing machine driven by a motor of 5 h.p. (Fig. 5), and a tenoning machine driven by a 10-h.p. motor, and illustrated in Fig. 6. Fig. 2 gives a general view of this shop, from which a good idea of the general arrangement can be obtained.

Occupying part of the space beneath the sawmill is an artificial drying chamber, heated by steam-piping from a large boiler at one end of the shops. For the purpose of rendering the temperature of the chamber slightly lower when it is necessary for men to work therein, a large fan driven by a 4-h.p. motor is fitted into one of the walls. This fan reduces the temperature of the room in a very short time, so that men can go and work there in comfort.

For the rapid and easy handling of the huge logs of timber which daily pass through the yard, and for the unloading of the timber barges on the Bridgwater Canal, a six-ton overhead travelling crane (Fig. 7) has been installed by Messrs. Craven Bros., of Manchester, which runs along the side of the machine sheds and overhangs the canal. This crane is equipped with one 2-h.p. and two 10-h.p. alternating-current squirrel-cage motors.

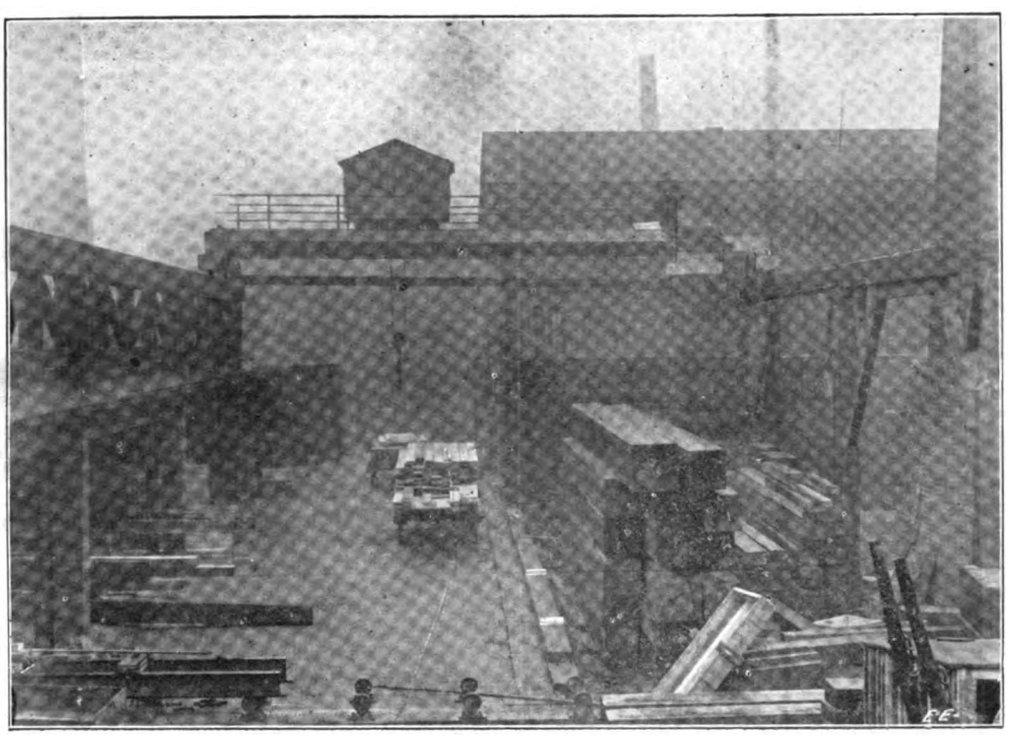

FIG. 7.—Six-ton Overhead Travelling Crane by Messrs. Craven Bros., of Manchester.

The factory is busy at present with a large contract with Messrs. Craven and Markham, for the Great Central Railway Company, for the supply of all the woodwork for a large factory which the latter company is erecting at Dukinfield. In addition, the firm carry out work for builders and contractors, undertaking the manufacture of all wooden parts, such as window frames, doors, stairways, and so on, and with the present up-to-date plant they are in a favourable position to undertake such work much more quickly and with far greater ease than before.

MECHANICAL STOKERS.*

BY JOHN EGERTON BARNES, GRADUATE, OF LONDON.

General Remarks.—In endeavouring to give some information on the subject of mechanical stokers, the author wishes to explain that it is not possible within the limits of this paper to include full details of all the various types of mechanical stokers which are or have been on the market; he therefore contents himself with describing briefly, so far as he can, the different features of the principal mechanical stokers in use at the present time and endeavouring to show what he conceives to be their advantages and drawbacks. The idea of firing boilers mechanically is, of course, by no means a new one, and yet it is only comparatively recently that their use has become general, and, in fact, almost universal. It might at first be thought that the principal object of substituting hand stoking by mechanical stoking is economy of labour, but this is not so, though labour is, in most cases, greatly economised. The chief thing to be aimed at is economy of fuel, and this is what a mechanical stoker efficiently handled secures. Modern practice in the boiler-house demands that the highest degree of efficiency shall be maintained; an essential feature of this is that no black smoke shall issue from the chimney stack. Now with a well-designed mechanical stoker, the cheapest and most smoky bituminous coal can be burnt to the satisfaction of all concerned, including the smoke inspector. On an ordinary grate it is not possible to burn cheap slack with any degree of satisfaction by hand firing, because in order to prevent smoke it is necessary to "fire" so often that the doors are practically always open, which means comparatively cool air getting into the combustion chamber, causing great inefficiency and often serious tube-plate or other troubles. But this cheap coal can be burnt with advantage where mechanical stokers are in use, because the doors being shut, practically all the necessary air passes through the fire, with the result that combustion is facilitated and the temperature of the furnace gases is not unduly lowered. In certain cases mechanical stokers are not only desirable, but almost indispensable—for instance, where the coal used contains a large percentage of refuse, and, consequently, self-cleaning of the furnace by mechanical action is advisable. Again, it is evident that where there are many boilers, a saving can often be effected in the number of firemen employed. With regard to economy, it should be remembered that in small installations where the grates are not self-cleaning and there are no coal conveyors, the labour is often considerably increased, because "cleaning out" has to be done more frequently, as low-grade fuel contains a large percentage of ash; and, because of its lower thermal value, more coal has to be thrown into the hoppers for the same quantity of steam generated. It should also be borne in mind that mechanical stokers, like all other high-class

* Abstract of paper read at the Institution of Mechanical Engineers Graduates' Association) on Monday, April 13,

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machinery, want a certain amount of attention, and that when makers guarantee a substantial percentage of reduction in the coal bill, they assume that the machines are going to be handled with common-sense. If, therefore, an engineer cannot get satisfaction in the first week or so, he should, before condemning them, wait until his firemen have had time to get a little more accustomed to them. The author knows of several cases where trouble experienced with mechanical stokers has been entirely due to want of knowledge or carelessness on the part of the firemen employed. The advantages of mechanical stokers may perhaps be roughly summarised as follows: smoke prevention by uniform firing; constantly closed doors; economy in working by using cheap coal; more perfect combustion; more uniform and more easily regulated evaporation; economy of labour.

Types of Stokers.—Mechanical stokers may be divided into two classes—viz., those on the sprinkling system and those on the coking system. In the former, the coal is sprinkled by means of throwers over the grate, sometimes over the entire area, sometimes over the front half only. There are various patterns, and in nearly all cases there are moving bars. These bars travel towards the back of the furnace with the burning fuel, the ash dropping into the ash chamber; they move back independently so as to prevent the fuel from coming back with them and also to prevent it caking. Stokers on the coking system are the more numerous, and here again the bars are in the majority of cases moving. The coal is slowly fed on to the front and becomes gradually consumed as it reaches the back of the grate. The advantage of this system is that the combustion of the volatile gas, which is liberated at the front of the furnace during the coking process, is perfected by passing over the incandescent fuel at the rear end. In the case of shell boilers, the clinker is taken out of the ash chamber, between the bridge and the end of the firebars, at convenient intervals. With water-tube boilers there are generally ash bunkers, into which the clinker can be dropped direct. Mechanical stokers on the coking system may be divided into two classes—viz, overfeed and underfeed. In the former case the coal is fed on to the grate and is carried towards the back of the furnace by the grate itself; in the latter case the coal is forced up under the burning fuel by means of "rams" or "pushers," so that the gas given off by the fresh coal while "coking" has to pass directly through the incandescent fuel above it before getting to the combustion chamber. This, of course, further facilitates combustion.

Methods of Driving.—The most usual method of driving mechanical stokers is by a line of shafting running the entire length of the boiler-house just in front of the boilers. The shafting is from 10ft. to 20ft. from the floor according to the type of boiler; the motion from this shaft is transmitted to the stoker gear by means of a belt, rope, or eccentric and rod according to the make of stoker; the motion is imparted to the coal by means of worms, worm-wheels, ratchets, etc. One drawback to this method is that if the motor or steam-engine driving the shafting breaks down the whole bank of boilers is put out of commission. Another disadvantage is that if only one or two boilers are required, power has, nevertheless, to be supplied to the whole line of shafting, and waste results. Of course, clutches of some sort can be fitted to connect up short lengths of shafting, but this means extra expense, and in most cases is not considered necessary. Another method of running the stokers is by an independent steam motor, working on the slow-speed feed-pump principle, fitted to each furnace, but as the temperature of the exhaust steam from a single cylinder slow-speed motor of this type is unnecessarily high, the arrangement is rather extravagant; the exhaust steam can, of course, be used for a feed-water heater of some sort, but this is not always convenient. However, the great advantage of this method is that each unit is self-contained, and in case of a breakdown to one of the motors only one boiler is affected, though it must be admitted that the greater number of moving parts means greater risk of breakdown. On the whole the shafting method is the more satisfactory, it requires less attention, and is more economical as regards running and upkeep.

Coal.—The coal most commonly used in mechanical stokers is a Midland, North Country, or Scotch small, the pieces ranging from about the size of a walnut to that of a pea. In some cases much finer slack is used, but the fineness is often limited by the air-spaces between the bars of the stoker. Of course, any coal that does fall through the bars can be raked up and put back into the hoppers, or used for firing the independently fired superheaters, if any, but this should be avoided if possible. It will be understood that a coal which cakes badly is not suitable by itself for mechanical stokers of the coking class, as it is desirable where possible to dispense with the use of fire-irons altogether. This coal can, however, often be used satisfactorily if mixed with other kinds of coal which do not cake, the proportion of the mixture varying with the class of coal.

Draught.—In most cases a forced draught of some sort is used. This is done sometimes by jets of superheated steam placed in the front of the furnace, just below the firebars so as to play along them, the ashpan being open, as in the case of an ordinary grate, and sometimes by jets of superheated steam surrounded by a tapered cylinder so as to form an air injector, the ashpan in this case being closed. The latter method is the more economical, and both have the advantage of being self-contained and independent of other gear, but both are often accompanied by a hissing noise, which is generally considered a drawback. Another method is by means of a centrifugual fan driven by an electric motor or steam-engine, the air being conveyed to the fires by an air-duct running along under the floor in front of the boilers, and branch pipes leading from this duct to the fires, each pipe being fitted with a damper. The great advantage of this method is that not only can the draught to each furnace be controlled independently, but the draught to the whole line of boilers can be regulated to a nicety by varying the speed of the fan. With underfeed stokers a draught of about 1½in. of water is generally used, this being supplied by a fan. In chain-grate stokers a natural draught of about ½in. is all that is necessary, and in most other types the steam-jet system is used. Of course, where forced draught is used all the regulating is done by the air-inlet dampers and not by those at the flue end of the boiler. It is generally considered, and rightly so, that the greatest waste in the boiler-house is due to excess of air in the furnace, but it must not be forgotten that insufficient air is equally wasteful, as this will prevent complete combustion. The usual method of ascertaining whether the right amount of air is being admitted is by a CO_2 recorder. This instrument should show from 14 to 15 per cent. of CO_2 in the flue, at the exit of the boiler. When this percentage is obtained with bituminous coal, there is about 1·3 times the theoretical quantity of air necessary for complete combustion passing through the flues, and this quantity is about the lowest obtainable in practical working.

Working.—In working a mechanical stoker it should be borne in mind that it is not sufficient to fill the hoppers, start the gear and draught going, and then let it look after itself. Even when the load is perfectly constant, and the fireman has become used to the coal he is burning, a frequent and regular inspection of the fires is necessary to see that the entire surface of the grate is covered, and that the coal is being fed where it is wanted, because the quality of low-grade fuel varies to an astonishing degree, the first ton or two from a bunker burning, perhaps, splendidly and the next ton (which, by the way, may have been tipped out of the same truck) taking about twice as long to be consumed, so that if the maximum efficiency and low repairs costs are to be maintained the feed of the fuel and the draught must have constant attention. In stokers of the moving-grate type, the feed of the coal and the rate at which the grate moves must be so regulated that while the surface of the grate which is being supplied with air must be covered with a fairly deep fire, no unburnt coal must drop into the ash chamber. Often in the effort to keep unburnt coal out of the clinker, the fire at the back is allowed to get so thin that cold air gets in where it can do no good and possibly much harm. The depth of the fire in stokers of this class varies from about 12in. in the front to about 3in or 4in. at the back of the furnace,

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but here again the proper depth depends upon the quality of the coal used.

Upkeep.—In the foregoing remarks there has been, perhaps, a tendency to emphasise the advantages of the mechanical furnace over the hand-fired one; they have, however, their drawbacks, and chief among these is cost of maintenance—a moving bar which has to be connected in some way to the power which moves it is necessarily more complicated than a "dead" bar—and the greater cost of renewal and fitting must not be lost sight of. As a set-off to this, it may be said that the life of the bar which moves relatively to the fuel is considerably lengthened. And, on the whole, the cost of upkeep generally is, as a rule, not so high as is usually imagined.

Description of Various Makes of Stokers.

Chain-Grate Stokers.—The two principal machines of this class are the Babcock and Wilcox and the Bennis. In both cases the grate consists of an endless chain of short bars, which are supported at each side of the grate by rollers running on side frames. These frames, which rest on wheels, constitute the carriage for the grate, and can, if desired, be drawn entirely free from the brickwork setting, as there are rails provided for the purpose. At each end of the grate there is a toothed drum, over which the chain passes, the movement of the grate being caused by a worm gearing into a worm-wheel on one of the drums; this worm-wheel is driven by a ratchet wheel and pawl, and the number of teeth into which the pawl is arranged to engage regulates the speed of travel. The coal is fed on to the whole width of the grate, and the depth of the layer is regulated by the door, which can be raised or lowered by gearing. The grate carries the coal very slowly, and by the time the charge at the front reaches the back it is exhausted, and what remains falls over the dumping bars or plates into the ashpit. Both machines are fitted with an arrangement of vanes for cutting off the air supply to a portion of the grate if necessary. The main difference between the two machines is in the shape of the grate bars and the dumping arrangement.

The Underfeed Stoker Company's Machines.—There are three types of stoker made by this company. They are the B type for shell boilers, E type for water-tube boilers, and the D type for marine use. The principal feature of the B type is the slowly-revolving tapered "worm" or "spiral" which runs along the whole length of the centre, at the bottom of the retort. The coal from the hopper falls by gravity on to the front end of this spiral, and is carried by it into the furnace; the coal then rises up the centre and falls on to plates which slope down on either side and form the grate. The clinker is pulled out, or the fire "banked," much in the same way as in an ordinary grate; the air comes through the tuyere bars and between the plates on each side. In the E type a sliding plate, which forms the bottom of the retort, is substituted for the revolving spiral of the former type. Fixed to this plate are wedge-shaped blocks, which take the coal with them on the forward stroke, but allow it to slip over them on the backward stroke. The coal then rises in the same way as in the other case, but falls on each side on to bars which are parallel to the front of the boiler. These bars are about 2ft. long, and slope down away from the centre, every alternate couple moving backwards and forwards towards the centre and sides of the furnace respectively. The motion of the coal is caused by a steam cylinder, the piston rod being coupled direct to the sliding bottom of the retort, and the bars are moved by an oscillating rod which engages into the bars at their upper end. On the front end of this rod is a very coarse pitched screw, and a nut fixed on to the cross-head of the steam motor causes the oscillation. Between the lower end of the bars and the sides of the furnace there is a dumping tray about 12in. wide which can be dropped by means of a lever at the front end of the boiler, allowing the clinker to fall into ashpits at each side of the grate. The air from the chamber which surrounds the retort is made to pass along inside the hollow bars before passing through the spaces between the bars to the fire.

Erith's Grateless Stoker.—This machine is also an underfeed, and its chief feature is simplicity. In place of a grate there is a bed of fuel which is constantly rising, and on each side of the bed there are "dead" plates, from which the clinker is taken, this being pulled out of the front doors in the same way as with hand-fired grates. The coal is fed from the hopper to the retort by a steam "ram"; and a lifting movement is given to the fuel by means of a sliding rod and wedge blocks, fixed at the bottom of the retort, and moved by the ram. The air enters the fire only through the tuyere blocks which are placed round both upper edges of the fuel retort.

Meldrum's Koker Stoker.—In this machine the coal is pushed on to the bars by a sector-shaped ram which works on a pivot fixed at the base of the hopper. The movement of the bars is caused by revolving cams which engage into them at their front end. These cams are so arranged that all the bars travel forward together, but come back independently. This action causes the burning fuel to be carried into the furnace, and the clinker to be worked off the end of the grate at the back, and to fall into the ash chamber. The draught is caused by jets of steam working air injectors. In some types of this stoker where the bars are hollow and of box section, the air enters the bars themselves at their front end.

Sprinkler Stokers.—All the machines already described are of the coking type. The three principal machines that work on the sprinkling system are the Bennis, Triumph, and Proctor. At the base of the hoppers of these machines there is a sliding pusher-plate, which, at every stroke, pushes a small quantity of coal in front of a shovel or thrower. A revolving shaft carries a three or four fingered cam, which engages into a trigger fixed on the spindle of the shovel; this pulls the shovel to the starting position of its stroke, against the tension or compression of a spring. When the trigger is released, the spring causes the shovel to fly forward, throwing the coal over the fire. The bars are moved by a revolving shaft carrying cams, which cause the bars to move forward all together but to come back independently; this action prevents clinker from sticking to the bars, and carries the fire into the furnace at the same time. The ash falls into the ash chamber, and is taken out at convenient intervals through a door which is placed underneath the bars at the back; this door is to prevent air from getting to the combustion chamber by way of the ashpit. A natural draught assisted by steam jets is generally used with these machines. In some of the Bennis machines the bars are hollow, and air is forced into the bars themselves at the front by jets of superheated steam forming injectors at the mouth of the bars.

The author wishes to acknowledge the courtesy shown by the various firms who have enabled him to gather details, and have supplied him with many of the slides used to illustrate this paper.

ELECTRICITY IN MINES AND MAGNETIC ORE SEPARATION.

The following extracts from the "James Forrest" lecture, 1908, on "Some Unsolved Problems in Metal Mining," by Prof. Henry Louis, M.A., M.I.C.E., are particularly interesting to electrical engineers. Those in our profession who have to do with the electrical equipment of mines will do well to read the whole of this valuable lecture. When dealing with transportation, Prof. Louis said: Metal miners have, as a rule, somewhat neglected this branch of the subject, and it is rare to find them using anything like the elaborate systems of haulage that are in vogue in coal mines, the reasons for this difference being obvious enough. Nevertheless, most metal mines worked upon any large scale might with advantage pay more attention than they do to this subject, and I could quote numerous examples where underground transport costs several times as much as it ought to. Electric haulage is particularly well adapted to the conditions of metal mines, and several types of electric locomotives have been used with success, especially in long straight adit levels; there is here, however, considerable scope for improvement. A system of transport that appears to me to offer great possibilities has been used tentatively in one

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or two mines—namely, a monorail suspended from the roof of the level, upon which run boxes or buckets slung from carriers like those used on aerial tramways. There are various advantages that such a system should possess over tramlines and mine cars of the usual type, even if not combined with any method of mechanical haulage, and the ease with which electric traction could be applied to it is also evident; the idea is a novel one, and deserves, in my opinion, more attention than it has yet attracted. As regards winding, the existing methods may be said to be quite satisfactory for moderate depths When greater depths are attained, a number of very serious problems in winding will have to be faced, foremost amongst which we may perhaps place the winding ropes and the materials from which they will have to be made.

Pumping from great depths is another problem that awaits solution, although there are no grounds for supposing that it will present any formidable difficulties. In ordinarily deep mines it is now generally performed in stages of moderate height, and there is no difficulty in multiplying such stages to any desired extent. Moreover, single lifts up to 2,000ft. have already been worked in special cases. Much is expected from the modern system of multiple centrifugal pumps coupled direct to electric motors, which have been used to advantage in several cases for the unwatering of deep mines within the last few years.

The ventilation of the deeper mines has hitherto occasioned but little difficulty in the majority of cases, though some trouble has been experienced in some of the Victorian gold mines. It is probable that as mines become deeper, and at the same time very extensive, this branch of the subject will require more attention than has hitherto been needed on the part of metal miners, but there is at present no reason to suppose that the methods of ventilation elaborated to meet the requirements of coal mines will not prove equal to all demands that may be made upon them.

We come lastly to the treatment of the crude minerals after their extraction, which, as already pointed out, must take a prominent place among the mining problems of the future, because upon it depends in great measure the possibility or otherwise of working to advantage a number of low-grade deposits. This statement applies more particularly to the dressing of masses of rock containing disseminated ore, which requires concentration as a preliminary to its further treatment by smelting.

As already stated, the older process of separation depended entirely upon differences of density, and were conducted in hand appliances. About 1832 a Cornishman, Petherick, devised a mechanically-worked jigging machine, closely followed in 1833 by Berard in France, but it was not until the distinguished Austrian engineer, Von Rittinger, turned his attention to this subject about 1850 that any substantial advance was made, Rittinger being apparently one of the first to appreciate the importance of employing continuous-acting appliances for dressing purposes. Within the last half-century the art of dressing has made great advances, for which we are largely indebted to American ingenuity; I need only mention the Frue Vanner, an elaboration of the old Brunton cloth, invented in 1843, and the Wilfley table, a similar improvement on Rittinger's original side-blow percussion table, to indicate the trend of modern inventiveness.

Although all the earlier efforts of ore dressers were applied to separation of minerals of different specific gravity by the aid of water (hydraulic separation), attempts have not been wanting to perform the same operation in air (pneumatic separation). The first attempt at pneumatic separation appears to have been made about 1828, but without success, and very little more was done until Krom brought out his air-jig in 1868. This found application in a few isolated cases, and from that time to the present machines for pneumatic separation have been brought out periodically, but none have yet secured for themselves a permanent hold upon the art of dressing. The latest form is a percussion table, on which finely-divided mineral is kept in a state of mobility by air currents ascending through it, and it remains to be seen whether this will answer the expectations of its inventors.

The field for pneumatic concentration must always be a restricted one, owing to the fact that none but perfectly dry material can be submitted to the process, which in the majority of cases involves the expensive operation of artificial drying; nevertheless, there are certain special circumstances in which pneumatic separation could be applied with advantage, provided that a satisfactory machine were available.

I have already said that for centuries the only property made use of to effect the separation of minerals was the difference in their densities; in 1858, however, an entirely new property was brought into play for the purpose—namely, the difference in their magnetic susceptibilities. The idea was due to a famous Italian engineer, Sella, whose name is well known in connection with the Mont Cenis Tunnel. He was called upon to treat the iron ores of Traversella in Piedmont, which consist of magnetite containing a certain proportion of copper pyrites (the mass carrying 2 to 4 per cent. of copper), which interfered with the use of the ore for iron smelting. Sella devised a machine carrying rotating electromagnets, by which the magnetic iron ore was separated from the non-magnetic copper ore, so that both could be utilised.

Other machines on similar principles were subsequently devised, and, naturally enough, they emanated from countries rich in deposits of magnetite, such as Scandinavia and some of the Eastern States of America. Sweden especially took a prominent part in the development of the magnetic system of separation, and the Wenström machine, patented in 1884, which was one of the first practical machines brought out, is still largely used, as it is well adapted to the separation of lump ore. Other machines, more particularly designed for the treatment of finely crushed ore, were brought out in rapid succession, and to-day one of the main difficulties that beset the mining engineer lies in the selection of the most suitable machine for any given purpose out of the vast number with which the market is flooded. All these machines work either by means of a moving magnetic field, produced by travelling pole-pieces, passing through the mass of crushed ore, or by causing a stream of the ore to traverse a stationary field, these results being obtained either by travelling belts or revolving drums, or, as in the case of Edison's machine, by the deflection of a falling stream. It soon became apparent that, where very clean concentrates were required, the best results could only be obtained by applying magnetic separation to a pulp of mineral suspended in water, and wet magnetic separators were soon introduced, and are to-day preferred wherever possible; they avoid the necessity for artificial drying, which is, moreover, in the case of minerals that contain iron pyrites, apt to affect the magnetic susceptibility of this mineral sufficiently to interfere seriously with the success of the operation. Attempts have been made to devise magnetic separators without moving parts, by the use of polyphase rotating fields, but although the idea looks promising, no satisfactory machine on this principle has yet been constructed.

At first magnetic separation was only applied to the naturally magnetic ores, magnetite, and magnetic pyrites; it was soon, however, extended to certain other minerals that can be rendered magnetic by heating, such as spathic iron ore, brown hæmatite, iron pyrites, etc. As early as 1875 a magnetic separator was used at Przibram for separating roasted spathic ore from zinc blende, this forming an excellent example of the value of magnetic separation. The presence of spathic iron ore causes great difficulties in smelting zinc ores, as it forms a readily fusible silicate of iron which destroys the zinc retorts; at the same time, the densities of the two minerals are so nearly the same that separation by ordinary dressing is impossible. The application of magnetic separation has solved the difficulty, and has rendered available for the smelter numerous ferriferous zinc ores that were previously useless. The process is receiving an extended application in America for treating argentiferous galena and zinc blende, finely divided, and intimately mixed with a large proportion of iron pyrites, in which the proportion of zinc is too high to admit of the ore being smelted direct, whilst the large amount of iron pyrites present interferes with ordinary wet dressing. This ore is crushed and then

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gently heated, which renders the pyrites magnetic, so that it can be removed by a magnetic separator; the dressing of the residual mixture of zinc and lead ores by the ordinary methods then offers no particular difficulties

While the ordinary methods of magnetic separation were thus extending the sphere of their applicability, another form of magnetic separation was coming to the front. For a long time the method was confined to minerals that were naturally or artificially magnetic in the everyday acceptance of that word—that is to say, were capable of being attracted by an ordinary horse-shoe magnet. Faraday had discovered as far back as 1845 that numerous bodies, not magnetic in this ordinary sense, were nevertheless affected by powerful magnetic fields, but it was not until 1896 that this principle was applied to the separation of minerals by J. P. Wetherill. He succeeded in separating a series of minerals, all very feebly magnetic, from the somewhat more feebly magnetic zinc oxide and other zinc ores of New Jersey by the use of very powerful magnetic fields, produced by means of electromagnets with wedge-shaped pole-pieces, and since his original invention this principle (the magnetic separation of non-magnetic material, as it is sometimes called) has found an extended application, one of the most recent being the magnetic concentration of specular hæmatite by the Edison deflection method, using pole-pieces of the Wetherill type. Such separations as that of wolfram from tinstone, of raw spathic ore from zinc blende, of garnets from silver ore, which are necessary before any rational metallurgical treatment of the ores is possible, but which offer insuperable difficulties to the ordinary methods of dressing, have been rendered possible by the adoption of the Wetherill principle, and I see no reason to doubt but that it will find still more extended application in the future. I may point out that no successful wet separator for feebly magnetic minerals has yet been devised; this is a problem presenting numerous difficulties, but probably quite capable of solution, and, at the same time, very well worth solving.

Magnetic separation, though so comparatively novel, has already been extensively applied, the largest installations being naturally those for the treatment of iron ores. At the present moment the output of high-grade magnetite concentrate, produced by this process in Sweden, cannot fall far short of half a million tons per annum, and in Norway active preparations are in progress for work on a much larger scale at Dunderland, Salangen, Ofoten, and Sydvaranger, from which a yearly output of fully two millions of tons of high-class iron concentrates is expected.

Attempts to utilise other properties of minerals for their separation may be said to belong wholly to the present century. Thus Messrs. Blake and Morscher in 1901, and Mr. Negreanu in 1902, have attempted to use electrostatic methods, depending upon the variations in the electrification of minerals due to their varying electric conductivities. The former of these two methods has been used with success for the dressing of blende in the United States.

Finally, the difference in surface tension has been employed in Elmore's oil separation process, in the various flotation processes, devised since the discovery of the principle by C. V. Potter in 1901, and applied to the very intractable zinc-lead ores of the Broken Hill district of New South Wales, and finally in the Elmore vacuum process.

ELECTRIC SUPPLY PROSPECTS AND CHARGES AS AFFECTED BY METALLIC-FILAMENT LAMPS AND ELECTRIC HEATING.

The adjourned discussion on the paper on the above subject by Mr. H. W. Handcock and Mr. A. H. Dykes before the Institution of Electrical Engineers took place on Thursday, April 23.

Mr. Charles P. Sparks, who was the first speaker, said that as a supply companies' engineer he was very much interested in the paper by Messrs. Handcock and Dykes. Personally, he welcomed the advent of the metallic-filament lamp, which he looked upon as the greatest step forward in the electricity supply business during the last 20 years. He was not so pessimistic as the authors as to the effect of the new lamps upon electricity supply undertakings, and he thought there were many reasons why the business would not be handicapped by the advent of these lamps. In the first place, any new development came about gradually. The whole of their consumers could not change from carbon lamps to metallic-filament lamps in one day, and there was consequently a period for development. Then there was the question of the standard of lighting. If the public were content with the present standard, there might be some ground for suggesting that the supply business would be handicapped. But the whole standard of lighting would be raised by the metallic-filament lamp. He did not follow the authors' argument that as the gas companies were hit by the introduction of the incandescent mantle, so would the electric lighting undertakings be hit by the metallic-filament lamp. It had to be borne in mind that when the incandescent mantle came the gas companies had already a wide field without much room for further extension, whereas the field at present occupied by electric lighting was small, and, therefore, offered much scope for development. He thought it would pay them to connect a lot of moderate consumers. As to the different classes of business, the greatest effect of the metallic-filament lamp would be felt in the private lighting business. There were many small companies who carried on little more than this class of business, and in their case there might be a slight set-back, but the large companies and municipalities owning undertakings would obtain a great advantage. Discussing the question of tariffs, he said that he appreciated Mr. Arthur Wright's methods of charging, but he felt that they owed him a grudge for the introduction of the demand indicator, the use of which was now almost extinct. One of the reasons that business had gone ahead of late years was the simplification of tariffs. Not only was the demand indicator very complicated, but it could not be relied upon for accuracy. He thought the only method of charging which would be acceptable to the public was the flat rate. With regard to Mr. Long's system at Norwich, this might do very well in a small town owning a municipal supply undertaking, but it would not do in the case of companies.

Mr. C. H. Stearn agreed with the authors that the most satisfactory transition from carbon to metallic filament lamps was made on alternating currents by the use of automatic transformers. In that case they could obtain a lamp comparatively small and cheaper in cost. When, however, they came to direct currents, or alternating currents, without the use of transformers, the problem was much more difficult. They had then to burn them in series. The evil of this system was that the higher the voltage the larger must be the unit of light that was concentrated on one spot. If it was necessary to burn in series, it seemed to him that the best plan was either to collect all the filaments in one bulb, or place each filament in a separate bulb or tube, and connect them on a common base. The latter was the most efficient means of lighting. It reduced the risk of loss through breakage, for if one filament got broken it could easily be replaced. Again, the average life of the lamp was much increased. He had recently carried out some experiments with this system, and found that the total cost of burning the lamps worked out at 2s. for 500 hours, instead of 5s. for 600 hours with ordinary lamps. The slightly increased first cost would be more than counterbalanced by the saving in maintenance. Of course, lamps used in this way would still leave the difficulty of large concentration of light on one spot, but this would be overcome by distributing the lights round the room instead of connecting them on one base. One objection to this was that if one of the lamps became extinguished, all others would go in the same way, and there would be difficulty in finding out which lamp had gone wrong. Mr. Stearn gave a demonstration with this method of placing the filaments in separate bulbs and connecting them on a common base, and showed an arrangement which prevented all lamps going out if one of them failed. This consisted of putting a fuse in the circuit which shunted the current through the resistance and maintained it. In this way he had been able to burn 10 units of 20 volts each, eight units of 25 volts each, and four in series of 50 volts each. Series lighting could be employed with high pressures almost as conveniently as parallel lighting.

Mr. Percy Still (Chelsea Company) thought the authors' scheme of a contract demand tariff interesting and ingenious, and, from the point of view of providing an adequate return for the capital laid out in giving a supply to each individual consumer, was satisfactory. A point in its favour, too, was that it did away with the necessity of using more than one meter. He regretted, however, that the system of charging was not practicable, and pointed to two very serious difficulties which it offered. In the first place, the arbitrary fixing of the contract demand by the central-station manager would be a very difficult matter, and would lead to constant differences with the consumer, more particularly in the case of private house lighting. Whatever knowledge the manager might have of the consumers in his district, it was impossible for him to know the habits of the individual con-

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sumers, the manner in which the installations had been wired, the distribution of lights in rooms, the candle-power and efficiency of lamps, and the uncertainty as to how the lamps might be changed by the consumer. Again, the irregular use of heating and other electrical apparatus made the fixing of the tariff a difficult matter. The limit indicator would be unsatisfactory and expensive to maintain, and would lead to difficulties with the consumer. The second objection was that any system based on a constant demand presupposed a fairly regular annual demand by the consumer. This might be all right in the case of shops, but not in private houses, owing to the irregular manner of its use. His practical experience of electricity supply works had led him to believe that for domestic electric supply it was of the utmost importance to have the simplest form of charging, and what the private lighting consumer wanted was a flat rate.

Mr. LEONARD ANDREWS was of the same opinion as the previous speakers in respect of the excellence of the metallic-filament lamp, and he drew attention to the annual report of a certain undertaking which last year showed a large falling off in revenue due to the use of metallic-filament lamps. He had also heard of another station at which the normal rate of increase was 17 per cent. per annum, but which, since the new lamps were used on the circuit, showed an increase of only 4 per cent. As to charging, he thought the more they talked about it the further they seemed to get away from any real solution. He was of the opinion that even a flat rate was very inequitable, and urged that we should get away from the idea that a unit of electricity was a commodity which could be sold for a fixed price no matter for what purpose it was to be used. He next spoke of the system at Hastings, to which reference had already been made, and stated that the reason the system had worked so satisfactorily was that the consumers understood it very well.

Mr. JOHN F. C. SNELL took a more optimistic view of the metallic-filament lamps than the authors did. He thought that the automatic transformer and fixing the lamps in series were only temporary expedients, and he was of the opinion that the inventive genius of the lamp manufacturer would get over the difficulty of burning low candle-power metallic-filament lamps on high-voltage circuits. The authors' figures in respect of capital outlay gave a very pessimistic impression, but he pointed out that the average profits in the case of gas was 5·44 per cent. and electricity 6·89 per cent. If the gas companies had to pay to a sinking fund in addition to their interest on capital n the same way as electricity undertakings, they could hardly hope to pay even the average profits that they did. As to charging, he asserted that the flat rate was not only scientifically the correct way of charging, but was commercially sound. As the supply of electricity became more general, they would be in a better position to charge a uniform flat rate with varying degrees of discount according to the class of user.

Mr. ROBERT HAMMOND thought it unfortunate that an evening devoted to a paper on metallic-filament lamps should be taken up in discussing tariffs. The metallic-filament lamp was a magnificent thing for the electrical industry, as it afforded them the opportunity of supplying electricity cheaper than gas. In many foreign cities gas had been entirely abolished. He thought that there was too much light in the rooms of many houses at present. The new lamps would send electric lighting into the rooms of houses having an electric lighting installation, which were now lit by gas, and they would also open out a much wider field by taking in small consumers. Smaller outputs were to be expected for a short time, but they would soon get over this. He quoted statistics showing that in London, at all events, they were not going back. In 1901 the output in London amounted to 69 million units, an increase of 34 per cent. on the output of the previous year. In 1902 the output was 86 million units, or 26 per cent. increase on that of 1901. In 1903 the output was 110 million units, showing an increase of 27 per cent. In 1904 the output was 129 million units, an increase of 17 per cent., and in 1905 it was 154 million units, or 19 per cent. greater than in the year preceding it. In 1906 the increase was 13 per cent., and up to March 31, 1907, it was 12 per cent. He agreed with the authors of the paper as to the absurdity of charging heating at a different rate from lighting, though a differential rate was permissible in factories with a large load factor. The point they had to arrive at was what was the form of charge which would secure to the electricity undertaking the most profitable class of consumer. They were all agreed that that class was the one that used the light the longest number of hours. Some seemed to be under the impression that this consumer could be best obtained by a flat rate. He entirely dissented from those who held that opinion. The flat rate was the form of charge which tended to encourage the short-hour consumer, since by it he obtained his electricity at lower than cost, the loss upon his consumption being put upon the long-hour consumer. Mr. Hammond was strongly of opinion that Messrs. Handcock and Dykes were working on the right lines, and that their proposed contract demand system was one which would abolish many of the unpleasantnesses connected with the Wright maximum demand system. He saw, however, some objection to a system which might entail a constant source of anxiety upon the consumer, and he welcomed Mr. Long's bright idea that each consumer should be charged a rental based upon the assessment value of his house, and in addition a small running charge. The desire of the consumer to know exactly what his electricity was going to cost would almost be entirely satisfied by the general application of the system, as he could very easily be made to understand what would be the probable addition in respect of running charges for the amount of electricity consumed. Mr. Hammond trusted that the outcome of the debate would be a determined attempt on the part of the leaders of the industry to get the Board of Trade to insert into their next Electricity Bill a provision enabling the electricity supply undertakings throughout the kingdom to make a fixed charge, whether by means of a "rate per kilowatt of maximum demand" or by a proportion of the assessment of the premises. With regard to the "fixed rate per kilowatt of maximum demand," this had figured in all the recent Power Acts and Bills, and was included in the three Bills of this session.

Mr. LEON GASTER suggested that the consumer should have the advantage of the maximum demand, subject to the condition that when the rate was worked out he was charged a little more than he would be under the flat rate, to cover the use of the apparatus. If this were done, it would benefit the industry. What the central station should do was to educate the consumer how to use his lamps properly. If they wanted to increase their load, they would have to employ a well-educated canvasser, who would make a special study of the electric illumination business, and who would act as a medium between the central station and the consumer. He suggested that central-station engineers should confine their attention to the more remunerative fields and leave gas alone where they could not hope to compete with it satisfactorily, instead of fighting it tooth and nail.

Mr. K. A. SCOTT-MONCRIEFF said that in many cases the cost of house services had decreased, and would continue to decrease. When they could get more services, they would get a lower cost of mains for lamps fixed. Hitherto, when they had gone for small consumers it was those of the two or three rooms type. But they ought to make a bid for the class of consumer who lived in larger houses, such as in the provinces were known as £30 per annum houses. He pointed to the motor load as a valuable means of making-up for the temporary diminution in the output. At Darlington last year, 38 per cent. of the output was used for traction, 38 per cent. for lighting, and 24 per cent. for motors.

Mr. E. T. RUTHVEN MURRAY (North Metropolitan Power Company) asked for further particulars as to tests on the authors' power transformer. With regard to small consumers, one of his companies had 23 per cent. of the free-wiring class. and while five years ago the revenue on capital expenditure was 16 per cent. it had now gone down to 12½ per cent. Even the latter figure was good, and made it worth the company's while to develop that class of business. The three-wire installation consisting of about six lights was a good thing in small towns. They got about 20 units for 8-c.p. lamps connected on these three-wire installations. In his opinion the reason the maximum demand system had been unsatisfactory was because the contractors did not understand it, and if they had taken the trouble to find its simplest form, the use would have been much more general than it now was. As to the difference in charging and the necessity for separate meters, he pointed out that the schedule prescribed one price for lighting and another for power and all other purposes. He thought the contract demand would give one a burdensome life.

Mr. FRANK GILL (National Telephone Company) proposed to speak of rating only, and, although he had not particularly studied electric light rating, he had made a very careful study of the subject of telephone rating, and he thought that the experience with the one might be of some guidance in dealing with the other. It seemed to him that the maximum demand system of any kind acted as a disadvantage to a consumer to put in lamps or other devices. It was important that there should be a schedule of prices which was satisfactory and easily understood. In the telephone system they had a maximum demand system, but it was much simpler and had a larger sliding scale than the maximum demand system they had been discussing. The telephone system took into consideration the standing charges, the cost of getting ready to serve, and the cost of serving. If electric lighting people put their charges into a scale like this, they would obtain more satisfactory results.

Mr. R. B. MATTHEWS urged that the central stations should aim at increasing the standard of illumination, encouraging a demand for other current-consuming devices, increasing the number of consumers, and reducing the cost of service connections. He took exception to the authors' statement that there were not many places where the number of consumers could not be increased, and thought it could easily be accomplished in two years by a well-organised publicity department.

Mr. W. M. MORDEY thought that "metallic filament" was an improper designation for the new lamps, and suggested that they should be known as "wire lamps." He agreed with other

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speakers that the wire lamps were going to do great things for the electrical industry. He also adversely criticised the demand system, and pointed out that it did not give what it was supposed to do. As showing how its use was being abandoned, he mentioned that in 1901 there were three demand systems to one flat system. Now there was one demand system to three flat systems, while a third had also arisen in the meantime. The ratio was now three flat, three optional, and one demand. Since 1901 the output from stations had increased fourfold, and the average price per unit had come down threefold.

The PRESIDENT (Colonel R. E. Crompton) briefly summarised the debate. He said it was interesting to hear how completely each man looked at the question from his own point of view only. He pointed out that those engaged in the business of electricity supply were not now the hopeful people that they were once. They had got nearly to the bottom of their curve as to cost, and nothing would help them except greatly increased outputs and improved load factors. Those who blamed central-station engineers for not doing everything possible to get greater outputs were wrong. They had endeavoured to encourage the lighting and heating and power loads, but had been disappointed. It generally happened that the heating load came on at the same time as the power load. The companies had to pay back to the municipalities 10 per cent. in rates, and this figure was likely to increase, while the cost of fuel was really considerable. As to the question of charging, he was surprised that none of the speakers had tackled the Norwich question, of which the chairman spoke favourably. Their water charges were based upon the rateable value of their houses, and it seemed to him an eminently equitable method.

Mr. A. H. DYKES, one of the joint authors of the paper, replied to the discussion. He said that tariff reform was a difficult subject even if it was only in the electrical world, and they were, therefore, not surprised that very diverse opinions had been taken of the points raised in the paper. In replying to the discussion, he proposed to treat first the effect of the metallic-filament lamps on the station output if the rates were kept as at present. Mr. Wright said they must induce people to use three times the amount of light to keep their consumption the same—a delightful solution to the problem, but how could it be done? People did not greatly increase their light, but they did reduce their consumption. Probably every member could bring forward instances of this, and many, particularly those in charge of alternating-current stations supplying residential districts, could point to the mournful fact that their output had fallen considerably below what it was a year a two ago. He referred to a diagram on the wall showing the output of a certain well-known alternating-current station. It showed that during the last three years lamp connections had increased with satisfactory regularity, and up to last summer the output increased in an equally gratifying manner. During last autumn the district was invaded by the new lamps, with the result that the station output gradually diminished, until at the present time it is well below what it was two years ago. The engineers in charge of these stations were advised not to be troubled, but to wait patiently, and in a few years' time the increase in the number of consumers would more than repay them for the temporary diminution in their receipts. Mr. Hirst, with his well-known business ability, saw clearly from the beginning that the effect on the stations might be serious to commence with, and, personally, he regarded it as a great pity that the offer which he made to the station engineers was not accepted. He, nevertheless, was one of those who strongly urged that station engineers should do nothing. Mr. Hirst had been a maker of lamps for years: when the conditions altered he found himself in the possession of a lamp which would give three times the light for the same amount of current. At the same time the station engineer found the conditions changed, and his current was able to give three times the amount of light that it did formerly. Mr. Hirst's advice to the station engineer was to continue to sell current at the same price, cheerfully endure the loss for a longer or shorter period, in the hope that eventually he would recoup himself. It was to be expected, therefore, that Mr. Hirst sold his new lamps at the same price as the old, and trusted to the increased sales to repay him. Is that what had happened? No. Mr. Hirst charged for his new lamps four times as much as for the old, but promised that as the sales increased, and he found himself in a position to do so, he would lower the price. Mr. Dykes thought the station engineer would do well to follow Mr. Hirst's practice rather than his precepts. Again, if it were true that the effect of these lamps, giving three times the amount of light for the same current, would be to induce such a rush of customers as to more than repay the station engineers for their initial loss, surely the same thing might have been met in the days of carbon lamps by boldly reducing the price of current to one-half. Mr. Wright stated that if the output of the Marylebone station were doubled, the cost would immediately come down from 4½d. to 2½d. Surely, then, if their critics were right, what he should have done a year or two ago was to reduce his price from 4½d. to 2½d., when the increase in new consumers would have more than recouped the loss. He did not do so, however. Both he and Mr. Bottomley Smith were well aware of the service difficulty, and both hoped that it would be overcome in the future; but that day was not yet, and meantime he thought it might be taken that the discussion had endorsed their view that if matters were left as they were the stations would be, for a longer or shorter time, badly affected. Capital was at the present time very nervous, and local authorities hesitated before expending money on electrical plant. The effect of a cessation of dividends or a call on the rates, even if only for a short time, would be very far-reaching and would greatly affect every section of the electrical industry. In the light of the fact that a consumer using the new lamps could be charged as high as an average of 1s. 2d. per unit without affecting his total lighting bill, what possible reason was there for the industry incurring a loss when it could be avoided by a slight adjustment of price? Given that a readjustment was necessary, on what basis should it proceed? Since their paper had been written they (the authors) had been gratified to find that many others who had given thought and attention to the subject had arrived at practically the same conclusions as themselves. Mr. Long was one of those, and he had explained his method of carrying it into effect. His system was practically the same as their own, with the exception that he did not use limit indicators, and relied for carrying it into effect on his knowledge of every consumer's load factor and maximum demand, the latter obtained apparently by maintaining their lamps. He supplied two valuable facts: firstly, that the consumers easily understand the system, and did not object to it, thus answering Mr. Smith; secondly, that the consumption per lamp increased.

Mr. Bowden, of Poplar, had sent in a written copy of his contribution to the discussion. He pointed out that in 1906, without having metallic-filament lamps in mind, he came to the same conclusions as themselves—viz., that consumers should be charged a rental depending on their demand on the station, and, in addition, a meter charge to cover the running costs. After careful analysis of the Poplar accounts they constructed a table showing that at that time the consumer who used his lights on an average of only a quarter of an hour per day cost the station 28d. per unit; the one-hour consumer, 7·35d.; the six-hour consumer, 1·6d.; and the 24-hour consumer, 0·74d.; or, in other words, that the short-hour consumers were a dead loss to the station even if charged the full 8d. per unit. If that were true in the case of a large metropolitan station, it was still more true in the case of a rural or suburban station. What possible justification could there be under these circumstances for charging a flat rate, and for the Legislature by retaining the 8d. limit, causing the station to charge a man who should only pay 0·74d. per unit four or five times as much, simply in order that a number of other consumers should have their current at far below cost price. Engineers generally being agreed upon the principle of charging, the question remained as to the best method of carrying it into effect. Mr. Bowden stated that the whole paper "is based upon a misconception of the fundamental principle of equitable charging." To prove his point he took the following figures relating to the Poplar station. He estimated that during the year the figures would be:

	Maximum load on station.	Units consumed.	Price per unit charged.	Total revenue!
Power	1,700 kw. ...	4¼ millions. ...	1·05d. ...	£18,593
Private lighting	1,000 kw. ...	1 million. ...	3·43d. ...	14,291
Public lighting	200 kw. ...	¾ million. ...	1·5d. ...	4,687

He then attempted to apply their system to these figures, but, unfortunately, had made two mistakes. The first was that he had added all his expected profit on to the rental charge, and the second that he had charged the consumers on the capacity of plant or lights installed instead of on their contract demand. The effect of that, of course, would be the same as the original Hopkinson method—to reduce the lights installed. All that concerned the station was the demand the consumer elected to make on it. They agreed, nevertheless, that the effect of their system on his figures would be to somewhat increase the charge for power and reduce it for private lighting. This Mr. Bowden considered absolutely wrong. On examining his figures they found that his revenue from 1,700 kw. power demand was £18,593 per annum, or, in other words, he got £10·94 per kilowatt of demand on the station, for which he supplied 2,500 units per kilowatt, which was equivalent to running his plant for 2,500 hours per annum. From the 1,000 kw. of private lighting demand he received a revenue of £14,291, or £14·3 per kilowatt of demand on the station, for which he supplied 1,000 units per kilowatt, equivalent to running his plant for 1,000 hours, and for public lighting £23·43 per kilowatt of demand for 3,750 hours. Thus the lighting consumer paid nearly 40 per cent. more per kilowatt of demand on the station, although the latter used the plant two and a half times as long. It was clear also that public lighting was also penalised to subsidise the power consumer. This was also clearly not "equitable charging," although they did not deny that in certain cases it might be good business policy to encourage the use of current for power

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purposes. Mr. Wright also pointed out that the current for power should be supplied at less cost than for lighting, owing to its greater diversity factor. Their system, as proposed, went a long way towards meeting this, and could be made to do so absolutely. If a consumer had lamps connected of a total capacity of 100 kw., he would probably put his contract demand at 70 kw. If he had motors of an aggregate capacity of 100 kw., owing to the greater diversity factor he would probably put his contract demand at 35 kw. In the first case, therefore, his rental charge would be double what it would be in the second. This, however, like the maximum demand system, was not quite fair to the consumer with only one motor, as his diversity factor in that case would be unity. It was well known that if a demand indicator were put in works with 10 1-h.p. motors, and then demand indicators were put in 10 works each with one motor, the revenue derived from the 10 installations with one motor each would be considerably greater than that derived from the works with 10 motors. The point, however, was easily met by charging power consumers a lower rental per kilowatt of contract demand, and public lighting a somewhat higher one than lighting consumers, the exact difference depending on the ratio between their diversity factors and the proportion which each bore to the total demand on the station. To show how this worked they took Mr. Bowden's figures, which were very interesting, their own used in preparing the paper being for stations supplying practically private lighting only. The total revenue was £37,571. of which £4,000, or just over 10 per cent., was profit. He sold 6,000,000 units, which at 0·45d. (his estimated running costs), plus 10 per cent. for profit, equalled £12,375. His standing charges, including 10 per cent. profit, were £24,200. It was clear that this amount must be allocated amongst the three classes of consumers in proportion to their maximum demand on the station. (This assumes, as would be approximately the case, that the demands coincided.)

Power should pay 17/29 of £24,200
= £14,180 + 4¼ million units at 0·495d. = £22,945.

Private lighting should pay 10/29 of £24,200
= £8,344 + one million units at 0·495d. = £10,406.

Public lighting should pay 2/29 of £24,200
= £1,669 + three-quarter million units at 0·495d. = £3,218.

Having thus obtained the total amounts to be obtained from each of the three classes of consumers, it only remained to allocate it amongst the individual members of each in proportion to their contract demands. What proportion these would bear to the maximum demand on the station could only be arrived at by one familiar with the district and the individual consumers. They assumed that the 1,700 kw. maximum power demand on the station derived from 6,370 kw. installed would give 3,685 kw. of contract demand; 1,000 kw. private lighting, 2,500 kw. installed, 1,500 kw. of contract demand; 200 kw. public lighting, 200 kw. installed, 200 kw. of contract demand. This would bring out the charges for the three classes:

Power	£3·84 per kw. contract demand and	0·495d.	per unit.
Private lighting	£5 56 ,,	,, 0·495d.	,,
Public lighting	£8·3 ,,	,, 0·495d.	,,

For comparison they had put these figures beside Mr. Bowden's:

Mr. Bowden's			Handcock and Dykes		
Total revenue.	Average per unit.		Total revenue.	Average per unit.	Rent per kilowatt contract demand.
			Power.		
£18,593 ...	1·05d. ...		£22,945 ...	1·29d. ...	£3·84
			Private lighting.		
£14,291 ...	3·43d. ...		£10,406 ...	2·49d. ...	£5·56
			Public lighting.		
£4,687 ...	1·5d. ...		£3,218 ...	1·027d. ...	£8·3

At first sight, some might be surprised that the rental per kilowatt for public lighting should be more than for power or private lighting. The reason was, of course, that owing to the long hours and unity diversity factor of public lighting load a portion of the plant was practically reserved entirely for it.

Mr. Rawlings raised a very practical point as to what would happen, say in a West-end house, where they occasionally wanted a temporary extension of their installation for an entertainment. This would be met by a special charge for the evening being made, and the amount of this charge would obviously depend on the time of year and whether the plant of the station was fully loaded or not, and would easily be arranged by the engineer in charge of the station. A complaint was often made against electrically-lit houses that, owing to passage and bedroom lights, etc., being immediately switched off when not actually required, the houses look dark. Again, people often used gas for kitchens and passages and other long-hour lights, and kept electricity for the short-hour lights. This state of affairs, which was absurd in the light of the figures given in the paper as to the relative capitalisation of gas and electricity undertakings, had been brought about entirely by the use of the flat rate. Once the contract demand system was adopted it made very little difference in the annual bills if such light were used for double the length of time, a result which would go very far to make electric lighting popular. This effect was clearly borne out by Mr. Long's results. The system could, of course, be adopted without increasing the average price at all, if it was not considered that an increase was necessary. Consumers would be given the option of being charged on this system or on the maximum flat rate provided in the schedule of that particular order. In many districts it would probably be found advisable to boldly recommend all consumers to use the new lamps, pointing out to them the saving to be effected, and adjusting the rental charge to such a figure as would give an increased return per unit, sufficient to counteract the falling off in the demand of individual consumers. Although this would meet the position in most cases, they were strongly of opinion that the inequality of the present legal flat rate should be brought before the authorities. The Board of Trade, they had reason to believe, would consider sympathetically any representations made by the Institution. They were of opinion that it would be necessary to raise the average price above the present statutory limit, but were firmly convinced that they should have powers to charge unprofitable short-hour consumers more than they were at present paying in order to reduce the price to the more remunerative long-hour consumers, and thus compete with other illuminants on a more logical and at the same time more remunerative basis. Obviously there were many points better discussed and many speakers who would prefer to speak in private, and they ventured, therefore, to suggest that the Institution should call together a committee of those most interested in the matter to consider if joint action was advisable, and, if so, to formulate proposals.

Mr. W. R. Cooper (*communicated*) thought the authors were to be congratulated on bringing this subject before the Institution, although there might be great differences of opinion as to the metallic-filament lamp doing any harm to the industry. It was a curious fact that we had all devoutly desired the advent of the high-efficiency lamp for years past, and yet when it came it was not received with universal thanksgiving, except by the consumer. In this connection it was worth while to remember that a great deal had been done in recent years for the station engineer, and it was only fair that the consumer should now begin to benefit. The consumer had suffered by having to use comparatively inefficient lamps to enable the station engineers to use higher pressures. Doubtless the consumer had benefited in a way; he got his energy at 4d. instead of 6d., but he had to use six units where four units ought to have been enough. Nevertheless, they had no wish to see the station engineer in difficulties. He (Mr. Cooper) thought there would not be any great falling off in revenue except on alternating-current networks, and this would be more than counterbalanced in many cases after a time by the new fields rendered available by metallic-filament lamps. Meanwhile there might be some difficulty. But any restrictions on consumers would be most unwise, and the raising of prices as a solution of the difficulty should be adopted only a last resource, as it might interfere seriously with the use of electricity for purposes other than lighting. Probably the most important point raised by the authors was the question of the small consumer. Cheapness in light was essential to the small consumer, but if he became unremunerative owing to the cost of the service, it would be a serious matter. It would be necessary to modify their methods and to imitate those in use on the Continent. Hitherto they had done their work in many instances in too solid a style. There should be no great difficulty in running a service cheaply along a whole block of buildings, say, under the first-floor windows. Such methods, combined with the cheap Continental system of wiring with unprotected wires, would do much to improve the situation. But this would not come about without some combination between contractors and station engineers. Another most important point raised by the authors was that of tariffs. There was much to be said in favour of the tariff suggested by the authors, and it was often absurd, as had been pointed out, to distinguish between different uses to which the energy was put. The great defect, however, of all systems depending on a maximum demand was that no distinction was drawn between different times of day. There was no objection to a comparatively heavy load from a consumer if it did not come at the time of peak load at the station; in fact, it would be welcomed, but any maximum demand tariff discouraged it, and thus the use of energy for heating was penalised.

A CONSTANT-VOLTAGE DYNAMO.

M. Iglésis recently described before the Société International des Electriciens a simple method of obtaining a constant-potential variable-speed dynamo. He arranges for a variable amount of brush lead according to the speed, and so reduces the number of effective conductors as the speed increases. This is attained automatically by keeping the brushes fixed, but allowing the magnets to be more or

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less displaced around the armature by the electromagnetic drag which exists between the armature conductors and the magnets. This drag is opposed by the weight of the magnets. For each speed there is a definite position of equilibrium for the magnets, and this position for high speeds is equivalent to a greater amount of displacement of the brushes from the neutral line than is the position for low speeds. In this way variations in the speed of dynamos driven from the axles of a train or a motor can be completely and quickly compensated for. The arrangement can be conveniently used in connection with a battery and automatic cut-out.—*L'Industrie Electrique.*

RECENT IMPROVEMENTS IN STORAGE BATTERIES.

The Chloride Electrical Storage Company, Limited, have recently introduced some modification in the design of their well-known wood separator, which is such a distinctive feature of the Chloride accumulator. The thin sheet of wood (Fig. 1) the exact size of the plates with which it is employed forms a continuous diaphragm between each positive and negative plate, and is supported by two wooden dowels slotted to receive it. These, instead of resting on the bottom of the box, as was formerly the case, are now provided with small rubber rings at their top ends, which enables them to be suspended from the edge of the plate, and the wood dowel projects but little beneath the bottom of the plates. The wood forming the separator is subjected to a special treatment before being put into the cells, which entirely removes from it all substances which would otherwise be deleterious to the plates and cause rapid disintegration.

FIG. 1.—Chloride Wood Separator.

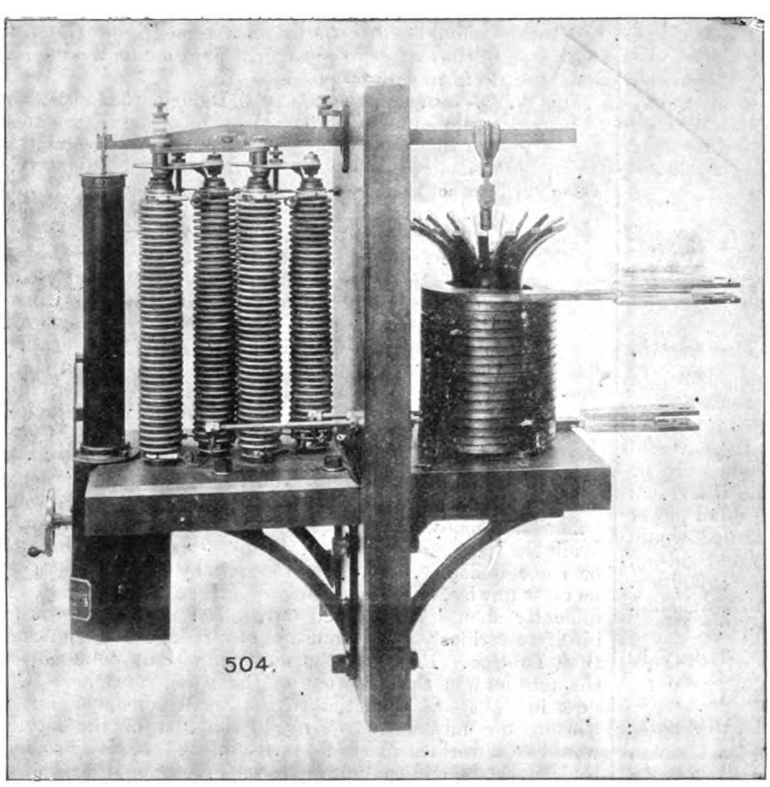

FIG. 2.—Entz Type Battery and Booster Arrangement.

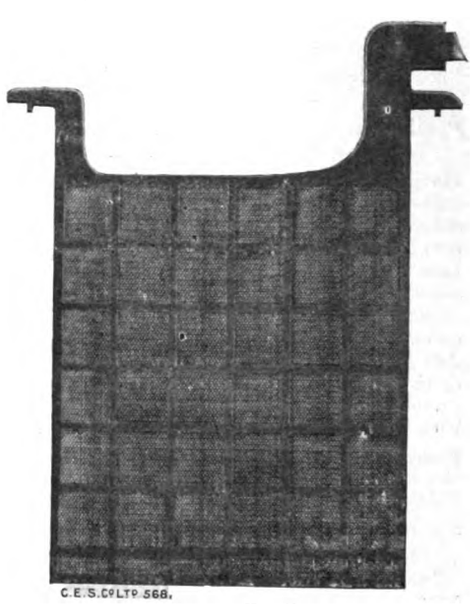

FIG. 3.—Box Negative.

The new type of negative plate which the company are now manufacturing is a radical departure from the usual design, the frame being made in two halves, riveted together after the insertion of the active material, which is thus contained in a series of small cages or boxes. For this reason the type of plate is called the "box" negative. It will be noticed from the illustration (Fig. 3) that the outside of the plate is covered with a finely-perforated sheet of lead, which prevents the active material from falling out. The chief advantage of this method of construction is that the capacity of the plate can be maintained practically constant over a long period of years, the arrangement of the active material and its special composition together proving an ideal combination.

The Chloride Company have for many years past been devoting special attention to the adoption of batteries in series with automatic reversible boosters in conjunction with generators working on very variable loads, such as traction circuits and the like, and have attained some striking economies in this class of service with their Entz type booster (Fig. 2). The operation of this is controlled by a special carbon regulator, consisting of piles of thin carbon discs which are coupled up like the arms of a Wheatstone bridge, the current in the exciter fields varying in direction and amount with changes in the pressure on the carbon piles. Over the carbon piles is pivoted a balanced lever, from one end of which is freely suspended the soft-iron core of a solenoid which carries the entire generator load, while to the other end is attached a helical spring, the tension of which may be adjusted by hand to counterbalance the pull of the solenoid at any desired load on the generators. Slight variations of load above or below this amount will cause changes in pressure on the carbon piles, resulting in wide variations in their contact resistance, thus controlling the field excitation of the booster.

In one electricity works supplying current for both lighting and power purposes, although the power load with which the battery booster deals is only about three-eighths of the total output of the station, the total consumption was reduced by 20 per cent. when the battery and booster were started up, which resulted in a saving of over 2,000 tons of coal per annum, comparing the cost per unit delivered before and after the booster was installed. Results obtained elsewhere entirely corroborate the results mentioned above.

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TRANSATLANTIC WIRELESS TELEGRAPHY.*

BY G. MARCONI.

Before I go into my subject of Transatlantic wireless telegraphy, it might interest you to know that the invitation from the Royal Institution to deliver this lecture was sent to me by Transatlantic wireless telegraphy on Oct. 19 when I was in Canada. The following is the text of the message:

"MARCONI, Glace Bay.

"Hearty congratulations on behalf of Royal Institution, the home of Faraday. We invite you to give first Friday evening discourse on 17th January next. Please reply by wireless.

"SIR WILLIAM CROOKES, Royal Institution, London."

To which I replied, also by wireless:

"By means of ether waves across Atlantic I thank you for honour invitation to lecture at Royal Institution. Owing uncertainty my future plans, greatly obliged if you will permit me postpone acceptance until I return to London. "MARCONI."

I have had the honour on previous occasions of describing before this institution some of the stages through which the application of electric waves to telegraphy through space has passed. This evening I propose to confine myself chiefly to describing the results and observations recorded during the numerous tests and experiments which I and my collaborators have been carrying out with the object of proving that wireless telegraphy across the Atlantic was possible, not merely as an

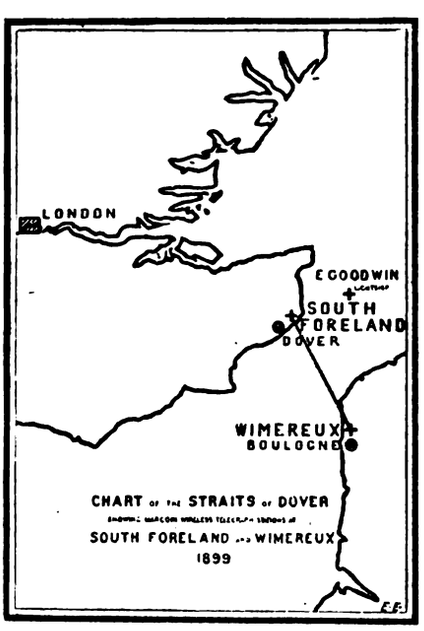

FIG. 1.

experimental feat, but as a new and practical means for commercial communication.

In March, 1899, communication was established by means of my system of wireless telegraphy across the Channel between England and France (see Fig. 1), and the *Times* of March 29 of that year published the first Press telegram ever transmitted to England from abroad by means of electric wave telegraphy. At that time a considerable discussion took place in the Press as to whether or not wireless telegraphy would be practicable for much longer distances than those then covered, and a general opinion prevailed that the curvature of the earth would be an insurmountable obstacle to long-distance transmissions, in the same way as it was, and is, an obstacle to signalling over considerable distances by means of optical signals, such as flash-lights, the heliograph, or the semaphore. Other difficulties were anticipated as to the possibility of being able practically to employ and control a transmitter capable of radiating an amount of electrical energy large enough to actuate a receiver at really great distances, and, granting the possibility of this, whether such a powerful radiator would not interfere with the working of all other wireless stations which might be established on shore or ships within the sphere of influence of the long-distance sender.

What so often occurs in most pioneer work has repeated itself in the case of long-distance wireless telegraphy—the anticipated obstacles and difficulties were either imaginary or else easily surmountable, but in their place unexpected barriers manifested themselves, and my efforts and those of my collaborators have been mainly directed to the solution of problems presented by difficulties which were not anticipated when the tests over long distances were first initiated. In January, 1901, wireless communication was established between St. Catherine's Point, in the Isle of Wight, and the Lizard, in Cornwall, over a distance of 186 miles. The height of these stations above the sea-level did not exceed 300ft. (100m.), whereas to clear the curvature of the earth a height of more than a mile at each end would have been necessary. The result of these tests went far to convince me that electric waves produced in the manner I had adopted were able to make their way round the curvature of the earth, and that, therefore, it was not likely that this factor would constitute a barrier to the transmission of waves over greater distances. At this time I had achieved a considerable measure of success, by means of syntonic or tuning devices, in preventing mutual interference between stations, and Prof. Fleming described in a letter to the *Times*, dated Oct. 4, 1900, the results obtained, and which he and others had witnessed.*

The principle on which the transmitters and receivers at St. Catherine's Point and the Lizard were worked is shown in Diagrams 3 and 4. At the transmitting end a condenser, usually taking the form of a battery of Leyden jars, had one terminal connected to one spark ball of an induction coil or transformer, and the other to the primary circuit of an oscillation transformer. The opposite terminal of this transformer circuit was joined to the second spark ball. The condenser was charged to the potential necessary to produce a suitable spark by means of an induction coil. The secondary circuit of the oscillation transformer was inserted between the vertical conductor or aerial wire and earth, and an adjustable inductance coil included in the circuit. The circuits consisting of the oscillating circuit and radiating circuit were more or less closely "coupled" by varying the distance between the primary and secondary of the oscillation transformer. By the adjustment of the inductance inserted between the elevated conductor and earth, and by the variation of the capacity of

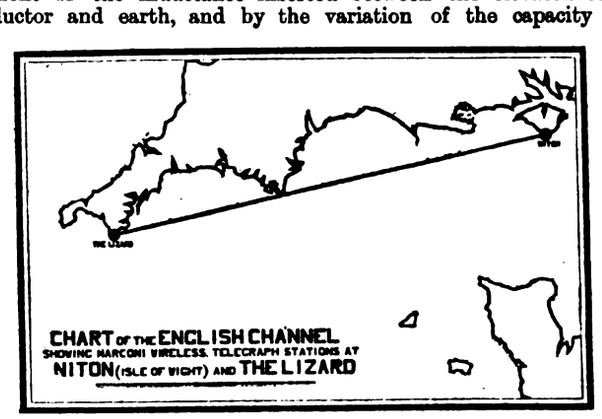

FIG. 2.

the primary circuit of the oscillation transformer, the two circuits of the transmitter could be brought into resonance—a condition which I first found was absolutely necessary in order to obtain efficient radiation. The receiver consisted also of a vertical conductor or aerial connected to earth through the primary of an oscillation transformer, the secondary of which included a condenser and a coherer, or other suitable detector, it being necessary that the circuit containing the aerial and the circuit containing the detector should be in resonance with each other, and also in tune with the periodicity of the oscillations transmitted from the sending station. The energy employed to signal over a distance of 186 miles could be brought as low as 150 watts, and even less if a higher or larger aerial had been used. The facility with which distances of over 100 miles could be covered prior to 1900 and the success of the methods for preventing mutual interferences* led me to advise that two large power stations be constructed, one in Cornwall and the other in North America, in order to test whether it was possible to transmit messages across the Atlantic Ocean.

I have often been asked why I did not first endeavour to establish commercial communication between places situated at a shorter distance. The answer is very simple. The cables which connect England to the Continent, and between most Continental nations, are Government-owned, and these Governments would not, and will not, allow the establishment of any system, wireless or otherwise, which might in any way tamper with the revenue derived from these cables. As regards Transatlantic communication, however, the conditions were different. There was no law either here, in Canada, or in the United States to impede the working of wireless telegraphy across the Atlantic. A further potent reason—moreover, an economical reason—prompted me to attempt communication with America. Notwithstanding the cost of high-power stations, I am convinced that it is more profitable to transmit messages at 6d. a word to

* Lecture given before the Royal Institution, Friday night, March 13, 1908.

* See *Journal* of the Society of Arts, vol. xlix., No. 2,530, May 17, 1901.

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America than at, say, ½d. a word across the Channel, and that the economical advantage of wireless over cables and land lines increases instead of diminishing with the distance. A site suitable for a long-distance station was chosen at Poldhu, in Cornwall, and here in 1900 work was commenced in earnest — work in which I was ably assisted by Prof. J. A. Fleming, of the University of London. The transmitter at Poldhu was similar in principle to the one I have already described, but it is obvious that the considerable distance over which it was proposed to transmit signals necessitated the employment of more powerful electromagnetic waves

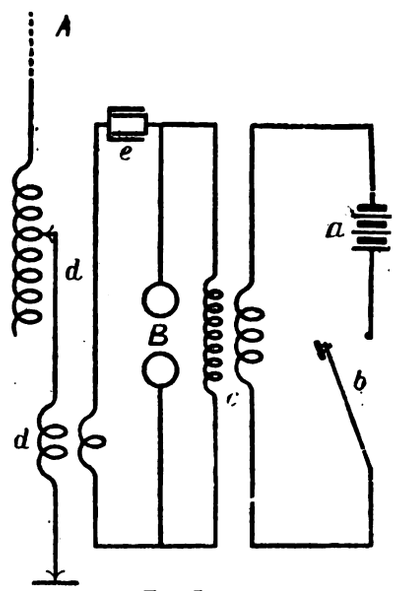

FIG. 3.

than those ever previously used. These were obtained by means of a generating plant consisting of an alternator capable of an output of about 25 kw., which, through suitable transformers, charged a condenser having a glass dielectric of great strength.

Time does not permit me to describe in detail all the engineering difficulties which were encountered in controlling electrical oscillations of a power which at that time was certainly unprecedented, and as the tests were made possible by commercial organisation, the objects of which do not consist solely in the advancement of science, you will understand that a detailed description of the plant used at the Transatlantic

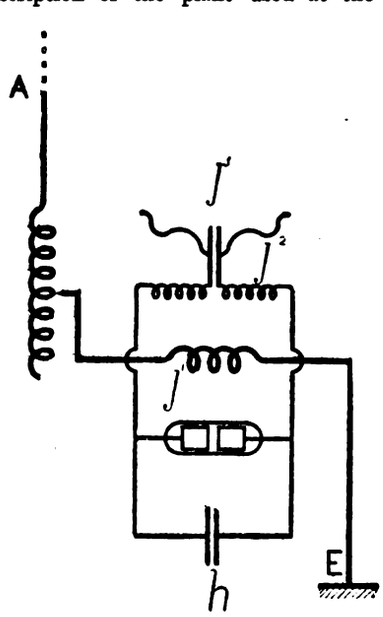

FIG. 4

stations cannot, for the present at least, be made public. My early tests on wireless transmission by means of the elevated capacity method had convinced me that when endeavouring to extend the distance of communication it was of little utility merely to increase the power of the electrical energy applied to the transmitting circuits, but that it was also necessary to increase the area or height of the transmitting and receiving elevated conductors. As it was economically impracticable to use vertical wires of very great height, the only alternative was to increase their size or capacity, which, in view of the facts I had first noticed in 1895, seemed likely to make possible the efficient utilisation of large amounts of electrical energy.* The form of aerial which I first proposed to employ consisted of a conical arrangement of wires insulated at the top and gathered together at a lower point in the form of a funnel. This aerial was supported by a ring of 20 masts, each 200ft. high, arranged in a circle of 200ft. in diameter. During the first tests an arrangement of circuits (Fig. 5) proposed by Dr. Fleming, and consisting of a modification of the system shown in Fig. 3, was employed. In this arrangement, in place of one high-frequency oscillation circuit, two are employed, and the constants of the two circuits are so arranged that very high tension discharges can be obtained from one of the condensers—the one which is inductively connected with the aerial—without danger of damage to the circuits of the generator.†

Simultaneously with the construction of the station at Poldhu, the erection of another one on substantially the same

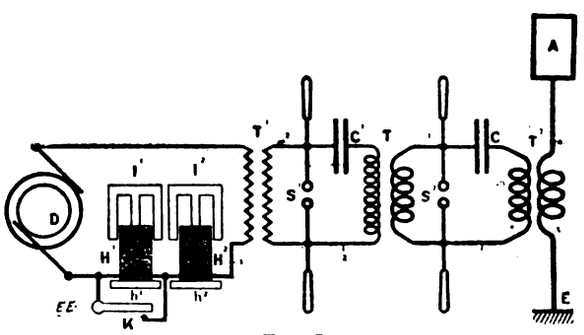

FIG. 5.

plan was undertaken at Cape Cod, in the United States of America. The completion of the arrangements was delayed owing to a storm which wrecked the masts and aerial at Poldhu on Sept. 18, 1901, but by the end of November the aerial was sufficiently restored to enable me to complete the preliminary tests which I considered necessary prior to making the first experiment across the Atlantic. Another accident to the masts at Cape Cod seemed likely to postpone the tests for several months more. I, therefore, decided that in the meantime I would use a purely temporary receiving installation in Newfoundland for the purpose of testing how far the arrangements in Cornwall had been conducted on right lines. The transmitting elevated conductor employed at Poldhu during the experiments with Newfoundland consisted of 50 almost vertical copper wires supported at the top by a horizontal wire stretched between two masts 48m. high and 60m. apart. These wires converged together at the lower end in the shape of a large fan, and were connected to the transmitting instruments situated in a building (Fig. 6). The transmitting condenser used with this aerial had a capacity of one-fiftieth of a microfarad, and was

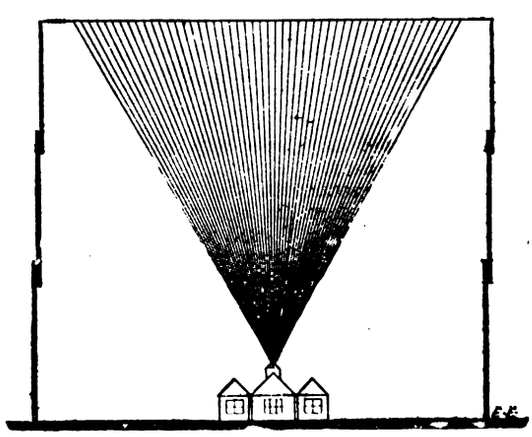

FIG. 6.

charged to a potential sufficient to produce a suitable spark discharge between spheres 3in. in diameter, 1½in. apart, the wavelength being 1,200ft. The actual power employed for the production of the waves was about 15 kw.

I left for Newfoundland on Nov. 27, 1901, with two assistants. As it was impossible at that time of the year to set up a permanent installation with poles, I decided to carry out the experiments by means of receivers connected to elevated wires supported by balloons or kites—a system which I had previously used when conducting tests across the Bristol Channel for the Post Office in 1897.‡ It will be understood, however, that when it came to flying a kite on the coast of Newfoundland in the

* See *Journal* of the Institution of Electrical Engineers, vol. xxviii., March 2, 1899, pp. 278-79.

† "The Principles of Electric Wave Telegraphy," 1906, p. 506.

‡ See "Signalling through Space without Wires" lecture by Sir William Preece, June 4, 1897.

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month of December, this method was neither an easy nor a comfortable one. When the kites were got up much difficulty was caused by the variations of the wind producing constant changes in the angle and altitude of the wire, thereby causing corresponding variations in its electrical capacity and period of electrical resonance. My assistants at Poldhu, in Cornwall, had received instructions to send on and after Dec. 11, during certain hours every day, a succession of S's followed by a short message, the whole to be transmitted, at a certain prearranged speed, every 10 minutes, alternating with five minutes' rest. Owing to the constant variations in the capacity of the aerial wire in Newfoundland, it was soon discovered that an ordinary syntonic receiver was not suitable, although at one time a number of doubtful signals were recorded. I, therefore, tried various microphonic self-restoring coherers placed either directly in the aerial or included in the secondary circuit of an oscillation transformer, the signals being read on a telephone. On Dec. 12 the signals transmitted from Cornwall were clearly received at the prearranged times, in many cases a succession of S's being heard distinctly, although probably, in consequence of the weakness of the signals and the constant variations in the height of the receiving aerial, no actual message could be deciphered. The following day we were able to confirm the result. The signals were actually read by myself and by my assistant, Mr. G. S. Kemp.

I have often been asked why I adhered to the practice of transmitting series of the letter S for these tests. The reason is that the switching arrangements at the sending station at Poldhu were not constructed at that time in such a manner as to withstand long periods of operation—especially if letters containing dashes were sent—without considerable wear and tear, and that if S's were sent an automatic sender could be employed. Moreover, the immediate object of these experiments was not to transmit actual messages across the ocean,

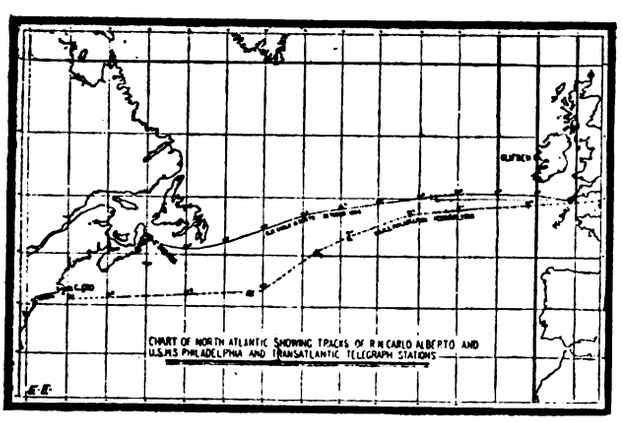
CHART OF NORTH ATLANTIC SHOWING TRACKS OF R.M. CARLO ALBERTO AND U.S.M.S. PHILADELPHIA AND TRANSATLANTIC TELEGRAPH STATIONS

FIG. 7.

but to ascertain the possibility of detecting the effects of electric waves at a distance of 2,000 miles. The result obtained, although achieved with imperfect apparatus, was sufficient to convince me and my co-workers that by means of permanent stations—that is, stations not dependent on kites or balloons for sustaining the elevated conductor—and by the employment of more power in the transmitters it would be possible to send messages across the Atlantic Ocean with the same facility with which they were being sent over much shorter distances. About two months later, in February, 1902, further tests were carried out between Poldhu and a receiving station on board the American liner "Philadelphia" *en route* from Southampton to New York. The sending apparatus at Poldhu was the same as that used for the Newfoundland experiments. The receiving aerial on the ship was fixed to the mainmast, the top of which was 60m. above sea-level. As the elevated conductor was fixed and not floating about with a kite, as in the case of the Newfoundland experiments, good results were obtained on a syntonic receiver, and the signals were all recorded on tape by the ordinary Morse recorder. On the "Philadelphia" readable messages were received from Poldhu up to a distance of 1,551 miles, S's and other test letters as far as 2,099 miles. The tape records of the signals are in my possession, and some of them are here exhibited to-night. The distances at which they were received are all verified and countersigned by the captain and chief officer of the ship, who were present during the tests. Captain Mills, of the "Philadelphia," was also good enough to mark on a chart, which I have here to-night, the various positions of the ship between England and America at which the communications from Poldhu were received. I mention these facts as an attempt was made, and has been lately revived, to throw doubt on the accuracy of the result obtained between Poldhu and Newfoundland, it being suggested that I had probably mistaken the effects of local atmospheric electricity for the Poldhu signals.

Although I never had the slightest doubt in my mind as to the genuineness of what was accomplished between Poldhu and Newfoundland, the results obtained on the "Philadelphia" amply prove that the station at Poldhu was capable at that time of transmitting signals to a distance of at least 2,000 miles, which is the distance separating Cornwall from Newfoundland, and that if it was practicable to send a message over 2,000 miles of sea from shore to ship, it should also be practicable to send it over the same space of ocean from shore to shore. A result of some scientific interest which I first noticed during the tests on the s.s. "Philadelphia" was the very marked effect of sunlight on the propagation of electric waves over great distances.* At the time of these tests I was of opinion that this effect might have been due to the loss of energy at the transmitter by daytime, caused by the diselectrification of the highly-charged transmitting elevated conductor operated by the influence of sunlight. I am now inclined to believe that the absorption of electric waves during daytime is due to the ionisation of the gaseous molecules of the air effected by ultra-violet light, and as the ultra-violet rays which emanate from the sun are largely absorbed in the upper atmosphere of the earth, it is probable that the portion of the earth's atmosphere which is facing the sun will contain more ions or electrons than that portion which is in darkness, and, therefore, as Prof. J. J. Thomson† has shown, this illuminated and ionised air will absorb some of the energy of the electric waves. The fact remains that clear sunlight and blue skies, though transparent to light, act as a kind of fog to powerful Hertzian waves. Hence the weather conditions prevailing in this country are usually suitable for long-distance wireless telegraphy. Apparently the amplitude of the electrical oscillations and the lengths of waves radiated have much to do with the interesting phenomena, small amplitudes and long waves being subject to the effect of daylight to a less degree than large amplitudes and short waves. I never considered that this daylight effect would be an insuperable obstacle to Transatlantic telegraphy, as sufficient sending energy could be used during daytime to make up for the loss of range of the transmissions.

(To be continued.)

EMERGENCY TRANSFORMER CONNECTION.

BY M. C. GODBE.

At a mine where some 4,000 kw. in transformers, designed for 88,000 volts primary and 460 volts secondary, and 3,000 h.p. in motors, were being installed, it became necessary to furnish temporary service to some 2,300-volt and 460-volt three-phase motors from a 4,000-volt four-wire three-phase line. It was very important that power be furnished to these motors before the sub-station and permanent service were complete. Three 250-kw. 2,300 to 460 volt transformers, which were to be used to step up from the switchboard E.M.F. of 460 volts to 2,300 volts for some motors operating a mile from the sub-station were available, and these were temporarily connected, as shown in Fig. 1, to the 4,000-volt line from which it was

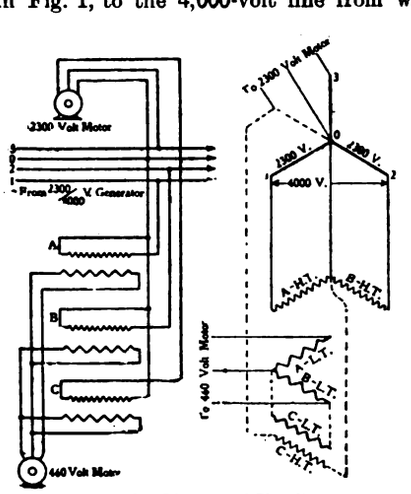

FIG. 1.—Diagram of Circuits.

permitted to take a maximum of 300 kw. The primaries of transformers A and B were connected to the neutral and lines 1 and 2. The secondaries of these transformers were connected in "V" for 460 volts by reversing the secondary of one transformer. For the 2,300-volt service three-phase power was obtained by connecting the neutral and line 3 for one

* *Proceedings*, Royal Society, vol. 70, p. 344, "A Note on the Effect of Daylight upon the Propagation of Electromagnetic Impulses over Long Distances." Paper read June 12, 1902.

† *Phil. Mag.*, August, 1902, ser. 6, vol. 4, p. 253, J. J. Thomson.

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phase. The low-tension side of transformer B was used to excite C, the primary of which was connected as shown to give the proper three-phase relation with the phase from neutral to 3. Satisfactory service was furnished in this manner, and no trouble was experienced. The E.M.F.'s on the 2,300-volt motors were not perfectly balanced at full load, but were not enough out of balance to give the slightest trouble.—*Electric Journal.*

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Thirteenth Annual Convention, Nottingham, June 30 to July 3.

We have received a copy of the preliminary programme of the thirteenth annual convention to be held at Nottingham from June 30 to July 3, 1908. The arrangements, which are subject to alterations, are as follows:

Tuesday, June 30.

Morning.—Reception of the members by the mayor; presidential address; reading and discussion of papers; luncheon given by the chairman and members of the Electricity Committee.
Afternoon.—Visits to works.

Wednesday, July 1.

Whole day excursion to Dovedale.

Thursday, July 2.

Morning.—Annual general meeting.
Afternoon.—Visits to electricity and other works.
Evening.—Members' annual dinner.

Friday, July 3.

Morning.—Reading and discussion of papers.

The following are some of the subjects to be discussed during the convention: (1) the experiences of a convener in establishing an electrical undertaking; (2) the equipment of a testing department; (3) alternating-current accumulator sub-stations; (4) the designing of electrical generating stations; (5) overhead equipment.

A detailed official programme will be issued in due course, and in the meantime all communications should be addressed to Mr. C. McArthur Butler, Staple-inn-buildings, Holborn, London, W.C.

THE INSTITUTION OF CIVIL ENGINEERS.

At the annual general meeting of the Institution of Civil Engineers held on Tuesday evening, April 28, the result of the ballot for the election of officers was declared as follows:

President.—Mr. James Charles Inglis.

Vice-Presidents.—Mr. W. R. Galbraith, Mr. G. H. Hill, Mr. A. Siemens, and Mr. W. C. Unwin.

Other Members of Council.—Mr. J. A. F. Aspinall (Liverpool), Mr. B. H. Blyth (Edinburgh), Mr. C. A. Brereton, Mr. W. B. Bryon, Mr. R. Elliott-Cooper, Colonel R. E. B. Crompton, C.B., Dr. G. F. Deacon, Dr. F. Elgar, Mr. M. Fitzmaurice, C.M.G., Mr. A. T. Grant-Dalton (South Africa), Mr. R. A. Hadfield (Sheffield), Dr. C. A. Harrison (Newcastle-on-Tyne), Mr. J. Robson (Canada), Mr. W. Hunter, Mr. G. R. Jebb (Birmingham), Sir Wm. Thomas Lewis, Bart. (Aberdare), Sir George T. Livesey, Mr. A. G. Lyster (Liverpool), Mr. Thos. Matthews, Mr. A. B. Moncrieff (Australasia), Mr. A. Ross, Mr. J. H. Ryan (Dublin), Mr. J. Strain (Glasgow), Sir Frederic R. Upcott, K.C.V.O. (India), Mr. W. B. Worthington (Derby), and Mr. A. F. Yarrow.

This council will take office on the first Tuesday in November, 1908.

The council have made the following awards for papers read and discussed before the institution during the past session: a Telford gold medal to Mr. W. Barclay Parsons (New York); a Watt gold medal to Sir Whately Eliot; George Stephenson gold medals to Sir John Ottley, K.C.I.E., Dr. A. W. Brightmore, and Messrs. J. S. Wilson and W. Gore; Telford premium to Messrs. F. W. Davis (Darlington), C. R. S. Kirkpatrick (Newcastle-on-Tyne), Hugh T. Ker (Glasgow), G. H. Scott, R. R. Gales, F.C.N. (India), and S. H. Ellis.

ELECTRO-THERAPEUTICS.

Recently the King of Denmark honoured the memory of Niels R. Finsen in being present at the inauguration of the clinic for internal diseases in connection with the Finsen Medical Light Institute. Ever since Prof. Finsen began to study the action of actinic rays he regarded the universal effect of the rays on the organism as being of the highest interest and importance. In his last address to the board of directors of the Light Institute he expressed his belief that the light rays as a therapeutic means would be particularly valuable in the form of light baths in chronic diseases. But Finsen did not live to see his ideas on this point carried out. After his death certain investigations on the universal action of light rays, made by Dr. K. A. Hasselbalch, now director of the Finsen Institute laboratory, are claimed to support Finsen's ideas, and in consequence the new clinic has been erected.

The Copenhagen correspondent of the *Lancet* sends an interesting account of a discussion of the subject in the medical society of that city. Of particular interest to our readers will be the account of a communication made by Dr. Bie and Dr. Bing to the Society for Physical Therapeutics and Dietetics, and reported in our contemporary. These investigators had tried to apply the treatment to heart diseases and other affections in the Kommune Hospital, of Copenhagen. Instead of using a 150-ampere arc lamp, as Dr. Hasselbalch and Dr. Jacobæus had done, they had employed the far less costly "uviol lamp," a mercury incandescent lamp with "uviol" glass. The light of this lamp contains plenty of the effective ultra-violet rays, but only few of the particularly heating rays, so that it is possible to place the lamp quite near to the skin. An illumination of the skin for a period varying from 15 to 30 minutes, with the lamp at a distance of from 15cm. to 30cm., results in a very pronounced erythema of the same intensity and duration as that brought about by the arc lamp. The skin retain its scarlet colour for about one week, after which desquamation sets in and pigmentation takes place, so that after two weeks the skin becomes of a brownish tinge. But even several months after the light bath a slight remnant of dilatation of the vessels of the skin was discernible. It is scarcely to be expected that the dilatation takes place in more than a few tenths of a millimetre of the uppermost layers of the skin.

INTERNATIONAL TELEGRAPH CONFERENCE.

At a plenary meeting of the Berlin Chamber of Commerce held on the 25th ult. it was decided to lay before the Secretary of State for Posts and Telegraphs its objections to the proposal which the Chamber understands will be submitted to the meeting of the International Telegraph Convention at Lisbon on May 4, whereby for code telegrams the number of letters forming a word would be reduced from ten to eight. The Chamber of Commerce will further request the Minister to instruct the German delegates to offer a determined opposition to the proposal, which, it points out, would result in an extraordinary complication of commercial telegram traffic as well as the entire international telegraph service, especially with over-sea countries, and would, moreover, necessitate a complete revision and alteration of codes now in use, and cause considerable trouble and expense to the users.

The New Zealand Government is also strongly opposed to the proposed restriction of the use of code words, and in favour of maintaining the present system, and the Government will strenuously oppose any alteration.

INSTITUTION OF ELECTRICAL ENGINEERS.

The nominations for election of Council and officers for the year 1908-9 were announced at the ordinary general meeting held at the Institution of Civil Engineers last night (Thursday, April 30).

President.—W. M. Mordey (new nominee).

Vice-Presidents.—F. Gill, C. P. Sparks (new nominees; these members having served only two years as vice-presidents are both eligible for re-election for one year in that capacity); Colonel H. C. L. Holden, F.R.S., Dr. G. Kapp (remaining in office).

Members of Council.—T. Mather, F.R.S., Major W. A. J. O'Meara, C.M.G., Prof. A. Schwartz, J. F. C. Snell, G. Stoney (new nominees); S. Evershed, H. E. Harrison, Dr. E. Hopkinson, J. W. Jacomb-Hood, J. E. Kingsbury, M. O'Gorman, G. W. Partridge, W. H. Patchell, W. Rutherford, A. A. C. Swinton (remaining in office).

Associate-Members of Council.—J. E. Taylor (new nominee); J. Hunter Gray, H. Human (remaining in office).

Honorary Treasurer.—Robert Hammond (new nominee).

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

WOOD PRESERVATION.

Much study is being devoted by the United States Forest Service to the preservation of wooden poles, ties, etc., by creosote oil and to determining what the composition of the oil should be to give the best results in preserving timber, under different conditions, and how the most desirable creosotes may be obtained. The reports of these studies, together with detailed description of the more economical processes of applying the preservatives to wood, have been worked into circulars which the Government has placed at the disposal of all users of timber, and which will be furnished to all who make the request of the Forester at Washington.—*Electrical World.*

FORTHCOMING EVENTS.

FRIDAY, MAY 1.

Royal Institution.—At 9 p.m., "The Scientific Work of Lord Kelvin," by Prof. J. J. Larmor.

MONDAY, MAY 4.

Society of Engineers.—At 7.30 p.m., at the Royal United Service Institution, Whitehall, "The Design and Waste and Wear of Wheel Teeth," by Prof. R. H. Smith.

TUESDAY, MAY 5.

Royal Institution.—At 3 p.m., "The Development of the Modern Turbine and its Application," by Mr. Gerald Stoney.

THURSDAY, MAY 7.

Institution of Electrical Engineers.—At 8 p.m., at the Royal Society of Arts John-street, Adelphi, W C, "The Manufacture of Electrical Condensers," by Mr. G. F. Mansbridge.

Civil and Mechanical Engineers' Society.—At 8 p.m., at Caxton Hall, "Abbreviated Formulæ for Structural Engineers," by Mr. E. Fiander Etchells.

FRIDAY, MAY 8.

Physical Society.—At 8 p.m., in the Physics Laboratory of the Royal College of Science, Imperial Institute-road, South Kensington: "A Modified Theory of Gravitation," by Dr. C. V. Burton; "An Examination of the Formulæ for the Grading of Cables," by Mr. C. S. Whitehead; "Illustrations of Geometrical Optics," by Mr. R. M. Archer.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONIC.

SIR,—Mr. H. Laws Webb refers in your issue of April 17 to the single calls sold at public telephone stations. If he can prove that the call at a public station—public, limited duration of conversation, double the price charged (at least in Germany)—is the same thing as a call at a subscriber station—private, unlimited conversation, half the price charged—he is right; if not, he is wrong. The very same reason for which the permanent subscriber must pay a certain number of calls to cover the costs for his line and apparatus is the principal, but not only, cause why the subscriber's single call is *not* the unit of telephone service.

If Mr. Webb can demonstrate that a sixpenny loaf is called a sixpenny loaf justly because it costs twelve pence on the top of the Rigi, I will heartily agree with the hopeless assertion that the subscriber's effective call is the unit of sold matter in telephone service.—Yours, etc.,

J. BAUMANN,
Editor of *Zeitschrift für Schwachstromtechnik.*

Munich, April 22, 1908.

TELEPHONE RATES.

SIR,—I have read with interest the letter of Mr. Burgiss, and I quite agree with him that the message is not the absolute unit of telephone service. I have previously pointed out that the scientific unit is the "minute-mile," since the cost of service necessarily varies with the amount of plant used and the time during which it is used. If we carried out the whole theory of telephone costs to its logical conclusion, charging each subscriber strictly in proportion to the plant he uses, and charging for each message strictly in proportion to the distance it travels and the time occupied in transmission, we should get a tariff far too complicated for commercial use. It is for these reasons that we adopt the local message as the practical unit, much in the same way that the American tramway company adopts a uniform local fare.—Yours, etc.,

HERBERT LAWS WEBB.

RE QUESTION No. 1,059

SIR,—Kindly allow me to point out some errors in the figures given by "D. H. B." In Fig. 1 the apparent power is 500 kw., and the true power is 350 kw. The leading wattless component to be introduced into the circuit must be

$$\sqrt{(500+350)\,(500-350)} = 375 \text{ kw.}$$

Rating of synchronous motor $= \sqrt{(357)^2+(37)^2} = 359$ k.v.a.

Power factor of motor = 10·3 per cent.

In Fig. 2 the true power, including input to motor = 376 kw. If the power factor of the generator is to be ·95 when delivering this amount of power, the leading component of the synchronous motor must be

$$357 - \frac{\sqrt{376^2-376^2}}{\cdot 9025} = 234 \text{ kw.}$$

Rating of synchronous motor $= \sqrt{(234)^2+(26)^2} = 235$ k.v.a.

Power factor of motor = 11 per cent.

In Fig. 3 the true power is 475 kw. and the apparent power is 500 kw. Leading component to be introduced into the circuit is

$$357 - \frac{\sqrt{475^2-475^2}}{\cdot 9025} = 201 \text{ kw.}$$

Rating of synchronous motor $= \sqrt{(201)^2+(125)^2} = 237$ k.v.a.

Power factor of motor = 52·7.

I am at a loss to see how one is justified in saying that we could obtain 100 kw. in the shape of mechanical power. Surely the capacities of the boilers, engines, condensers, pumps, etc., have not been based on a load of

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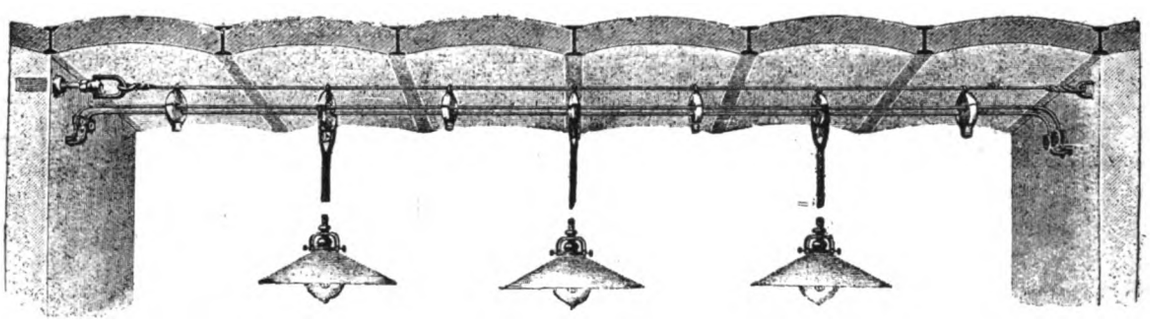
500 kw. at 100 per cent. power factor. If this be the case, the plant has only been developing 70 per cent. of its normal rating. The capacity of the engines, boilers, condensers, pumps, etc., should, in my opinion, correspond to 350 kw. true power (approximate). The generator should be rated 350 kw., 70 per cent. power factor; or, in other words, 500 kw., 100 per cent. power factor.

The steam plant will then be developing its "normal power" when the generator is delivering 350 kw. at 70 per cent. power factor (500 kw. apparent power). Therefore the outlay on steam plant will be considerably reduced; the efficiency of the plant will also be somewhat increased.

I should like to know the opinions of other readers on this point.—Yours, etc., M. G. MORETON.

A SPAN-WIRE SUSPENSION FOR INCANDESCENT LAMPS.

The accompanying figure shows a cheap and effective method of wiring due to Messrs. S. Schön, of Vienna. It is especially suitable for use in reinforced concrete buildings. All the parts are exceptionally strongly constructed.



The span wire is fixed to the walls by adjustable clamps, and may be supported from the ceiling at intervals if necessary. The lamp supports are clamped firmly to the span wire so as to avoid displacement.—*Der Elektrotechniker.*

DIRECT CURRENT OR ALTERNATING CURRENT FOR CARBIDE FURNACES.

This subject is discussed by H Lee and A. Beyer in *Zeitschrift für Electrochemie.* If an electric arc is operated in air between metallic electrodes, a much higher voltage is required with alternating current than with direct current, because with alternating current the arc is broken periodically and must be lighted again. It is essentially different in electric furnaces, like carbide furnaces, because the arc plays here in a highly heated gaseous atmosphere. Experiments of the authors show that with the same arc length the voltage is here the same for direct and for alternating current. The results in carbide manufacture are the same with direct or alternating current, under otherwise equal conditions. In laboratory furnaces direct current at 30 or 35 volts is advantageous. On an industrial scale alternating current is preferable, on account of its easier transmission and transformation, and the higher voltage (60 or 65 volts) is necessary, because in order to pass a large current one must have a voluminous arc of a certain fair length.

HIGH-TENSION LINES IN NEW YORK STATE.

A Bill has been introduced in the New York State Legislature which calls for the installation of a properly grounded "catchnet" under every line of 20,000 volts or over crossing public streets, highways, railway tracks, canals, or which passes over other aerial wires. It is specified that the net should be at least 8ft. below the high-tension circuit, shall not be less than 20ft. wide nor less than 22ft. from the ground, nor less than 4ft. from any other wire. Furthermore, it shall be supported by poles, towers, or other structures erected outside of the limits of the public street, highway, etc., for the full width of the crossing and at least 6ft. beyond on each side, and of sufficient width and so constructed as to assure the retention of any transmission lines that may fall upon it.

LONDON ELECTROBUS COMPANY.

The London Electrobus Company, Limited, during the past week invited subscriptions at par for 240,000 ordinary shares of £1 each and 12,000 deferred shares of 5s. each. Subscribers for ordinary shares of this issue were given the right to apply for one deferred share for each 20 ordinary shares. After the holders of the ordinary shares have received in each year a dividend of 10 per cent. the available balance of profits will be divided as to one-half among the holders of ordinary shares, and as to the other half among the holders of deferred shares. The company was formed to run electric omnibuses for the conveyance of passengers on the streets of the Metropolis, and after experiments and nine months' actual service with a small fleet of electrobuses, the directors claim that the results show that the electric omnibus must replace other omnibuses on the streets of London. The prospectus states that, starting with only a few vehicles in July, 1907, the number has been gradually augmented, and it is intended to utilise the proceeds of this issue to increase the number of vehicles and to provide such further garage accommodation as may be necessary. Contracts for the supply of 125 vehicles with the right to call for delivery of a further number, and contracts for the maintenance of tyres and accumulators, have been entered into. The actual running figures for the nine months from July 15, 1907, to April 14, 1908, as supplied and vouched for by the company's traffic manager and garage superintendent, and certified as correct by the company's auditors, are as follows: number of passengers carried, 970,271; number of car miles run, 93,482; average takings per car mile, 13·069d. Taking Sir Douglas Fox and Partners' estimate of 9½d. per car mile for expenses, a profit of 3½d. per car mile is shown.

METROPOLITAN ASSOCIATION OF ELECTRIC TRAMWAYS MANAGERS.

The members of this association met in conference at 4.30 p.m. at the Municipal and County Club, Whitehall, S.W., on Friday, the 24th ult., to receive and discuss the report of their committee on matters relating to the licensing of electric cars, etc. It was unanimously decided to press for modification of such clauses of the Metropolitan Public Carriage Act of 1869 as were deemed necessary for present-day practice. The members subsequently held their usual dinner, and those attending were Messrs. Blain (West Ham, chairman of the association), Bruce (London County Council), Coveney (Erith), Schofield (Leyton), Hammond (Metropolitan Electric Tramways), Shaw (Ilford), Howard (Barking), Mittelhausen (Bexley), Ullman (East Ham), and Goodyer (Croydon, hon. secretary). Messrs. Murray (Walthamstow), Spurr (Walthamstow), Hulme (South Metropolitan Tramways), Balfour (Dartford), and Sir Clifton Robinson (London United Tramways) were unavoidably absent.

PUBLICATIONS RECEIVED.

"DEVELOPMENT AND ELECTRICAL DISTRIBUTION OF WATER POWER," by Lamar Lyndon, consulting engineer. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 8vo. vi. + 317 pages, 158 figures. Cloth, 12s. 6d. net. This is not a text-book, but a purely engineering treatise in which all the

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salient facts concerning the hydraulic development of power, its conversion into electrical energy, and its transmission over long distances are collated and their interdependence shown.

"ELECTRICITY: WHAT IS IT?" by W. Denham Verschoyle. London: Swan Sonnenschein and Co., Limited. 2s. 6d. net.

"MACHINE DESIGN, CONSTRUCTION, AND DRAWING," by Harold J. Spooner, A.M.I.C.E., M.I.Mech.E., etc. London: Longmans, Green, and Co., 39, Paternoster-row, E.C. 10s. 6d. net. This is a text-book for the use of young engineers, and contains 86 tables and over 1,400 figures.

"THE EVOLUTION OF FORCES," by Dr. Gustave Le Bon. London: Kegan Paul, Trench, Trübner, and Co., Limited, Dryden House, 43, Gerrard-street, Soho, London, W. 5s. In this work Dr. Le Bon develops further the strikingly novel and original theories put forward by him in "The Evolution of Matter." As in the last-named work, he enunciated the doctrine, which he was the first to deduce, that all matter is continually in a state of dissociation and decay, so in this he goes into detail into the corollary that the atom is a great reservoir of energy, and itself the source of most of the forces of the universe.

Catalogues, Lists, etc.

The Accumulator Industries, Limited, 4, White-street, Moorfields, E.C., have issued a new price-list of A1 ignition accumulators.

Messrs. T. W. Broadbent, Limited, Victoria Electrical Works, East-parade, Huddersfield, have sent us a copy of their latest leaflet which deals with two and three phase motors.

Messrs. Credenda Conduits Company, Catherine-street, Aston, Birmingham, have sent us a copy of their latest list of conduits and fittings, the patterns illustrated being ones which have proved most efficient where a watertight installation is used.

The Consolidated Accessories Company, 27, Clements-lane, London, E.C., selling agents for Messrs. Geo. W. Green and Co.'s traction specialities, have issued a pamphlet dealing with tangential suspension for overhead conductors, the patent of Mr. P. J. Pringle.

The Electrical Company, Limited, 121-125, Charing Cross-road, London, W.C., have sent us copies of several publications dealing with electricity in printing works and in cotton mills, and the steam-turbine equipment on the express steamer "Kaiser," of the Hamburg-Amerika Line.

Messrs. Venner and Co., 6, Old Queen street, Westminster, S.W., have issued a list relating to the "Venner" time switch, which is suitable for incandescent street-lighting. The clock has a high-class lever escapement, fully jewelled, non-magnetic, compensated for temperature. It is entirely enclosed in a dust-proof, spun-brass cap, and is insulated from the switch. It runs 14 days on one winding. The switch is very simple, positive in action, and gives rapid make and break on platinum contacts. It is suitable for 1½ amperes at 250 volts.

Messrs. Morris and Lister, Coventry, in their latest list (No. 12) give particulars of the Morcom and Walshe patent inductive load or choking coil which they are manufacturing. This piece of apparatus is of an entirely novel design. It was fully described in the recent paper read before the Birmingham Branch of the Institution of Electrical Engineers by Mr. R. K. Morcom and Mr. D. K. Morris. As was clearly pointed out in the discussion which followed the paper, it is an article which is of considerable value in connection with the testing of large alternators on a given power factor.

Messrs. Bergtheil and Young, Limited, 12, Camomile-street, London, E.C., have recently put upon the market as a very important addition to their already well-known variable-speed electric motor driving equipments, a single-phase alternate-current variable-speed motor which is capable of developing a starting torque equal to twice full-load running torque, or a slightly higher torque than this, and of running at any speed between an absolute crawl and maximum for any length of time. This motor is eminently suitable for the driving of rotary and flat-bed printing presses, calenders, calico-printing machinery, machine tools, electric lifts, organ-blowing equipments, and so on. Details of this motor and the push-button controlling system are given in leaflets, which will be supplied to anyone interested.

The Wilson-Wolf Engineering Company, Limited, Thornton-road, Bradford, have issued their new catalogue of "Arctic" propeller ventilating fans. They have embodied several improvements in their fans—viz., a combined "thrust and journal" ball bearing, which enables a standard fan to be fixed in either a vertical or horizontal position to discharge air in either direction, and the new "Propeller" type blade, which is capable of dealing with a much larger quantity of air than the old-fashioned box-type blade. They are, however, prepared to fit the box blade if desired. The catalogue has been compiled with a view to supplying all information likely to be of use to contractors, shippers, consulting engineers, and the trade generally, and gives full details of prices of fans, regulators, accessories and spare parts, dimensioned fixing drawings, and shipping weights, etc., together with outputs of both belt and electrically driven fans.

Messrs. Taylor, Taylor, and Hobson, Limited, Stroughton-street Works, Leicester, have issued a pamphlet describing their indicators of temperature for hardening steel, which depend on the very simple fact that at the recalescence temperature at which carbon steel should be hardened it becomes non-magnetic. Other pyrometers as used for hardening steel require the preparation of cooling curves for each sample of steel to be treated, and the use of pyrometers somewhat delicate to handle are liable to error. Their magnetic indicators require no cooling curves to be taken, but deal perfectly with any variety of carbon steel as it comes to be hardened, and have little or nothing to get out of order. We have seen a sample fracture of a piece of common tool steel hardened by means of the simple hand indicator. The fineness of grain shows the effectiveness of the gauge. We are assured that these appliances, which Messrs. Taylor, Taylor, and Hobson, Limited, have used daily in their own toolroom for nearly two years, have established the remarkable record that of all the miscellaneous jobs that have been dealt with, not a piece has been wasted by poor hardening or by the very common troubles of warping and cracking. Prof. J. O. Arnold, of Sheffield, says: "The theory of your device is scientifically correct, because in steel capable of properly hardening, the carbon change point, Ac1, and the magnetic change point, Ac2, are practically identical, occurring in a range of temperature extending from about 720deg. C. to 740deg. C., the maximum absorption of heat being registered by the pyrometer at about 730deg. C."

PERSONAL.

The Bury St. Edmund's Town Council have increased the salary of the borough electrical engineer, Mr. S. E. Day, to £175 per annum.

Mr. J. A. Sykes has resigned his position as deputy electrical engineer of Heston and Isleworth in order to take up an appointment in Glasgow.

Mr. Herbert Laws Webb sailed for New York on Saturday, the 25th ult, by the "Lusitania" for the purpose of looking into the latest developments in telephone work.

Mr. A. Blackmore, of the clerical staff of the Bournemouth Corporation tramways, has been presented with an inlaid rosewood clock from the staff of the Corporation tramways on the occasion of his marriage.

We congratulate Mr. John G. Bruce, resident engineer of Willesden, on the occasion of his marriage to Miss G. Brown, second daughter of C. T. Brown, Esq., of Hampstead, which was solemnised at the parish church, Hampstead, on April 22.

Mr. Patrick Hamilton, formerly manager of the electrical department of Messrs. Kelvin and James White, has joined the board of directors of Everett, Edgecumbe, and Co. Mr. Hamilton will take an active part in the supervision and design of the company's various products and in the management of the business generally.

On the 15th ult. the Birmingham Local Section of the P. and O. Batti-Wallahs' Society held their first smoking concert under the chairmanship of Mr. J. P. Kemp, of the Birmingham electric supply department. A very successful evening was spent, nearly 70 members and their friends being present, which augurs well for the success of the first local section of the society. All particulars of the society may be obtained from the hon. secretary, 50, Alcester-road, Moseley, Birmingham.

LEGAL INTELLIGENCE.

SPENGEL v. RAND CENTRAL ELECTRIC WORKS.

In the Chancery Division on Wednesday Mr. Justice Swinfen-Eady heard a claim by Mr. Spengel in the matter of the Rand Central Electric Works. The question his Lordship was asked to determine was the amount for which Mr. Sprengel had to prove in the winding up of the company. His claim was under an agreement by which he was appointed general manager of the works and business of the company. He was to be paid a salary and a further remuneration by percentage upon the profits. No question arose about his fixed salary; the whole question was with regard to his further remuneration. The agreement provided that he was to be paid a further remuneration equivalent to 5 per cent. of the surplus net profits of the company. The company carried on business for a time, and in 1907 it was sold to the Victoria Falls Power Co. The claimant said that on the sale of the assets the proceeds were more than sufficient in value to repay the capital account, that there was a surplus left, and that he was entitled to a percentage. He had an alternative claim. He said that the liquidator in estimating the profits for the period from Dec. 31, 1905, to Jan. 1, 1907, had made a mistake, because he had debited as against the profits of the year and before arriving at the net profit a sum of £26,990, and the claimant said that that was strictly a renewal fund, and that seeing that before the balance sheet and profit and loss accounts were made up the works had been sold to the Victoria Falls Co., there was no need for any renewal.

HIS LORDSHIP said the short answer to the first part of the claim was that the claimant had failed to prove that the proceeds of sale were such as he alleged. As regarded the alternative claim he was satisfied that the claimant's objection was not well founded. The practice of the company had been to write off a proper and sufficient sum for depreciation. In his Lordship's opinion the claimant was not

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entitled to take as the net profit for the 13 months the gross profit. He was bound to allow a proper sum for depreciation, and the £26,990 so-called renewal was, in fact, 13 months' depreciation, and that must be deducted before the net profits were arrived at. The claimant was entitled to £64. 6s. 11d. the balance, plus £144. 12s. in respect of a slip which had occurred.

COMPANIES' MEETINGS AND REPORTS.

BRITISH ALUMINIUM.

The thirteenth ordinary general meeting of the British Aluminium Co. was held on Friday last at Winchester House, Old Broad-street, E.C., Mr. John D. Bonner, chairman of the Company, presiding.

In moving the adoption of the report (*Electrical Engineer*, April 24), the CHAIRMAN said the profit for 1907 of £120,481 was, with the exception of the record profit for 1906, considerably greater than that of any previous year. He felt this was satisfactory in view of the derangement of the metal markets of the world which followed on the collapse in copper last June. The immediate consequence of that collapse was a tremendous falling off in the demand for all metals, and this had since continued sluggish, notwithstanding the material recessions in price which had from time to time take place. Latterly, however, aluminium had been in much better request, and important buyers had assured him during the last few weeks that great developments in the industry might be expected when consumers realised that continuous supplies of the metal could be counted upon at about the present price, or, at all events, at a price not greatly higher than that now ruling. There was an impression existing, he said, that prices had been reduced by the principal producers in the hope of killing smaller competitors, and that if that end were attained a sharp advance might be expected. The best answer he could give to that was that they had contracts concluded for deliveries extending to 1910, and contracts for further large quantities were on the point of completion on the basis of that day's current price. The fact was that the aluminium industry had entered upon a new phase. They would have in the future to be content with a much smaller percentage of profit than they had hitherto been accustomed to, so that they would have to greatly increase their sales to continue to secure satisfactory results. Up to the end of last year their only producing works were those at Foyers, but now that their works at Stangfjord and their temporary works at Kinlochleven were in operation their output should this year be about twice what it was last year, and by about the middle of next year their great works at Kinlochleven should at last reach the producing stage. The development of their Orsieres power scheme was proceeding very satisfactorily, but they were not expecting to have any power available there until after the end of next year. Needless to say, the prosecution of those works had necessitated the provision of further capital, and they had accordingly issued 20,000 more "A" preference shares and 40,000 1908 conversion shares. These latter would become fully paid and be divided into preference and ordinary shares at the end of the year, and the capital account would then be materially simplified and would consist of three classes of shares—namely, £300,000 "A" preference shares, £500,000 7 per cent. preference shares, and £500,000 ordinary shares, the two last-named participating equally in any profits remaining after 7 per cent. had been paid upon the ordinary shares.

Mr. E. E. SAWYER, M.A., M.I.C.E. (vice-chairman), seconded the resolution, which was carried unanimously.

SANTOS IMPROVEMENTS.

The twenty-seventh annual general meeting of the shareholders of the City of Santos Improvements Co. was held in London on the 23rd ult., Mr. D. M. Fox, chairman of the Company, presiding.

In moving the adoption of the report, the CHAIRMAN said that the property of the Company was not now, as was the case a few years ago, limited to the supply of gas and water, but in addition to these important services it now comprised the tramway system of the city and suburbs, a railway line between Santos and the neighbouring town of San Vicente, besides a light railway in connection with the water supply—in all about some 35 miles of line—and, finally, an electric light and power installation of 450 kw. So far he saw no reason to regret these new ventures, for the extension of the scope of the Company's operations during the past 10 years had resulted in an advance year by year in the net receipts from the different branches of enterprise equal to, if not exceeding, expectations. Turning to the report, he pointed out that the profit in London for the past year, after making allowance for depreciation and bad debts, was £45,363. 17s., an increase of £570, which, added to £2,630. 14s. 1d. brought forward from last year, made a total of £47,944. 11s. 1d. After providing for service of debentures, dividends on the preference shares, and an interim dividend on the ordinary shares, paid in November last, the disposable balance amounted to £18,124. 11s. 1d. The directors proposed to deal with this balance in the following manner: £4,000 to reserve fund (raising it to £36,000), £2,000 to tramway renewals account (making it £6,000), and the payment of a final dividend of 4½ per cent. (making 7 per cent. for the year, tax free), leaving a balance of £3,124. 11s. 1d, to be carried forward to the next account. The chairman then dealt with each undertaking separately. With regard to the electric light undertaking, the net revenue for the year under review showed an increase of £736, which was a material improvement over the previous year, and he hoped that during the current year still better results would be obtained. There were 417 Nernst street lamps for public lighting and 270 private consumers on Dec. 31 last. The expenditure on capital account on the various undertakings, but chiefly electric lighting, amounted to £10,785. 9s. 2d. He mentioned that further capital would be required for the electrification of a section of the tramways, and for other purposes. The work was commenced in November last, but the rainy season between October and March had prevented any great progress being made. They considered it advisable in the shareholders' interests that a member of the firm of Messrs. Mordey and Dawbarn (the Company's consulting electrical engineers) should go out to Santos to report as to the best means of carrying out the electrification of a portion of the tramways. He was glad to say that they had reported favourably on the whole scheme. Nearly all the rails required were on order, and other material was in hand, and it was their intention to push forward the work as vigorously as possible to completion.

Mr. F. HENDERSON seconded the motion, which was unanimously adopted.

BABCOCK AND WILCOX.

The annual general meeting of the shareholders of Babcock and Wilcox was held on Friday at the Cannon-street Hotel, E.C., Mr. John Dewrance, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report (*Electrical Engineer*, April 24), said that the accounts showed a balance of £266,264 for disposal, which appeared to be a considerable proportion as against the capital of the Company; but the balance-sheet revealed that the nominal capital, owing to the conservative policy which had always been pursued, was very small in proportion to the total assets and to the total transactions of the Company, and, therefore, the profit was really not a very large one upon the Company's trading. Some of their customers fancied that too large profits were made, but such was not the case. The reason why they were able to make such a good profit was that they had a magnificent organisation throughout the world, that the factory had been extended, and that every detail of the machinery had been perfected to such an extent that the Company were able to make a profit on prices which their competitors could not even touch. Much of the business was extremely competitive, and it was only on account of the exceedingly well-organised arrangement of the Company that they were able to make a profit in these competitive branches. The factory had been very well occupied for the first three months of the current year, and the directors had every reason to believe that the next accounts would not show any very considerable slump as compared with those now presented. They were threatened with a very serious legislative attempt to restrict the output of coal, which was a highly important factor, and he hoped that the legislators would think twice before entering upon so very dangerous a step. Practically every man who was largely interested in coal had expressed the opinion that the Bill, if passed, would be an extremely serious thing for the country, and he trusted it would not pass into law. In addition to the shortage of supply which would result from it, the Act of Parliament would stimulate an enormous amount of commercial disturbance, with strikes in all parts of the country, which could not fail to have a serious effect upon this Company as well as upon others. There had been instances of these dangerous legislative threats being shelved. He hoped it might be the case with this one. Otherwise he thought he could safely say that the staff which had worked so well for the Company would be equal to most of the ordinary commercial contingencies against which they had to provide.

Mr. CHARLES A. KNIGHT seconded the motion.

Replying to shareholders' questions, the CHAIRMAN said that the value of the investments was not written down at Dec. 31 because it was felt that the depreciation then existing was abnormal; but a reserve was made against such depreciation. Since Dec. 31 the value had improved, until it was now within £7,000 or £8,000 of cost. It was interesting to note that in the last three years the dividends received on gilt-edged securities only equalled the depreciation in their value to Dec. 31, 1907.

The report and accounts were adopted, and a resolution was passed providing for the payment of the preference dividend for the half-year to Dec. 31, together with a dividend of 8 per cent. and a bonus of 4 per cent., both free of income tax, to holders of ordinary shares registered on April 13, with £100,000 to the reserve fund and £38,664 carried forward.

DUDLEY AND DISTRICT ELECTRIC TRACTION.

The ordinary general meeting of the Dudley, Stourbridge, and District Electric Traction Co. was held at Norfolk-street, London, on the 23rd ult., Mr. A. C. Miles presiding. There was a very small attendance, and the proceedings were brief and formal.

Mr. MILES said that, in spite of the inclement weather and the depression caused by bad trade in the district, satisfactory progress had been made. The traffic receipts had been maintained to within 11d. of the amount for the previous year, notwithstanding a falling off in passengers to the number of nearly 130,000. Expenses of repairs and maintenance had increased on account of the additional repairs that had to be carried out to the rolling-stock and the permanent way, which had called for the greatest attention. The items under administration and general expenses were about the same as last year. There was no doubt that the centralisation of the workshops for the whole system at Tividale would tend to economy. It would also be seen that the directors had provided for renewals before arriving at a profit, and a sum of £2,000 had been set aside for that purpose, thus reducing the divisible profit to £7,948. After paying debenture interest, etc., the remaining profits had been allocated to preference dividend and to the reserve. This the directors considered a very satisfactory manner of dealing with it. They deplored the result of the appeal case before the House of Lords, by which the Company would receive some £16,000 less than had their

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undertaking been purchased under the Light Railways Act. They proposed to use the purchase money to be received from Dudley for the purpose of purchasing the Kinver Light Railway, which was one of the most improving properties, the net profit showing as much as 33 per cent. more this year than that earned in the previous year. The increased profit on this line could be traced almost exclusively to the fact that under the management of the joint committee passengers went from all points of Birmingham right through to the holiday resort. With regard to the agreement proposed to be entered into with the Shropshire Power Co., it was hoped that an economy would be effected. The power company would be able to generate electricity on a much larger scale than the Company, and the Company would thus be able to purchase current much cheaper than they had ever been able to generate it for themselves. The parcels and goods traffic showed a profit of £96. This was only in the early stage of development, and the directors hoped that it would become a substantial portion of the Company's undertaking.

The report and accounts were adopted, a dividend of 5 per cent. being declared.

JOHNSON AND PHILLIPS.

The third annual general meeting of the shareholders in Johnson and Phillips was held on Monday at Winchester House, Old Broad-street, E.C., Mr. Robert W. Blackwell, chairman of the Company, presiding.

The CHAIRMAN said: At this, the third meeting of the Company, I am glad to be able to say that the business of the Company has been sustained—in fact, the turn-over has been the largest during any year of our existence. That, however, must be attributed in some considerable part to the very large increase in the cost of material during the earlier part of the year. At the present time we have to report that the profit for the year on trading account, after making provision for bad and doubtful debts, and after charging to revenue for maintenance of buildings, plant, etc., £4,300, amounts in all to £31,529. 19s. 9d. The balance brought forward from the previous year was £11,451. 11s. 7d., and that puts at our disposal for appropriation a total amount of £42,981. 11s. 4d. It has seemed well to the directors out of this amount to provide for depreciation on buildings, plant, etc., the sum of £5,500. The remuneration of your directors and your auditors' fees take up £1,360. The interest on debenture stock to Dec. 31, 1907, amounts to £8,498. 4s. 3d., and in view of the general depreciation which has taken place in all industrial securities your directors have thought it best to write down the investments of the Company by £500. The total of the above deductions amounts to £15,858. 4s. 3d., so that we have left available for dividend a balance of £27,123. 7s. 1d. Out of this amount it is proposed to pay a dividend at the rate of 7 per cent. per annum on the 175,000 ordinary shares, which will absorb the sum of £12,250, and your directors and auditors have decided that out of the balance it will be better to put aside to reserve, so as to make for the general security of the undertaking, the sum of £8,000, and to carry forward to the next year the balance of £6,873. 7s. 1d. The principal matter to which I would like to call your attention at the present moment is that the business of the Company being centred in general telegraphic and submarine work, in the working of indiarubber and in the manufacture of cables of all varieties, we have consequently been sufficiently fortunate to escape the very great troubles which have been met with by those companies who are solely engaged in the manufacture of distinctly electrical engineering apparatus. The new works which were started in the earlier part of last year have been entirely completed. I am glad to say that they have been thoroughly and entirely occupied during the whole period under review, and I believe that any shareholder who pays a visit to the works will see how well the new shops have been kept in operation, and will consider that the investment made therein has been thoroughly justified. In view of the very considerable price which we have to pay annually for the supply of motive power, we are extremely glad to note that steps are being taken to obtain such parliamentary powers as will really provide for something in the nature of a bulk supply for London. At the present moment we are practically dependent upon a single source of electrical power, so that any breakdown in an individual station would prove to be of the very greatest possible disadvantage to us, whereas if we obtained a constant and reliable supply from a central source it would not only be of a great advantage to us, but it would unquestionably be of great advantage to all other manufacturing interests established in the neighbourhood of London. There is just another point to which I wish to call your attention. We have just received a circular which has been issued by a firm of brokers who are apparently desirous of disposing of a certain number of shares in Johnson and Phillips, and who have taken this method of calling the attention of possible purchasers to the fact. You will see from a first glance at this circular that it produces the impression it is the Company itself which is issuing shares. As a matter of fact, the directors wish me to forcibly state that they consider this method of trade advertisement as one which is most detrimental to the affairs of any limited company, and is wholly unjustifiable. The circular, it will be noticed, includes not only a complete copy of Johnson and Phillips's balance-sheet and the names of the directors in full, but it also includes a blank application form for the amount of shares which they are apparently empowered to issue. This circular seems to have reached certain of our shareholders on Saturday last, and we have received constant inquiries as to why we are selling these shares, what we guarantee in connection therewith, and why we are cutting the price, etc. Now, we believe as thoroughly as anybody in push, in business enterprise, and in advertising, but this type of hustle is, to my mind, something which should be most seriously condemned. I have nothing further to add, and I will now conclude by moving: "That the report of the directors produced, together with the annexed statement of the Company's accounts at Dec. 31, 1907, duly audited, be received, approved, and adopted."

Sir HENRY BENBOW, K.C.B., D.S.O., R.N., seconded the motion.

Replying to various criticisms, the CHAIRMAN said that the new buildings were entirely fireproof in every respect. The erection of the buildings themselves was properly chargeable to capital account, but the expense incurred in moving into the new works had been charged to the revenue account. That, to a certain extent, was the explanation of the slight drop of something under £2,000 in the total amount of the gross profit. With regard to the question of taking shares as part consideration of purchase money, the Company had taken little or nothing in shares in any concern; in fact, it would be noticed that the Company only held investments of every class to the amount of £4,422. With regard to the remark which had been made in respect to the circular, he had not the slightest objection to any person issuing shares in Johnson and Phillips, but what he objected to was the form in which the offer was made, which to his mind gave the impression that it was the directors of the Company who were issuing the shares. What he complained about was the way in which the firm's name had been used. By putting the name of Johnson and Phillips at the top of the circular it gave the impression that it had been issued by the Company. As to the prospects of the Company, at present they were not so full of orders as they were at this time last year, but they had no reason to suppose that they would continue to have less business than they had last year. They were a little below what they were a year ago, but that was largely due to the fact that they had cleared the shops of very large contracts almost immediately before the end of the year. The shareholders must remember that last month's work was several times greater than that of any of the previous months.

The resolution was then put to the meeting and carried unanimously, and Sir Henry Benbow, the retiring director, was re-elected a director of the Company.

The CHAIRMAN next proposed: "That the following dividend be now declared out of the net profits of the undertaking for the 12 months ended Dec. 31, 1907, upon the capital issued on that date—namely, on the £175,000 ordinary shares a dividend of 7 per cent. for the year, such dividend to be paid on April 30 next to the shareholders appearing on the register to-day."

The resolution was seconded by Sir HENRY BENBOW, and unanimously adopted.

BRISBANE ELECTRIC TRAMWAYS.

The seventh annual general meeting of shareholders in the Brisbane Electric Tramways Investment Co. was held on Wednesday, Mr. H. R. Beeton presiding.

The CHAIRMAN, in moving the adoption of the report, said the results of the past year exceeded in excellence those of any previous year in the history of the undertaking. They were due to a continuance of the growth of prosperity which they had experienced during the preceding two years, and reflected the perhaps unexampled progress of Queensland since the return of favourable climatic conditions three years ago. Since 1904 the statistics of production and revenue in Queensland had grown by leaps and bounds. During this short period over £1,000,000 had been expended upon works of public utility without any increase in the public debt. Such financial results were the more encouraging when they considered the disturbance in revenue which Queensland suffered in consequence of federation. Their figures showed, briefly, that in three years, with no extensions, no material additions to plant, and with very little increase in the number of miles run, they had carried 33 per cent. more passengers and taken 25 per cent. more receipts, so that the car mileage receipts had risen from 9½d. to nearly 1s., in spite of a reduction in the average fare; and their percentage of working expenses had fallen from 60 to 53 per cent., in spite of an increase in the cost of coal and labour. Whilst such results were mainly attributable to the improvement in the economic conditions to which he had referred, they were partly due to the capable and assiduous management of Mr. Badger, to whom the shareholders continued to be deeply indebted. Turning to the accounts for the past year, and combining the figures of the two companies, the total receipts amounted in 1907 to £159,230, as compared, in 1906, with £141,732, showing an increase in receipts of £17,497; and the expenditure in 1907 was £88,116, as compared, in 1906, with £82,770, or an increase in expenditure of £5,345. There was a net improvement in 1907, as compared with 1906, of £12,151. The Brisbane Tramways Co., of which they held all the shares, had placed to its renewals fund a sum of £15,000, thereby raising it to £39,000 and bringing the total of undivided profits available for renewals, etc., to about £58,000, and was paying in dividend a total for the year of £57,000. This enables them to satisfy debenture stock interest and preference dividend, and to recommend the payment of a dividend on the ordinary shares of 4s. per share, or 4 per cent., free of income tax, and to carry forward to next account £2,130. 1s. 3d. The current year was showing already a considerable improvement on the past one, the comparative receipts for the past three months showing the following increases: for January, £1,875; for February, £2,390; and for March—when the weather was exceedingly bad—£1,291; or a total for the first quarter of £5,556. Taking into account the incidence of leap year the receipts gave an increase for the same number of days of over £5,000 as compared with 1907, and the receipts per mile run for the first three months of this year had been 12·2d., as compared with 10·77d. in the corresponding period of last year. The traffic, indeed, was growing at such a rate that the tramway company's plant was being increased by the addition of another generating unit and 12 new cars. They had hoped to have these all in operation in time for the annual agricultural exhibition, which took place in August, but owing to the strike on Tyneside there was likely to be some delay in delivery of

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the generating unit. Mr. Badger, however, might be relied upon to do what was possible to meet the difficulty. He moved: "That a balance dividend on the preference shares of 2s. 6d. per share, less income tax, be declared, making, with the interim dividend paid in November last, 5 per cent. per annum, and that a dividend of 4s. per share, or 4 per cent., free of income tax, be declared on the ordinary shares." This, after being seconded, was unanimously agreed to.

WOLVERHAMPTON DISTRICT TRAMWAYS.

Presiding at the annual general meeting of the Wolverhampton District Tramways in London on the 23rd ult., Mr. S. R. BLUNDSTONE said that, although the profit available was apparently less by £1,000 than the previous year, the directors had adopted the principle of providing for a renewals fund before arriving at the profit, and £1,000 was charged for that purpose, and a further sum of £500 was placed to reserve. That compared with £1,000 for the two items last year. The traffic receipts were £1,000 more, the passengers carried having increased by 28,000, which was a very satisfactory figure considering that trade was very bad in the district covered. The car miles run were also more. During the present year they did not expect that repairs would be so heavy. The general expenses also included items for the new Tividale car-sheds—a large establishment for all the companies—and the subscription to the British Electrical Federation. Those items had not previously appeared in the accounts. There was a considerable delay in the payment of the purchase price of the tramways which the Company sold to the Corporation, but that arose on the question of the appeal to the House of Lords. That, however, had now been settled, and the terms of the lease to be granted were being considered.

A dividend was declared at the rate of 1½ per cent. per annum.

KALGOORLIE ELECTRIC TRAMWAYS.

The report of the Kalgoorlie Electric Tramway (Western Australia) for the year 1907, to be submitted at the meeting on May 6, states that the gross receipts were £48,008, as compared with £51,379 for the previous year, while the net profits amounted to £16,270, against £17,546 for 1906. The directors regret to report a falling off both in receipts and profits, owing to the reduction in the number of men employed at mines which have installed labour-saving machinery, and also owing to the smaller number mining on their own account. During the year the cars travelled 650,530 miles and carried 3,052,241 passengers, as compared with 673,544 miles run and 3,220,728 passengers carried during 1906. The number of units consumed in 1907 was 930,231 (value, £10,658), as against 933,109 (value, £10,929) in 1906. The earnings per car mile in 1907 were 17·63d. and expenses 11·17d., as against 18·22d. earnings and 11·34d. expenses during 1906. The expenses per cent. of earnings in 1907 were 63·36d., while in 1906 they were 62·24d. The Bill for the Trans-Continental Railway scheme was reintroduced, and passed by the Commonwealth Parliament, and this all-important work is, therefore, one step nearer accomplishment. Owing to the depression in the money market, the directors have been able to redeem a larger amount of debenture stock than was anticipated when the Company was formed. The directors deeply regret to announce the sudden death of their valued colleague, Mr. R. C. F. Ogilvie, A.M.I.C.E., whose advice on technical engineering subjects, especially during the construction, was of great service to the Company. The construction being now completed, the directors do not propose to fill the vacancy, but to reduce the expenses accordingly.

MERTHYR ELECTRIC TRACTION.

The report of the Merthyr Electric Traction and Lighting Co. for the year ended Dec. 31, 1907, states that the total capital expenditure to Dec. 31, 1907, amounted to £107,288. The directors have had under consideration the question of making provision for the cost of renewals other than those ordinarily charged against the year's revenue, and have accordingly debited the profit and loss account with £1,000, to be placed to a renewals provision account. The gross receipts on light railways for the year amounted to £11,265, and the gross receipts on account of electrical supply to £5,872, making with £206 sundry receipts a total of £17,344. After deducting all expenses chargeable to revenue, including £2,056 for debenture interest and placing £1,000 as mentioned above to a renewals provision account, there remains a surplus of £4,347, making with the £436 brought forward a total of £4,783. The payment of the dividend on the preference shares for the 12 months ended Oct. 15, 1907, amounting to £1,500, reduces this sum to £3,283. The directors recommend to place £1,250 to depreciation and reserve account, to pay a dividend of 5 per cent. on the ordinary shares, and to carry forward £533. The sum of £263, being the cost of renewing plates in the battery, has been charged against the renewals provision account. The results from the year's working of the electric supply continue to show satisfactory progress. The gross receipts amounted to £5,872 and the expenditure to £2,103. The gross receipts from the light railways show an increase of £626 and the expenditure an increase of £336, making a total improvement of £289 in the gross profit.

GREAT NORTHERN TELEGRAPH OF DENMARK.

The report of the Great Northern Telegraph Co. of Denmark states that the Company's submarine system has not been subject to more frequent interruptions in 1907 than in previous years, although during the last two years the number of cables in Europe has been increased by two, or rather by four, the Shetland-Faroe-Iceland cable and the Denmark-Libau-St. Petersburg cable, each being composed of two distinct section. The downward tendency of the traffic receipts has not yet ceased, as they decreased by about £13,200 as compared with 1906, owing to the same reasons as those mentioned last year, and further to the loss on exchange, which amounted to about £5,000. Interest has slightly increased, whilst sundries has slightly decreased. As to expenses, salaries and wages have increased by about £6,520, and will continue to grow, the more so as the enhanced cost of living appears to have become chronic also in Europe. Expenses of stations, etc., have increased by about £1,480. Ordinary supervision and maintenance, etc., have decreased by about £500 and instruments and cells by £120. The maintenance of buildings has increased by about £1,200, rates and taxes by about £1,700, and travelling expenses by about £200. Bank commission has decreased by about £300, and sundries by about £1,700. Altogether the ordinary expenses are about £8,500 higher than those of 1906. The balance-sheet shows under "Assets" that the investments has decreased by about £3,560 on account of drawn bonds. It is impossible to increase this item because the directors are in exactly the same position in 1907 as in the preceding year—namely, that all the receipts of the reserve fund, and something more besides, has been absorbed by the expenses towards the St. Petersburg-Libau-Danmark cable, etc. The advances guaranteed by banks has been reduced by about £55,555 for the same reasons as in 1906, whilst the cash balance has been increased by about £28,000, it being necessary to have funds available, and, lastly, sundry debtors has been increased by about £9,000. Under "Liabilities" the reserve and renewal fund has been decreased by about £21,500 on account of the heavy extraordinary expenses. The dividend equalisation fund has been increased only by the ordinary interest of its capital—about £14,000. The directors, however, propose the same dividend and bonus as in the previous year—namely, 20 per cent., of which 5 per cent. has already been paid as interim dividends. The chairman was obliged, on account of failing health, to ask to be allowed to resign the position of managing director in the course of the present year. The Board has decided to substitute for the managing director a board of management.

EASTERN TELEGRAPH.

The accounts of the Eastern Telegraph Co. for 1907 show, subject to final audit, that, after making a contribution to the general reserve fund, payment of interest on the 4 per cent. mortgage debenture stock, dividend on the 3½ per cent. preference stock, and three interim dividends of £1. 5s. per cent. each on the ordinary stock to Sept. 30 last, there is a balance available out of which the directors recommend the payment of a final dividend of £1. 5s. per cent. and a bonus of £2 per cent., both free of income tax, making, with previous payments on account, a total distribution of 7 per cent. on the ordinary stock for the year ended Dec. 31, 1907.

SWANSEA IMPROVEMENTS AND TRAMWAYS.

The report of the Swansea Improvements and Tramways Co. for the half-year ended Dec. 31, 1907, states that the directors have had under consideration the question of provision for expenditure on renewals and reconstructions as distinguished from ordinary repairs and maintenance, and they have decided, in addition to the depreciation and reserve fund, to build up out of each year's revenue a fund to be available for defraying or equalising the cost of extraordinary renewals of the permanent way and plant and equipment. They have accordingly set aside out of the year's profits the sum of £2,500 for this purpose. The gross receipts amount to £27,816, being an increase of £2,741 upon the corresponding period of the previous year. After deducting all expenses chargeable to revenue, including debenture and other interest, and the amount payable to the Swansea Corporation in respect of the tramways and light railways leased from the Corporation, and after charging profit and loss account with £2,500 for provision for renewals, there remains a surplus of £5,288. The addition of the sum of £3,442 brought forward brings the available balance up to £8,731. The directors recommend to place to reserve and depreciation fund £2,000, to pay a dividend on 13,000 ordinary shares at the rate of 3 per cent. for the year, and to carry forward £1,531.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The report of the Kalgoorlie Electric Power and Lighting Corporation for the year 1907 states that the trading as regards the amount of power sold during this period constitutes a record. The increase in the profit earned, though not proportionate to the power sold owing to the reductions made in price, is satisfactory. For the 12 months the profit is £26,597. After writing off reconstruction and registration expenses (£850) and the cost of issuing debentures (£3,736) to replace those which matured on Feb. 12, 1907, the balance is £22,010, which has been appropriated as follows: debenture interest account, £2,091; dividends on preference shares, £6,750; dividend tax in Western Australia, £337; reserve for depreciation and renewals, £7,500; carried forward, £5,330. Since the date to which the accounts have been made up a dividend has been declared at the rate of 6 per cent. per annum for the six months ended March 31, 1908, on the preference shares, and the directors recommend a dividend at the rate of 5 per cent. per annum for the six months ending June 30, 1908, on the ordinary shares.

CRAIGPARK ELECTRIC CABLE.

The report of the Craigpark Electric Cable Co. for the year ended March 31, 1908, states that the accounts show a net profit of £7,128, which with £604 brought forward makes the sum of £7,732. The

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directors recommend the following appropriations—namely, depreciation written off buildings and machinery, £1,000; dividend (already paid) on 37,500 6 per cent. preference shares for half-year ended Sept. 30, 1907, £1,125; ditto for half-year ended March 31, 1908, £1,125; dividend on 37,500 ordinary shares at 6 per cent. for the 12 months ended March 21, 1908, £2,250; reserve account, £1,000; balance carried forward (subject to payment of directors' fees for the past year), £1,232. The cable department of the Company's business shows a satisfactory increase, notwithstanding the general depression in trade. The prices of raw materials are more favourable, and the directors look forward with confidence to the business of another year. During the year the Company became members of the Cablemakers' Association, and the directors are of opinion that this will prove beneficial to the Company.

WEST COAST OF AMERICA TELEGRAPH.

The report of the West Coast of America Telegraph Co. for the year ended Dec. 31, 1907, states that the gross receipts amounted to £61,854, against £68,048 in 1906. The working expenses were £34,616, as compared with £34,173 for the previous year. After providing £6,000 for the interest on the 4 per cent. debentures, £800 for the interest on the 4 per cent. income bonds, and £192 for income tax, there remains a balance of £20,244, to which is added the sum of £1,922 brought forward, making a total of £22,167. Of this amount £16,000 has been placed to the general reserve fund, and £2,000 to the maintenance ship's reserve fund, and the directors recommend the payment of a dividend of 2½ per cent., free of income tax, leaving a balance on the revenue account of £1,354 to be carried forward. The directors are grieved to report the death of their colleague, Mr. Frederick Walters, on June 15, 1907. Mr. Francis Alexander Johnston has been appointed to the vacancy.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The report of the British Westinghouse Electric and Manufacturing Co. for the year ended Dec. 31 states that the debit balance on profit and loss account for the period ended Dec. 31, 1906, was provided for in the reduction of capital, together with other items of loss and depreciation incurred in the past, so far as ascertained up to the time of presenting the petition to the Court. The results for the 12 months ended Dec. 31, 1907, show a marked improvement over previous years. The trading profits amount to £92,383. After deducting debenture interest (49,654), interest on temporary loans (£14,379), and sundry depreciations not ascertained at time of reduction of capital (£17,009), a balance of £11,341 is carried forward. Having regard to the recent writing down of the various assets, it has not been deemed necessary to make further provision in this year's accounts for depreciation in respect of the works and plant. In their circular of Jan. 4, 1908, the directors referred to the proposed financial plans. In accordance therewith £250,000 (out of £300,000 authorised) of 6 per cent. prior lien debentures have recently been issued at 98 per cent., and have been fully subscribed. The balance of £50,000 will be held in reserve to be used as and when required for the general purposes of the Company. The arrangement with the American companies has been carried out whereby indebtedness amounting to £186,374 has been liquidated by the transfer to the American companies of shares in the Traction and Power Securities Co. at their par value. Out of the proceeds of the prior lien issue the loans from bankers will be paid off, and a substantial sum added to the working capital of the Company. The institution of economies throughout the administration is continuing to have the careful consideration of the directors. During 1907 there was a substantial increase in the volume of the Company's business. At the present moment demand is slack, but the Company's improved commercial position, both at home and abroad, will enable it to take advantage of any revival in trade.

NEW COMPANIES REGISTERED.

North British Electric Power Syndicate, Limited.—Registered March 31. Capital, £4,325. 10s. in 4,300 "A" shares of £1 each and 510 "B" shares of 1s. each. Objects: to promote a company or companies for constructing, establishing, and working an undertaking or undertakings for the generation, distribution, supply, and employment of electricity in the United Kingdom or elsewhere; to adopt agreements (1) with the Hon. Ferdinand C. Stanley and F. M. Voules, (2) with B. Bernheim and W. B. Cownie, and (3) with the National Electric Construction Co., Limited. No initial public issue. Registered office: Queen Anne's-chambers, Westminster, S.W.

Prowodnik Tyre and Rubber Co., Limited.—Registered April 2. Capital, £1,000 in £1 shares. Objects: to take over the London agency of the Forma Prowodnik of Riga for solid omnibus tyres and motor and pneumatic tyres carried on by J. Lang at 63, Regent-street, W.; to acquire the benefit of two contracts between the said J. Lang and the Forma Prowodnik, etc. No initial public issue. Registered office: 63, Regent-street, W.

Private Telephone Co., Limited.—Registered April 4. Capital, £1,000 in £1 shares. Objects: to adopt an agreement made between M. Atkinson and M. C. Greenhill and L. M. Porter, and to carry on the business indicated by the title, and that of electricians, manufacturers of and dealers in electrical apparatus, mechanical and electrical engineers. No initial public issue.

Liens Registered.

Electrolytic Alkali Co., Limited, Middlewich.—Lien, March 13, £1,700 4½ per cent. debentures, part of £50,000. Amount previously issued, £34,850. Trustees: Liverpool Mortgage Insurance Co. Property charged: undertaking and assets.

Leicestershire and Warwickshire Electric Power Syndicate, Limited, London, E.C.—Lien March 24, £100 6 per cent. debentures, part of £5 000. Amount previously issued, £850. No trustees. Property charged: undertaking and assets.

Rhondda Tramways Electric Supply Co., Limited, Westminster, S.W.—Assignment of leasehold redemption policies March 19, supplemental to a trust deed dated Aug. 8, 1907, for securing a series of £44 000 5 per cent. debentures. Trustees: C. A. Scott-Murray and L. Bernhard Schlesinger (policies in various insurance offices amounting to £44,000).

Provincial Tramways Co., Limited, London, E.C.—Discharge in full, March 2, of debentures dated May 27, 1904, for £125,000, of which sum only £121,500 was issued.

Delhi Electric Tramways and Lighting Co., Limited, London, E.C.—Lien March 2, £23 200 5 per cent. debentures, part of £50,000. Amount previously issued, £100. Trustees: R. C. Pearman and James Greig. Specific charge on lands, properties, rights, and the benefit of the Delhi Municipality Electric Licence, 1905, and the Delhi (Municipality) Electric Tramway Order, 1906. Property charged: undertaking, business, goodwill, and assets, excluding the uncalled capital.

Cape Electric Tramways, Limited, London, E.C.—Trust deeds and particulars required by Sub-Section 4, Section 14, of the Companies Act, 1900, March 16 relating to a series of £140,000 5 per cent. debentures of £100 each. Trustees: C. Rube and L. Breitmeyer. Property: present and future, also certain shares held by the company in various tramway companies.

Telephone Co. of Egypt, Limited, London, E.C.—Acknowledgment of indebtedness March 5, supplemental to a trust deed dated July 27, 1904, for securing a further sum of £50 000 4½ per cent. debenture stock, ranking *parri passu* with £100 000 like stock already issued, and forming part of an authorised amount not to exceed £200,000. Trustees: Sir A. Colvin and G. F. Braithwaite. Floating charge on the undertaking, property, and assets, present and future, excluding the uncalled capital.

Telemarken Copper Mining and Smelting Co., Limited, London, E.C.—Particulars required by Sub-Section 4, Section 14, of the Companies Act, 1900, Feb. 27, relating to a series of £15,000 debentures. No trustees. Property charged: seven mines at Amdal, Telemarken, Norway, undertaking and assets, present and future.

Micanite and Insulators Co., Limited, Walthamstow.—Lien April 2, £15,000 5½ per cent. debentures. No trustees. Property charged: undertaking and property, present and future, including the uncalled capital.

Charing Cross, West End, and City Electricity Supply Co., Limited, London, W.C.—Trust deed April 2, for securing £600 000 debenture stock. Trustees: Union of London and Smith's Bank, Princes-street, E.C. Property charged: the City undertaking and the assets and money now or hereafter belonging to that undertaking.

Tasmania Copper Co., Limited, London, E.C.—Trust deed and particulars required by Sub Section 4, Section 14, of the Companies Act, 1900, March 14, relating to a series of £30 000 debentures. Trustees: F. L. Cox and J. White. Property charged: mines situated in Tasmania and South Australia, and all buildings and works, also on the undertaking and property, present and future, including the uncalled capital.

APPOINTMENTS VACANT.

Premium Pupil. Apply, Electricity Works, Canterbury. See advertisement.

Premium Pupil, Shrewsbury Corporation Electricity Works. Applications to Mr. C. M. Johnston, engineer and manager. See advertisement in last issue.

Shift Engineer, Ayr Corporation Electricity Works. Wages, 35s. per week, increasing to 40s. per week after one year's service. Applications to the manager.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Daireaux (Buenos Ayres).—A local company is being formed for the electric lighting of the town.

Navan.—The Urban District Council have under consideration a scheme for lighting the town with electricity.

Necochea (River Plate).—An electric light station has been opened for the supply of electricity to the town.

Glencoe (Ontario).—The Municipal Council have decided to have an electric lighting plant installed in order to supply light and power.

Electrical Exhibition at Marseilles.—An international exhibition of electrical appliances was opened on the 23rd ult. in the presence of the foreign consuls.

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Frinton-on-Sea.—At the last meeting of the Urban District Council consent was given to the electric light company to lay their cable in the Queen's-road.

Pyle.—The Parish Council have decided to ask the Tythegston Higher Parish Council to meet them to consider the question of a joint scheme of public lighting.

Taunton.—An inquiry will be held by the Local Government Board on May 6 into the Town Council's application for sanction to borrow £2,000 for electric lighting purposes.

Stock Exchange.—The Stock Exchange Committee has appointed May 6 a special settling day in Rheinbach Copper Mines' 30,007 shares of £1 each, 15s. paid, Nos. 1 to 30,007.

Newport.—At a meeting of the Council Electricity Committee on Tuesday it was reported that there was a general increase of customers for electric light and of tramcar passengers.

Stockport.—The Local Government Board will hold an inquiry on May 7 into the application of the Corporation for sanction to borrow £10,500 for the purposes of their electricity undertaking.

Ebbw Vale.—It was reported at the last District Council meeting that 18,085 units had been sold at the Council electricity works during the quarter ended March 31, 1908, an increase of 15,029 units.

Toronto.—The Sunbeam Incandescent Lamp Co. of Canada have offered to purchase from the City Council 100ft. of land on the east side of Dufferin-street for the purpose of erecting a factory thereon.

Battersea.—The Borough Council have decided to purchase a feeder booster and accessories at an estimated cost of £1,847 in order to cope with the increased demands for power in the Nine Elms district.

Stirling.—The report by Mr. Papworth, electrical engineer to the Corporation, shows that for the four weeks ending March 14 33,121 units of electricity were generated at the power station, as compared with 31,360 for the same period last year.

Wireless Telegraphy.—At a meeting of the Liverpool Chamber of Commerce on the 28th ult. a letter was received from the Colonial Office stating that the suggestion to provide short-distance wireless telegraphy stations between British colonies was receiving attention.

Bradninch.—At the Tiverton Rural Council meeting the Parochial Committee of Bradninch recommended that the Council should grant an application from the Hele and Bradninch Electric Light Co. for sanction to erect posts and an overhead cable. The recommendation was agreed to.

Eastern Extension, Australasia, and China Telegraph Co.—The directors of this company have declared a dividend for the quarter ended Dec. 31 last of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1907.

Great Massingham.—During a thunderstorm on Sunday night some slight damage was done to Great Massingham Church, the top of the flagstaff being broken, and an electrical apparatus in connection with the bells was smashed. The lightning was very vivid, and hailstones of an immense size fell.

The Indian Electricity Act.—The secretary to the Government of India Public Works Department will shortly publish the names of the members of a committee which the Government propose to constitute to advise it in respect to the revision of the existing rules under the Indian Electricity Act.

Swansea Harbour Trust.—At a meeting of the Harbour Trust executive on Thursday week, Sir Griffith Thomas presiding, it was decided to officially inspect the new dock works on May 6. The committee again discussed exhaustively the question of whether electric or hydraulic power shall be adopted at the new dock, and eventually a committee was selected to submit a report.

Huddersfield.—The Corporation electricity undertaking shows an income on revenue account of £30,353. 15s. 7d., as compared with £27,923. 19s. 5d. for the previous year. The surplus, after providing for interest and sinking fund on the debt, amounts to £985. 12s. 10d., which has been carried to depreciation and contingencies account, bringing the total balance of that account up to £11,874. 10s. 5d.

Tunstall.—At the vestry meeting of St. Mary's parish the vicar announced that the Finance Committee had considered the lighting of the church by electricity. They had procured what was considered a reliable estimate of the cost of carrying out the work. After deliberation it was decided that the church should be lighted by electricity, and the exact scheme should be left to the Finance Committee to decide.

Chester.—The Council have decided to purchase four 27-h.p. motors and one 5-h.p. motor at an estimated annual cost for the next three years of £176, to have the necessary additional cable laid from the main to the works at an estimated cost of £47, and to sell the steam-engines at present in use at the works. It is considered that the substitution of electric current for steam will probably effect a saving of £100 a year.

Brighouse.—On the 28th ult. a Local Government Board inquiry was held by Mr. W. O. Meade-King into an application of the Corporation to borrow £3,624 for the purpose of wiping out the cost of the old generating plant and to defray the cost of the recently laid underground cables. It is also proposed to apply for a further loan of about £4,000 with which to erect a transforming station to deal with the electricity in bulk proposed to be received from the Yorkshire Power Co.

Honley.—On Tuesday evening an explosion of gas occurred at the house of Mr. Ernest Woodcock, Southgate, Honley, but, fortunately, the damage was not great. Throughout Tuesday a smell of escaping gas was noticed, but all attempts to locate it failed. About nine o'clock there was a loud explosion underneath the bedroom floor, and flames burst through the bedroom chimney. The plaster of the kitchen ceiling fell to the floor, some alighting on Mrs. Woodcock, who suffered much from the shock.

Perth.—Incandescent gas lamps for street-lighting seem to be doomed in Perth, as at the last monthly meeting of the Town Council it was decided that all the incandescent gas lamps in Marshall-place should be substituted by metallic-filament lamps. It was stated at the meeting that the metallic-filament lamps, besides being cheaper, gave a greater illumination. There can be no doubt, therefore, that it is only a question of time before the remainder of the incandescent gas lamps for street-lighting are superseded.

Liquidations.—The *London Gazette* announces that the Kevan Electric Co. has been wound up voluntarily, and Mr. E. Heisch, 120, Fenchurch-street, London, E.C., appointed liquidator. Creditors are required to send all particulars of their claims to the liquidator by June 3. 1908.—A general meeting of the Electric Safety Appliances Co. will be held at 82, Victoria-street, Westminster, at 11 a.m. on May 26, for the purpose of receiving the liquidator's account, showing the manner in which the winding up has been conducted.

Exeter.—The Electric Lighting Committee are recommending the Council to agree that from July 1 next the normal charge for lighting to private consumers be reduced from 5d. to 4½d. per unit., and that the charge for power be fixed upon a scale to be arranged from 2½d. to 1½d. per unit, according to consumption, in lieu of the present scale ranging from 2½d. to 2d. per unit. The committee further recommend that the Council make application to the Local Government Board for sanction to the borrowing of £8,100 for the purpose of the extension of electric mains.

Radcliffe.—At the last meeting of the Council Electricity Committee the clerk submitted a statement showing actual income and expenditure on electricity works account for the year ending March 31, 1908, as compared with estimates for same, also estimates of income and expenditure for the year ending March 31, 1909. The total estimated number of units was 716,500 and estimated receipts £4,004; actual, 773,249 and £4,562; for 1908-9 855,000 units, estimated to produce £4 951. The estimated expenditure for the year was £4,030; actual, £4,436; showing an actual profit of £126. The estimated gain for 1908 9 is £498.

Kalgoorlie Electricity Co.—The Kalgoorlie Electric Power and Lighting Co. announces a profit for last year of £26,597. After writing off the cost of issuing debentures (£3,736) and providing £7,500 for depreciation and renewals, £5 330 is carried forward. The directors now recommend a first dividend at the rate of 5 per cent. per annum for the six months ending June next on the ordinary shares. The new plant continues to give satisfaction, and it has been decided to make an addition, which it is hoped will still further reduce the cost of maintenance and upkeep. The company's 10s. ordinary shares are now quoted officially at 5s, while the £1 6 per cent. non-cumulative preference are obtainable at about 14s., to yield 8½ per cent.

Haslingden.—The following amended terms for the supply of electricity for the lighting of the workhouse buildings were submitted by the Rawtenstall Corporation to the last meeting of the Board of Guardians: for 15,000 units, 4½d. per unit; for 20,000 units and over, 4¼d. per unit; for 25,000 units and over, 4d. per unit. The Corporation also agree to lay and maintain the necessary cables, and are prepared to enter into an agreement for five years in the first place, subject to determination thereafter at any time by six calendar months' notice on either side. The Guardians have decided to defer consideration of the matter until a deputation has met the Corporation representatives, and have appointed representatives for this purpose.

Gloucester.—At the last meeting of the Electricity Committee the engineer reported that it would shortly be necessary to lay a main for supplying electricity to the girls' high school in Denmark-road, and asked whether it should be laid from the Tewkesbury-road up the Denmark-road, or from Heathville-road down Denmark-road to the school, the distance being nearly the same in each case, and the cost of providing and laying the required main being estimated at £250. It was resolved that it be recommended that the main be laid from Heathville road. It was further resolved that the Council be recommended to apply to the Local Government Board for sanction to borrow not exceeding £2,000, when required, for further extension of the electricity mains.

Liverpool.—The National Telephone Co. are about to erect a new exchange in South John-street. The premises known as Caxton-buildings are being demolished for that purpose. The scheme foreshadowed is a most important one, elaborate plans having been prepared for submission to the Corporation authorities indicating that the proposed structure is to be of a comprehensive and handsome character. There is reason to believe that it will be the finest and most spacious telephone exchange in the North of England, and that it will form the headquarters of the company in Liverpool, although it is not intended to transfer thereto any of the actual working apparatus from either the Central or Royal exchanges, situated in the Exchange-buildings and Rathbone-street.

Rotherham.—The income from sale of current from the Corporation electricity works during 1907-8 was larger than that of the previous year by £1,999. the total units sold having been 1,698,174 and the receipts £13,108 13s. 9d., representing 1·852d. per unit. The cost of generation, distribution rates, and management expenses absorbed ·88d. per unit as compared with ·87d. in the previous year. The increased cost of fuel, of course, accounts for the increase. The manufacturing profit for the year was £7,214. 19s. 10d., as compared with £6,315. 0s. 5d. for the previous year. After paying loan charges the net surplus for the year is £3,302. 5s. 6d. Out of that sum £1,959. 17s. 10d. falls to be deducted for depreciation and renewals account, leaving a net surplus of £1,341. 17s. 8d. for the year.

Tankersley Colliery.—On Saturday afternoon a fire broke out in the dynamo-house at the Tankersley Colliery of Messrs. Newton,

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Chambers, and Co., which was not extinguished until the building had been wrecked, and much damage done to valuable machinery. The outbreak, which was discovered by the manager of the coke ovens, arose from an extensive fusing in one corner of the house, and spread so rapidly that virtually nothing could be done to save the establishment, and though plenty of help was forthcoming from the pit itself, it was only possible to confine the outbreak to the area already affected. This was very necessary, as the engine-house is situated near to a store, and also the pithead. The Sheffield and Barnsley fire brigades were telephoned for, the former arriving first on the scene, to be quickly followed by the Sheffield motor tender and hose-engine, though none were used, the fire having practically burned itself out by the time of their prompt arrival, the whole business, from the first alarm to the falling in of the roof, occupying an almost incredibly short period. The damage was somewhat extensive.

Electrical Apparatus for Russia.—Among recent contracts obtained by the transformer department of Messrs. Ferranti Limited, Hollinwood, is that for the supply of 55 transformers to the St. Petersburg Corporation. The competition for this contract on the part of the chief Continental manufacturers was extremely severe. Owing to the very high Russian import duty, which is assessed upon the weight of the articles, light but bad efficiency transformers are at an advantage as regards initial cost, and such transformers have as yet been exported into Russia by the German and other manufacturers who have hitherto handled this trade. Some time ago Dr. Garrard, Messrs. Ferranti's transformer department manager, secured permission to submit several special high-efficiency type "E X" transformers as samples to St. Petersburg. The tests on these were so satisfactory, and the saving shown to be possible over a number of years was so large, that the result has been that the above contract has been placed. It is to be hoped that, now that the superiority of English goods in this line has been demonstrated, a considerable development in the near future is to be expected.

Electric Supply Football League—The first season of this league was brought to a close by the meeting of the Metropolitan Electric *v.* L.C.C. Tramways at Acton-lane, Willesden, the former gaining a runaway victory by nine goals to one. At the last council meeting, held in the offices of the St. James's Electric Co., it was resolved to extend the number of clubs in the league, by embracing clubs connected with the manufacturing electrical companies and others engaged in the electrical industry. Representatives of these clubs are invited to attend the annual general meeting of the league, which will be held on Tuesday, May 26, at 7.30 p.m., in the offices of the St. James's Co., 19, Carnaby-street, Golden-square, W. The table appended shows the Metropolitan Electric F.C. to be the first winners of the league, not having lost a match.

Name of club.	Played.	Won.	Lost.	Drawn.	Points.	Goals. For.	Goals. Against.
Metropolitan*	6	6	0	0	12	20	6
St. James's	6	3	2	1	7	28	13
St. Pancras*	6	2	4	0	4	16	17
L.C.C.*	6	0	5	1	1	5	33

* Metropolitan *v.* St. Pancras and L.C.C. *v.* Metropolitan not played.

Fire at Heron Court, Christchurch, Hants.—The fire which broke out at Heron Court last Sunday might have had much more serious consequences but for the fact that electricity came to the aid of the house staff in the form of an electrically-driven fire-pump. Quite recently a special system of fire-extinguishing apparatus, designed by Messrs. Handcock and Dykes, consulting engineers, of Victoria-street, was installed by Messrs. Rawlings Bros., of South Kensington. In this system the water is stored at a low level, instead of on a tower or neighbouring hill. The house supply of water is maintained by a special electric pump, which runs at a moderate speed. On an alarm of fire this pump can be run at full speed by means of special switches situated at various points in the building, raising the pressure in the fire-mains, so that the highest point in the building can be reached by the hydrants with ease. Thus the emergency pump and the everyday service pump are one and the same thing, an advantage which cannot be over-estimated. It is interesting to note that the electric lights with which the mansion has just been fitted on the "Kalkos" concentric-tube system throughout withstood their baptism of fire and water without flinching. Although the tubes hung in places amid blackened and dripping debris, the lights could all be used in all the damaged rooms.

Plymouth.—At the last meeting the electrical engineer reported to the Electricity Committee that for the quarter ended March a total sale of 635,453 units, producing estimated receipts of £6,874, compared with 583,145 units sold and £6,526 received in the corresponding period of last year. The Corporation trams were largely responsible for the increase both in consumption and receipts, the cars having consumed in the quarter 34,936 more units, for which they have to pay an additional £255. There was only a slight increase in the consumption for private lighting, but the return showed a relatively much larger growth in the use of current for power purposes. At the end of March the number of consumers was 941, against 880, and the lamp connections 73,670, against 66,114 last year. The committee decided to ask the Council to empower them to obtain another cargo of coal for use after the end of May, when the present supply will be exhausted, and also to obtain and accept tenders for a 12 months' supply. Application was received for the supply of the current to premises in Salcombe-road, and the engineer was empowered to lay a cable at a cost of £47. 10s., provided additional consumers were obtained in the neighbourhood. Mr. Okell was authorised to attend the annual conference of the Incorporated Municipal Electrical Association at Nottingham from June 30 to July 3.

Edinburgh.—The Postmaster-General has intimated to Edinburgh Town Council that he consents to the use for the purpose of underground telegraphs of the telephone ducts in Rose-street and Hope-street to Haymarket. In his letter the Postmaster-General says that, in spite of the drawbacks of such a scheme, he is willing to consent to it on the understanding that facilities are given. Negotiations in reference to the matter have been going on for some time, and alternative routes were suggested. The Town Council held out against any interference with Princes-street.—The estimates in connection with the electricity undertaking for the year from May 15, 1908, to May 15, 1909, were submitted at a meeting of the Electric Lighting Committee of the Town Council. The estimated ordinary expenditure for the year is £70,230, as against the estimate for the current year of £65,040. The payments to interest and sinking fund contribution in respect of debt are estimated at £56,070, as against £50,065 for the current year. This gives a total estimated expenditure of £126,300, as against £121,105 for the current year. The estimated revenue for 1908-9 is £136,200, against £132,585 for the current year. This will leave a surplus of £9,900, compared with the estimated surplus at the close of the current year of £11,408. The estimated capital expenditure is £33,090, principally to finish the alterations and additions at M'Donald-road station.

Manchester.—Considerable interest is evinced in manufacturing circles in the West Riding in the electrical exhibition to be opened at Manchester on Oct. 3 next, and to be continued throughout the month. The object of the exhibition is to further the use of electricity for manifold purposes, and, more especially, to show its adaptability for driving textile, mining, and other machinery. The Bradford Corporation electricity supply department has a special scale of charges in operation, which it is claimed enables electricity successfully to compete with other sources of power. The Bradford Corporation is taking a direct interest in the exhibition, and, together with other municipal bodies, has made a donation to the funds. The Manchester Corporation is giving the exhibition every support, and has offered a commodious site in the Fallowfield district, upon which buildings especially constructed for the purpose of the exhibition and covering a space of over 100,000 square feet are to be erected. This Corporation has also made arrangements to supply the necessary current for driving the exhibits upon liberal terms. It is anticipated that the exhibition will be the largest of its kind ever held in the country, and the way in which it is being supported gives promise of its complete success. Local firms who have either electrical machinery or textile machinery adapted for electric driving which they desire to bring before the public notice should find the Manchester exhibition a convenient and suitable medium for achieving that object. The president of the exhibition is Lord Stanley, and the secretary Mr. Walter Davenport, 2, Queen Anne's-gate, Westminster, London, S.W.

Greenock.—At the last meeting of the Town Council resolutions were submitted from the Law and Finance Committee affecting the negotiations between Greenock and Port-Glasgow as to the supply of electricity to the latter burgh. These referred chiefly to the fact that the Clyde Valley Electrical Power Co. has already obtained statutory powers to supply electricity, by consent, within Port-Glasgow, and it was resolved to intimate to the town clerk of Port-Glasgow that these powers should be revoked before any agreement was entered into between the two burghs. Subject to this request being complied with, the committee approved of the proposed heads of agreement as a basis of negotiation, and authorised the Electricity Committee to continue such negotiations, and submit the draft of a detailed agreement for approval. Treasurer Brown, in explanation of the position relating to these negotiations, said he was satisfied that a demand sufficient to warrant going on with the supply to Port-Glasgow existed, and also that the best method was that it should come from the Greenock station. A good deal had been said about a cash or a power guarantee. There was none, but he had no hesitation in saying that before the negotiations were completed a certain cash guarantee would be forthcoming to guard against any risks that would be incurred. Still, he regarded that it would be good business without a guarantee. There would be something like 1,000 h.p. taken at once at current rates, bringing a revenue of £2,800 a year, which would leave an ample margin and justify them in spending the necessary outlay. They might, therefore, safely allow the committee to continue the negotiations on the proposed heads of agreement.

Rawtenstall.—The Town Council having applied to the Local Government Board for sanction to the borrowing of £34,000 for the purposes of electric lighting and purposes connected with the supply of electrical energy (including provision for the supply of electricity for tramway purposes, and of the appropriation of a part of the Hareholme Estate for such purpose), Mr. H. R. Hooper, M.I C.E., Local Government Board inspector, held an inquiry into the same at the Council Chamber, Rawtenstall, on the 23rd ult. The town clerk (Mr. J. Whalley) said the borough contained 9,528 acres, and the area of electrical supply was the whole of the borough. The population at the 1901 census was 31,053, and the estimated population at the present time was 32,000. The annual assessable value was £110,327, and the rateable value £120,200. The outstanding loans under the Sanitary Act amounted to £68,443. The borrowing powers unexercised amounted to £7,227. The application was made in pursuance of the Public Health Act, 1875, the Electric Lighting Act, 1882, the Rawtenstall Corporation Act, 1907, and resolutions of the Town Council of July 18 and Aug. 15, 1907, and is for sanction to borrow the sum of £34,000 for as long a period as possible on the security of the district fund and general district rates, for the purpose of electric lighting and purposes connected with the supply of electrical energy (including provision for a supply of electricity for tramway purposes) and for the appropriation of part of the Hareholme Estate for such purposes. The £34,000 comprises the erection at Hareholme of generating station with necessary plant, £23,162; the provision of the necessary feeder and distributing cables, £10,733; and two 30-kw. static transformers for Goodshaw and Whitewell Bottom, £105. After hearing the evidence the inspector intimated his intention of reporting the facts.

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Birmingham.—At a Local Government Board inquiry at the Council House on the 28th ult. some remarkable figures were given to illustrate the rapid development of the city's electric supply undertaking. The inquiry, which was conducted by Major C. E. Norton, on behalf of the Local Government Board, had reference to an application by the Corporation for sanction to borrow £251,285 to carry out extensive additions to the undertaking. The Town Clerk (Mr. E. V. Hiley), who represented the case for the Corporation, said the progress of the undertaking had been most remarkable. On March 31, 1900, the first year of the municipal control, the number of consumers was 1,530, but by the same date in 1905 it had increased to 2 546. In the following year it was 2,773, in 1907 the number was 3,103, and on March 31 last 3,549. The total number of lamps installed had increased from 66,031 in 1900 to 278,172 in March of the present year. The number of meters had increased in the same period from 197 to 1,550. The units sold also showed a considerable increase, the most remarkable jump occurring between March. 1906, and March, 1907, when the tramway load began to be felt. The units sold increased from 5,383,904 in 1906 to 10,887,684 in 1907. The amount for tramway purposes was just over 4,000,000 units, but the total for 1907 showed an increase of 102 per cent. on the previous year. The increase during the year 1907-8 was also remarkable, being equal to 90·98 per cent., or practically double that of the preceding year. That was largely due to tramways, but not exclusively. The units sold for tramway purposes in that year amounted to 11,192,776 out of a total of 20,793,670, which left 9,600,894 for private consumers. The revenue for the year ended March, 1908, showed an increase of 52 87 per cent. on the previous year, which was also an increase of 37·85 per cent. over 1906. The surplus profits had been allocated to reserve. The extensions it was now proposed to make, continued Mr. Hiley, affected the central and the sub-stations, and the loan would be split up as follows: Summerlane station, £183,635; Water-street station, £17,300; Dale End station, £11,500; and other sub-stations collectively, £14,850. In addition to the £20,000 for motors, it was proposed to spend £4,000 for meters.

TRACTION.

Southend.—The Town Council have decided to extend the electric tramways from the Kursaal to the Halfway House, a distance of nearly two miles, at an estimated outlay of £14,000.

Bradford.—The Corporation, after making extensive inquiries, have decided to weld all the joints on their proposed tramway reconstruction, amounting to about six miles, by the Thermit process

Birmingham.—The number of passengers carried on the Corporation tramways for the week ending April 25 numbered 1,513,112, an increase of 206,251 over the corresponding week of last year. The receipts were £6,023, against £5,053.

Hythe.—The Council have received a communication from the National Electric Construction Co. to the effect that the tramway scheme, which has been before the local public for a considerable time, will be proceeded with as the necessary money is forthcoming. Already £30,000 has been spent by way of preliminaries.

Edinburgh.—The Tramway Committee of the Town Council have declined to agree to a request by the Edinburgh and District Tramway Co. that the rent of the new Gilmore-place line should only run from May 15 next. It was agreed to ask the company to resume the running of cars in Morrison-street, in view of the exhibition traffic.

New Tube Railway.—A meeting of the frontagers of the Edgware-road section of the projected tube railway from Victoria to Cricklewood, *via* the Marble Arch and Edgware-road, has unanimously passed a resolution approving a memorial, bearing 30,000 signatures, in favour of the immediate construction of the line, for which parliamentary powers have long been granted.

Woolwich.—The Borough Council have decided to make representations to the London County Council tramways department as to making the workmen's fares on the electrified tramway uniform with those in other parts of London, and also to urge the desirability of running a larger number of cars when workmen were leaving the Arsenal, particularly to pick up at the middle gate.

Kalgoorlie.—The Kalgoorlie Electric Tramways, which is under the control of the Kalgoorlie Electric Power and Lighting Co, announces a net profit for last year of £16,270, against £17,546 for 1906. The directors regard the Trans-Continental Railway scheme an all-important matter for the future of Kalgoorlie, as "one step nearer accomplishment" The company's 5 per cent. "A" debentures are quoted at 88½, to yield 5⅝, while the 6 per cent. "B" debentures are at 73, thus returning 8¼ per cent.

Aberdeen.—At a meeting of the Tramways Committee of the Town Council it was agreed to adhere to the former resolution to give the contract for additional car covers to Messrs. Milne, Voss, and Co., Birkenhead, their offer being the lowest. On the sub-committee's recommendation in regard to the services of the electrical engineer to the tramway department, it was agreed to pay the electrical department one-half of the sum previously paid in consequence of part of the work being transferred from the electricity to the tramway department.

Oldham, Ashton, and Hyde Tramways.—At the meeting of the Oldham, Ashton, and Hyde Electric Tramways, held in London on the 23rd ult., Mr. E. Garcke, the chairman, said the position of the company continued to be satisfactory. During the last year they had carried over 200,000 more passengers than in the preceding year, which represented an increase of about 4 per cent. The net profit was £647 better than last year. A dividend of 6 per cent. was proposed on the ordinary shares, applying the increased profit to improving the financial position of the company.

Birkenhead.—During the past four weeks the tramways have shown a very satisfactory increase over the corresponding period last year. Nearly a million passengers have been carried, and the receipts total £4,161. 3s. 8d., as against £4,102. 12s. 8d. The New Ferry line is recovering its prosperity, and shows an increase of £50, whilst a remarkable figure is the increase of £55 on the docks route, Claughton-road (£33) and Conway-street (£24) being the only lines to show any considerable decline. The actual total increase is £58. 11s., nearly £12 a week, which means something like 3,000 passengers more.

Brooklyn (U.S.A.).—Two electric street cars, both heavily laden with passengers, collided on the 21st ult. with disastrous results. So violent was the impact that one of the cars fell over on its side, the confusion and terror of the passengers being intensified by the fact that the vehicle burst into flames. Fortunately, a number of firemen were quickly on the scene, and they used their axes with such effect that within the space of a few minutes they succeeded in rescuing the passengers from being burned in the blazing car. As it was, however, 16 of the passengers received more or less serious injuries, recovery being regarded as hopeless in the case of three of them.

Huddersfield.—The miles run by the Corporation trams during the last year were 1,960,329, an increase of 155,584 over the previous year. During that time there were carried 16,130,334 passengers, an increase of 878,184. Calculated on the basis of population of 120,000—100,000 for the borough and 20,000 for the districts of Honley and Slaithwaite served by the tramways—the average journeys per head of the population were 134 against 127 for 1906-7, or, in other words, the entire population had been carried 134 times over during the 12 months. The receipts for passenger traffic last year were £81,082, against £77,815 for 1906-7; the postmen's contract was the same, £300; the parcels, £1,161; advertising, £1,275; coal haulage, £869; sundry, £19—total £84,704.

Rotherham.—The gross traffic receipts of the Corporation tramways department amounted during the past year to £31,653. 12s. 10d., being an increase of £4,737 over the previous year, and representing on the car mileage 11 53d. per car mile, as compared with 10·45d. per car mile for 1906-7. The expenses were, however, considerably larger than those of 1906-7, especially the renewals of permanent way and cars. The traffic expenses amounted to £8,124. 9s. 3d., representing 2·96d. per car mile, or nearly 25¾ per cent. on the gross receipts. After debiting the whole of the working expenses and repairs, there is a balance of £10,330. 4s. 10d. of working profit. After paying the loan charges (which, of course, include redemption of debt), the net surplus for the year, subject to provision for renewals fund, is £5,618. 11s. 9d.

Lancaster.—A long discussion on tram fares took place at the last meeting of the Town Council. When the trams were started ½d. fares were charged for short distances, but after three or four years, in which there was a loss on the working of the system, 1d. was made the minimum fare, and for the long distances 2d. was charged. The tramways, however, have continued unremunerative, the loss being about £3,000 a year. The committee now recommended that 1d. should be the fare for all distances from the centre of the town, with an occasional car to the station at ½d. extra. The proposal met with great opposition from the representatives of the wards using the trams, and after various suggestions had been made an amendment was carried re-establishing the ½d. stages and fares—four on each route, without overlapping.

Leeds.—At a meeting of the Tramways Committee of the Leeds Corporation on Tuesday last, the general manager (Mr. Hamilton) submitted the financial statement for the year ended March 31 last. The gross revenue amounted to £340,368. 5s. 5d., an increase of £12,574, as compared with the previous year, while the gross expenditure was £177,316. 17s. 2d., an increase of £6,107. The gross profit was £163,051. 8s. 3d., and, after deducting rates and taxes and sinking fund charges, there was a net balance in relief of rates of £64,246. 13s. 7d. Twelve months ago the net balance was £69,262, but during the year an additional £9,775 was expended on the renewal of the permanent way and the electrical equipment, and the old reserve fund having been wiped out last year, there was no bank interest from that source. Taking these circumstances into consideration, the surplus was regarded as very satisfactory.

Sheffield.—The Leopold-street tramway scheme has been commenced, and the two Corporation departments responsible for it intend to attempt a hustling feat. They are going to work day and night without cessation, as far as the weather will allow, until they have carried through what is undoubtedly one of the most complicated and awkward pieces of tramway work Sheffield has for some time had to tackle. From 120 to 150 men will be employed, and it is hoped they will finish the scheme in time for its being brought into use at the Whitsuntide holidays. One of the chief difficulties will be that of keeping the traffic in proper order along Fargate, Pinstone-street, Church-street, and Bow-street while the double junctions involved in the scheme are being laid. Through running in the centre of the city is of vital importance, and it is hoped to maintain this by means of a temporary track and by rapid nightwork on the existing track. The scheme is estimated to cost about £5,000.

Halifax.—The Town Council have decided to make a charge of 1d. for carrying dogs on their cars when accompanying passengers. The Tramways Committee have decided to recommend the Town Council to rent the room in the basement of the Victoria Hall as a temporary central office, so that they will be in a position to deal more effectively with the work associated with the introduction of the ticket system of collection of fares, a system which is shortly to be extended to other routes. The Tramways Committee have had under consideration the question of the painting of the tramcars. It is thought that if the present painting in blue and white was substituted for red—or, rather, crimson lake—the cars would not require so much cleaning,

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and the paint itself would be more lasting. In order that they might see the effect of such a change, one of the cars is to be painted in red. At a cost of £200 the Tramways Committee have recommended that a loop line be placed at the bottom of Pellon-lane.

Electrification of German Railways.—For some months past one of the Berlin suburban lines has been run with electric traction, the object of the Prussian State railway authorities being to ascertain by practical experiment whether this is economically practicable. Apparently the experiments have been successful, for it is now announced that the State railway authorities intend adopting electric traction on the longer ordinary lines with both passenger and goods traffic. The lines selected are from Leipzig to Magdeburg, and from Leipzig to Halle, the former having a total length of 80 miles and the latter 23 miles. It is proposed at first to reduce the number of carriages, and to run shorter trains more frequently than at present. Instructions have been given by the Minister for Public Works to the railway officials at Halle to make the most careful and minute observations, in order that comparisons may be made between the cost and practicability of electric and steam traction respectively.

Loch Lomond Tramways.—Great progress continues to be made with the laying of the tramrails from Clydebank boundary to Balloch. Rail-laying has now commenced at the Dalmuir end, and so speedily is the work being accomplished that it is expected the line will be laid as far as Old Kilpatrick by the end of the week. At this village some property has to be taken down, so as to widen the road, but the work cannot be entered upon until the tenants have removed from their houses. But no movement has yet been made on the part of Glasgow Corporation to extend the system to Clydebank boundary. The line is all laid, but a bridge has to be erected over the Forth and Clyde Canal at Dalmuir before it can be opened. Tenders for the construction of this bridge were issued months ago, and though the Corporation have frequently given the assurance that the work would be started without delay, no movement in that direction has yet been made. There is every likelihood, therefore, that the line from Dalmuir to Balloch will be completed before the bridge over the canal has been constructed, thus enabling the two systems to meet. From the present terminus of the Glasgow cars to the point where the Dumbartonshire tramway begins the distance is about half a mile, whereas, when the bridge is in position, the separation will only be a few yards.

Twickenham.—A large motorcar, occupied by five passengers, was wrecked on Sunday night while endeavouring to pass between two tramway cars on the Twickenham-road at Isleworth. Three of the motorists, all belonging to Hounslow, were seriously injured, one being in an extremely critical condition. The injured are: Frederick Sane, chauffeur, concussion of the brain, deep wound on the head, internal injuries, lying unconscious in hospital; Thomas Higgins, injuries to head, severe shock; Miss Lizzie Kingsley, concussion of the brain, wounds on the face and head. The car, the owner of which is Captain O'Brien, of the 2nd Dragoon Guards, was being driven in the direction of London. It was following a tramway car, and suddenly swerved in its endeavour to pass it. In doing so it crashed into the side of another tramway car coming in the opposite direction from Hampton Court. Before the first tramway car could be stopped it collided with the back of the motorcar as it reeled across the road from the shock of the impact with the Hampton Court tramway car. The motorcar was thus wedged between the two tramway cars, and was reduced to wreckage. The chauffeur was thrown several yards across the road, and fell heavily on his head, while the other occupants of the car were hurled among the wreckage. Both tramway cars suffered severely. The front of the one with which the motorcar collided was crushed in, and the window of the second were shattered. A passenger in one of the tramway cars said that the motorcar was crushed "like a filbert nut." The wheels of the car were torn off, the back seats were wrenched away, and the gear wheels and cogs thrown across the road in an indescribable manner.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Tarragona.—Tenders are invited for the erection of an electricity generating station. Tenders by May 31

Victoria.—The Postmaster-General invites tenders for one common-battery switchboard. Tenders by May 26.

Valparaiso.—Tenders are invited for supplies for the Chilian Navy, including electrical machinery. Tenders by May 30.

Bedford.—Tenders are invited for the supply of coal for the electricity works. Tenders to the Town Clerk by May 15.

Queensland.—The Postmaster-General invites tenders for battery glassware, etc., battery material and chemicals. Tenders by June 1.

South Australia.—The Postmaster-General invites tenders for telephone material, telephone instruments, and telephone switchboards. Tenders by June 3.

Rugby.—The Urban District Council invite tenders for the supply of about 880 yards of paper-insulated, lead covered, and armoured service cable. Tenders by May 5.

Hackney.—The London County Council invite tenders for electrically wiring and fitting the tramways car-shed at Mare-street, Hackney, N.E. Tenders by May 12.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Darlington.—The Corporation invite tenders for the supply of a Lancashire boiler and superheater. Specification, etc., from the Borough Electrical Engineer. Tenders to the Town Clerk by May 11.

Glasgow.—The Corporation invite tenders for the supply of about 100,000 tons of coal for their electricity generating stations for year ending May 31, 1909. Tenders to the Town Clerk by May 7.

Cheltenham.—Tenders are invited for an electric light installation at the new destructor. Specification to be seen at the office of the Borough Surveyor, Cheltenham, to whom tenders are to be sent by May 2.

Birkenhead.—The Corporation invite tenders for the supply of coal to the electricity generating stations. Particulars from Mr. W. Wyld, borough electrical engineer and tramways manager. Tenders by May 11.

Sydney.—The Postmaster-General invites tenders for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators (best white porcelain, large). Tenders by May 20.

Wakefield.—Tenders are invited for the supply of two exhaust electrical fans and necessary wiring, switches, etc., for the laboratory, for the West Riding of Yorkshire Rivers Board. For particulars apply to Rivers Board, Wakefield.

New South Wales.—Tenders are invited by the Postmaster-General for 8½ tons wire, hard-drawn copper (200lb. per mile), 3cwt. tape, binding, copper (150lb. per mile), 2,700 insulators, best white porcelain, large. Tenders by May 20.

New South Wales.—Tenders are invited by the Postmaster-General for eight tons wire, hard-drawn copper (400lb. per mile), 1½cwt. tape binding, copper (200lb. per mile), 1,300 insulators, best white porcelain, large. Tenders by June 10.

Bermondsey.—The Borough Council invite tenders for the supply and erection of one boiler, one steam dynamo, one condenser, and cooling tower at the electricity and destructor works. Tenders to the Town Clerk by May 18. See advertisement.

Manchester.—The Tramways Committee invite tenders for the supply of hard-drawn copper trolley wire. Particulars from the General Tramways Manager. Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by May 5.

London, S.W.—The London County Council invite tenders for 175 double-deck car bodies, swing bolster trucks, and complete electrical equipments for overhead trolley, surface-contact, and underground conduit systems of electric traction. Tenders by May 9.

Victoria.—Tenders are invited for the following for the Postmaster-General's Department: 2,600 jacks, in strips of 20; 1 mile 64-wire switchboard cable; 50 3-conductor cords, 7ft. long, for "B" boards; 96 3-part plugs, and 66 listening and ringing keys. Tenders by June 9.

Johannesburg.—Tenders are invited for a refuse destructor plant. Specification, etc., may be obtained from Messrs. E W. Carling and Co., St. Dunstan's-buildings, St. Dunstan's-hill, London, E.C. Tenders to the Town Clerk, Municipal Offices, Plein Park, Johannesburg, by June 10.

West Bromwich.—The Town Council invite tenders for the installation of a modern refuse-destroying plant at their electricity works, Black Lake, West Bromwich. Particulars from Mr. Albert D. Greatorex, borough engineer and surveyor, Town Hall, West Bromwich. Tenders by May 9.

Stockport.—The Tramways Committee invite tenders for the manual and team labour required in taking up and relaying the permanent way, paving, etc, in the repairs and renewals to the tramway track on the Woodley route and in Heaton-lane. Particulars from the Borough Surveyor. Tenders to the Town Clerk by May 4.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors, 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

Rawtenstall.—The Corporation invite tenders for the supply, delivery, and erection of steel poles, overhead line equipment, and accessories. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Sillar, and Leigh, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders by May 4.

Adelaide.—The Postmaster-General of South Australia invites tenders for 1,000 tons of steel rails, 80lb. per lineal yard; 1,000 tons steel rails, 60lb. per lineal yard; 2,300 tons steel rails, 50lb. per lineal yard; 68 tons steel fishplates for 80lb. rails; 67 tons steel fishplates for 60lb. rails; 159 tons steel fishplates for 50lb. rails. Tenders by May 19.

East Ham.—The Corporation invite tenders for the reconstruction for electric traction on the overhead trolley system of the existing section of horse tramways between High-street North and Green-street, Romford-road, including the permanent-way paving (including margins) and overhead line construction. Particulars from the Borough Engineer. Tenders by May 5.

Rio de Janeiro.—Tenders are invited for the supply of new lighting apparatus and accessories for the lighthouse on Raza Island. Tenders will be opened on June 2 in the Ministry of Marine (Secçao de Pharóes) at Rio de Janeiro. No deposit is required. Further particulars may be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 2,000 tons of steel girder tramway track rails and fastenings required for the electrification of further portions of the Council's tramways; also alternative tenders for supply and delivery of about 5,000 tons of track rails and fastenings. Particulars from the chief engineer to the Council, Mr. Maurice Fitzmaurice C.M.G., at the County Hall, Spring-gardens, S.W. Tenders by May 19.

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RESULTS OF TENDERS.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Electricity and Tramways Board have accepted the tender of Willans and Robinson for a 2,000-kw. turbo-alternator and condensing plant for the sum of £8,250.

Rawtenstall.—The Town Council have accepted the following tenders: Chamberlain and Hookham for direct-current meters, the General Electric Co. for alternating-current meters, and that of Yates and Thom for a Green's economiser.

Huddersfield.—The Corporation have accepted the tenders of J. Radcliffe and Sons, Huddersfield, for the construction of foundations for new plant, the British Thomson-Houston Co. for meters, and of McPhail and Simpson, Wakefield, for superheaters.

Elsecar.—Messrs. D. Selby Bigge and Co. have placed an order with the British Thomson-Houston Co. for one 350-kw. exhaust steam turbo-alternator, with heat accumulator, condenser, and the requisite switchgear, for Earl Fitzwilliam's Colliery, Elsecar, near Sheffield.

Coatbridge.—The tender of the British Thomson-Houston Co. has been accepted for the supply of one 250-kw. (310 k.v.a) three-phase generator, 550 volts, 50 cycles, coupled to Belliss engine, for Messrs. Robert Adie and Sons Collieries, for their Rose Hall Colliery, Coatbridge.

Melbourne.—The City Council have accepted the following tenders for the supply of electrical stores for 12 months: J. A. Newton and Co., Lawrence and Hanson, Wm. McLean and Co., and Henley's Telegraph Works Co.; supply of drilling machine, James Dixon and Co., £32. 10s.

Leeds.—Thermit Limited have received an order from the city tramways for welding material to cover the whole of their requirements during the year 1908, this being the sixth year in succession that the Leeds Corporation have made the whole of their joints by means of the Thermit process.

Polesworth.—The British Thomson-Houston Co.'s tender for main switchboard, pit bottom and feeder panels, one 75-h.p. three-phase motor for driving endless haulage gear, and the requisite feeder cable, for Messrs. Morris and Shaw, Birch Coppice Colliery, Polesworth, near Tamworth, has been accepted.

Portsmouth.—Owing to the withdrawal of the tender of S. Cooper, of Bournemouth, which was noted in our last issue as having been accepted by the Town Council for electric lighting the new South-parade Pier, the Council have now given the contract to Mr. Taylor, of London, for the sum of £1,310.

Lydney.—An order has been placed with the British Thomson-Houston Co. by Messrs. D. Selby Bigge and Co. for two 300-kw., 375-r.p.m., 2,750/3,000-volt, 50-cycle three-phase alternators, complete with exciters and rheostats, for direct coupling to high-speed engines, for the Cannock Collieries, near Lydney, Glos.

Glasgow.—Messrs Stevenson, McGuffie, and Milne, of Glasgow, have placed an order with the British Thomson-Houston Co. for two 62-kw. continuous-current generators coupled on combined base to one Howden engine, and one four-panel switchboard, for the Binley Colliery, belonging to Messrs. Merry and Cunninghame, Glasgow.

Atherstone.—The Ansley Hall Coal and Iron Co., Atherstone, Warwickshire, have accepted the tender of the British Thomson-Houston Co for the supply of one 500-kw., 340 r.p.m., 500-volt, compound-wound, open-type continuous-current generator, to be driven by ropes by a pair of Robey engines running at 85 r.p.m., and two switch panels for above.

Hammersmith.—The tender of the British Thomson-Houston Co. has been accepted for testing plant, consisting of a 120-kw. motor-generator set, made up of two 60-kw. continuous-current generators tandem coupled to one induction motor, one 110 k.v.a. three-phase motor-generator, and a motor exciter of 10 kw. for Messrs. Gwynnes, Limited, Hammersmith.

Johnstone.—Messrs. Finlayson, Bousfield, and Co.'s Linen-Thread Mills, Johnstone, Scotland, have placed an order with the British Thomson-Houston Co. for one 200-kw., 428-r.p.m., 500-550-volt, 50-cycle three-phase alternator, with three pedestal bearings, protection caps, rope pulley, base-plate, and direct coupled exciter, together with the necessary switchgear.

Darlington. — Messrs. Pease and Partners, Darlington, have accepted the tender of the British Thomson-Houston Co for the supply of one 120-h.p., 480-r.p.m., 440-volt, 40 cycle, three-phase, slip-ring, protected-type haulage motor, with tramway-type reversing controller and panel; one 25-h.p. 770 r.p.m. fan motor; one 130-kw., three-phase, 2,750-440-volt, oil-cooled transformer, with the necessary switchgear, for the Bowden Close Colliery.

Admiralty Contracts.—The Admiralty have placed a contract with the British Thomson-Houston Co. for nine motor-generators (eight 120 amperes and one 80 amperes) for operating searchlights on H.M.S. "Defence"; and Messrs. Vickers, Sons, and Maxim, on behalf of the Admiralty, have ordered from the same company 21 motor-generator sets, each giving 120 amperes at 55 volts (6·6 kw.), 1,600 r.p.m., with the necessary control panels. These are to operate searchlights on board H.M.S. "Vanguard," a battleship of the "St. Vincent" class, which Messrs. Vickers, Sons, and Maxim are building.

Sheffield.—The tenders of the British Thomson-Houston Co. have been accepted for the supply of one 250-kw., 375-r.p.m., 3,000-volt, 50-cycle, three-phase B.T.H.-Belliss generating set, three-panel main switchboard, five sets of main and tail haulages (two 30-h.p. and three 50-h.p.), two motor-driven pumps (30-h.p. and 80-h.p.), one 100-kw. and two 70-kw. transformers, and high-tension and low-tension panels for the Sheffield Coal Co. for the Birley Collieries, near Sheffield; and for a 750-kw., 285-r.p.m., "M.P." type, continuous-current generator for direct coupling to Belliss engine, for Messrs. Steel, Peach, and Tozer, Sheffield.

Southend.—The tender of the British Thomson-Houston Co. has been accepted for the supply and erection of an additional switchboard panel and gear at the generating station, and required in connection with the new 500-kw. engine and dynamo; the tender of E. and B. H. Davey for the construction of a condenser tank for £370; the tenders of J. E. and S. Spencer for the supply and erection of steam-pipes, and Aiton and Co. for the supply and erection of exhaust pipes, at prices amounting to £50. 10s. and £315. 5s. respectively; and that of the Tudor Accumulator Co. for the provision of a positive battery at a cost of £369, and for the maintenance thereof for the sum of £46 per annum for a period of 10 years.

Huddersfield.—The tender of the British Thomson-Houston Co. has been accepted for complete installation, consisting of 23 three-phase induction motors, totalling upwards of 800 h.p., with the necessary steelwork for mounting the ceiling motors and controlling gear and cables. This is the first textile mill to be electrically driven from the Corporation three-phase mains in the Huddersfield district, which is one of the main centres of textile industry. This contract should be as far-reaching in its influence on the development of textile driving in this district as the Acme mill has been in Manchester. The work has been carried out for Messrs. Joshua Whiteley and Co., Huddersfield, for their Albert textile mills.

South Australia.—The Postmaster-General has accepted the following tenders: Common-battery switchboard and 3,000 subscribers' sets for Adelaide, for the sum of £17,620; common-battery switchboard and cables for the new Windsor (V.) Telephone Exchange, £20,268, R. B. Hungerford; 1,000 jacks, five point, in strips of 20 each, for the sum of £125; 100 plugs, metallic circuit, for £18. 15s., W. McLean and Co., Melbourne; 100 indicators, clearing, in strips of 10 each, at £2. 12s. 6d. per strip, Unbehaun and Johnstone, Adelaide; 100 keys, combined listening and ringing, at 10s. 6d. each, A. W. Dobbie and Co, Adelaide; 64 tons hard-drawn copper wire (400lb. to the mile), at £71. 13s. 4d. per mile; 8,000 insulators, porcelain, No. 5, for £175. 15s., G. Wills and Co., Adelaide; 5cwt. soft binding wire (50lb. to the mile), at £3. 15s. per cwt., O. Haes, Sydney; 8,000 copper tapes for 400lb. wire and No. 5 insulators, at £2. 15s. per 1,000; 8,000 copper binders for 400 lb. wire and No. 5 insulators at £3. 18s. 3d. per 1,000, Rabone, Feez, and Co., Sydney.

OPENINGS FOR CONTRACTORS.

ABERAMAN—Miners' rescue station, Mr. Hann, Powell Duffryn Co.'s Office.

ABERCARN—Twenty houses, Trustees Gwyddon-road Building Club.

ABERDARE—Hall, schoolrooms, etc., Trustees of the Siloa Welsh Independent Chapel.

ABERDARE—Ten houses for Monk-street Building Club.

ALCESTER—Secondary school, Warwickshire Education Committee.

ALLOA—Elementary school, Grange District (£8,000), Burgh School Board.

ALNWICK—New offices for nurses' home, Bailiff-gate, Mr. R. R. Temperley.

ANNFIELD PLAIN—Two houses, Northgate-street, Mr. L. H. Armour; two houses, Catchgate, Mr. J. H. Cockburn; conversion of chapel into dwelling-houses, Mr. J. H. Downs; four houses, Fines House, Mr. R T. Johnson.

ANSTRUTHER—Free library, Town Council.

APPLEBY—Elementary school, Westmorland County Education Authority.

ARDEE—Improvement scheme (£21,172), Rural District Council.

ASKAM-IN-FURNESS—Schoolroom, Wesleyan Methodists.

AYR—Extension, electricity undertaking (£15,050), Town Council.

BALLYMONEY—Alterations to St. James's Church, Ecclesiastical Commissioners

BANNOCKBURN—Council chambers, Cross (£1,280), St. Ninians Parish Council.

BARGOED—Vicarage (£1,800), Churchwardens, Parish Church.

BARNES—School, Lonsdale-road, Messrs. Jarvis and Richards; 24 houses, Vicarage-road, Messrs. E. and P. Horsey; additions, St. Mary's Roman Catholic Schools, Messrs. A. Hunt and Son.

BARNSLEY—Elementary school, Worsborough Dale Education Committee.

BARNSLEY—Conversion of offices, etc., into shops, Eldon-street—Messrs. Crawshaw and Wilkinson, architects; motor-house, Union Inn, Messrs. Beverley Bros, Wakefield.

BASFORD—Alterations, workhouse (£360), Guardians.

BEBBINGTON—Temporary school, Board of Education.

BECKENHAM—Installation of electric light, Alexandra Schools (£225), Education Committee.

BEN RHYDDING—Wesleyan church (£2,600), Trustees.

BILLINGE—Two houses, Mr. W. Melling.

BIRTLEY—Elementary school, Durham Education Committee.

BLACKPOOL—Extensions, electricity supply mains (£5,000), Town Council.

BLACKPOOL—Post office, H.M. Commissioners of Works.

BLACKWELL—Elementary school, Durham Education Committee.

BLAGDON—Stationmaster's house, Great Western Railway Co.

BLAENGARW—Two houses, Mount Pleasant. Mr. P. J. Thomas, architect.

BLAGDON—Stationmaster's house, etc., G.W.R Co.

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BLAYDON—Elementary school, Durham Education Committee.

BOCOMBRA—Orange hall near Portadown.

BODMIN—Enlargement, St. Mewbred's Church, Cardynham, Church Building Society.

BOGNOR—Improvements, pier (£6,000), Local Company.

BORSTAL—Additions, prison buildings (£8,000), Commissioners of Public Works.

BOWBURN—Elementary school, Durham Education Committee.

BRADFORD—Alterations, premises, Hall Ings, Town Council.

BRIDGEND—Enlargement of St. Theodore's Church, Kenfig Hill, Church Building Society.

BRIDGWATER—Ornamental bandstand (£130), Town Council.

BRIGHOUSE—Electricity supply extensions (£3,600), Town Council.

BRISLEY—Enlargement of Non-Provided school, Trustees.

BROMLEY—Additions to Broadway House, High-street, Messrs. Levens and Son; telephone exchange, Church-road, Messrs. Bromley and Watkins.

BUDBROOKE—Elementary school (£2,230), Warwickshire Education Committee.

BUSHEY—Public offices, etc. (£3,350), Urban District Council.

BYKER—Church, parish of St. Lawrence, Ecclesiastical Commissioners.

CAMBRIDGE—Enlargement, Selwyn College (£2,600), Governors.

CAMBRIDGE—Six houses, Sturton-street, Mr. W. Pate; two houses, Cherryhinton-road, Mr. J. S. Condor; beer store, Panton-street, Messrs. Bailey and Tebbutt; offices, etc, Newmarket road, Cambridge Gas Co.; house, Huntingdon-road, Church wardens St. Giles's Church

CANTON—Three houses, Clive-road, Mr. W. R. Davies.

CARDIFF—Block of three houses, Clive-road. Mr. W. H. Dashwood Caple, architect.

CHELMSFORD—Elementary school (£10,500), Education Committee.

CHELTENHAM—Extensions to electric lighting, Town Council.

CHESTER-LE-STREET—Elementary school, Durham Education Committee.

CHOPWELL—Elementary school, Durham Education Committee.

CLAYTON—House, High-street, Mr. J. Knowles; bank, High-street, Manchester City and County Bank; 12 houses, Cemetery-road, Mr. Birtwell.

COCKFIELD—Elementary school, Education Committee.

COCKTON HILL—Elementary school, Durham Education Committee.

COLWYN—Church room and vestry at the Wesleyan Methodist Church.

CONSETT—Elementary school, Durham Education Committee.

CORNFORTH—Elementary school, Durham Education Committee.

COUNDON—Minister's house, Trustees of the Shildon Primitive Methodist Circuit.

COXHOE—Plans for seven houses passed by Rural District Council.

CROMPTON—Elementary school, Education Committee.

CROWTHORNE—Bungalow and villa, Mr. C. J. Brake.

CROXTON—New mixed school, etc., Trustees of the Non-Provided school.

CROYDON—School to accommodate 818 scholars, Education Committee.

CRYNANT (GLAM.)—Church, parish of St. Margaret, Ecclesiastical Commissioners.

CUCKFIELD—Improvements and additions, laundry (£450), Guardians.

DACCA—Residence for the Secretary to the Board of Revenue (Rs.30,000), Indian Government.

DAIKU—Police station (Rs.17,500), Burmese Government.

DARLINGTON—Elementary school, Cleveland-avenue, Durham County Education Committee.

DARLINGTON—Fifteen houses, Whessoe Foundry Co.

DEAN BANK—Elementary school, Durham Education Committee.

DEWSBURY—Extension, institution, Dewsbury and District General Infirmary Board.

DISLEY—Two houses, Furness-vale, Mr. Jackson; two houses, Mr. Allen.

DOVER—Parish hall, Churchwardens of St. Mary.

DOVER—Shelter on sea-front, East Cliff, Town Council.

DUBMIRE—Elementary school, Durham Education Committee.

DURHAM — Branch stores, Nevill's Cross, Durham Co-operative Society.

EARBY—Church (£3,000), Churchwardens, Thornton-in-Craven.

EASTBOURNE—Public convenience, Tamarisk Bank, Sanitary Committee.

EAST HAM—School to accommodate 1,580 scholars, Altmore-avenue, Education Committee.

EAST HAM—Eighty-four houses, Hollington-road, Messrs. W. and G. Mitchell; house, Hall-road, Mr. P. Cornish; 17 houses, Norfolk-road, Mr. C. Manning; 23 houses, Whitehorse-road, Mr. F. Ansted; two houses, Shrewsbury-road, Mr. H. Harding; house, Kempton-road, Mr. C. Saxon.

EDINBURGH—Police office, Torphichen-street (£7,157), Town Council.

EPSOM—Rebuilding Church of St. Martin, Incorporated Church Building Society.

ERDINGTON—Public elementary school, Warwickshire Education Committee.

FALMOUTH—House, Clifton-hill, Mr. P. Ould; two houses, Gyllyngvase-terrace, Mr. Charles.

FAKENHAM—Primitive Methodist chapel (£2,500), Trustees.

FERMOY—Workmen's dwellings (£9,200), Rural District Council.

FERRYHILL—Plans for six houses passed by Rural District Council.

FOUR OAKS—Church for the parish of All Saints, Ecclesiastical Commissioners.

FULWELL—Elementary school, Durham Education Committee.

GILESGATE MOOR—Elementary school, Durham Education Committee.

GLASGOW—Elementary school, Mollinsburn-street, School Board.

GOLCAR—House, Leymoor-road, Mr. B. Wood.

GOREY—Workmen's dwellings (£7,340), Rural District Council.

GRANGEMOUTH—Supplementary and higher-grade school, Parish School Board.

GRANGE VILLA—Elementary school, Durham Education Committee

GREAT HARWOOD—Dwelling-house, Mr. J. W. Baron; house, Park-road, Mr. T. Gregson.

GREENCROFT—Elementary school, Durham Education Committee.

GREENSIDE—Elementary school, Durham Education Committee.

GWAUN-CAE-GURWEN—Fifty houses, Gwaun-cae-Gurwen Colliery Co.

HACKNEY—Primitive Methodist church. Plans passed by North Darley Urban District Council.

HAMMERSMITH, W.—Houses and shops, Mr. C. Pawley; additions to St. Thomas Seminary, Hammersmith-road, Messrs. Hubbard and Moore.

HARDINGHAM—Primitive Methodist chapel, Trustees.

HARTBURN—Elementary school, Durham Education Committee.

HAVANT—Church, Stubbington-avenue, Churchwardens, St. Mark's.

HAVERTON HILL—Elementary school, Durham Education Committee.

HENDON—Three houses, Temple Fortune-lane, Mr. A. J. Reynolds; 24 houses, Finchley-road, Mr. F. C. Carter; 10 houses, Hampstead Garden Suburb, Manager, Estate; drill hall, Colin Deep-lane, Messrs. Emden, Deakin, and Co.; 16 houses, Woodstock Estate, Messrs. Tucker and Humphrey; four houses, Audley-road, Mr. E. Evans; 101 houses, Messrs. Hamiltons, Limited; eight shops, Golders Green, Messrs. Edmondson's, Limited; four houses, Rodborough-road, Messrs. Barnett and Brochie; church extension, Colin Deep-lane; 18 houses, St. John's-road, Mr. E. Streather.

HENDON—Eight houses, Portsdown-avenue, Mr. A. Marsh; 27 houses, Messrs. W. Moss and Son; shop and house, Golder's Green, Mr. P. Adams; 20 houses, Rotherwick-road, Mr. H. Laverack.

HENDON—Enlargement, etc., St. Mary's Church (£5,500), Ecclesiastical Commissioners.

HIGH CLARENCE—Elementary school, Durham Education Committee.

HIGHFIELD—Elementary school, Durham Education Committee.

HORNSEY—Three houses, Muswell Hill, Messrs. Edmondson's, Limited; 16 houses, Burlingford road, Mr. A. Deeks; nine houses, Danvers road, Mr. H. E. East; four houses, Muswell Hill, Mr. G. H. Paine; six houses, Priory-road, Mr. C. W. Boswell; 163 houses, Rookfield Estate, Crouch End, Messrs. W. J. Collins.

HOUGHTON-LE-SPRING—Five houses, Silksworth, Mr. J. Hodgson; two houses, Grasswell, Mr. J. H. Wood; house and shop, Mr. J. White.

HOUGHTON-LE-SPRING—Elementary school, Durham Education Committee.

HOXTON, E.—Elementary school to accommodate 400 scholars on the Hoxton House site, also higher elementary school to accommodate 600 scholars, London County Council.

HUDDERSFIELD—Twelve houses, Almondbury Bank. Mr. E. W. Lockwood, architect.

HULL—Station buildings and stationmaster's house, North-Eastern Railway Co.

ILFORD—Library and public hall, High-street, Urban District Council.

ISLINGTON, N.—Elementary school, Shelbourne-road, London County Council.

KENDAL—Enlargement of Staveley Abbey Home (£600), Board of Guardians.

KESSINGLAND—Improvements to church (£1,250), Ecclesiastical Commissioners.

KILWINNING—Additions, Eglington District School, School Board.

KINGUSSIE—Electric lighting scheme (£3,000), Council.

KIRKHAM—Elementary school, Medlar-with-Wesham Education Committee.

LANCASTER—Five houses, Wingate-Saul-road, Mr. J. N. Grubb; additions to Royal Albert Asylum, Asylum Committee; two houses, Westbourne-road, Mr. J. W. Batty; two houses, High Caton-road, Mr. J. W. Taylor; rebuilding Athenæum Theatre, St. Leonard's-gate, Mr. H. Wilkinson; four houses, Ashfield-avenue, Mr. W. J. Edmondson.

LANCASTER—Wesleyan church and Sunday schools, Trustees.

LASSWADE—Public offices, Parish Council.

LEADGATE—Elementary school, Durham Education Committee.

LEE—Elementary school, Manor-lane, London County Council.

LEEDSTOWN—Wesleyan Sunday school, Trustees.

LEEK—Additions to the Memorial Cottage Hospital. Messrs. W. Sugden and Son, architects.

LETCHWORTH—Elementary school (£9,000), Hertford County Council.

LEXDEN—Alterations and additions, workhouse infirmary, Guardians.

LEYTON—Enlargement, sorting office, Commissioners of H.M. Works and Public Buildings.

LONGWELL—Church, parish of All Saints, Longwell Green, Bristol, Ecclesiastical Commissioners.

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LLANDRINDOD—Public lavatories, recreation ground (£1 200), landing stage, refreshment-room, etc., Pump House Common (£800), Urban District Council.

LLANSAMLET—Chapel, Peniel Green, Welsh Calvinistic Methodists.

LONDON, W.—Blocks of flats, North Audley-street, Messrs. Harris and Gillow.

LONDON, W.—Rebuilding hospital for women, Soho-square (£40,000).

LONDON, W.—Additions, Langham Hotel, Portland-place, W. Mr. J. MacVicar Anderson, architect.

LONDON, W.C.—Buildings, Catherine-street, Messrs. Cross and Co.

MAIDSTONE—School to accommodate 1,000 scholars, Town Council.

MANSFIELD—Three houses, Brunt-street. Mr. J. Pembleton; 23 houses, Moor-street, Messrs. J. and F. L Parsons; house, West Hill-drive, Mr. E. Archer; six houses, Skerry-hill, Mr. F. Seagant.

MARCH—High school (£4,000), Isle of Ely Education Committee.

MARKET RASEN—Villa, stabling, etc., Waverley Temperance Hotel Co.

MARYHILL—Extensions, Possilpark School, School Board.

MATLOCK BATH—House, Four-lane, Mr. G. Ogden.

MEDOMSLEY EDGE—Elementary school, Durham Education Committee.

MIDDLESBROUGH—Free library, Victoria-square, Free Library Committee.

MILE END, E.—Elementary schools, Morpeth street and Essex-street, London County Council.

MILLWALL E.—Sub-station Poplar Electricity Committee.

MILNSBRIDGE—Houses, Radcliffe-road. Mr. J. Ainley, architect.

MORTLAKE—Sixteen houses, Messrs. G. Smith and Son; additions to Railway Tavern, Messrs. Watney, Combe, and Co.

MORTLAKE—Elementary school, Surrey Education Committee.

NAIRN—Public school on Millbank lands, Education Authorities.

NAVAN—House, G.N.R. Co.

NAVAN—Post office, Board of Public Works.

NEWCASTLE (IRELAND)—Rebuilding and extension, Presbyterian church.

NEWPORT—Higher elementary school, Stow Hill, Education Committee.

NORTH BIERLEY—New Board-room (£1,100), Board of Guardians.

NUNEATON—Public abattoir, St. Mary's-road (£1,800), Town Council.

OAKENSHAW—Villa, Mr. A. T. Verity.

OLDHAM—Laboratories, etc., Waterloo Council School, Greengate-street, Education Committee.

PADDINGTON, W.—Elementary school, London County Council.

PELTON—Elementary school, Durham Education Committee.

PENISTONE—Council offices (£950), Thurlstone Urban District Council.

PENZANCE—Secondary school, Cornwall Education Committee.

PEVENSEY—Covered stand. Mr. F. G. Cooke, architect, Eastbourne.

PLUNSTEAD—Rebuilding St. Nicholas's Parish Church, Church Building Society.

RADYR—Church, parish of St. John the Baptist, Ecclesiastical Commissioners.

RAMSHAW—Elementary school, Ryhope, Durham Education Committee.

RAWTENSTALL—Laundry at working-men's home, King-street; house, Kay-street, Mr. Taylor; mission chapel, Bury-road, Rev. W. H. Finney.

REDDITCH—Electricity undertaking (£1,500).

RENFREW—Public lavatories, St. Andrew's Cross (£450), Town Council.

ROTHERHITHE, S.E.—Elementary school, Cow-lane, London County Council.

RUGBY—Two houses, Manor-road, Mr. A. J. Shillitoe.

RYHOPE—Elementary school, Durham Education Committee.

ST. GEORGE'S (LONDON, E.)—Elementary school, Fairclough, London County Council.

ST. HELENS—Elementary school, Durham Education Committee.

ST. PANCRAS, N.W.—Enlargement, Mansfield road London County Council School.

SACRISTON—Elementary school, Durham Education Committee.

SALFORD—Public baths, Town Council.

SEAFORTH—Secondary school, Cambridge-road, District Council.

SEATON—House and cottage. Messrs. E. H Harbottle and Sons, architects Exeter.

SEDGEFIELD—Forty-two houses, Chilton-buildings, six houses, Brewery-bank, Rural District Council.

SHERBURN HILL—Elementary school, Durham Education Committee.

SHILDON—Elementary school, Durham Education Committee.

SHIPLEY—Six houses, Mr. W. Baxter.

SHREWSBURY—Two secondary schools (£18,000), County Council.

SILKSWORTH—Elementary school, Durham Education Committee.

SILSDEN—Fire station, Urban District Council.

SKEGNESS—Elementary school, Lindsey County Education Committee.

SLOUGH—Public-house, Salt Hill, Messrs. Neville, Reid, and Co.

SOUTHAMPTON—Additions to grammar school, Argyle-road, Town Council.

SOUTHAMPTON—Extension, Western District School, Education Committee.

SOUTH HETTON—Higher-grade school, Education Committee,

SOUTH SHIELDS—Extensions, marine school, Governors.

SPAIN—Construction of building to be called Alphonso XIII. National Institute of Hygiene (£20,684).

SPALDING—Post office on site in sheep market, H.M. Commissioners of Works.

SPENNYMOOR—Higher-grade school, Durham Education Committee.

STEPNEY, E.—Elementary school, Ben Jonson-street, London County Council.

STOCKPORT—Infirmary with furnishing (£14,720), Guardians.

STOCKTON—Elementary school (£2,500), Warwickshire Education Committee.

STOW-IN-THE-WOLD—New post office, Commissioners of Public Works

STRABANE—Labourers' dwellings, Rural District Council.

SUMMERHILL—Church and Sunday school (£2,500), Baptist Trustees

SWANNINGTON—Wesleyan church and schools, Trustees.

SWANSEA—Forty-four houses, Baptist Well Estate, Mr. M. Hoskins.

TANFIELD—Higher-grade school, Education Committee.

TAUNDWINGYI—Secondary school (Rs.21,000), Burmese Government.

TEBAY—Elementary school, Westmorland County Education Authority.

TEMPLEPATRICK—Alterations and additions, manse, Committee Templepatrick Presbyterian Church.

TIDEFORD—Chapel, St. Germans local Wesleyan Methodists.

TREALAW—Institute and Judge Williams's Memorial Hall. Messrs A. O. Evans, Williams, and Evans, architects.

WANDSWORTH—Elementary school, Littleton-street, London County Council.

WARWICK BRIDGE—Elementary school, Cumberland County Education Committee.

WASHINGTON—Elementary school, Durham Education Committee.

WATFORD—House, Hempstead-road, Messrs. Clark Bros.; shops, Whippendell-road, Mr. C. Brightman; house, The Avenue, Mr. J. Taylor; two houses, Sussex-road, Mr. Sutton; house, Rickmansworth-road, Mr. E. Keen; house, Monmouth-road, Mr. W. King; house, Hempstead-road, Mr. F. W. Stimpson; motor-house, Whippendell-road, Mr. Wheeler; motor-house, Upton road, Dr. Hardenburg; house, Sandringham-road, Mr. A. Lunt; two villas, Kingsfield-road, Mr. J. Freshwater; house, The Avenue, Mr. H. B. Watkins; two houses, Field-road, Mr. Wright; shops and offices, Aldenham-road, Mr. J. Rodwell; five houses, Judge-street, Mr. J. Russell.

WEDNESBURY—Independent electric plant (£8,000), Town Council.

WESTBURY—Dwellings, parish of Dilton Marsh (£1,800), Rural District Council.

WESTERHOPE—Twelve houses near Newburn. Mr. T. G. Wilson, architect.

WEST HAM—Alterations to Canning Town School, Education Committee.

WESTON—Alterations and improvements at the Council school, Cheshire County Council Education Committee.

WHITECHAPEL, E.—Elementary school, Buxton-street, London County Council.

WHITTON PARK—Council school, Durham Education Committee.

WIRKSWORTH—Extension, town hall (£300), Council.

WISBECH—County hall and offices, Station-road, March, Isle of Ely County Council.

WOLSINGHAM—Elementary school, Durham Education Committee.

WORCESTER—Continuation school adjoining Victoria Institute (£6,000), City Council.

WORTH—House, Dover-road, two houses, Deal-road, Messrs. Turner and Watts.

YIEWSLEY—Elementary school to accommodate 300 scholars, Middlesex Education Committee.

YSTRAD RHONDDA—Business premises, Ton Industrial Co-operative Society.

PROVISIONAL PATENTS, 1908.

APRIL 13.

8138. Improvements in fixing commutators for dynamo-electric machines or other bodies to their supports. Siemens Bros. Dynamo Works, Limited, and Emil O. Kieffer, Queen Anne's-chambers, Broadway, Westminster. (Complete specification.)

8148. Electric foot-warmer. Otto Krüger, 345, St. John-street, London. (Complete specification.)

8190. Improvements in interrupters for electrical ignition. The firm Robert Bosch, Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, March 23, 1908, being date of application in Germany.) (Complete specification.)

8209. Improvements in or relating to the process of manufacturing certain electric appliances and apparatus therefor and for other purposes. Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, London.

8210. Ear instrument with diaphragm which can be kept electrically vibrating but open to direct sounds while in use by the deaf. William Henry Warn, 563, Stretford-road, Old Trafford, Manchester.

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8206. Improvements relating to electrical devices for the measurement of speeds. Elektrizitäts Ges. Alioth, 322, High Holborn, London. (Date applied for under Section 91 of the Act, May 2, 1907, being date of application in Germany.) (Complete specification.)

APRIL 14.

8253. Electric arc lamp lens and screen for theatrical stage effects. George Alfred Applebee, 97, Norroy-road, Putney, London.

8277. Improvements in or relating to the production of high-frequency electrical oscillations. Otto Scheller, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Aug. 13, 1907, being date of application in Germany.) (Complete specification.)

8283. Improvements in and relating to electric switches. Frederick Hugh Smith, 18, Southampton-buildings, London.

8287. Improvements in or relating to transporting apparatus. Felten und Guilleaume-Lahmeyerwerke Act.-Ges., 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, April 24, 1907, being date of application in Germany.) (Complete specification.)

8288. Improvements in or relating to differential relays. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, May 4, 1907, being date of application in Germany.) (Complete specification.)

8289. Circuit tester, fault and spark locator for electrical circuits of induction coils and the like. Arthur Edwin Lamkin, Edward Thomas Crofts, and Kate Beazley, 6, The Exchange, London-road, Thornton Heath.

8298. Improvements in choking coils for use with arc lamps. Louis Oscar Langworthy, 53, Chancery-lane, London. (Complete specification.)

8300. Improvements in or relating to telegraphy. Frederick George Creed and William Arthur Coulson, 46, Lincoln's-inn-fields, London. (Complete specification).

8308. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

APRIL 15.

8346. Improvements in controllable electric motors receiving and transmitting impulses which may be used for gun fire control. Henry James Creffield, Faraday House, Avenue-road, Erith.

8357. Electric device for preventing collisions of railway trains. Charles Lagden and Alfred Catchpole, 22, Burgoyne-road, Harringay, London.

8375. Improvements in electric arc lamps. Adrian Denham Jones, Hartham Works, Hartham-road, Holloway, London.

8377. Improvements relating to alternating electric current distribution systems. John Sedgwick Peck, Westinghouse Building, Norfolk-street, London.

8414. Improvements in and relating to alternating-current motors of the commutator type. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, April 17, 1907, being date of application in Germany.) (Complete specification.)

8415. Improvements in and relating to dynamo-electric machines. Jakob Emil Noeggerath, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, April 25, 1907, being date of application in United States.) (Complete specification.)

8416. Improvements in and relating to incandescent filaments for electric incandescent lamps. Wolfram-Lampen Akt.-Ges., 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, April 26, 1907, being date of application in Germany.) (Complete specification.)

8421. Improvements relating to incandescent filaments for electric incandescent lamps. Wolfram-Lampen Akt.-Ges., 7, Southampton-buildings, London. (Date applied for under for Section 91 of the Act, May 13, 1907, being date of application in United States.) (Complete specification.)

8422. Improved method of preventing the corrosion of the internal parts of boilers due to electro-chemical action. Peregrine Elliott Gloucester Cumberland, 55, Chancery-lane, London. (Date applied for under Rule 13, June 10, 1907. An invention comprised in application No. 13,417 dated June 10, 1907.) (Complete specification).

8425. Improvements relating to the production of electrical discharge. William Edward Evans, 27, Chancery-lane, London. (Elektrochemische Werke, Germany.) (Complete specification.)

APRIL 16.

8449. Improved sunk switch box and cover for electric light. William Todd, 6, Cumberland-street, Edinburgh.

8467. Improved arrangement of driving and braking gear for overhead electric cranes. Alexander Jack, 65, Chancery-lane, London.

8481. Improvements in and relating to electric contact makers, distributors, and the like. Arthur Gerald Benstead, 45, Great Eastern-street, London.

8471. Improvements connected with certain kinds of electric heating apparatus. Veritys, Limited, and Herbert Samuel Smith, 11, Burlington-chambers, New-street, Birmingham. (Complete specification.)

8479. Improvements in magnetically-operated ignition plugs for internal-combustion engines. Charles William Higgs and William Wrentmore Stanton, 304, Vauxhall Bridge-road, London.

8507. Device for stretching cables or ropes. Felten und Guilleaume Lahmeyerwerke Akt.-Ges., 111, Hatton garden, London. (Date applied for under Section 91 of the Act, April 18, 1907, being date of application in Germany.) (Complete specification.)

8521. Improvements relating to alternating electric current distribution systems. Gilbert North and John Sedgwick Peck, Westinghouse Building, Norfolk-street, Strand, London.

8522. Improvements in turbo-electric generator systems. Ernst Julius Berg, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, April 20, 1907, being date of application in United States.) (Complete specification.)

8523. Reinforced concrete pole or mast for supporting electric conductors or for other purposes. Heinrich Wilhelm Oberlies, 40, Chancery-lane, London. (Complete specification.)

8543. Improved system of fixing electric punkahs. Arthur Bergtheil, 1, Queen Victoria-street, London.

8547. Improvements in field magnets for magnetic inductors. Hermann Ruthardt, 55, Chancery-lane, London. (Date applied for under Section 91 of the Act, April 16, 1907, being date of application in Germany.) (Complete specification.)

8558. Electric order and alarm apparatus. Johan Joahim Fredrik Dickmann, 322, High Holborn, London.

APRIL 18.

8626. Improvements in joints for flexible metallic tubing. Charles Winn, 77, Colmore row, Birmingham.

APRIL 21.

8679. Improvements in or relating to electric kettles, urns, water, or other liquid heating and boiling apparatus and the like. John Edmund Pownall, 16, Hillfield-road, West Hampstead, London.

8713. Improvements in electrical ignition apparatus for internal-combustion engines. Jean Frédéric Henrique, 60, Queen Victoria-street, London. (Date applied for under Section 91 of the Act, April 20, 1907, being date of application in France.) (Complete specification.)

8719. Improved pitch compound for use under the application of heat as an insulating cement for assisting in the joining or connecting of electric cable cores or electric wires, or for use for coating electric cable joints or joined electric wires with a ductile flexible insulating and waterproof covering. Thomas Marriott, 33, Knights-park, Kingston-on-Thames.

8737. Improvements in filaments or bodies for incandescent electric lamps. Charles Alfred William Hopton, 4, South-street, Finsbury, London. (Complete specification.)

8746. Improvements in the manufacture of incandescent filaments. Gaston Auger, 18, Southampton-buildings, London. (Complete specification.)

8748. Improvements in electrical cut-outs. Phillip Thomas McNally, 18, Southampton-buildings, London.

APRIL 22.

8752. Improved sparkless surface-contact electric motor starter and automatic regulator. Charles Lillicrap, 59, Robert-street, Manselton, Swansea.

8773. Improvements in electric lamps. Emily Böhm, 46, Hillmartin-road, London.

8787. Improvements in electrical ignition apparatus for use in internal-combustion engines and for other purposes. Arthur James Postans, Birkbeck Bank-chambers, Southampton-buildings, London. (Application for patent of addition to No. 5194/07.)

8794. Improvements in electrical storage batteries. George Anna Carpenter, 53, Chancery-lane, London.

APRIL 23.

8818. Improvements in and relating to incandescent electric lamps. William Kennedy-Laurie Dickson and Henri Jacque Guillaume Reeser, 61, Strand, London.

8850. Improvements in the method of utilising waste steam power in connection with the production of electricity by steam. Henry Ernest Fry, 24, John-street, Bedford-row, London.

8863. Improvements in time-controlled electric switches. John Gunning, Birkbeck Bank-chambers, Southampton-buildings, London.

8874. New or improved electric ventilator. Max Levy and Wilhelm Mehlhose, 323, High Holborn, London. (Complete specification.)

8887. Improvements in apparatus for disinfecting telephones. Theodor Lutz, 18, Southampton-buildings, London. (Complete specification.)

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8904. Improvements in electrical furnaces. Jean Bouneau, 31, Bedford-street, Strand, London. (Date applied for under Section 91 of the Act, April 24, 1907, being date of application in France.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on May 7.)

1907.

5764. Process and apparatus for electrically fusing, refining, and moulding refractory substances, such as quartz Mackenzie. (Ludwig Bolle und Co. Ges.)

6034. Single-phase alternating-current motors. Cramp.

8376. Electric switches. Vandervell.

8471. Electric alarm bells. Kessler and Jelich.

8504. Multiple switch controlling apparatus for electric circuits, specially applicable to motor starters. Brook and Hirst.

8623A. Means of propulsion of electrically-driven trains and the like. Stone and Migotti. (Date applied for under Rule 13, April 13, 1907.)

8841. Incandescence bodies for electric lighting and heating purposes. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, April 17, 1906.)

9157. Controlling devices for electrical machines. Balachowsky and Caire.

9684. Machines for insulating electrical conductors. British Thomson-Houston Company. (General Electric Company.)

11044. Electric cables and the bonding thereof. Tanner and Claremont.

12871. Electrically heated vulcaniser. Gornall and Union Rubber and Chemical Company.

13270. Mercurial thermostatic circuit "closers." Cossor.

13582. Electrical resistances. Jones.

15169. Combined telegraph and telephone apparatus. Dickson.

15522. Means for operating gas taps, electric light switches, and door bells. Maskelyne.

16530. Refractory metallic electrical conductors for use in incandescent electric lamps and the like. British Thomson-Houston Company. (General Electric Company.)

16736. Method of melting or fusing glass or like vitreous material around and on to electric conductors. Bastian, Calvert, and Sanders.

16956. Arc lamps. Angold and Maxim Electrical Company.

17012. Wall plugs and sockets for use in electric lighting, heating, and power circuits. Bevis and Krause.

17839. Electrical attachment for racking off casks. Allison. (Speitschka.)

18346. Shade-holders and shades specially applicable for electric incandescent lamps. Dawson.

18515. Protective devices for electric transmission systems. British Thomson-Houston Company. (General Electric Company.)

18834. Friction clutches. Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.)

21476. Manufacture of incandescent electric lamps having metal filaments. Bloxam. (Siemens und Halske Akt.-Ges.)

21811. Control of electric motors. Benrather Maschinenfabrik Akt.-Ges. (Date applied for under International Convention, Oct. 3, 1906.)

22467. Rotary transformers for electric current. Pinot. (Date applied for under International Convention, Nov. 9, 1906.)

22609. Trolley mechanism for electrically-propelled cars. Craig.

24670. Arrangements on electricity meters for determining the maximum consumption. Elektrizitäts Akt.-Ges., vorm. Schuckert und Co. (Date applied for under International Convention, Nov. 20, 1906.)

24807. Electric furnace. Viel.

25919. Electricity generators. Ferguson.

26834. Apparatus for producing high-frequency electric discharges. Haddan. (Synchronous Static Company.)

27090. Bracket for supporting or locating electric cables, pipes, and the like. Gill.

27401. Electric fuses. Rawlings and Smith.

27447. Safety devices for electric winding plants. Siemens Bros. Dynamo Works, Limited, and Clift.

28690. Cable telegraphy. Kitsee.

1908.

401. Electrolytes for alkaline storage batteries. Edison. (Date applied for under International Convention, May 10, 1907.)

3465. Clutch for electric arc lamps. Andersson. (Date applied for under International Convention, Feb. 18, 1907.)

6157. Apparatus for the electric ignition of large internal-combustion engines. Firm of Robert Bosch. (Date applied for under International Convention, Sept. 16, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅛-¼
—— Ord., 1,125,000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	11/16-13/16
—— Ordinary, Nos. 1-125,000	1	..	3/16-5/16
British Aluminium Co., Ordinary, 2 001-40 000	5	..	3⅝-4⅛
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4⅜-4⅞
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4⅛-4⅜
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3⅜-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	102-105
—— 5½ per cent. Loch Leven Deb. (Reg.). Red., 1-3 000	100	..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6¼-6⅝
—— 6 per cent. Cum. Pref., 1-100 000	5	..	6⅝-6¾
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	95-100
British Westinghouse Elec. and Manuf. 10 per cent. Pref., 275,001-475,000	3	..	½-¾
—— 4 per cent. Mortgage Debenture Stock	100	..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	3/16-7/16
—— 4½ per cent. 1st Debenture Stock	100	..	74-79
—— 4½ per cent. 2nd Debenture Stock	100	..	59-64
Callender's Cable, Debentures	100	..	106½-108½
—— Ordinary	5	..	10⅛-1⅛
—— 5 per cent. Pref.	5	..	5⅛-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	7/16-9/16
Crompton and Co.	3	..	1⅜-1⅝
—— 5 per cent. Debentures	100	..	92-95
Dick, Kerr, and Co., Ordinary, 1 250 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Edison and Swan United, "A" Shares, 1-99 261	5	..	¾-1
—— "A" Shares, 01-017,139	5	..	1⅛-2⅛
—— 5 per cent. Debentures	100	..	85-87
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112,100	2	..	¼-½
—— 7 per cent. Cumulative Pref.	2	..	1⅛-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100	..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100	..	75-80
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅞-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	87-90
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	4⅛-⅜
—— 4½ per cent. Debentures	100	..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	98-100
National Electric Construction Co., 1-170,000	1	..	5/16-9/16
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	30½-32½
—— 4 per cent. Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4⅝-5¼
Bournemouth and Poole, Ordinary	10	..	10¾-11⅛
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	10-11
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10½-11
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105
Bromley (Kent) Electric Light and Power Co.	5	..	4¼-5 xd
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	96-99
Brompton and Kensington, Ordinary	5	..	7⅛-8¼
—— 7 per cent. Preference	5	..	6⅞-7⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5	..	6⅞-7⅛
—— Nos. 80,000-100,000	5	..	6⅞-7⅛
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-12¾
Canadian General Electric Co., Common Shares	$100	..	90-94
—— 7 per cent. Cum. Pref. Stock	$100	..	107-109
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3⅝-4⅛
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	4⅛-⅜
—— 4 per cent. Debenture Stock, Red.	100	..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	3⅞-4⅛
—— ditto (1905) 40,001-80,000	5	..	4⅛-4⅜
Chelsea Electricity Supply	5	..	3-3½
—— 4½ per cent. Debentures	100	..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9½-10¼
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	123-126
—— 4½ per cent. 2nd Deb. Stk., Red.	100	..	101-104
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	£0	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3-3½
—— 5 per cent. Preference, 1-50,000	5	..	4¼-4½
County of London Elec. Supply, Ordinary	10	..	7⅜-8¼
—— 6 per cent. Cum. Pref.	10	..	10¾-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	107-110
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	98-101
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	⅛-⅜
—— 6 per cent. Cum. Pref.	5	..	¼-1½
—— 4½ per cent. First Mort. Deb.	100	..	53-57
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	74½-77½ p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2¼-2⅜
—— 5 per cent. Debenture Stock, Red.	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	91-94
Folkestone Electric Supply, Ord., Nos. 1-10 000	5	..	4⅜-5¼
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	..	5-5¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-15,000	5	..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	95-98
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100	..	92-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	3/16-5/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	7⅞-8⅛
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	96-99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3	1-1⅛
—— 6 per cent. Pref.	5	4⅛-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	89-92 xd
Metropolitan Ordinary, 100,001-200,000	5	4⅛-5⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4⅛-5⅛
—— 5½ per cent. Mortgage Debenture, Red	100	85 90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1 4,400 ($1 000	—	76-7[illegible] p.c.
Mexican Light and Power Co., Capital Stock	$100	4⅛ 4⅜
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	83-85
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	5⅛-5⅛
—— do., 57,010-75,000	5	5⅛-5⅛
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	6⅛-6⅜
—— 5 per cent., Pref., 1-57,009	5	5⅛-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5	5⅛-5⅜ xd
Notting Hill Electric Lighting	10	11½-12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5⅛ 6⅜
—— 4 per cent. Debenture Stock	100	94-98
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120 507	1	15/16-1 1/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	29/32-1 1/32
—— 5 per cent. Debenture Stock, Red.	100	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	4⅜ 5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	4⅜-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛-1⅛
—— 4 per cent. Debenture Stock	100	70-74
South London, Ordinary	5	2⅜-2⅝ xd
South Metropolitan Electric Light and Power, Ord.	1	⅞-⅞
—— 7 per cent. Cum. Pref.	1	1⅛-1⅜
—— 4½ per cent 1st Mort. Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7⅛-8⅛
—— 7 per cent. Pref.	5	6⅛-7
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	87 90
Westminster, Ordinary	5	7⅛-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅜-5⅛

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5	6⅛ 6⅜
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	7⅜-8⅛ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100	132-137
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	104-107
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent. Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	⅜-⅝
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	11/16-3/16
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	93-96
Blackpool and Fleetwood Tramroad	10	13⅜-1⅝
Bombay Elec. Supply and Trams. Co., 6 per cent. Cum. Pref.	10	10-10½
—— 4½ per cent. Deb. Stock, Red.	100	93-96
Brisbane Tramway Invest., Ord., 1-75,000	5	3⅛-4⅛
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4⅜ 5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	98-102
British Columbia Electric Railway Co., Ord Def.	100	132-135
—— Ord. Pref.	100	111-115
—— 5 per cent. Cum. Perpetual Pref. Stock	100	106 110
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	99-103 xd
—— 4½ per cent. Vancouver Power Deb.	100	101-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	1⅛-1⅜
—— 6 per cent. Cm. Pf., 30,0001-60 000	10	4 4⅛
—— 5 per cent. Perpetual Debenture Stock	100	80-85
—— 4½ per cent. 2nd Deb. Stock	100	71-75
Bueno Ayres and Belgrano Trams	5	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	95-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	97-101
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, Ord., Nos. 1-137,610	5	6-7
—— 5 per cent. Cum. Pref., Nos. 1 20,000	5	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	103 105
Cape Electric Tramways, Nos. 1-480,000	1	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5	4⅜-4⅝
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	97-100 xd
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	99-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	89-93
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12⅛-13⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10	12⅛-13⅛
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	91-97
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	80 85
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	⅜-1⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	87-91
—— 6 per cent. "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10-10⅛
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
† £296,500 2nd Mort. Deb. Stock	—	—
† £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1⅛
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10	6⅛-7⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	80-85
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 201-21,635 and 436-25,000	5	4⅛ 5
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	88-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1	1/16-3/16
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	11/16-13/16
—— ½ per cent. Deb. Stock, Red.	100	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	86⅛-87½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort. Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74 000	5	⅛-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mit. Deb. Stk	100	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1	⅛-¼
—— per cent. Cum Pref., 300,001-545 000	1	⅛-¼
—— per cent. Debenture Stock	100	95-96
Provincial Tramways Co., Ordinary, 1-24,912	10	4⅜-5⅛
—— per cent. Cum. Pref., 1-10,000	10	9⅛-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5	5⅛ 5⅝
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	87-89
Sao Paulo Tramway, Light, and Power Co.	$100	129-134
—— 5 per cent. 1st Mort Deb., Red. 1929. 1-12,000	$500	96½-98½ p.c.
South Metropolitan Electric Tramways and Lighting Co., 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-1
—— 4 per cent. Deb Stock, Red. 1940	100	78-82
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	75-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100	75-78
—— 4 per cent. Pref.	100	84-86
—— " " deferred	100	54-57
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	100-103
City and South London, Consolidated Ordinary	100	39-41
—— 4 per cent Debenture Stock	100	101-104
—— 5 per cent. Pref. Stock '91	100	113-116
—— " " " '96	100	112-115
—— " " " '01	100	110-113
—— " " " '03	100	106-109
Liverpool Overhead, 5 per cent. Pref.	10	10-10½
—— Ordinary, 1-50,000	10	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	84-86
Underground Electric Railways of London, 5 per cent Profit-sharing Secured Notes	—	36-40
—— Deposit Receipts	—	36-40

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	85 87
Anglo-American Telegraph Co., Ordinary	100	55-58 xd
—— 6 per cent. Preferred Ordinary	100	99-101 xd
—— Deferred Ordinary	100	13⅛-13⅜
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	98½-101½
Chili Telephone Co., 1-44,000	5	7-7½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	86-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	7⅛-8⅛
—— 10 per cent Preference, 1-6 000	10	16-17
Direct Spanish Telegraph Co., Ordinary	5	3⅛-3⅜
—— 10 per cent. Cum. Preference	5	8⅛-9⅛
—— 4½ per cent. Debs., 1-600	50	99½-102½
Direct United States Cable Co.	20	13⅛-14 xd
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	99½-101½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	10-10⅜
Eastern Extension, Australasia and China, 1-300,000	10	13-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100	99½-102½
Eastern Telegraph Co., Ordinary Stock	100	131-136
—— 3½ per cent. Preference Stock	100	84-87
—— 4 per cent. Mortgage Debenture Stock	100	101½-101⅞
Great Northern Telegraph Co. (of Copenhagen)	10	30-32
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100	99½-101½
Indo-European Telegraph Co.	£5	55-58
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	15/16-1 1/16
—— 5 per cent. Preference, 1-86,492	1	⅜-1
National Telephone, Preferred	100	107-109
—— Deferred Stock	100	108½-110½
—— 6 per cent. Cum. First Pref.	10	10⅛-12⅛
—— 6 per cent Cum. Second Pref.	10	10⅛-12⅛
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	98-100
—— 4 per cent. Deb. Stock, Red.	100	101½-103½
Oriental Telephone and Electric Company	1	1⅜-1½
—— 6 per cent. Cum. Pref.	1	1⅜-1½
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5	6-6½
—— 5 per cent. Cum. Pref., 1-40,000	5	4⅜-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10½
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	98½-101½
West India and Panama Telegraph Co., Ordinary	10	9/16-11/16
—— 6 per cent. Cum. 1st Preference	10	8⅛-8⅜
—— 6 per cent. Cum. 2nd Preference	10	8⅛-9
—— 5 per cent. Debs., Red., 1-800	100	101-104
Western Telegraph Co., 1-207,930	10	13⅛-13⅜
—— 4 per cent. Debenture Stock, Red.	100	99-102

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week. Ending	1908.	1907.	Increase or decrease. Week.	Current year.	Miles of track open. 1908.	1907.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	April 22	1,251	1,156	+ 95	− 1,266h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 25	319	212	+ 106	—	8	8	,, 15	15,283	3,603,789	378,834	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 25	3,485	2,470	+1,015	+12,629	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 26	1,064	973	+ 91	+ 150	23·53	23·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 18	6,183	5,241	+ 942	—	56½	56½	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 22	1,891	971	+ 920	+ 59	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·03
Blackpool Corporation	,, 23	2,235	448	+1,787	+ 771	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	,, 26	2,299	2,068	+ 231	+ 8 5	42	42	March 31	111.294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 22	2,533	1,589	+ 944	− 323	29¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·23
Bradford Corporation	,, 18	4,676	4 204	+ 472	+ 2,145	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 26	899	498	+ 101	+ 162	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 24	5 899	4,682	+1,217	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 25	1,195	1,158	+ 37	—	19¾	19¾	,, 31	62,699	11,967,488	1,205,830	1·31	12·48	5,825	8·21
Burton Corporation	,, 26	954	968	− 4	—	9⅞	8½	,, 31	15.576	3,383,527	421,317	1·07	8·87	1,708	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04*	9·74	3,266	6
Carlisle Tramways Company	April 25	178	160	+ 18	+ 62	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 25	5 532	5,850	− 3,128	− 3,573	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,357	5·22a
Charing X, Euston, & Hamp. Ry.	,, 25	3 665	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 25	3,432	2 825	+ 607	+ 6,225	9	6¼	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 22	233	173	+ 60	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 23	468	462	+ 6	− 467	15½	15½	Dec. 31	25,032	5,966,364	891,9·8	—	6·74	—	4 78
Croydon Corporation	,, 24	1,468	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 24	274	244	+ 30	+ 37	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	,, 18	202	189	+ 13	− 178	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	,, 24	176	112	+ 64	+ 44h	6¾	6¾	—	—		—	—	—	—	—
Dublin U.T.	,, 24	5,608	5,275	+ 333	+ 648	54¼	48¾	—	—		—	—	—	—	—
Dundee City Tramways	,, 8	1,144	1 195	− 51	—	22	22	May 15	57,672	15,554,905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	,, 25	870	817	+ 53	− 121	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 25	17,666	19,080	− 1,415	+15,596h	177½	169	May 31	887,381	224,063,098	20,350,367	·95	10 47	5,035	5·21
Gloucester Corporation	,, 22	327	229	+ 98	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 25	5 660	3,975	+1,685	+27,541	9¼	9	—	—	—	—	—	—	—	—
Halifax Corporation	,, 14	1,413	1,283	+ 130	—	52·574	37	,, 31	77,996	18,899,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	Mar. 21	1,443	1,471	− 28	+ 3,269	35½	35	,, 31	81,196	15,252,150	1,804,745	1 22	10·79	2,770	5·9a
Hull Corporation	April 25	2,493	2,215	+ 278	− 89	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	Mar. 14	391	414	− 23	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	April 22	161	117	+ 44	− 14	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 8	280	215	+ 35	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1 73	4 95
Lancashire United Tramways	,, 22	2,193	1,075	+1,118	+ 1,037	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 18	6 534	6 011	+ 523	− 415	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5·58
Leicester Corporation	,, 25	2,366	2 023	+ 343	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 4	10,801	11,797	− 996	− 2,944	104	104	Dec. 31	563,793	122,094,528	12.115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 26	1,477	1,465	+ 12	− 230h	9 25	6·65	June 30	77,568	10 957,148	1,102,809	—	—	—	—
London County Council	,, 11	31 291	27,783	+3,308	+ 5,173	98	98	March 31	1378,014	314,227,090	30,130 997	1·05	10 98	—	8·56
Lowestoft Corporation	,, 18	171	138	+ 33	+ 71	3½	—	Sept. 30	11,079	2,622,922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 16	164	96	+ 68	—	3½	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2,956	6 2
Manchester Corporation	,, 25	15,494	13 665	+1,829	+ 4,197	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 25	8.633	7 722	+ 911	+16,758	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 26	16,026	15 369	+ 657	+ 2,476	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 25	126	129	− 3	− 128	2¾	2¾	March 31	7,709	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 25	4,300	3 893	+ 407	− 1,655	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 18	641	536	+ 45	− 123	14½	14½	,, 31	32,421	7,760,403	772 753	1 03	10 01	1,525	6·67
Oldham Corporation	—	—	—	—	—	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·2·9
Portsmouth Corporation	Mar. 28	1,460	2,086	− 626	—	28½	28½	,, 31	98,911	20.668.825	2,199,823	1·15	10 79	—	—
Reading Corporation	—	—	—	—	—	13½	13½	,, 31	32,661	8,130.179	918,825	·96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6·03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10·45	2,691	7·38
Salford Corporation	April 20	5,368	4,202	+1,166	− 862	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	7 01
Sheffield Corporation	,, 19	5.503	5,174	+ 329	− 1,857	66½	65¾	March 25	276,907	73,966,299	6,804,656	·898	9 767	4,174	5·94
Southampton Corporation	,, 22	1,127	864	+ 263	+ 103	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 22	491	289	+ 202	− 25	9	9	,, 31	20,076	4,431,728	390,538	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 26	1,091	1,279	− 188	− 1,091	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6·37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 23	570	154	+ 416	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 25	939	736	+ 203	− 69	12 68	12·43	‡ ,, 31	42,810	8,312,592	890,906	—	11·53	—	—
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965,296	429,785	—	10 724	1,989	6·95
West Ham Corporation	,, 23	2,474	2,144	+ 330	− 859	14·7	14·7	,, 31	122,881	35,502,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 22	1,045	773	+ 272	− 56	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·096

* 1905-6 figures. ‡ 1907-8 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE
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IPSWICH TRAMWAY AND ELECTRIC SUPPLY FINANCE.

The Corporation of Ipswich are to be congratulated on the businesslike way in which they attacked last week the question of the upkeep and renewal of their tramway and electric supply plant. Some corporations seem to be afraid to face the present expense of providing for renewals which they know will be required in the future. They prefer to use in relief of rates at the present time money which should be laid by for the renewal, for instance, of tramway track. By so doing they defer for a few years a financial crisis which must eventually be faced. Coming now to the Ipswich case, the chairman of the Electric Supply and Tramways Committee instructed their engineer and manager (Mr. Frank Ayton) to prepare a report as to what charge, if any, should be made against the revenue of each department to cover the upkeep and renewal of plant. This report, which we reproduce elsewhere in this issue, is a clear statement such as will commend itself to business men. He finds that the chief item which will have to be renewed before the expiration of the tramway loan, which was obtained on a forty years' basis, is the track. The cost of this renewal, which will be required about 1919, is estimated at £42,500, and the repayment of loan will by that time amount to £10,408. Hence such sums should be set by year by year as to accumulate with interest to £32,092 in the year 1919. This report has been adopted by the Corporation after consideration by the Finance Commitee. It is stated that the present returns from the tramway do not enable any such sums to be laid aside for special track renewal, although the interest on loans and annual repayments are being fully met out of revenue. The Finance Committee also endorse the recommendations in Mr. Ayton's report, and agree to the necessity of accumulating a special track renewal fund. They point out that within the next three years a number of existing loans will be completely repaid, which will relieve the Corporation of annual charges more than sufficient to form the above fund. This enables them to avoid a special rate for the purpose for the next year or two, and equalises the demands on the Ipswich ratepayers. It is, of course, rather a long time to look forward to the date when the Ipswich electric lighting and tramway loans will have expired, but it must be remembered that the Corporation will then have these valuable undertakings quite free of annual charges for interest and sinking fund, and so long as the Corporation maintain the business character shown in last week's meeting there can be no financial crisis meanwhile.

THE JOHANNESBURG POWER STATION TROUBLES.

The power station problem still continues to excite the attentions, not to say the passions, of the Johannesburg Town Council. Many meetings have been held, at which proposals were made for the lease of the station to a firm of contractors on terms which certainly seem favourable to the municipality, inasmuch as it will receive a substantial sum in cash, with a large share of debentures in the new company, as well as a "bulk" supply, and the option to take over the undertaking at the end of a certain period, but so far no decision as to them has been arrived at. The latest scheme emanates from Messrs. J. and W. Beardmore, of Glasgow, and from the details which we publish in another column our readers will be able to form some idea of its merits. The main features of the scheme are the proposals that the Council sell to the company the gas

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plant and its accessories, which stand in the books at £183,565, and in return receive £50,000 in actual cash and £125,000 in guaranteed 4 per cent. debentures. The Council will, however, retain in their possession the steam plant installed and on order, which is valued at £100,000. The company undertakes to supply the Council with power in bulk at 1·25d. per unit. The municipal loan, which was for thirty years, has still twenty-six years unexpired, and the provision for a sinking fund is taken at 2 per cent per annum and the interest at 4 per cent. The agreement in which these features are embodied would be terminable at the Council's option at the end of the following periods—ten years, fifteen years, and twenty-one years—and in the event of the Council exercising their option, the lighting company's plant has to be taken over at its then value as decided by expert valuers. These, in brief, are the main features of the scheme which is before the Council. It has been most favourably reported upon by a firm of consulting engineers before whom it was submitted and by the municipal engineer. The Tramways and Lighting Committee have strongly recommended its acceptance. But a section of the Council is stoutly opposed to it, and at the last meeting succeeded in having the proposition deferred for six weeks. Of course, the Council may be expected to know better than anyone here what is the best course to adopt in the interests of the city, and outside interference is in such cases sometimes better avoided. But this matter is, we venture to think, of sufficient importance to warrant attention in this country too. The alternative to Messrs. Beardmore's scheme is a fight with the contractors in the law courts, and it is difficult to see what benefits the Council are likely to get from a protracted lawsuit. Even if the Council won their case they would be considerably out of pocket, and would also have lost the interest during the two years that would be spent in litigation, on the whole plant and buildings (about £11,000 per annum), as they would not be permitted to touch any machinery until judgment had been finally given. In any case it is always advisable to avert the uncertainty and delay of a lawsuit, more particularly where it is possible, as here seems, for the Council to get out of their difficulty so well.

LORD KELVIN.

Just as the prophet, according to the familiar saying, is not without honour except in his own country, so may it be said that the greatness of a man and the immortality of his life's work will never lack appreciation, except, perhaps, in his own time and generation. Many a really famous man has, in his lifetime, lain in deep obscurity, which a later generation has stigmatised as cruel, but the quality of which was, perhaps, after all, speculative. No such obscurity, however, enshrouded the life of Lord Kelvin. Honoured by his contemporaries, and the object of the generous estimate of those who were best able to judge him in life, his greatness stands out with even more prominence now that we are able to regard him from some little distance. Two notable tributes to this great philosopher were paid last week. One of these was by Prof. Silvanus P. Thompson in the "Kelvin Lecture" before the Institution of Electrical Engineers on Thursday and the other by Prof. Joseph Larmor at last Friday's meeting of the Royal Institution. Prof. Thompson brought to our minds in eloquent language an impression of Kelvin's ideas which have found their way into our modern theoretical knowledge of mechanical and electrical and optical philosophy, and of his remarkable activity, which was, perhaps, unprecedented in scientific annals. He has given us some account of Kelvin's evolution of the scientific basis for telegraphy in connection with the early Atlantic cables, and of his preparing the way in all directions for the still more recent electric transformations of mechanical engineering. There are many who may share the regret expressed by Prof. Larmor—a regret which was at one time held and but shortly afterwards abandoned by Helmholtz, who was Kelvin's only peer in general physics in these early days—that technical developments should have withdrawn his attention in the time of his greatest fertility from theoretical problems. It is certainly true that his theoretical work will bring enduring fame, but we believe that his remarkable genius for converting the results of these abstruse investigations into the development of industry, and to the service of mankind, has stamped his life and work with a fame which is both unique and immortal.

INTERNATIONAL CONFERENCE ON ELECTRICAL UNITS AND STANDARDS.

We are pleased to see that the Government is taking a keen interest in the above conference, as this will add greatly to the value of the proceedings. As an evidence of this, the President of the Board of Trade has appointed a committee, consisting of Mr. G. R. Askwith, K.C., Sir John Gavey, K.C.B., Dr. R. T. Glazebrook, F.R.S., Major P. A. MacMahon, F.R.S., Major W. A. J. O'Meara, R.E., C.M.G., and Mr. A P. Trotter, to prepare a programme for the consideration of the delegates to this International Conference on Electrical Units and Standards, and to make arrangements for the reception and assembly of the delegates attending the conference. Mr. M. J. Collins, of the Board of Trade, will act as secretary to the committee. The conference is to be held in London this autumn. The gentlemen thus appointed on the committee are well known to electrical engineers and highly respected We feel sure that they will so draft the programme as to facilitate definite issues being put before the conference, so that the proceedings may be productive of decisions which will help the industry. We must admit, however, that we would have appreciated the addition of one or two more engineers to the committee who might have been selected from the ranks of our best manufacturers and from those in charge of power supply undertakings.

ELECTRIC PROPULSION OF SHIPS, WITH NOTE ON SCREW PROPELLERS.*

BY HENRY A. MAVOR (MEMBER).

The electrical engineer is on the outlook for new worlds to conquer. He has placed his mark on all other branches of engineering, and it does not seem too much to expect that he may also have a share in the further development of marine engineering. No great advance takes place without a preparation for change. The applications of electricity have been conspicuous examples of this rule. The end of the first thirty years of the history of the practical use of electricity for the transmission of motive power is approaching. Two generations of steam engineering preceded its advent, and prepared the way for rapid development. On land, steam engineering and electric engineering have exercised a powerful mutual influence, and the development of the steam-turbine has been a direct outcome of this interaction.

The use of the steam-turbine for propelling ships is

* Paper read before the Institution of Engineers and Shipbuilders in Scotland.

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already strongly influencing marine engineering, and this would in itself justify a re-examination of the problem from a new standpoint. The use of steam in a turbine involves essentially a speed of rotation far above what is customary in reciprocating engines. Formerly existing methods have involved direct application of the energy of the prime mover to the propulsion of the ship, and these methods are closely related to the comparatively slow speed of rotation of the reciprocating steam-engine. It is not surprising, therefore, that the steam-turbine, when applied to marine propulsion, should be materially modified, and that the marine steam-turbine is a compromise in which some sacrifice of economy has been made for the sake of avoiding a greater loss due to the characteristics of the propelling apparatus. Within the limits of practice, the efficiency of the steam-turbine is increased by increased speed of revolution, while the efficiency of the propeller is decreased by a corresponding change.

Fast-running turbines and slow-running propellers are respectively highly efficient instruments, but hitherto there has been no proper method of coupling them together. The underlying principle of the proposals here made is the use of a high-speed turbine running at a uniform velocity for all speeds of the ship, and driving a dynamo from which electric power is taken to a variable-speed motor or motors coupled direct to the shafts of propellers of maximum efficiency. The dynamo and motor here occupy an intermediate position, as, indeed, they do in all cases, between the power and the work, and in effect constitute a gearing which can submit to modifications of its own characteristics to meet the characteristics, on the one hand, of the prime mover and, on the other hand, of the machinery to be operated. It is precisely in this region that electricity has found a place in engineering on land, and it is now proposed to examine the possibility of its use at sea. If such a possibility can be established and practical applications made, no doubt the methods of applying the power will be subjected to modification, but this reaction has been on land of very slow growth, and little has yet been done in the way of making special machinery to take full advantage of the properties of electric transmission. For this reason it is not necessary to enter into any questions involving material modification of the ship or the methods of operating it.

For present purposes, in considering electric motors, attention may be confined to two types which have proved themselves capable of the most extended adaptation. The use of alternating currents for electric distribution is developing very slowly in Great Britain. The reasons for this are various, the most important being that continuous current had established itself as a commercial success before the advent of the multiphase systems. But even in new countries, where development on the most convenient lines is free, the continuous current still holds the field for direct application of power, and in the application of electricity to transit continuous-current methods are still in the first position. Notwithstanding the fact that the power stations are equipped with alternating-current plant, the supply to the street cars is by continuous current, the conversion being accomplished in sub-stations. A very important fraction of the total electric power generated in this country is used in this way, and this has tended to perpetuate the idea that alternating currents are not suitable for direct application of power. The superiority of the multiphase alternating induction motor in respect of compactness, endurance, and simplicity, together with the fact that nearly all large electric generators over about 1,000 h.p. are made for alternating current, is gradually leading to a more general adoption of this class of machine, and attempts have for some years been in progress to overcome its difficulties in practical application. The chief of these difficulties is the low torque at start—that is to say, when the motor is at rest it requires artificial means to enable it to develop its full turning moment. These means are more complicated and costly than the equivalent apparatus for continuous-current motors. The ordinary multiphase induction motor also compares unfavourably with the continuous-current motor in respect of its availability for changes in speed. The continuous-current motor can now be made to give varying speeds through any necessary range without much loss of efficiency, the only consideration being cost. Hitherto the induction motor has not been able to meet this requirement. This latter disability is less serious than is generally supposed, because the cases requiring a smooth speed change are comparatively few, and where they exist they have been in many instances dealt with by mechanical means. Where very frequent starting and stopping have to be combined, as they often are with gradually varying speed, something new must be attempted if the alternating motor is to take the field. The author has been at work on this problem for some years, with the result that he claims to have solved the problem, and that he can meet most of the demands which are likely to arise in practice and deal with some new fields of enterprise which have hitherto, for various reasons, remained closed to the electrical engineer.

Hitherto the use of electric motors for marine propulsion has been confined to small craft, such as submarines, and one or two small barges and other craft on the Russian rivers and canals. A small electrically operated and propelled dredger has also been constructed in Germany. The motors in these cases are continuous-current machines. The continuous-current motor, which is so convenient for small applications of power up to 100 h.p., becomes less convenient over this size. Above 1,000 h.p. it is not a very practical machine for power purposes where starting and stopping have to be frequently accomplished, and it is not specially suitable for marine work. The multiphase induction motor, on the other hand, has all the properties to be desired in a marine motor except hitherto the facility of speed control. This problem may now be said to be solved.

Some years ago the idea of rotating the outer member of the motor, usually called the stator, occurred to the author, and appeared to offer a solution of the starting difficulty, and this suggestion was made at a meeting of the Institution of Civil Engineers in 1904. The proposal was that the external member should be mounted so as to be free to revolve concentrically with the rotor or armature of the motor. The armature being connected to the load and the outer member being free to rotate, the outer member starts to revolve in a direction opposite to the working direction of the rotor, and having only its own inertia and friction to overcome, it quickly reaches synchronous speed. The motor is now in a position to develop its full-load torque with full load current, and all that is necessary is to apply a mechanical or other brake to the external member, bringing it to rest gradually while the rotor starts and accelerates as the outer member or "spinner" comes to rest. The start can thus be made without excessive call for current and without jerk. This idea soon developed into a proposal to modify the ordinary working speed of the motor by so arranging the external member that it could be driven at any desired speed by gearing interconnecting both members, and an arrangement was worked out and patented for putting this idea into practical shape. It will be seen that by the use of a fast and loose pulley or friction clutch to transmit a part only of the power of the motor the starting can be accomplished with a very small loss of energy. This method, although serving the purpose for which it was designed and giving a useful solution of the difficulty, did not appear to be the final stage. The idea of rotating the outer member and controlling its speed suggested the idea of controlling its motion independently of gearing or other arrangements which involved disadvantageous complications, and the simple apparatus now exhibited was evolved, which entirely gets over the difficulty of starting, and gives a change of speed in either direction. In this machine the outer member or spinner is made to act as the inner member or rotor of a second motor, the stator of which embraces the spinner. The machine is thus two motors concentrically arranged round the common axis. The three speeds, which may be described as prime, secondary, and tertiary, are attained without loss of efficiency, but if intermediate speeds are desired they are obtained by a slipping brake or external resistance in each case equally with a consequent loss of efficiency. This loss of efficiency is very small, and is less than the loss involved where series-wound continuous-

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current motors are used for speed variations; or intermediate speeds may be obtained by providing a separate supply of current to the external motor and changing its speed by change of periodicity of the supply. The attainment of three speeds without any loss of efficiency in this class of motor is a very important improvement, because it at once renders it available for such work as steel-rolling mills, haulages, hoists, calendering and printing machines, lathes and boring mills, and last, and perhaps the most important of all, driving vehicles either on or off rails, including vessels on the sea.

A proposition to apply electric motors to drive a ship involves primarily a consideration of the conditions with respect to the propeller and the prime mover. Naturally, the propeller with its shaft comes first, as upon its efficiency of transformation of energy depends the size of the prime mover. It is necessary to institute a comparison for any given ship of the normal propeller as used with existing machinery, and see what are the prospects of economy by the substitution of electric transmission for the direct connection between the engine and the screw. At first sight it did not appear that any economy could be made by the introduction of two successive energy transformations in the dynamo and motor respectively to take the place of a direct transmission. The maximum possible efficiency of these two transformations with the transmission shaft is not more than about 88 per cent., while the efficiency of the direct transmission shafting is probably not less than ·95. We thus have a loss of at least 7 per cent. as a primary handicap against the proposal. This consideration may be taken as disposing of the possibility by change of transmission of any economy in ships of moderate size with slow-running propellers of upwards of 70 per cent. efficiency. If electric driving is to be introduced into such ships, it must be on other grounds than propeller economy. The case is different on coming to deal with ships in which the power is large and the propellers are run at a high speed. Such cases are becoming common in vessels driven by steam-turbines. A very short incursion into the study of propellers is sufficient to show the trend of the conditions which here emerge.

The subject has been treated in some detail in Prof. Biles's book on "The Marine Steam-Turbine," 1906, where are given the results of researches on propellers and the methods generally adopted in the design of propellers are fully explained. The causes of loss of efficiency in turbine vessels due to adopting propellers too small for the best efficiency are also discussed in the same book. A ready and convenient method of making comparisons without the detailed labour of designing groups of propellers is desirable in the present connection, and for this purpose the author has developed a method. It will be seen that for any given ship the designer who is at liberty to choose a large propeller for any given power has considerable advantage, as the efficiency may be as high as 70 per cent. and as low as 45 per cent. To say what improvement is possible in any case is by no means an easy matter, because the actual efficiency of any given propeller is often unknown, but the difference in efficiency between the probable bests, when the diameter can be changed, may be found approximately, and it is this which has been attempted. The introduction of electric drive enables one to include in the consideration all speeds of revolution of the propeller, both low and high.

In seeking for higher efficiency in the propeller, the limits imposed by practical considerations must, of course, be taken into account, such as the beam and draught of the vessel. On the other hand, the revolutions at which the propeller may be efficiently used are fixed by the diameter and pitch. While, therefore, one may have ascertained what is the possible improvement in efficiency, one must before claiming the possibility of such improvement deal with the problem with the limiting diameter of the propeller as a first element in the calculation. It is this consideration which makes any saving in propeller efficiency difficult in high-speed passenger steamers of shallow draught. The difficulty of improving the efficiency of ships of moderate size with slow-running propellers has been shown, so that the most attractive field of enterprise, from the propeller point of view, is in large ships of deep draught and high speed. Coming to the consideration of the prime mover, the scope of operations appears to be much wider. If the ship is to be electrically driven, it will probably be found that the most convenient steam prime mover will in all cases be a turbine. The limit of speed of rotation when the turbine is to be used for driving a dynamo or alternator is of a different order altogether from the limit of speed imposed upon the turbine by its direct connection to the propeller. In some cases it will be easy to adopt an increase of ten times in the speed of revolution. High speed of the turbine means high efficiency, and, therefore, the turbo-electric generator with its motors compares favourably in economy, cost, and weight with the marine steam-turbine directly connected to the propeller shaft, and, therefore, running at a speed

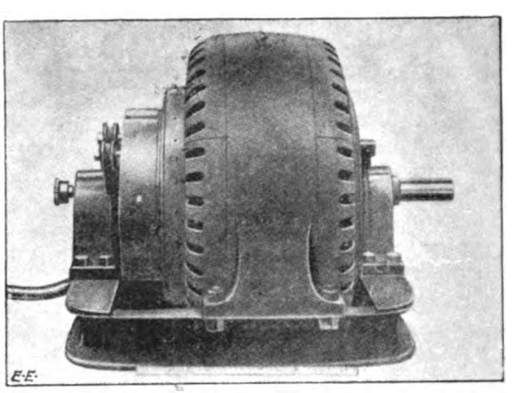

FIG. 1.

lower than that called for by considerations of steam economy in the turbine.

The reversibility and speed variability of the electric motor driven by the turbo-generator, run unidirectionally at constant speed, dispenses entirely with the objectionable heavy and costly go-astern turbines mounted on the propeller shaft. The marine steam-turbine has already fairly established its claim to economy in cases where the requirements of the propeller permit of a reasonably high speed of rotation relatively to the power used, and, therefore, a direct comparison may be made of the results to be obtained on a ship of large size driven direct by steam-turbines with what can be done by the application of electric gear. The ship has in the first case a total of 17,000 h.p. delivered to the three propellers, and a speed of 20¾ knots. The propellers are 8ft. 1½in. in diameter,

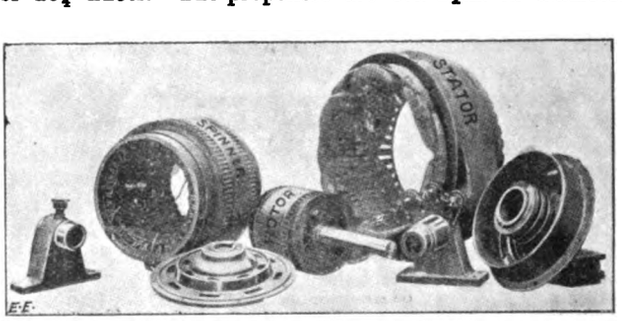

FIG. 2.

and the speed of revolution is 377 per minute. This example is worked out in detail in the appendix, and it is there shown that the maximum probable efficiency of these propellers is 62 per cent.—a figure which certainly does not err against the propeller in question. An electric equipment would permit of the use of propellers of about 14ft. diameter at 140 r.p.m., and an efficiency not less than 70 per cent.—an improvement more than sufficient to cover the loss in the electric motors. It is further to be noted that the slower-speed propellers would be free from the risks of cavitation troubles, which arise when the resistance is increased on a propeller already producing a high value of thrust per unit area. No attempt is made to put a figure on the economy emerging under this head, but its importance is evident.

Turning now to the generators, it will be found that the steam turbo-alternator, as used on land in sizes correspond-

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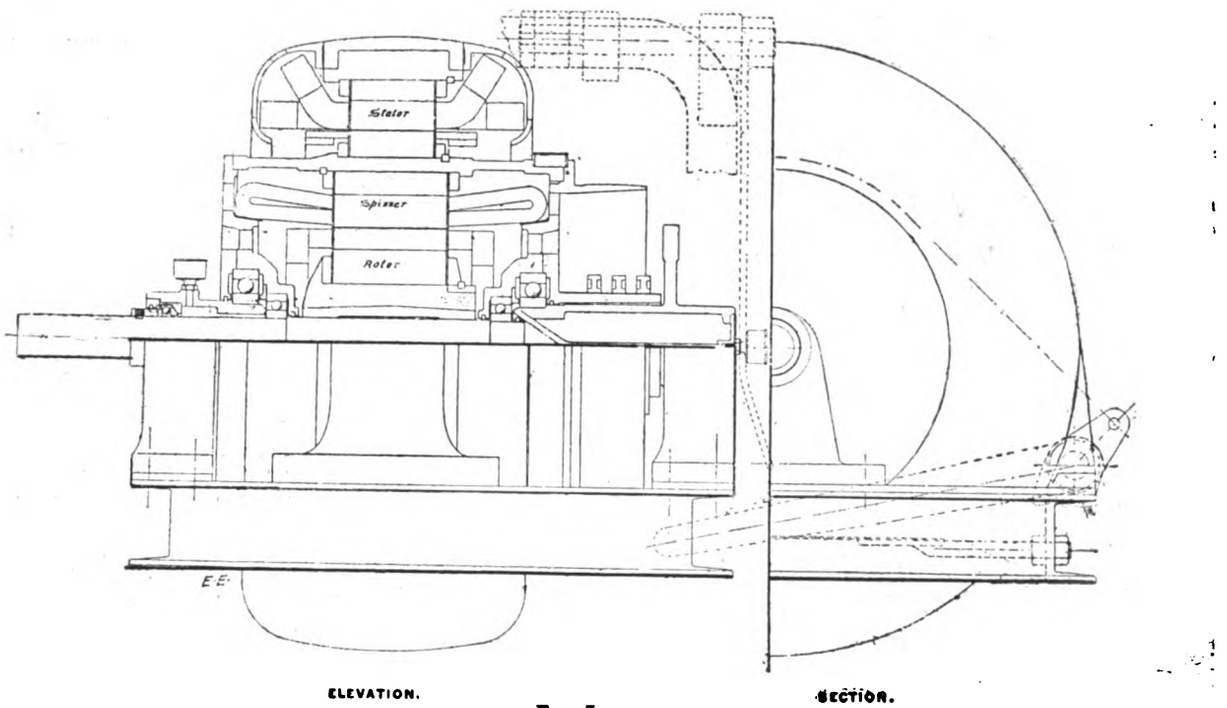
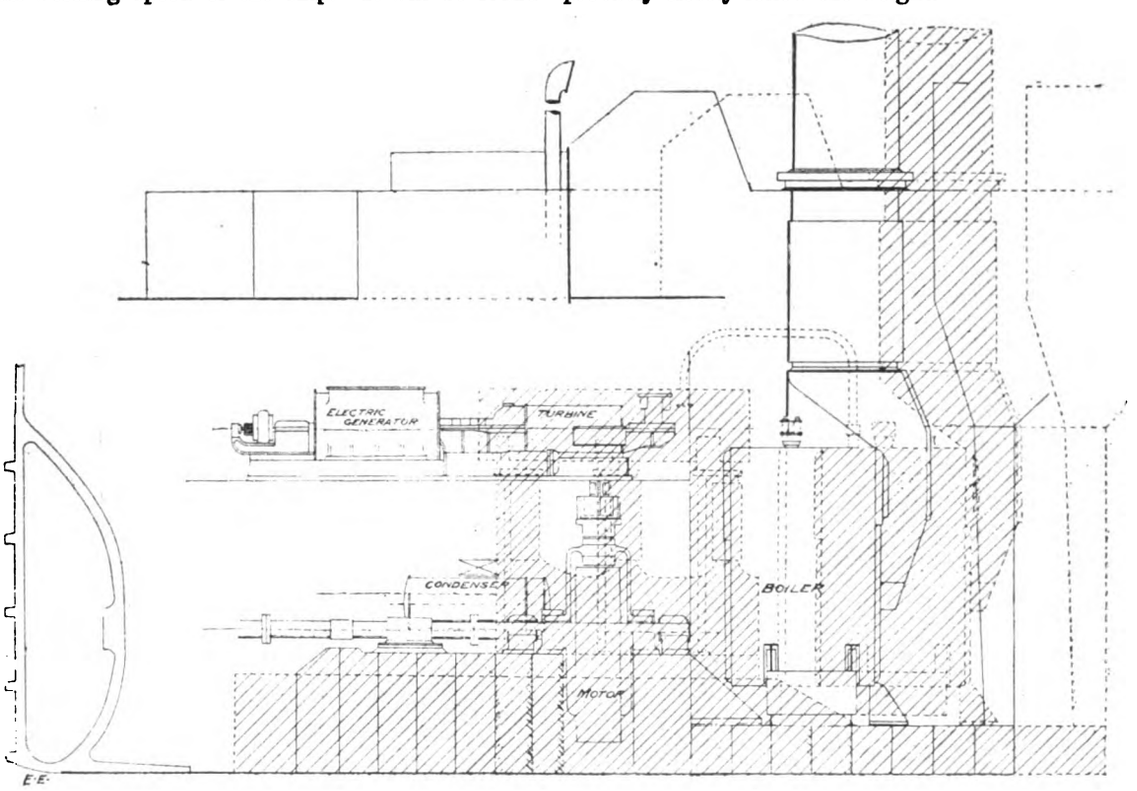
ing to those now under discussion, can deliver an electric horse-power to the motors for 12·2lb. of steam per horse-power hour, allowance having been made for all intermediate losses, and for 4 per cent. for driving auxiliaries, no superheat being used, so as to make the comparison



ELEVATION. SECTION.

FIG. 3.

with normal marine practice. This figure is startlingly lower than anything which has been touched at sea. It is for full speed and power, but the comparison must also be made at low speeds and powers, and more particularly at the normal working speed of the ship. It will be found that there is certainty of economy in this comparison, again, because of the higher speed of revolution of the turbine, which in the electric case runs at the same speed for all powers, while, of course, the direct-connected turbine must vary its speed of revolution with the speed of the ship. It is not possible to base any generally conclusive argument on these data, but there is evident encouragement to give detailed study from this standpoint to any particular case which may arise. The same limitation applies to weight and cost. In the example referred to an estimate has been made of the weight, with the result that it appears probable that the decrease in the weight of the steam equipment will more than compensate for the heavy slow-running motors and propellers, so that the weight will not be greatly changed. The cost will probably closely follow the weight.



LONGITUDINAL SECTION.

FIG. 4.

Figs. 1, 2, and 3 illustrate a small 5-h.p. model of a three-phase alternating-current "spinner' motor for ship propulsion. The motor is shown in elevation and part longitudinal section in Fig. 3. The electric current is delivered from an outside source to the primary windings of the stator and spinner respectively, passing in each case

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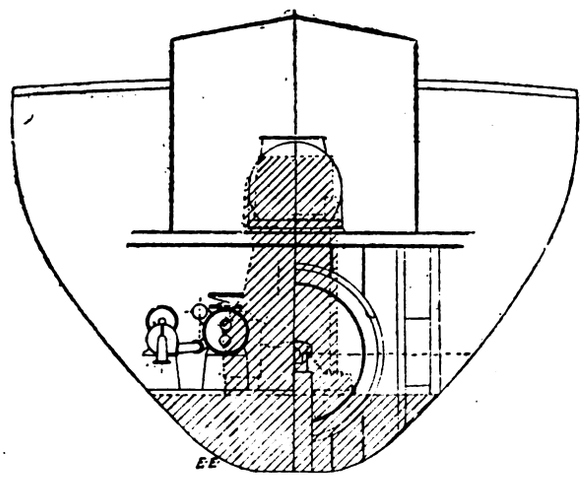
through a simple reversing switch which determines the direction of rotation. The stator circuit also supplies a magnet, which, when no current is passing, releases a brake which brings and keeps the spinner at rest. When current is passing, the magnet lifts the brake and leaves the spinner free to revolve. The three-speed motor provides a means of obtaining all the speed variations which are required on a ship. The intermediate speeds between the three normal speeds of the motor are obtained by variations in the speed of the generating plant, which are within the limits of practicability and economy. Each propeller shaft is provided with a directly connected motor on which there is coaxially superimposed a second motor for speed regulation. The regulating motor is mechanically connected and magnetically entrained with the first in such manner that the speed variation may be effected as follows: for slow speed, by running the regulating motor in the reverse direction to the direct-connected motor; for intermediate speed, by running the direct-connected motor alone, the regulating motor being stopped; for full speed, by running the regulating motor in the same direction as the direct-connected motor. This arrangement requires no spur wheels or friction gearing. Each motor is controlled by a simple reversing switch without any other mechanism, and there are no power-wasting devices.

The advantages of the adoption of this system are well illustrated in the case of a ship of 17,000 h.p. on three propellers at 21 knots maximum speed. At full speed the



CROSS SECTION
Fig. 5.

17,000 h.p. is provided by one turbo-generator of 10,000 h.p. which directly drives the direct-connected motors, and by a generator of 7,000 h.p. which drives the regulating motors, the whole plant being run at full speed and full power. When the speed is dropped from 21 knots to 18 knots the 7,000-h.p. turbo-generator is stopped, and the coal consumption per horse-power is the same at 18 knots as at full speed. When the speed is further reduced, the 10,000-h.p. may be stopped and the smaller unit again applied. It will thus be seen that, in addition to the economy obtainable at full speed, there is a very great improvement in economy at all lower speeds, owing to the possibility of choosing a suitable size of power unit for each speed. This advantage also appears in cases where the power required to drive the ship, at any given speed, is varied by the condition of weather or load; in short, the electric arrangements provide a means of approximating at all working speeds of the ship to the economy attainable on the trial trip at full speed. It is, of course, obvious that at very low speeds of the ship the economy cannot come within this region, but on the electric arrangements it is very much better than obtainable by the ordinary means.

The model has been made with ball bearings, but it is not proposed to use these in the actual machine, which will be arranged as shown in Fig. 4. The rotor circuit and the induced circuit on the spinner are permanently closed, being of what is known as the "squirrel-cage" type, the simplest of all forms of winding. Figs. 4 and 5 show the longitudinal and cross sections respectively of the engine-room arrangement of a cargo vessel fitted with reciprocating engines of about 1,200 h.p., and supplied with steam from two boilers. This ship is constructed under the patents of Mr. Henry Burrell, who has been good enough to supply the author with the drawings. The existing plant is shown in shade. The equivalent electric plant is shown in outline. The space occupied and weight are about the same in each case.

This paper is an incomplete treatment of the subject, but it may serve to elicit a discussion interesting to members of the institution and others. The author acknowledges gratefully his indebtedness to Mr. Thomas Bell, who specially directed his attention to this subject; to Prof. Biles, who has for many months lent his knowledge and experience in preliminary discussions, and who, it may be hoped, will contribute to the public discussion; also to Mr. Luke, Mr. Cleghorn, and to Dr. Caird, all of whom have taken a lively interest in these investigations and proposals.

[N.B.—We have not reproduced the appendix, which is particularly interesting to marine engineers.—Ed., *E. E.*]

THE KELVIN LECTURE.

BY PROF. SILVANUS P. THOMPSON, F.R.S.

Prof. Silvanus P. Thompson delivered the first "Kelvin Lecture" arranged by the Institution of Electrical Engineers on Thursday, April 30, the subject chosen being "The Life and Work of Lord Kelvin." Colonel R. E. B. Crompton presided. The following is a report of Prof. Thompson's lecture, which was listened to with appreciative interest by the crowded audience:

On Dec. 17, 1907, aged 83 years, died William Thomson, Baron Kelvin of Largs, president for the third time of the Institution of Electrical Engineers.

Adequately to set forth the life and work of a man who so early won and who for so long maintained a foremost place in the ranks of science were a task that is frankly impossible. The greatness of a man of such commanding abilities and such profound influence cannot rightly be gauged by his contemporaries, however intimately they may have known him. We of the present day are so essentially products of our generation, and have been brought up in modes of thought so largely moulded by him, that we cannot adequately realise how much of that which is familiar and commonplace to us is due to his genius. Whatever our appreciation of present scientific knowledge in the domain of natural philosophy, in which he was for more than half a century prominent over all others, we realise only the difficulty and imperfectly the prior state of things, and, therefore, cannot nearly discern how much of scientific progress is attributable directly to him. But if by the very circumstance that we have lived so near to him we are debarred from rightly estimating his greatness, we at least have the advantage over posterity that we have been able to speak with him face to face, to learn at first hand his modes of thought, to sit at his feet as students or disciples, to marvel at the greatness of his genius achieved before our very eyes, to learn to love him for his single-hearted enthusiasms, for his kindness of soul, his unaffected simplicity of life.

But if we may not attempt the impossible, we may at least essay the task of setting down in simple fashion some account of those things which he achieved in the profession represented by this Institution of Electrical Engineers. Let me first set down in briefest outline a sketch of his early life. William Thomson was born on June 26, 1824, in Belfast, being the second son of James and Margaret Thomson. James Thomson, who was at that time professor of mathematics in the Royal Academic Institute of Belfast, was the son of a small farmer at Ballynahinch, in co. Down, where his ancestors had settled about the year 1641, when they migrated from the lowlands of Scotland. James Thomson had early shown a taste for mathematical studies, and by study of books had mastered the art of making sundials. He had then been sent to a small school in the district to learn classics and mathematics, rising while still a youth to the position of

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assistant teacher. During the winters he followed the courses in the University of Glasgow, crossing back to Belfast for the summers to resume teaching at school.

After thus attending Glasgow University for five years he was appointed professor of mathematics in 1815 at the Belfast Academic Institute. His eldest son James (Lord Kelvin's eldest brother) was born in 1822, and William (Lord Kelvin), as already stated, in 1824 In 1830, when William was six years old, his mother died. His father would never send his boys to school, but taught them himself. In 1832, when William was eight years old, Prof. Thomson was offered the chair of mathematics at Glasgow, and he with his family of six children accordingly removed from Belfast. He was in many ways a remarkable man. He made several original contributions to mathematics and produced several sound text-books, including one on the differential and integral calculus. But his range of accomplishments was wide. He was an excellent classical scholar, familiar with both Latin and Greek, and able on occasion to give lectures in the classics to the university students. After his removal to Glasgow he still kept the education of his sons in his own hands, and so it happened that in 1834, when in his eleventh year, William Thomson matriculated as a student in the university without ever having been at school. He early made his mark by his progress in mathematics and physical science, and in 1840 produced an essay "On the Figure of the Earth," which won him the university medal. He also read Greek with Lushington, and moral philosophy. To the end of his life he was in the habit of bringing out quotations from the classic authors. His fifth year as a student at Glasgow (1839 40) was notable for the impulse towards physics which he received from the lectures of Prof. J. P. Nichol, and from those of David Thomson (a relation of Faraday), who temporarily took the classes in natural philosophy during the illness of Prof. Meikleham. In this year William Thomson had systematically studied the "Mécanique Analytique" of Lagrange and the "Mécanique Celeste" of Laplace, both mathematical works of a high order, and had made the acquaintance—a notable event in his career—of that remarkable book, Fourier's "Théorie de la Chaleur." On May 1 he borrowed it from the college library. In a fortnight he had read it completely through. The effect of reading Fourier dominated his whole career thenceforward. He took the book with him for further study during a two months' visit to Germany. During his last year (1840-41) at Glasgow he communicated to the "Cambridge and Glasgow Mathematical Journal," under the signature of "P. Q. R," an original paper "On Fourier's Expansions of Functions in Trignometrical Series," which was a defence of Fourier's deductions against some strictures of Prof. Kelland. He left Glasgow University after six years of study without even taking his degree, and on April 6, 1841, entered as a student at St. Peter's College, Cambridge. Here he speedily made his mark, and continued to contribute—at first anonymously—to the "Dublin and Cambridge Mathematical Journal" papers inspired by his study of the higher mathematics and his love for physics. The analogy of the movement of heat in conductors, along lines of flow, and across surfaces of equal temperature, with the distribution of electricity on conductors in such a way that the lines of electric force were crossed orthogonally by surfaces of equi-potential, led to his paper entitled "The Uniform Motion of Heat in Homogeneous Solid Bodies, and its connection with the Mathematical Theory of Electricity." Here was an undergraduate of seventeen handling methods of difficult integration readily and with mastery, at an age when most mathematical students are being assiduously drilled in so-called geometrical conics and other dull and foolish devices for calculus-dodging. It is true he followed the courses of coaching prescribed by his tutor Hopkins, but he could not be kept to the routine of bookwork. He also formed a close friendship with Stokes, then a young tutor, with whom, until his death in 1902, he maintained a continued interchange of ideas and suggestions in mathematical physics.

Of Thomson's Cambridge career so much has been written of late that it may be very briefly touched here. How he went up for his tripos in 1844; how he came out second wrangler only, being beaten by the rapid Parkinson; how he beat Parkinson in the Smith's Prize competition; how he rowed for his college to save Peterhouse from being bumped by Caius; how he rowed for Cambridge in the University race of 1844; how he won the Colquhoun silver sculls; how he helped to found the Cambridge University Musical Society, and played the French horn in the little orchestra which at its first concert on Dec. 8, 1843, played Haydn's "First Symphony," the overture to "Masaniello," the overture to "Semiramide," the "Royal Irish Quadrilles," and the "Elizabethen Waltzes" of Strauss! But these things, are they not written in the book of the "Cambridge Chronicle"? Once, when Lord Kelvin was in a chatty mood, I asked him point-blank how it occurred that he was not senior wrangler. His blue eyes lightened up as he proceeded to explain that Parkinson had won principally on the work of the first two days, which were devoted to text-book work rather than anything requiring analytical investigation. And then he added, almost ruefully: "I might have made up on the last two days but for my bad generalship. One paper was really a paper that I ought to have walked through, but I did very badly by my bad generalship, and must have got hardly any marks. I spent nearly all the time on one particular problem that interested me, about a spinning top being let fall on a rigid plane—a very simple problem if I had tackled it in the right way—but I got involved and lost time on it, and wrote something that was not good, and there was no time left for the other questions. I could have walked over the paper. A very good man Parkinson—I didn't know him personally at the time—who had devoted himself to learning how to answer well in examinations, while I had had—during previous months—my head in some other subjects not much examined upon—theory of heat, flow of heat between isothermal surfaces, dependence of flow on previous state, and all things I was learning from Fourier." And then he drifted off into a talk of his early papers, and to the mathematical inference (as the result of assigning negative values to the time t) that there must have been a creation. "It was," he continued, "this argument from Fourier that made me think that there must have been a beginning. All mathematical continuity points to a beginning—that is why I stick to atoms . . . and they must have been small; smallness is a necessity of the complexity. They may have all been created as they were, complexity and all, as they are now. But we know they have a past. Trace back the past and one comes to a beginning—to a time zero, beyond which the values are impossible. It's all in Fourier."

On leaving Cambridge with a college fellowship of £200 a year to maintain him, Thomson went to Paris and worked in the laboratory of Regnault at the Collège de France. He was here four months. There was no arrangement for systematic instruction, and Thomson's principal occupation was to work the air-pump to make a vacuum in one of two large glass globes which Regnault was weighing against one another in some determinations of the densities of gases. He made here the acquaintance of Biot, and of Sturm and Foucault, of whom he spoke in terms of admiration.

Thomson was now 21 years old, but had already established for himself a growing reputation for his mastery of mathematical physics. He had published about a dozen original papers, and had had experience in three universities. In 1846 the chair of natural philosophy at Glasgow became vacant by the death of Prof. Meikleham, and Thomson, at the age of 22, was chosen to fill it. His father, Prof. James Thomson, who died in 1849, still held the chair of mathematics, Prof. Thomas Thomson held that of chemistry, while Prof. Allen Thomson occupied the chair of anatomy. William Thomson was the youngest of the five Professor Thomsons then filling office in Glasgow. This professorship he continued to hold till he resigned it in 1899, after continued service of 53 years. Of his work as a university teacher this is hardly the occasion to say much; it will be fully described by his pupil and successor, Prof. Andrew Gray. The old college buildings where he lectured and worked for 24 years were ill-adapted for any laboratory facilities, yet he continued to organise a physics laboratory—the first of its kind in Great Britain—in some disused

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rooms in a dark corner of one of the quadrangles, and enlisted the voluntary service of a number of keen students in his early experimental researches on the electro-dynamic and thermo-electric properties of matter. In the lecture theatre his manifest enthusiasms won for him the love and respect of all students, even those who were hopelessly unable to follow his frequent flights into the more abstruse realms of mathematical physics. Over the earnest students of natural philosophy he exercised an influence little short of inspiration—an influence which extended gradually far beyond the bounds of his own university.

The next few years were years of strenuous work, fruitful in results. By the end of 1850, when he was 26 years of age, he had published no fewer than 50 original papers, mostly highly mathematical in character, and several of them in French. Amongst these researches there is a remarkable group which originated in his attendance in 1847 at the meeting of the British Association. He had prepared for reading at that meeting a paper on the exceedingly elegant method discovered by himself of treating certain problems of electrostatics by the method of electric images, a method even now not sufficiently well appreciated. But a more important event was the commencement of his friendship with Joule, whom he met here for the first time. Joule, a Manchester brewer, and honorary secretary of the Manchester Literary and Philosophical Society, had for several years been pursuing his researches on the relations between heat, electricity, and mechanical work, incited at first by Sturgeon into investigations on the electromagnet, and on the performance of electromagnet engines—that is, electric motors. In 1840 he had already communicated to the Royal Society a paper on the production of heat by voltaic electricity. He had also read papers at the British Association meetings: "On the Electric Origin of Chemical Heat," at Manchester in 1842; "On the Calorific Effects of Magneto-Electricity" and "On the Mechanical Value of Heat," at Cork in 1843; "On Specific Heat," at York in 1844; and "On the Mechanical Equivalent of Heat," at Cambridge in 1845. But at that date, when there was as yet no doctrine of conservation of energy, when scientific men were not accustomed to distinguish either in language or in fact between force and work, when "caloric" was classed with light and sound amongst the "imponderables," Joule's work was listened to with impatience, and his teachings fell upon deaf ears. Was he not an amateur dabbling in science, and carried away with strange notions? Joule, too, had prepared a paper for the Oxford meeting. Its title was "On the Mechanical Equivalent of Heat, as determined from the Heat evolved by the Agitation of Liquids." It was relegated to an unimportant place, and would have received as little notice as its predecessors but for Thomson's intervention. Thomson, although, in fact, he at first found difficulty in understanding its significance, threw himself heart and soul into the new and strange doctrines that heat and work were mutually convertible, and for the next six or eight years, partly in co-operation with Joule, partly independently, he set his unique powers of mind to unravel those mutual relations.

Thomson's mind was essentially metrical. He was never satisfied with any phenomenon until it should have been brought into the stage where numerical accuracy could be determined. He must measure, he must weigh, in order that he might go on to calculate. "I often say," he once remarked, "that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of *science*, whatever the matter may be. . . . The first step toward numerical reckoning of properties, more advanced than the mere reference to a set of numbered standards, as in the mineralogist's scale of hardness, or to an arbitrary trade standard, as in the Birmingham wire gauge, is the discovery of a continuously varying action of some kind, and the means of observing it definitely and measuring it in terms of some arbitrary unit or scale division. But more is necessary to complete the science of measurement in any department, and that is the fixing on something *absolutely* definite as the unit of reckoning." It was in this spirit that Thomson approached the subject of the transformation of heat. Joule had laid down on certain lines the equivalence of heat and work, and had even measured the numerical value of the equivalent. But before him, in 1824, Carnot, though he proceeded on the fallacious assumption of the material nature of caloric, had in his remarkable book, "Reflexions sur la Puissance Motrice du Feu," discussed the proportion in which heat is convertible into work, and had introduced the very valuable notion of submitting a body to a reversible cycle of operations such that, after having experienced a certain number of transformations, it is brought back identically to its primitive physical state as to density, temperature, and molecular constitution. He argued, correctly, that on the conclusion of the cycle it must contain the same quantity of heat as that which it possessed. But he argued, quite incorrectly, that the total quantity of heat lost by the body during one set of operations must be precisely compensated by its receiving back an equal quantity of heat in the other set of operations. We can see now that this is false, for if it were true, none of the heat consumed in the engine would be transformed into work. Those who were investigating the subject at this time, amongst them Clapeyron, Clausius, and Rankine, perceived this, and noted that since the steam received into the cylinder must be hotter than that expelled from it, the degree to which the transformation is successful must depend on the respective temperatures—a fact, moreover, recognised by all engineers since the date when Watt discovered the advantage of cooling the exhaust steam by a condenser. Carnot, indeed, proved that the ratio of the work done by a perfect (that is, a reversible) engine to the heat received from the source depends on the temperatures of source and condenser only; and when these temperatures are nearly equal the efficiency is expressible by the product of their difference into a certain function of either of them, called "Carnot's function." Rankine went further, in pointing out that this function was greater as the temperature in question was lower. But here Thomson's exact mind seized upon the missing essential. Temperatures had hitherto been measured by arbitrary scales based on the expansion of quicksilver, or of air or other gas, and the quicksilver thermometer scale did not agree precisely with that of the air thermometer. He was not satisfied with arbitrary scales. He had this in hand even before his first meeting with Joule, and in June, 1848, communicated to the Cambridge Philosophical Society a paper "On an Absolute Thermometric Scale founded on Carnot's Theory of the Motive Power of Heat, and calculated from Regnault's Observations." In this paper he set himself to answer the question, Is there any principle on which an absolute thermometric scale can be founded? He arrived at the answer that such a scale is obtained in terms of Carnot's theory, each degree being determined by the performance of equal quantities of work in letting one unit of heat be transformed in being let down through that difference of temperature. This indicates as the absolute zero of temperature the point which would be marked as −273deg. on the air-thermometer scale. In 1849 he elaborated this matter in a further paper on Carnot's theory, and tabulated the values of "Carnot's function" from 1deg. C. to 231deg C. Joule, writing to Thomson in December, 1848, suggested that probably the values of "Carnot's function" would turn out to be the reciprocal of the absolute temperatures as measured on a perfect gas thermometer, a conclusion independently enunciated by Clausius in February, 1850. Independently of Joule, Meyer and Helmholtz had been considering the same problems from a more general standpoint. Helmholtz's famous publication of 1847, "Die Erhaltung der Kraft" (on the conservation of force) (meaning what we now term energy), was chiefly concerned with the proposition, based on the denial of the possibility of perpetual motion, that in all the transformations of energy the sum total of all the energies in the universe remains constant. Thomson continued to work at the subject. He experimented on the heat developed by compression of air. He verified the singular prediction of his brother Prof. James Thomson of the lowering by pressure of the melting point of ice. He

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gave a thermodynamic explanation of the non-scalding property of steam issuing from a high-pressure boiler. He formulated in the years 1851 to 1854 with scientific precision in a long communication to the Royal Society of Edinburgh the two great laws of thermodynamics: (1) the law of equivalence discovered by Joule, and (2) the law of transformation, which he generously attributed to Carnot and Clausius. Clausius, indeed, had done little more than put into mathematical language the equation of the Carnot cycle, connected by the arbitrary substitution of the reciprocal of the absolute temperature, but Thomson never was grudging of the fame of independent discoverers. "Questions of personal priority," he wrote, "however interesting they may be to the persons concerned, sink into insignificance compared with the importance of the making of real advance in our knowledge of the secrets of Nature." He gave demonstration of the second law, founding it upon the axiom that it is impossible by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects. Further, by a most ingenious use of the integrating factor to solve the differential equation for the quantity of heat needed to alter the volume and temperature of unit mass of the working substance, he gave precise mathematical proof of the theorem that the efficiency of the perfect engine working between given temperature is inversely proportional to the absolute temperature. In collaboration with Joule he worked at the thermal effects of fluids in motion, the results appearing between the years 1852 and 1862 in a series of four papers in the *Philosophical Transactions* and four in the *Proceedings* of the Royal Society. Thus were the foundations of thermodynamics laid. This brilliant development and generalisation of a subject that had grown with startling rapidity (from the moment when Helmholtz denied perpetual motion and Thomson grasped the conception of the absolute zero) did not content Thomson: he must follow its applications to human needs and to the cosmic consequences it involved. And so he not only suggested the process of refrigerating by the sudden expansion of compressed cooled air, but propounded the doctrine of the dissipation of energy. If the availability of the energy in a hot body be proportional to its absolute temperature, it follows that as the earth and the sun—nay, the whole solar system itself, cool down toward one uniform level of temperature, all life must perish, and all energy become unavailable. This far-reaching conclusion once more suggested the question of a beginning—a question which, as already remarked, had arisen in the consideration of the Fourier doctrine of the flow of heat.

In 1852, at the age of 28, William Thomson married Margaret Crum, and resigned his Cambridge fellowship. The happiness of his life was, however, shadowed by his wife's precarious health necessitating residence abroad at various times. In the summer of 1855 they stayed at Kreutznach, from which place Thomson wrote to Helmholtz inviting him to come to England in September to attend the British Association meeting at Glasgow. He assured Helmholtz that his presence would be one of the most interesting events of the gathering, so that he hoped to see him on this ground, but also looked forward with the greatest pleasure to the opportunity of making his acquaintance, as he desired this ever since the "Conservation of Energy" had come into his hands. Accordingly, on July 29, Helmholtz left Königsberg for Kreutznach to make the acquaintance of Thomson before his journey to England. On Aug. 6 he wrote to Frau Helmholtz that Thomson had made a deep impression on him.

Hitherto Thomson's work had been mainly in pure science, but towards the end of the fifties, while still in the midst of thermodynamic studies, events were progressing which drew him with irresistible force toward the practical applications that made him famous. Early in 1853 he had communicated to the Glasgow Philosophical Society a paper on "Transient Electric Currents," in which he investigated mathematically the discharge of a Leyden jar through circuits possessing self-induction as well as resistance. Faraday and Riess had observed that in certain cases the gases produced by the discharge of sparks through water consisted of mixed oxygen and hydrogen, and Helmholtz had conjectured that in such cases the spark was oscillatory. Thomson determined to test mathematically what was the motion of electricity at any instant after making contact in a circuit under given conditions. He founded his solution on the equation of energy, ingeniously building up the differential equation and then finding the integral. The result was very remarkable. He discovered that a critical relation occurred if the capacity in the circuit was equal to four times the coefficient of self-induction divided by the square of the resistance. If the capacity was less than this the discharge was oscillatory, passing through a series of alternate maxima and minima before dying out. If the capacity was greater than this the discharge was non-oscillatory, the charge dying out without reversing. This beautiful bit of mathematical analysis, which passed almost unnoticed at the time, laid the foundation of the theory of electric oscillations, subsequently studied by Oberbeck, Schiller, Hertz, and Lodge, and forms the basis of wireless telegraphy. Feddersen, in 1859, succeeded in photographing these oscillatory sparks, and sent photographs to Thomson, who with great delight gave an account of them to the Glasgow Philosophical Society.

At the Edinburgh meeting of the British Association in 1854 Thomson read a paper "On Mechanical Antecedents of Motion, Heat, and Light." Starting with some now familiar but then novel generalities about energy, potential and kinetic, and about the idea of stores of energy, the author touched on the source of the sun's heat and the energy of the solar system, and then reverted to his favourite argument from Fourier, according to which, if traced backwards, there must have been a beginning to which there was no antecedent. This was a non-mathematical exposition of work which, as his notebooks show, had been going on from 1850 in a very stiff mathematical form, in which Fourier's equations for the flow of heat in solids were applied to a number of outlying problems involving kindred mathematics, including the diffusion of fluids and the diffusion or transmission of electric signals through long cables. The *Proceedings* of the Royal Society for 1854 contain the investigation of cables under the title "On the Theory of the Electric Telegraph." Faraday had predicted that there would be retardation of signals in cables owing to the coating of guttapercha acting like the glass of a Leyden jar. Forming the required differential equation and using Fourier's integration of it, Thomson drew the conclusion that the time required for the current at the distant end to reach a stated fraction of its steady value would be proportional both to the resistance and to the capacity; and as both of these are proportional to the length of the cable, the retardation would be proportional to the square of the length. This is the famous law of squares, about which so much dispute arose. This was followed by a further research, "On Peristaltic Induction of Electric Currents," communicated to the British Association in 1855, and afterwards in more complete mathematical form to the Royal Society.

(*To be continued.*)

JOHANNESBURG GAS-ENGINE POWER PLANT.

After a very protracted discussion the Johannesburg Town Council decided to refer back for further consideration an agreement proposed by the Tramways and Lighting Committee between the Council and Messrs. J. and W. Beardmore for the latter to take over the Council's undertaking (including the gas-engine plant), to erect a new station, and to give a bulk supply to the Corporation.

Under the proposed agreement the Council sell to Messrs. Beardmore all the plant supplied by and through Messrs. D. Stewart and Co., Limited, and certain foundations on which the plant is erected, along with certain accessories. Messrs. Beardmore are to pay as purchase price £175,000, payable £50,000 in cash and £125,000 in first mortgage debentures of a company to be formed by Messrs. Beardmore and referred to as "the lighting com-

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pany," the debentures to be secured by way of a first charge on the property and assets of that company, and forming a part of a total debenture issue of 2,500 of £100 each of the lighting company, carrying interest at 4 per cent. The company shall not without the consent of the Council be at liberty to create any charge on any of its property in priority to such debentures. Fifty of the total number of debentures shall be redeemed in each year by annual drawings commencing at the expiration of five years after the company's registration and continuing till 21 years after the date thereof, when the whole of the principal should be due and payable.

Simultaneous with the purchase by Messrs. Beardmore the Council shall grant them a lease of the site where the plant now is, together with all the generating and power station plant, excluding, however, the Council's lighting and traction feeder automatic switches, through which energy is supplied to the distributing cables. The period of the lease shall be 21 years, and the rent payable to the Council shall be £3,856 per annum, the lease providing for cancellation at the option of the Council in case of default in payment of rent three months after becoming due. Messrs. Beardmore shall be responsible for and indemnify the Council against the occurrence of any nuisance arising from the working of the plant, and shall also have the right within one year of the purchase to lease an additional adjoining piece of ground, in extent 1·25 acres, at a rental of £160 per annum. All rates levied by the Council in respect of the interest of Messrs. Beardmore in the property leased to them shall be paid by the firm, which within six months from the purchase shall put the plant into efficient and satisfactory working order so as to comply with the conditions as to output, etc., contained in the old contract with Messrs. Stewarts, or in any case furnish an output within 25 per cent. of the output stipulated in that contract. The work of putting the plant into satisfactory working order shall be completed within two years from the purchase, and if Messrs. Beardmore fail to do so they shall provide sufficient auxiliary steam or gas plant sufficient to fulfil the Council's requirements for power and light.

The Council will contract with Messrs. Beardmore, nine months after the ratification of the agreement, to take energy for light and power up to 10,000,000 units per annum, and pay for the same at the rate of 1¼d. per unit, the contract to continue for 10 years. If the Council's requirements exceed 10,000,000 units Messrs. Beardmore shall supply it. The Council shall pay for a minimum annual supply of 8,000,000 units notwithstanding that the actual requirements may fall below that figure. The balance of payment for minimum supply shall be ascer tained at the end of each 12 months during the continuance of the contract for supply or any extensions thereof on the basis of 1¼d. per unit for the number of units by which the total actual supply falls below the minimum which the Council are required to pay for. The supply shall be given and taken at the lighting and traction 'bus-bar sections of the switchboard, and shall for the purposes of traction be by continuous current at a pressure of not less than 550 volts; the supply for other purposes than traction being by continuous or alternating current as the Council may require at a pressure the Council shall deem advisable, the variation either plus or minus not to exceed 2½ per cent. Damages due to the raising of the pressure shall be made good by Messrs. Beardmore. All meters are to be open to the inspection of the Council.

In the case of interruption or diminution of the pressure—unless due to causes beyond the control of Messrs. Beardmore—the following penalties are prescribed: (*a*) In the case of energy supplied to the lighting feeder 'bus bars (1) during the hours between 7 a.m. and midnight for any interruption or diminution exceeding five seconds the sum of £5, and in addition 2s. 6d. for each of the first 10 minutes, and 10s. for each minute or portion thereof; (2) during the hours between midnight and 7 a.m., for any interruption or diminution exceeding five seconds £1, and in addition 2s. 6d. per minute up to 10 minutes, and 10s. for every minute thereafter. (*b*) In case of energy supplied to the traction feeder 'bus bars at any time, for an interruption or diminution exceeding 2½ minutes £5, and in addition 2s. 6d. for each of the next 10 minutes, and 10s. for each minute or portion of a minute thereafter. These penalties shall be deducted from the monthly payments to be made by the Council.

At the expiration of 10 years from the commencement of the supply the Council shall have the right to purchase from Messrs. Beardmore the plant and so much of additional plant as will be requisite for its requirements provided that the Council shall not be bound (*a*) in the case of the purchased plant to purchase the same or any part which has not been in an efficient state during the preceding six months; (*b*) in the case of any other plant to purchase any portion which has not been in efficient condition in the last six months.

The price of purchase is to be fixed by arbitration, and no consideration shall be paid for goodwill, and Messrs. Beardmore shall accept at par value as many debentures of the lighting company originally taken by the Council in part purchase payment as the Council may then be holding. In case the Council do not exercise their right to purchase, Beardmore's are entitled to an extension of the contract with the Council for five years, the price to be fixed by agreement, failing which arbitration to be employed, and the price in no case to exceed 1¼d. per unit. If the plant is not working efficiently at the time, the Council shall not be bound to enter into any contract unless there is other plant on the site capable of supplying the municipal requirements, or unless Beardmore's are in a position to supply the requirements from plant leased to them by the Council. If the contract is extended, the Council shall have the same rights to purchase as at the end of the first 10 years. If at the end of the five years the Council do not exercise their right of purchase, Beardmore's shall be entitled to a further extension of the contract for six years. After the expiration of five years, and before the expiration of nine years, the Council shall have the right to take over the entire plants for a sum equal to the amount of capital expended by the Beardmore's in the purchase of the plant and in the erection thereof, and, in addition, a sum equal to 5 per cent. per annum of such capital outlay for the period calculated from the date of the purchase to the date of the expiration of the 10 years, to be paid by way of compensation for loss of profit during such period. In the event of a constantly recurring default—involving stoppages or diminutions exceeding the margin allowed—the Council have the right to cancel the contract.

If the Council do not purchase the plant as provided above, Beardmore's have the right to purchase the whole of the ground, buildings, and accessories forming the subject of the lease at a price to be fixed by arbitration. The firm has also the right to supply energy to the mines in the municipal area and to the C.S.A.R, but not to other consumers. They shall also treat the tar up to 500 gallons per day so that it shall not contain more than 6 per cent. of water, and the Council shall purchase it at 8d. per gallon, the Council having the right to purchase all the tar produced by Beardmore's other stations. The lighting company referred to above shall have a subscribed working capital of at least £25,000, and the articles of association are to be approved by the Council, the company being formed to take over all obligations and liabilities of the Beardmore's to the Council, and shall take a first mortgage debenture issue of £250,000, and debentures to a face value of £125,000 shall form part of the price of the purchased plant. The Beardmore's are also to form another company—the power company—with a subscribed working capital of £200,000, of which not less than £50,000 shall be paid up on allotment, the objects of the company including the guarantee of the obligations of the lighting company and the erection and equipment of an electric station in the Transvaal, but the company shall not have power to supply others than the lighting company, the mines in the town area, or the C.S.A.R. with power. If the company make a debenture issue or charge its assets, it shall issue to the Council as security debentures for the sum of £150,000 secured on the whole of its assets. A nominee of the Council shall have a seat on the directorate of the power company, and the Council shall give facilities to the company for laying cables, etc., in the streets of Johannesburg.

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Messrs. David Gilmour and A. C. Holtby, who were consulted on the matter, have reported favourably on the agreement, which is to be discussed by the Council at a later meeting.

TRANSATLANTIC WIRELESS TELEGRAPHY.*

BY G. MARCONI.

(Continued from page 629.)

Turning again to Newfoundland, I ought to add that the experiments could not be continued or extended in consequence of the hostile attitude of the Anglo-American Telegraph Company, which claimed all rights for telegraphy, whether wireless or otherwise, in Newfoundland. However, as I had received an offer of assistance from the Canadian Government, it was decided to resume the tests between Great Britain and Canada, and these tests were very greatly facilitated by the subsidy of £16,000 granted by the Canadian Government to support my experiments. The construction of another long-distance station was, therefore, commenced at Glace Bay, in Nova Scotia, and very extensive tests and experiments were carried on with Poldhu during the latter part of 1902. Contemporaneously with the construction of the station at Glace Bay, alterations and modifications were executed at Poldhu. Four wooden lattice towers, each 210ft. high, were erected at the corners of a square of 200ft. side. The towers carried insulated triatic stays from which was suspended a conical arrangement of 400 copper wires forming the aerial, put up in sections so that more or less could be employed (Fig. 8).

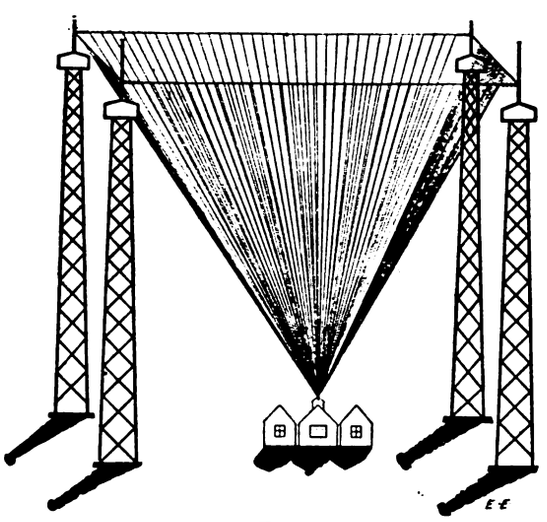

FIG. 8.

The buildings for the generating plant were placed in the middle of the space between the towers. Additional machinery was obtained, and alterations carried out in accordance with the experience obtained from previous tests. Identical towers and aerial arrangements were at that time adopted at the stations at Glace Bay and at the similar installation in course of erection at Cape Cod, Mass. In most of the experiments carried on from Poldhu the capacity of the sending condenser was one-thirtieth of a microfarad, the spark length 1¾in., and the wave-length 3,600ft. In these and subsequent tests the double condenser arrangement of Dr. Fleming was replaced by a single condenser, the arrangement being similar to that shown in Fig. 3.

During the time that constructional work was in progress at Glace Bay I carried out some tests with Poldhu over considerable distances, and these tests were greatly facilitated by the interest taken in them by the Italian Government, which placed the cruiser "Carlo Alberto" at my disposal. During these experiments the interesting fact was observed that, when using waves of over 1,000m. in length, intervening land or mountains do not bring about any considerable reduction in the distance over which it is possible to communicate. Thus messages and Press dispatches were received from Poldhu at the positions marked on the map 9, which map is a copy of the one accompanying the official report of the experiments.† In December, 1902, messages were for the first time exchanged at night between the stations at Poldhu and Glace Bay, but it was found that communication was exceedingly difficult and unreliable from England to Canada, whilst it was good in the opposite direction. The reason for this is that the Glace Bay station was equipped with more powerful and more expensive machinery—a condition rendered possible by the subsidy granted by the Canadian Government; whilst, as regards Poldhu, owing to the uncertainty of what might or might not be the attitude of the British Government at that time towards the working of the station, my company was unwilling to expend large sums of money for the purpose of increasing its range of transmission. As, however, messages could be sent then for the first time by wireless telegraphy from Canada to England, inaugural messages were dispatched to the sovereigns of England and Italy, both of whom had previously given me much assistance and encouragement in my work, and who, by their gracious replies, attested their appreciation of the results which had been achieved. Other messages were also sent to England by the Government of Canada. I should, perhaps, mention that officers delegated by the Italian Government, and a representative of the London *Times*, were present at the transmission of the messages.

Further tests were shortly afterwards carried out with the other long-distance station at Cape Cod in the United States of America, and a message from President Roosevelt was transmitted from that station to his Majesty the King in London. It is curious to note in regard to the transmission of this message that the energy employed at Cape Cod was barely 10 kw., and it was not anticipated that this amount of energy would be sufficient to carry direct to Poldhu. The message was, therefore, transmitted from Cape Cod, instructions having been given to the operators at Glace Bay to be on the look-out, and to repeat wirelessly on to Poldhu any message received from Cape Cod, and my assistant, Mr. J. P. Woodward, at Poldhu took in the message on one of my magnetic detectors.* The electromagnetic waves conveying this message travelled, therefore, 3,000 miles through space over the Atlantic, which distance included about 500 miles of land, following an arc of 45deg. on a great circle. In the spring of 1903 the transmission of news messages from America to the London *Times* was attempted, in order to demonstrate that messages could be sent from

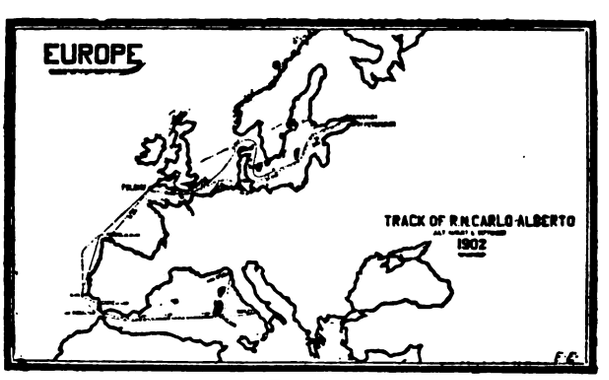

FIG. 9.

America by means of the new method, and for a time these messages were correctly received and published in that newspaper. By reference to the files of the *Times*, I find that 267 words of news transmitted across the Atlantic by wireless were published in the London *Times* during the latter part of March and the early part of April of that year. A breakdown in the insulation of the apparatus at Glace Bay made it necessary, however, to suspend the service, and, unfortunately, further accidents made the transmission of messages uncertain and unreliable. In consequence of this, it was decided not to attempt for the time being the transmission of any more public messages until such time as a reliable service could be maintained in both directions under all ordinary conditions.

As I found that many improvements evolved during the course of the numerous tests and experiments could not be readily applied to the plants at Poldhu and Cape Breton, it was decided to erect a completely new long-distance station in Ireland, and to transport the one at Glace Bay to a different site in the vicinity, where sufficient land was available for experimenting with aerials of much larger dimensions than had been hitherto employed. Experiments were, however, continued with Poldhu, and in October, 1903, it became possible to supply the Cunard steamship "Lucania," during her entire crossing from New York to Liverpool, with news transmitted direct from the shore. In November of the same year tests similar to those carried out with the Italian cruiser took place on behalf of the British Admiralty between Poldhu and H.M.S. "Duncan. Communication with Poldhu was maintained during the entire cruise of this battleship from Portsmouth to Gibraltar, and further communication was established between Poldhu and the Admiralty station situated on the Rock of Gibraltar. It should be noted that the distance between Cornwall and Gibraltar is 1,000 miles—500 over land and 500 over water. The aerial at Poldhu was shortly afterwards

* Lecture given before the Royal Institution, Friday night, March 13, 1908.

† *Rivista Marittima*, Rome, October, 1902.

* *Proceedings* of Royal Society, "Note on a Magnetic Detector of Electric Waves which can be employed as a Receiver for Space Telegraphy," vol. 70, p. 341.

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extended by the addition of wires sloping downwards, umbrella fashion, as shown in Fig. 10. This increased the capacity of the aerial, and some further tests were carried out with a station at Fraserburgh, in the North of Scotland. From these tests considerable advantage appeared to be derived, at least for communication over land, by the adoption of much longer waves than had been hitherto employed, and with a wave-length of 14,000ft. it was found possible to telegraph over a distance of 550 miles with an expenditure of energy of about 1 kw.

The operation of the long-distance stations in England and America made it possible to transmit messages to ships, whatever their position, between Europe and North America, and to the Cunard Company belongs the credit of having greatly

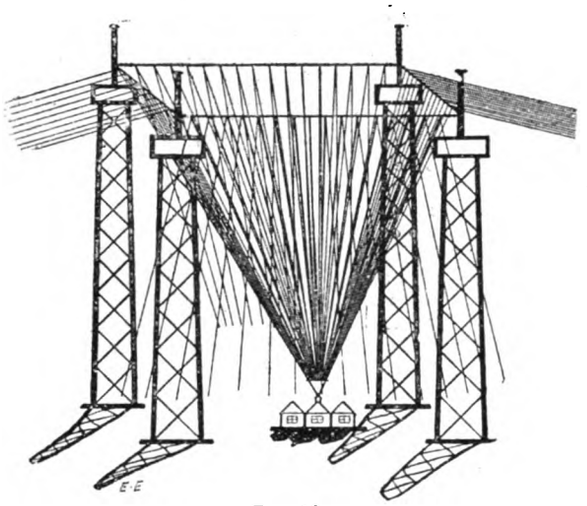

FIG. 10.

encouraged the long-distance tests, a circumstance which enabled them to commence in June, 1904, the regular publication on their principal vessels of a daily newspaper, containing telegraphic messages of the latest news from Europe and America. This daily newspaper has now been adopted by nearly all the large liners plying to New York and the Mediterranean, and it obviously owes its entire existence to long-distance wireless telegraphy. Therefore, the tranquility and isolation from the outside world, which it is still possible to enjoy on board of some ships, is rapidly becoming a thing of the past. But, however much travellers may sigh over the innovations which have lately been brought about, they seem anxious enough to avail themselves of the new method of communication on all possible occasions.

Early in 1905 the construction of the new station at Glace Bay was sufficiently advanced to allow of preliminary tests being carried out. The aerial was very large, and consisted of a vertical portion in the middle 220ft. long supported by four towers and attached to horizontal wires, 200 in number, each 1,000ft. long, extending radially all round, and supported at a height of 180ft. from the ground by an inner circle of eight and an outer circle of sixteen masts (Fig. 11). The natural period of oscillation of this aerial gave a wave-length of 12,000ft.

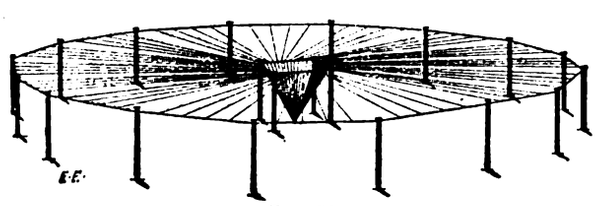

FIG. 11.

The capacity employed was 1·8 microfarads, and the spark length ¾in. Signals and messages from this station were received at Poldhu by day as well as by night, but no commercial use of the station was made at that time, in consequence of the fact that, although signals came through by day as well as by night, they were exceedingly weak and faint, and also because the corresponding station on the same plan had not yet been erected in Ireland. A further step in advance was the adoption at the Transatlantic stations of the directional aerial shown in Fig. 12. *The ordinary wireless telegraph aerials, which I have already described, send out electric radiation equally in all directions. This is, however, in many cases a disadvantage. Many suggestions respecting methods for limiting the direction of radiation have been made by various workers, notably by Messrs. Arton, Braun, and Bellini Tosi. In some of my earliest experiments, in 1896, I used copper mirrors, by the aid of which it was possible to project a beam of electric radiation in a certain direction, but I soon found that this method would only work over short distances.

About three years ago I again took up the subject, and was able to determine that by means of horizontal aerials, disposed in a particular manner, it was possible to confine the effects of electric waves mainly to certain directions as desired. True, the limitation of transmission to one direction is not very sharply defined, but it is, nevertheless, very useful. The practical result of this method has been so far that messages can be sent over considerable distances in the desired directions, while they travel only over a comparatively short distance in other directions, and that with aerials of moderate height greater efficiency in a given direction can be obtained than can be obtained all round by means of the ordinary aerials. When this type of aerial was adopted at Glace Bay a considerable strengthening of the received signals at Poldhu was noticed. It was, therefore, decided to adopt the directional aerial at all long-distance stations. A further improvement introduced at Clifden and Glace Bay consisted in the adoption of air condensers, com-

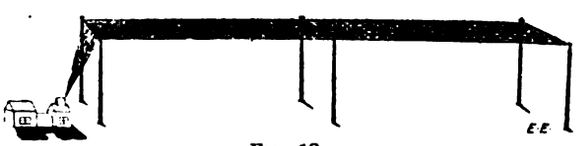

FIG. 12.

posed of insulated metallic plates suspended in air at ordinary pressure. In this manner it is possible to prevent the dissipation of energy due to losses caused by the dielectric hysteresis in the glass dielectric of the condensers previously employed; and a very appreciable economy in working, resulting from the absence of breakages of the dielectric, is effected. These air condensers, which have been in use since May of last year, have been entirely satisfactory. After very considerable delay and expense the new station at Clifden was got ready for tests by the end of May, 1907, and experiments were then commenced with Glace Bay. I ought to say that in the constructional and experimental work carried out at the Canadian station I have received valuable assistance from Mr. R. N. Vyvyan; and at Poldhu and Clifden Mr. W. S. Entwistle has assisted me in carrying out much original research work, required in the designing of novel apparatus necessary for long-distance transmission. Mr. P. J. Woodward has likewise rendered me valuable help in the receiving arrangements, and has on nearly every occasion been in charge of the receiving apparatus during the initial long-distance tests. I must also add that I have, for many years, had the benefit of the advice of Dr. J. A. Fleming, of the University of London, whose experience on all matters dealing with high-tension work and

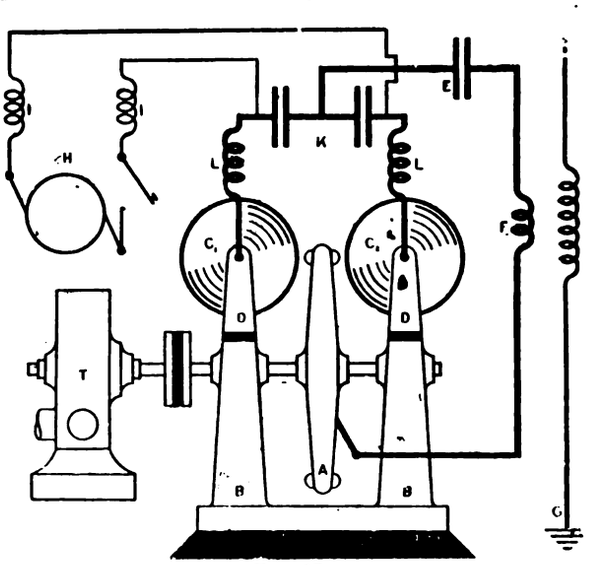

FIG. 13.

electrical oscillations is universally acknowledged. The wave-length used during these tests was 12,000ft., the capacity employed 1·6 microfarads, and the potential to which the condenser was charged 80,000 volts. Good signals were obtained at Cape Breton from the very commencement of the tests, but some difficulty was encountered in consequence of the effects of atmospheric electricity due to the prevalence of thunderstorms in the eastern part of Canada during the first few days of the tests.

Simultaneously with these tests others were carried out from Poldhu to Glace Bay with a new system of transmitting apparatus, by means of which continuous or semi-continuous oscilla-

* "On Methods whereby the Radiation of Electric Waves may be mainly confined," etc., *Proceedings* of the Royal Society, G. Marconi, annual vol. 77, 1906.

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tions could be produced. Proportionately to the energy employed, the signals from Poldhu were so much better than those from Clifden that I decided at once to adopt this new method of transmission at Glace Bay and Clifden. The apparatus which I have been using for producing continuous or closely adjacent trains of electric oscillations is as follows:* A metal disc, A (Fig. 13), insulated from the earth is caused to rotate at a very high speed by means of a high-speed electric motor or steam turbine. Adjacent to this disc, which I shall call the middle disc, are placed two other discs, C1, C2, which may be called polar discs, and which also can be rotated at a high rate of speed. These polar discs should have their peripheries very close to the surface or edges of the middle disc. If a small amount of energy is used, stationary knobs or points may be used in place of the side discs. The two polar discs are connected respectively through suitable brushes to the outer ends or terminals of two condensers, K, joined in series, and these condensers are also connected through suitable inductive resistances to the terminals of a generator, which should be a high-tension continuous-current dynamo. On the high-speed or middle disc a suitable brush or rubbing contact is provided, and connected between this contact and the middle point of the two condensers is inserted an oscillating circuit consisting of a condenser, E, in series with an inductance, which last is connected inductively or conductively to the aerial. If the necessary conditions are fulfilled, and a sufficient E.M.F. is employed, a discharge will pass between the outer discs and the middle disc, which discharge is neither an oscillatory spark nor an ordinary arc, and powerful oscillations will be created in the signalling condenser, E, and oscillatory circuit, F.

I have found that in order to obtain good effects a peripheral speed of over 100m. per second is desirable; therefore, particular precautions have to be taken in the construction of the discs. Electrical oscillations of a frequency as high as 200,000 per second can be obtained. The apparatus which I have had so

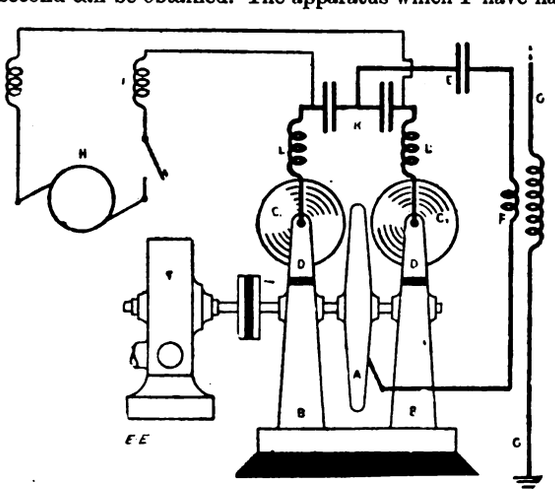

FIG. 14.

far constructed is on a large scale, and unsuitable for demonstrations in a lecture hall. I hope, however, very soon to be able to show before some scientific society the effects produced. The apparatus works probably in the following manner: Let us imagine that the source of electricity is gradually charging the double condenser and increasing the potential at the discs, say C1 positively and C2 negatively; at a certain instant the potential will cause the charge to jump across one of the gaps, say between C2 and A. This will charge the condenser E, which will then commence to oscillate, and the charge in swinging back will jump from A to C1, which is charged to the opposite potential. The charge of E will again reverse, picking up energy at each reversal from the condensers K. The same process will go on indefinitely, the losses which occur in the oscillating circuit, E F, being made good by the energy supplied from the generator, H. If the disc is not rotated, or rotated slowly, an ordinary arc is at once established across the small gaps, and no oscillations take place. The efficient cooling of the discharge by the rapidly-revolving disc seems to be one of the conditions necessary for the production of the phenomena. By means of this apparatus tests were carried out, but it was found, as was to be expected, that the oscillations were too continuous and of too high a frequency to affect a receiver, such as the magnetic detector, unless an interrupter was inserted in one of the circuits of the receiver. A syntonic coherer receiver would, however, work, in consequence no doubt of the considerable rise of potential which occurred at its terminals through the cumulative effect of resonance.

The best results over long distances have, however, been obtained by a disc as shown in Fig. 14, in which the active surface is not smooth, but consists of a number of knobs or pegs at the end of which the discharges take place at regular intervals. In this case, of course, the oscillations are not continuous, but consist of a regular succession of trains of undamped or slightly damped waves. In that manner it is possible to cause the groups of oscillations radiated to reproduce a musical note in the receiver, distinguishable in a telephone, and thereby it is easier to differentiate between the signals emanating from the transmitting station and noises caused by atmospheric electrical disturbances. By this method very efficient resonance can, moreover, be obtained in appropriately designed receivers. A few tests with apparatus based on the principle described were caried out between Glace Bay and Clifden, and on Oct. 17 of last year a limited service for Press messages was commenced between Great Britain and America. Difficulties were experienced, however, over the question of rates with the telegraph companies working the land lines between Glace Bay and the principal towns of Canada and the United States, and at present the strange anomaly exists that the rates for Press messages on the American land lines are much cheaper for messages going from England to New York than in the reverse direction. On Feb. 3 this service was extended to ordinary messages between London and Montreal.

(To be continued.)

* Patent application No. 20,119, Sept. 9, 1907.

"OVER SHOOTING": A NEW OBSERVATION ON TUNGSTEN INCANDESCENT LAMPS.

BY JOHN B. TAYLOR.

An article dealing with this subject recently appeared in our New York contemporary, the *Electrical World*, from which we reproduce the following:

The filament in the well-known carbon incandescent lamp has a negative temperature-resistance coefficient. That is to say, an increase of voltage gives a more than corresponding increase of current, and when connected to a source of constant potential, the current starts at a comparatively low value and increases to a maximum when the lamp has reached full candle-power. The filament in the tungsten incandescent lamp, on the other hand, has a positive temperature-resistance coefficient, which is equivalent to saying that an increase in voltage increases the current in a smaller proportion, and when connected to a constant-potential supply the current is greatest while the lamp is cold and falls off to its final value as the lamp comes up to full brilliancy. The most noticeable effect due to these different characteristics is the fact that a tungsten lamp comes up to full candle-power almost instantly, while a carbon incandescent lamp reaches full brilliancy only after a plainly noticeable interval of time.

The quicker response of the tungsten lamp on closing the circuit is a matter of common observation, and has been previously thoroughly discussed. Soon after installing one or two tungsten lamps the writer had the impression that the lamps "over shot" for a brief fraction of a second, after closing the switch. That is to say, if the lamp normally gave 40 c.p. for the brief fraction of a second, the candle-power was greater—for the sake of an argument, let us say 50 c.p. This apparent temporary increase of candle-power was called to the attention of a number of people, and it was then found that others had received the same impression, but in general had ascribed it to some physiological action connected possibly with the slow contraction of the retina of the eye, due to the suddenness of the light. This explanation did not seen satisfactory, as, if correct, similar impressions should be a matter of common experience. For example, a rapidly moving railroad train brings the observer suddenly into light of an incandescent lamp or arc lamp, and while this light may be dazzling, there is no impression of "over shooting." While endeavouring to check this impression with a tungsten lamp, it appeared that the "over shooting" effect was most noticeable if the lamp was cold before closing the switch. If a tungsten lamp is turned out, and then lighted again within a second or two, the "over shooting" effect is not noticeable. This impression was also checked by others.

In order to demonstrate definitely whether such "over shooting" is a physical or physiological fact, the light from a tungsten lamp was allowed to fall on a moving photographic film so that any variation or "over shooting" of light would give a corresponding change in opacity of the

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photographic film. This test was very easily made by taking a film drum and holder of the standard General Electric oscillograph and placing the same in a screw cutting lathe. A piece of cardboard with $\frac{1}{8}$in. slit was fastened to the tool post so that the travel of the lathe carriage caused this slit to move across the slit in the film holder. By this means the velocity of the film and the cross travel of the slit were very easily arranged without any special apparatus, and test was made on tungsten lamps of different voltage and candle-power as well as on carbon incandescent lamps for the sake of comparison. The development of the film demonstrated definitely that for a period of the order of one-tenth of a second, the light coming from the lamp is greater than normal. It could also be noticed that the test was made on an alternating 60-cycle circuit, and the alternate heating and cooling of the filament for each alternation is made evident by the striations.

Some little experimenting may be required to obtain the exposure that will make this phenomenon most plainly evident. It is believed that what might be termed an "under exposure," by placing the light some distance from the film, and somewhat prolonged development will make the contrast between the light and dark parts of the record more pronounced. The explanation of this phenomenon is at present little better than a conjecture, but it is assumed that the small amount of residual gas in the lamp is attracted to the walls of the globe while the lamp is cold, and after the lamp is lighted and becomes warm this residual gas is driven off, making the vacuum relatively less. While the vacuum is high, practically all the energy must be radiated from the filament, and when the vacuum is not so good some of the heat is carried away by convection and conduction. If all the heat must be dissipated by radiation, the filament will run at higher temperature and hence give more light. To prove or disprove this theory would require much investigation for which the writer has no facilities. It is hoped that this information may lead some of those who are better equipped for such investigation to explain the phenomenon.

THE POSITION OF THE PRIVATDOCENT IN THE GERMAN UNIVERSITY.

Prof. Paulsen, of Berlin, in the elaborate compilation on the German universities prepared at the instance of the Imperial German Government for the Chicago Exhibition, opened the chapter on the teaching body by the statement, as calmly propounded as if it were a law of nature: "In the German universities, in all the faculties, three classes of instructors teach side by side—ordinary professors, extraordinary (that is, assistant) professors (not professors' assistants), and Privatdocenten." As the Scottish universities are in the main of the same type as those of Germany, it is striking that the third class here mentioned has as completely disappeared from Scotland as if it had never existed at all—it might, in fact, be difficult to show that it ever did exist—whereas in Germany and Austria it flourishes most vigorously, growing with the growth of the universities, and strengthening with their strength. It is universally acknowledged to perform most useful service in the academic body, supplying the universities, as it does, with a copious supply of cheap—*i.e.*, to the nation—but highly competent teachers to meet the demands of the phenomenally increasing university attendance and supplying a fertile field from which vacancies in the professorate are fill up. Here it may be useful to indicate what originally was, and what now is, a Privatdocent. And here we may use the description of Prof. Paulsen.

Historically, says the professor, the Privatdocent may be viewed as a relic of the corporative constitution of mediæval universities. Whoever was declared by the faculty to be a "magister" or "master" of his science originally received thereby the right of teaching in that faculty; and in the faculty of arts this was not only a right, but often likewise a duty. After the custom had arisen of rewarding the older magistri legentes in this faculty with a seat in the collegium, a benefice, or an endowed lectureship, a distinction was thus developed between the regularly appointed and paid teachers, who were bound to lecture publicly and gratis, and the masters who lectured for fees, without obligation or salary. The distinction was more sharply drawn when, after the Reformation, the system of regularly paid professorships, already existing in the other faculties, became firmly established in the philosophical faculty as well. With this change the obligation of lecturing after the acquisition of the master's degree disappeared, the maintenance of instruction being now assured by the professorships. In its place there gradually arose the demand for additional proofs of learning from one who sought admittance into the faculty as magister legens. These were the Habilitationsleistungen (conditions to be satisfied before the "habilitation"), such as are nowadays everywhere imposed. An applicant for the venia legendi at the present day must, after obtaining the academic degree in the appropriate faculty, also submit scientific dissertations in type or in manuscript, pass an oral examination before the faculty, and deliver a public "trial lecture," and as a rule "habilitation" is not allowed within a certain period (commonly three years) after the completion of the candidate's studies at the university. It may be added that the faculties are by no means bound to admit Privatdocenten, and it may be truthfully said that they are not at all lenient in bestowing the venia legendi.

An additional touch may be given to this description by the words of Matthew Arnold in his book on "Higher Schools and Universities in Germany," published 40 years ago. He says: "The Privatdocent is an assistant to the professorate. He is free to use, when the professors do not occupy them, the university lecture-rooms. He gives lectures like the professors, and his lectures count as professors' lectures for those who attend them. . . ."

Both of these writers, moreover, agree in their handsome acknowledgments of the services to science and to university teaching rendered by those professors-in-training. The fact that the Privatdocent may, and often does, teach competitively with the professor, that the teaching and lectures of each count equally to the making up of a regular course for a degree, or for what in Germany is of infinitely more importance, the Staats-examen, or State-examinations for professional life; that the student has completely free choice to take whatever course he thinks best for his purpose—all this undoubtedly tends to impart freshness to the instruction of all classes of teachers and to keep it out of ruts. The youthful teacher is put upon his mettle to do his best to attract students, while the professor who, perhaps, preferred minute scientific investigation to active lecturing and vigorous teaching would find his members diminishing. The three sets of teachers teach side by side competitively with each other, and yet with nothing but the best of relationships existing between them. No doubt arrangements are often made between the different grades of teachers to avoid unnecessary duplication of courses in the same session; but at the larger universities it is quite common to have competitive courses appearing in the catalogue of lectures, and the student may choose one or other entirely as it suits his own convenience.

Of course, the ordinary professor is the official exponent of the subject, and he has his modest State salary, with students' fees, to support him, while the Privatdocent has nothing but the fees (much more moderate than in Scotland) of such students as he can attract. The professor, moreover, is the official examiner for university degrees, which, however, have not at all the importance that attaches to them in England, and from the professorial body mainly are appointed by the Education Department the examiners for the State's examinations.

THE PREVENTION OF BRIBERY.

At the annual meeting of the Secret Commissions and Bribery Prevention League, Incorporated, held at the London Chamber of Commerce, the result of the elections was announced. It was announced also that there is to be a public meeting in the city of London on the afternoon of May 27 to call attention to the Prevention of Corruption Act.

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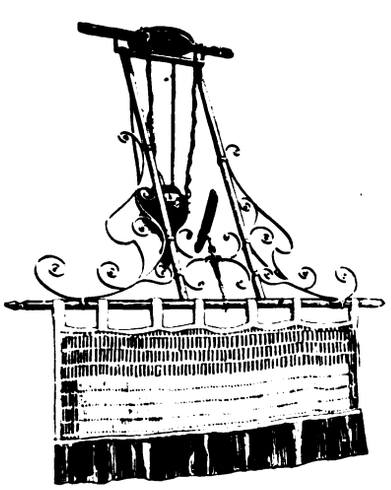
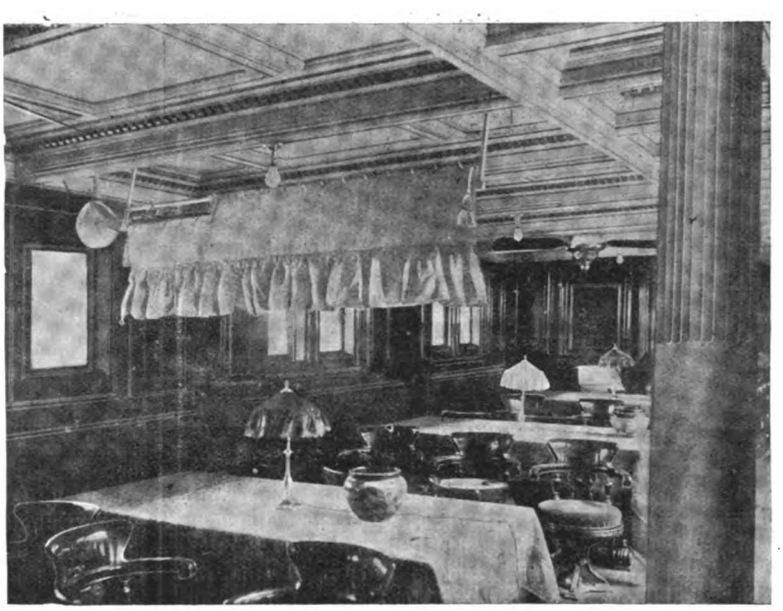
THE "BANDY" ELECTRIC PUNKAH.

A novel and ingenious means of inducing draught for the purposes of ventilation is secured by the electric punkah, which is intended to produce the same effect as is obtained in India by the loin-clothed, lean, and often lethargic native. Several attempts have been made to produce a device that would look like the hand-worked punkah. But in practice it has been found that one or other essential characteristic of the native punkah has been lacking. One of the greatest difficulties lay in the reproduction by mechanical devices of the "flick" peculiar to the hand-pulled punkah, and which, indeed, is necessary if the apparatus is to be of practical service. Another stumbling block has been the inability to so construct a machine that would be noiseless. To obtain some idea as to how far these difficulties have been overcome, it is only necessary to see in operation the various types of the "Bandy" patent electric punkah to become convinced that the difficulties encountered in many of the mechanical punkahs which have appeared from time to time are now solved, and that in the "Bandy" punkah we have a device which must take a leading place among ventilating fans.



"Bandy" Electric Punkah for Ventilating Rooms.



"Bandy" Punkah on the s.s. "Omrah."

The "Bandy" punkah, which is manufactured by Messrs. Bergtheil and Young, Limited, 12, Camomile-street, London, E.C., is capable of being adapted to any pitch of ceiling, and is equally suitable for ship or shore use. It can also be adapted for installation in railway carriages. The arrangement consists of a rigidly suspended motor with conical pulley on the underside and a swinging frame to which a short curtain is loosely hung. Attached to the upper side of the frame is a quadrant, pivoted on a bearing pin and controlled by springs. This quadrant is pressed to one side or the other of the coned pulley of the motor with which it engages. When the motor is started the pulley rolls against the quadrant, which carries it away from the vertical position. In fact, there is a sufficiently strong pull given to the quadrant to take it and the punkah clear of the pulley to a point from which it tends to swing back again by gravity. On the return stroke, therefore, the motor is still running, and as the quadrant now strikes the opposite side of the pulley, the punkah is swung in the opposite direction with a "flick." This cycle of operations is repeated while the motor continues to run. In the ship and railway carriage type of punkah exactly the same principle is adopted, with the exception that, with a view to economising space, the motor is fixed in a horizontal position, and the drive is obtained by the quadrant passing under and over the pinion instead of on either side.

A feature of this punkah, which can be supplied for use on both alternating and direct currents, is its adaptability for installation in almost any position where economy of space is either necessary or of no moment.

Some idea of its efficacy in theatres and such like places is well illustrated by the installation at the Alhambra in Leicester-square, London, which is the first music hall to take advantage of the facilities afforded by this entirely unique and original method of ventilation in England, in many respects superior to the ordinary desk and ceiling fans, which merely create a strong downward draught. We understand that at the present moment Messrs. Bergtheil and Young are engaged in perfecting a very much smaller type of punkah, suitable for use in private boxes and other places where little space is available, and we think these should prove conducive to the comfort of future theatre goers.

These punkahs are a veritable boon on liners and steamships. The s.s. "Omrah" has been equipped with an installation of them, and we are told that Messrs. Bergtheil and Young have, as a result of this first order from the Orient Steam Navigation Company, installed some further punkahs on one of their other boats—viz., the "Orontes."

We have seen the "Bandy" punkah in operation, and were impressed with the remarkable effectiveness of this device, whose motion so closely resembles that provided by the native punkah-wallah. Another feature that calls for admiration is the almost complete absence of noise. When the smaller sizes are ready, they should have a very wide vogue in bedrooms and other small rooms. We feel sure that this neat and effective device will be generally welcomed by the public when they are more familiar with it.

NEW ASBESTOS INSULATING MATERIAL.

Asbestos wood, the invention of Prof. C. L. Norton, and marketed by the H. W. Johns-Manville Company, is being introduced as an electrical and fireproof insulating material. Many advantages are claimed for it over marble, slate, fibre, and wood for switchboards, switch bases, insulating pieces, etc., as well as for general fireproof construction. It is easily worked with wood-working tools and can be sawed, nailed, or screwed the same as hardwood lumber. It is absolutely fireproof, making it especially desirable for all construction where there is danger of short-circuits. One of the many applications of asbestos wood is in the construction of doors in front of high-voltage stations, where an absolutely fireproof and insulating material is essential. The insulation resistance is extremely high, being almost equal to that of sheet mica, which is the best insulating material known. Asbestos wood has a smooth surface and will take any kind of finish that may be desired. For electrical purposes it is regularly furnished in ebony finish.—*Electrical World.*

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A NEW SAFETY GUARD AND SANDING DEVICE FOR TRAMCARS.

Experiments have recently been carried out on the Vienna tramways with the safety guard and sanding device illustrated in Figs. 1, 2, and 3. The guard consists of a light screen at the front of the car, raised about 5in. above the rail face, and controlling a more massive screen under the car and nearer the wheels. The front screen is free to move outwards, but as soon as it moves inwards, as would be the case if the car passes over any raised body, a rod is released which allows the back screen to drop

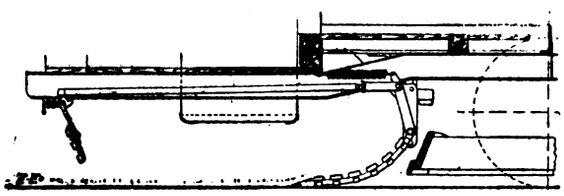

FIG. 1.

right on to the rail, against which it is pressed by means of a powerful spring. The rubbing edge of the screen is merely lined with a strip of rubber. The apparatus is shown in use in Fig. 1 and out of action in Fig. 2. The existing wooden safety guard surrounding the whole wheel base is also shown in position. The new arrangement is simple and inexpensive as regards upkeep, and a similar apparatus has been in effective use in Hamburg for some time.

In Fig. 2 a view is also given of the new sanding device, the details of which are shown in Fig. 3. When the Vienna tramways authorities decided to employ electrical braking under normal conditions, it became necessary to ensure the

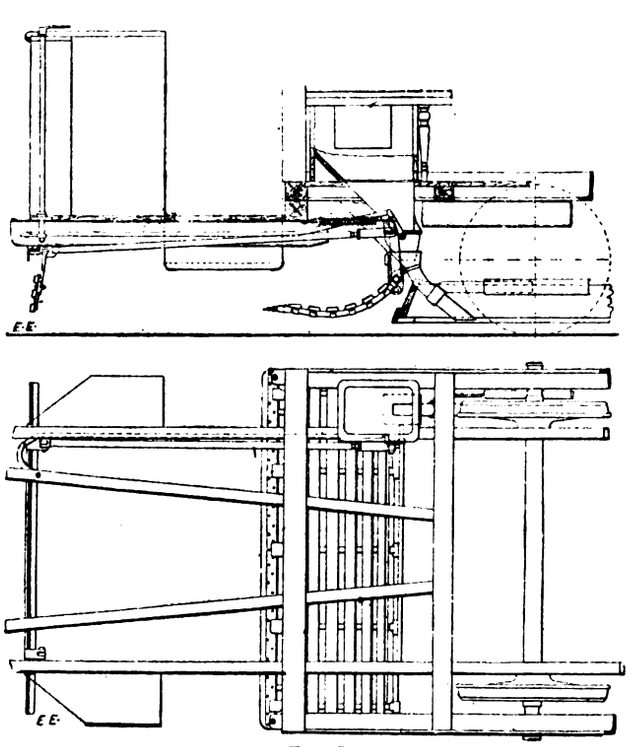

FIG. 2.

good condition of the rails at all times, as otherwise unskilful handling might easily lead to slipping at the wheels. Sanding had previously been carried out by hand by delivering the sand by means of a small shovel down a bent guide tube at the front of the car. The high speed attained by the sand in this way makes it rebound from the rails and prevent a good braking action being attained, especially on curves.

After numerous experiments, the following altered arrangement has been decided upon. The sand delivery in the small quantities normally required is effected by giving a to-and-fro motion to a small handle on the front of the car. If a large quantity of sand is to be poured on to the rails, it is only necessary to give the handle a more forcible blow, when it will remain fixed in its "open" position, and a continuous delivery of sand will result.

In order to avoid insulating the car, sand is normally only delivered on one rail, though it can be delivered on both if required. This sanding of both rails can be made to occur only when the handle is in the above described

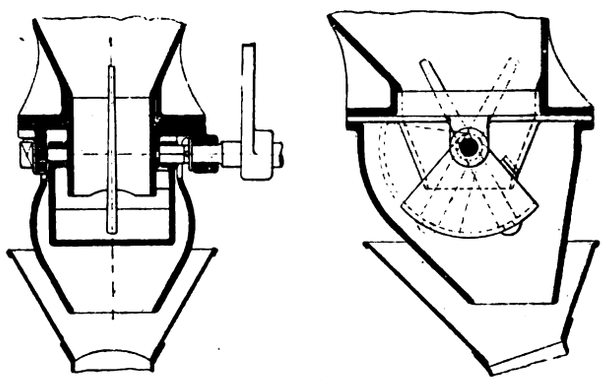

FIG. 3.

fully open position, if desired. It is also possible to arrange for the sanding device at the back of the car to come into action so as to provide for the braking of trailer cars. The sand is carried in a funnel-shaped vessel closed at the bottom by a semi-circular revolving shovel. When at rest this shovel completely closes the mouth, whilst when moved from side to side the mouth is more or less opened. As the shovel is moved to and fro an iron rod attached to it stirs up the sand and prevents clogging. The bearings on which the shovel revolves are outside the sand vessel, so as to avoid wear. The sand falls by gravity into a funnel attached to the wheel base which serves to deliver the sand on the rail close to the wheel. This device has proved very effective, reducing the braking distance to something like half its old value.—*E. K. und B.*

TECHNICAL ELECTROCHEMISTRY IN RUSSIA.*

BY PROF. N. PILTSCHIKOFF.

Before describing any new methods, it is necessary that the notes of J. B. C. Kershaw on the electrochemical works in Russia should be amplified. Besides the three works mentioned by Mr. Kershaw which prepare caustic soda and bleaching powder—viz, Lubunoff, Solvay et Cie., Zabkowickie Electrochemical Cie., and the Russian "Elektron" Company—there are several copper-refining factories—viz., that of the Siemens Company at Kalakant, which is not at present working, and a factory at Moscow, which produces annually 500 tons of electrolytic copper, one ton of silver, and about 80lb. of gold; tin, nickel, and chromium are also prepared. There is also a similar factory at Petersburg, and equipment for the extraction of copper from its ores is erected at the "Medianke" mine at Boleslav.

At the latter place the method of Laschinsky (patented) is used. According to his observations, the salts of iron, even in small quantities, are oxidised at the anode to a sulphate very rich in iron:

$$2FESO_4 + H_2SO_4 + O = Fe(SO_4)_3 + H_2O.$$

This minimises the effect of the current and lowers the quality of the deposit. To avoid this oxidation the plates are covered with lead which forms the anode in the electrolytic bath, while the liquid is continually stirred. The effect of this arrangement is remarkable: the iron is no longer oxidised, and copper is deposited regularly in amounts up to 1·15 grm. per ampere hour.

Several electrochemical methods are about to receive a technical application. Among these, the study of the electrical combustion of air made by Gorbov and Mitkievitch, professors in the Institut Polytechnique in Petersburg, may be cited. Their furnace (Fig. 1) consists of a chamber, B, whose upper part is formed by a funnel, K,

* A paper read before the Faraday Society, Tuesday, April 28, 1908.

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connected to a worm in which the products of combustion can be cooled. The arc is formed between carbon or metal electrodes, C_1 and C_2, and fills the whole of the funnel. Continuous or alternating current can be used (three electrodes are required with the three-phase system). The terminal voltage is from 1,000 to 3,000, and across the arc from 600 to 1,500. A current of air draws the arc into the worm, in whose mouth is formed a "bunch of fire," through which all the air has necessarily to pass. It is

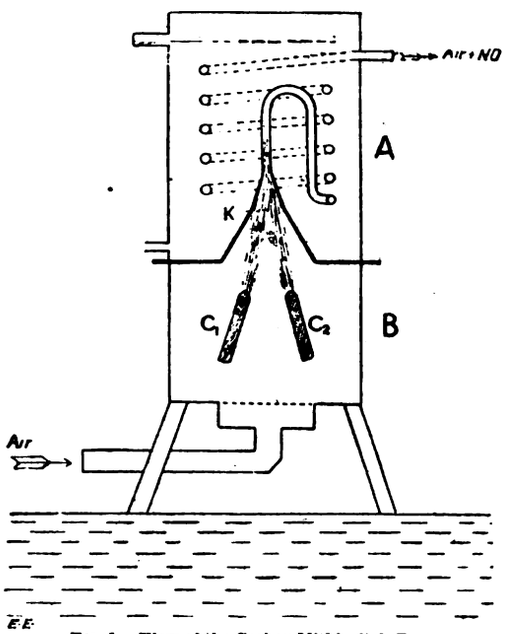

FIG. 1.—View of the Gorbov-Mitkievitch Furnace.

then cooled in the worm, which is placed in a bath, A, filled with water or oil, whose temperature is not allowed to exceed a certain limit.

Fig. 2 shows the operation of a Gorbov and Mitkievitch furnace with a 12-kw. arc. The abscissæ show the percentage volume of nitrous oxide obtained, while the ordinates are the weight of nitric acid in grammes per kilowatt-hour. This furnace has been compared with that of Birkeland and Eyde, and is found to be much more economical, while its construction is simpler.

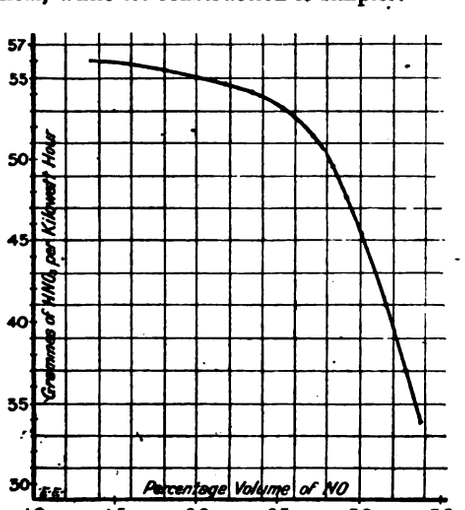

FIG. 2.—Operation of a 14-kw. Gorbov-Mitkievitch Furnace.

Prof. Kloboukoff (whose experiments have been interrupted by his death), of Kharkov, has perfected the tanning of hides by the electric current which prevents any fermentation in the bath. Dr. K. Danilevsky has studied the deposition of electrolytic copper on leather. The leather with its contained copper is harder, resists the action of lime to a greater extent, and wears out less quickly. Successful experiments have been made at Petersburg on the purification of various waters by ozone. The process is not yet widely used, probably for economical reasons. I have, however, seen at Moscow a very powerful and economical ozoniser due to Prof. Sokotoff.

SURFACE-CONTACT TRACTION.

The Suchowastawer System.

A patent has been granted to Mr. David Suchostawer for an invention which refers to improvements relating to that system of electric traction for road vehicles running on rails, in which the vehicle carries a contact shoe which derives its supply of electric current for driving the vehicle from stationary contact studs on the road or permanent way. The object of the invention is to provide a construction of such character that the system can be applied, if so desired, without disturbing the rails of the permanent way, and can be built in sections all ready to be placed in position and connected with one another. The

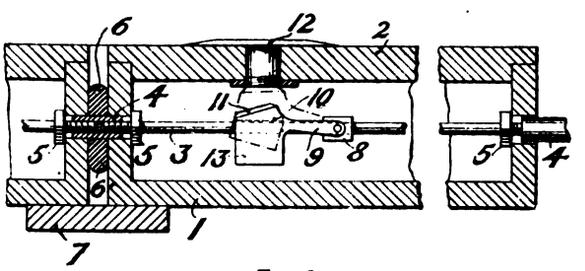

FIG. 1.

improved system can be applied to existing tramways or railways and cars without necessitating the entire reconstruction of the same. Fig. 1 is a vertical longitudinal section through a length and a portion of an adjacent length of boxing or troughing containing a length of line wire, and showing a joint, with a single stud carried by the top cover, and a rocker or switch arm attached to the line

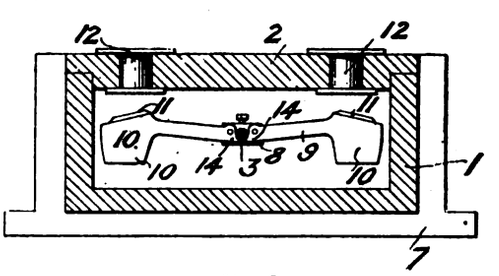

FIG. 2.

wire. Fig. 2 is a vertical cross-section of a boxing arranged to carry two sets of studs for a double line of rails. Fig. 3 is a sectional elevation showing an example where the switch arms are carried by the contact stud.

The inventor makes the following claims for his invention: In electric traction on the surface-contact system for

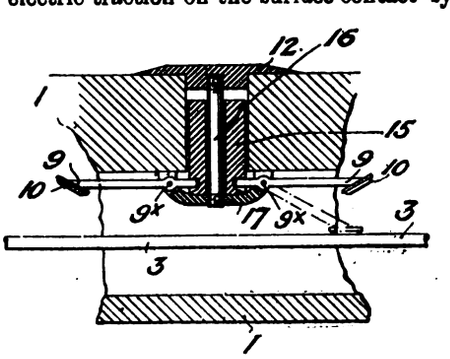

FIG. 3.

vehicles running on rails; providing lengths or sections of box or trough form, each carrying a length of electric conductor but slightly longer than the box, contact studs, and magnetically-operated switches, all assembled and fitted so that one section can be joined to the next section and fixed in position without disturbing the rails of the permanent way, substantially as described. In such a system, in which there are employed lengths or sections of box or trough form, each carrying a length of electric conductor, contact studs, and magnetically-operated switches, providing said sectional boxes or troughs with double lines of studs and double magnetically-operated switches adapted to be

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laid or fixed between two lines of rails or outside any single line of rails, to supply vehicles on both lines from a single line wire. The arrangement and connection of the electrical conductors within said boxes or troughs, the means for connecting one box or trough to the next section, and the arrangement of the pivoted switch arms and contact studs, substantially as described with reference to Fig. 1 of the accompanying drawings. The construction wherein the contact studs are arranged in two lines upon opposite sides of the centrally located conductor, and in which the pivoted switch arms extend at right angles to that conductor and upon each side of same, substantially as described with reference to Fig. 2 of the accompanying drawings. The construction of the magnetised skate or collector, the contact surface of which is composed of a series of rollers of magnetic metal mounted in slotted bearings, and free to rise and fall vertically so that they normally fall below the level of the contact studs, but can pass freely over the latter.

LIFE OF TANTALUM LAMPS.

Bulletin No. 19 of the University of Illinois is devoted to an account of comparative tests by Mr. T. H. Amrine of carbon, graphitised carbon, and tantalum filament lamps. The lamps were tested under both favourable and unfavourable conditions, in the first case being connected to a storage battery circuit, and in the second case supplied from a badly-fluctuating alternating current. On the basis of an average life to 80 per cent. of the original candle-power, the life in hours under the favourable conditions was 400 hours for the carbon filament, 780 hours for the graphitised carbon filament, and 820 hours for the tantalum filament; with the alternating current, the figures became 225, 350, and 350 respectively. With the widely fluctuating alternating current, the tantalum lamps thus made a better showing than the carbon-filament lamp.

INSTITUTION AND SOCIETY NOTES.

Institution of Electrical Engineers.

At the ordinary general meeting held on the 23rd ult. the following were elected:

Member.—C. D. Burnet, Electricity Works, Carlisle.

Associate Members.—F. S. Collings, 13, Pemberton-gardens, Upper Holloway, N.; I. Dalmer, 7, Balmoral-terrace, Glebelands-road, Sale; J. H. Fossett, 2, Evelinton, South Circular-road, Kilmainham, Dublin; Captain R. C. Hammond, R.E., Ordnance Barracks, Limerick; A. R. Low, care of Messrs. Johnson and Phillips, Limited, Old Charlton, S.E.; L. Oulton, Hillside, Gateacre, near Liverpool; W. E. Shuttleworth, 5, Cranbourne-street, Hull.

Associates.—G. B. Barham, 19, Mayfield-avenue, West Ealing, W.; E. T. Larner, 80, Lansdown-road, Seven Kings, Essex; V. I. Stephens, Chief Court Building Construction, Rangoon, Burma.

Students.—A. R. Alderson, 94, Yarburgh-street, Alexandra Park, Manchester; C. G. Dickinson, 32, Nithsdale-drive, Glasgow, N.B.; J. H. Eddison, Cragside, Ben Rhydding, Yorks; B. F. Hill, 59, High-street, Newton Heath, Manchester; R. D. Norman, 109, Clarendon-road, Putney, S.W.; J. Stephen, 38, Brighton-road, Birkdale, Southport.

Mr. H. F. Parshall attended the Institution meeting held on April 30, and presented to the Institution, on behalf of the American Institute of Electrical Engineers, a bust of Benjamin Franklin as a souvenir in happy remembrance of their trip to this country 1½ years ago. Mr. Parshall said it was proposed to present this souvenir when Lord Kelvin was in the chair. That was not to be, however. But he thought it would enhance the merit of the gift when he told the members that Lord and Lady Kelvin had seen it, and that his lordship had expressed his highest approval of it. Colonel Crompton, in accepting the gift on behalf of the Institution, expressed the deeply felt gratitude of the members to their American friends for their token of affection towards the Institution and of respect to the great man Kelvin. He also thanked Mr. Parshall for the very appropriate and kindly way in which he had spoken in making the presentation. They never forgot the kindness shown to them by American engineers when they visited the St. Louis Exhibition, and he thought that the visit to this country 18 months ago was a poor return for that kindness. He hoped there would be more of such meetings. The two institutions were one in thought and feeling, and this presentation would serve as an additional link between them.

Iron and Steel Institute.

The Canadian Mining Institute has extended to the members of the Iron and Steel Institute a cordial invitation to take part in the summer excursion of that society. Arrangements have now been completed for carrying out the programme. It is proposed that the excursion shall start from Montreal on Aug. 24. The party will proceed directly to British Columbia by the Canadian Pacific Railway, first visiting the coal mines of the Crow's Nest district, next the Rossland district, including the trail smelter, and the big copper mines and smelter of the boundary district. Before proceeding to the south coast a visit will be paid to the town of Nelson, where a reception will be held. A reception and a meeting for the reading of papers will also be held in Victoria, the capital of the province. Returning after two or three days' rest, the party will journey over the Canadian Pacific main line through the Rocky Mountains, stopping at Banff Hot Springs. It is then proposed to journey back to the nickel-copper district of Sudbury, *vid* the Soo line, and while in the province of Ontario to visit the cobalt district. A reception will then be held in Toronto. Returning to Montreal, the journey to the Maritime Provinces, taking in the Thetford asbestos region *en route*, will be made over the line of the Inter-Colonial Railway. It is estimated that the time necessary for the carrying out of this programme will be about six weeks. The cost to those taking part in the excursion, as outlined, will be probably from £50 to £60 sterling. The Canadian Mining Institute is, however, trying to arrange for exceptionally favourable terms with the railway companies, which if secured will reduce the expenses of individual members of the party accordingly. Members of the Iron and Steel Institute desirous of availing themselves of the kind invitation are requested to communicate with Mr. H. Mortimer Lamb, secretary of the Canadian Mining Institute, 413, Dorchester-street West, Montreal, Quebec, and kindly to intimate to Mr. Bennett H. Brough, the secretary, that they have done so. As accommodation on the steamers leaving for Canada during August is extremely limited, it is suggested that members should secure steamship berths without delay.

Manchester Local Section.

The annual general meeting of the Manchester Section of the Institution of Electrical Engineers was held in the physical lecture-room at Victoria University, Manchester, on April 14. A hearty vote of thanks to Mr. M. B. Field for his services in the chair during the past session, proposed by Mr. T. L. Miller and seconded by Mr. G. Preece, was carried with acclamation. Mr. Field responded suitably. Votes of thanks were also carried in favour of Mr. H. W. Wilson (the hon. secretary), Mr. A. L. Green (the assistant secretary), and Prof. Rutherford and the Victoria University for their kindness in lending the section the use of the physical lecture-room.

The following officers were elected for the forthcoming session: chairman — Mr. Miles Walker; vice-chairman — Mr. S. J. Watson; hon. secretary and treasurer—Mr. H. W. Wilson; committee—Prof. A. Schwartz and Messrs. W. Cramp, A. P. M. Fleming, J. Frith, G. Layton, V. A. H. M'Cowen, W. P. Maycock, J. S. Peck, P. A. Ramage, C. F. Smith, C. D. Taite, and A. P. Wood.

Birmingham Local Section.

The annual general meeting of the Birmingham Section of the Institution of Electrical Engineers was held on Wednesday last. Prior to the meeting Prof. Gisbert Kapp entertained the members to tea at the Grand Hotel.

The annual report of the committee, which was the chief business before the meeting, stated that the average attendance at the seven meetings held throughout the session was 71. The membership now stands at 342, which is an increase of 37 on the year ended April, 1907. The committee invite offers of papers from the members of the local section for reading and discussion during the session 1908-9. Such offers should be, as far as possible, in the hands of the hon. local secretary in time to enable the committee to draw up a complete programme for issue to the members before the first meeting in November. A list of nominations for office holders for 1908-9 was drawn up by the committee at their meeting on March 23, and was circulated to the local members with a request for further nominations. Since no other nominations were sent in, the committee's nominees were elected for the coming session as follows: chairman—Dr. G. Kapp; past chairmen—Dr. W. E. Sumpner, Messrs. R. Threlfall and R. A. Chattock; vice-chairman—Mr. R. K. Morcom; ordinary members of committee—Messrs. V. Bornand, A. R. Everest, A. Lindsay Forster, C. W. Hill, J. P. Kemp, Henry Lea, J. F. Lister, D. K. Morris, A. Pearson, M. Railing, A. M. Taylor, and J. C. Vaudrey; hon. secretary — H. B. Matthews. In accordance with the rules governing local sections, Messrs. A. H. Bate and W. E. Groves retire from the committee, having served in the same capacity for three years consecutively. These gentlemen are eligible for re-election in 1909-10.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE QUESTION No. 1,059.

SIR,—Whilst looking through the "Question and Answer" section of your paper some time ago the wording of one of the answers appeared to be very familiar to me, and on looking up a few old magazines I found the said answer to be an absolute copy—word for word—of a little article written by myself which appeared in one of your contemporaries some time previously.

In the current issue of the *Electrical Engineer* your correspondent who signs himself "X." has, I find, copied his answer practically word for word from Dr. Hay's book, "Alternating Currents," as a reference to pp. 128-132 will doubtless show.

I cannot help but think this method of answering a question a somewhat poor one. Does an answer by a "practical man" mean an answer which a man is "practical" enough to find in some text-book or journal, and "practical" enough to copy out word for word? I may be mistaken, but my idea of a practical answer is one written by a man who has had actual experience in the subject under discussion, and who is able to put down in his own words the results of his experience, or his *own* theory of a subject. Mr. Oscar Dinnerman's contribution is "practically" taken from Prof. Smith's book on "Alternating Currents"; a large portion is copied word for word, but he had the courage to mention the source of his information, while Mr. "X." gives his answer as coming from his own brains. Before closing, let me assure "X" that I am *not* a disappointed contributor to Question 1,059.—Yours, etc.,

CRIB.

[We have several times called the attention of those answering the technical problems to the need of acknowledging the source of all extracts and quotations made use of. It is impossible for us to trace these when looking through the answers received, and we do not consider that the use of quotations detracts in any way from the value of the answer. For example, the correspondent who made use of "Crib's" article to reply to Question No. 1,059 had evidently read the article in question, and noted it down for future reference in connection with the subject. His fault lay in not quoting the source of his information, which is indefensible. We are inserting a line at the head of our "Technical Problems" column which will, we hope, prevent the use of quotations without acknowledgment. Our correspondent may remember that in certain examinations men are allowed to take in with them pocket books for reference, provided they state at the head of their papers what books they have used. The practical engineer cannot possibly remember all the detailed information he needs, and to know where to find it is the next best qualification.—ED., *E. E.*]

PROPOSED ELECTRICAL EXHIBIT AT THE FRANCO-BRITISH EXHIBITION.

We are pleased to announce that there is every probability of an electrical exhibition at the forthcoming Franco-British Exhibition after all—thanks to the enterprise and the munificence of the London electric supply companies. The scheme owes its origin to the conference of chief officials of the London electric supply companies, and is fully explained in the following letter which Mr. F. J. Walker, the hon. secretary of the conference, has sent out:

You are doubtless aware that the steps which were taken to organise a collective electrical display at this exhibition were recently abandoned through lack of sufficient support. The electric supply companies of London are strongly of opinion that, having regard to the magnitude of the exhibition, the importance of which has not as yet been sufficiently realised, it would be detrimental to the interests of the industry if further efforts are not made to remove the necessity for this decision; and they have, therefore, resolved to make this appeal to the trade to secure their co-operation in promoting a collective exhibit worthy of the occasion. With this end in view, and because of the shortness of time at their disposal, my conference have taken upon themselves the responsibility of securing a suitable space in the machinery gallery, and have arranged with Messrs. Waring for the erection thereon of a handsome pavilion. Sufficient funds have been guaranteed by the supply companies to cover the cost of the space and pavilion, and the general superintendence of the exhibit will be undertaken free of charge by my conference, but there remains the expense of wiring, current, and attendance still to be provided for, which may be estimated not to exceed £600. If, as is hoped, not less than 30 firms respond to this invitation, the average inclusive contribution per exhibitor would not be more than £20, and as there is no obligation on exhibitors to provide attendance (though they are, of course, at liberty to do so if they think proper), it will be seen that the cost of participation is extremely moderate. It is proposed that half this contribution should be paid before the opening of the exhibit, and the balance or such amount of it as may be required at a later date.

The pavilion will be divided up into six sections, as follows: (1) a suite of furnished rooms, comprising hall, dining-room, drawing-room, bedroom, nursery, and kitchen, designed for the display of domestic lighting, heating, cooking, and ventilation; (2) small machinery worked by motors; (3) medical apparatus, including baths, high-frequency and X-ray appliances; (4) and (5) general exhibits; (6) reception-room and information bureau, which will be available for a few selected exhibits.

A meeting was held on Wednesday afternoon at the offices of the St. James and Pall Mall Company, which was largely attended by representatives of some of the principal manufacturing firms and contractors. All were unanimous as to the desirability of such an exhibition being held, and, judging from the offers of support which have already been made, the success of the exhibition seems practically assured. Messrs. Siemens Bros., Verity's, Rashleigh Phipps and Co., Bergtheil and Young, Berry, Skinner, and Co., Electromotors Limited, Edison and Swan, Blackmore, Armorduct Conduit Company, Rawlings and Co., Barlow Bros., Stearn Electric Lamp Company, and the Dowsing

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Radiant Heat Company have all taken up the scheme enthusiastically, while other firms, not represented at the meeting, have promised to support it. A complete suite of rooms will be fitted up by Messrs. Waring and Gillow for the display of fittings, lamps, cooking, heating, and domestic appliances. Of the spacious bays adjoining these rooms, in one will be displayed motors working different classes of machinery, and in another electro-medical appliances will be shown. The total cost of the exhibit is estimated at £1,625. The electric supply companies have guaranteed £1,000 down and another £250 if necessary. This leaves a comparatively small sum to be contributed by exhibitors. Each exhibitor will contribute according to the space occupied, but the average should not be higher than £20. The gentlemen present at Wednesday's meeting unanimously agreed to leave the whole matter in the hands of the standing committee of the conference of chief officials of London electric supply companies, and Mr. Cunliffe Owen and Mr. F. J. Walker are together carrying out the arrangements. It is hoped that some of the provincial companies will join the London companies in this undertaking, while support is also expected from some municipalities. The offices of the hon. secretary (Mr. F. J. Walker) are at 19, Carnaby-street, Golden-square, London, W.

THE "ORIECO" METALLIC-FILAMENT LAMP.

The "Orieco" metallic-filament lamp supplied by the International Electric Company has gained considerable ground since its introduction, and we are glad to know that the demand for same is increasing daily. The manufacture of the metallic filament is the outcome of prolonged experiments, and it is claimed that while it differs in its component parts from any other metallic-filament lamps on the market, it combines brilliancy with greater durability, notwithstanding that the current consumption is not more than 1¼ watts per English candle-power. The standard sizes of the "Orieco" lamp are 32 c.p. and 50 c.p., suitable to be run either in parallel or in series on circuits up to 125 volts, while lamps on 200 to 250 volt circuits can only be had in 50 c.p. The nature of the filament allows of it being burned either on an alternating or direct current, and the anchoring is carried out in such a manner as to permit the lamps to be burned in any position.

A speciality of the International Electric Company are metallic-filament lamps of a very low voltage, in particular those suitable for working with auto-transformers, etc. A variety of candle-powers—that is to say, 8 c.p., 16 c.p., and 20 c.p.—are supplied for circuits up to 25 volts, for use on primary and secondary batteries. They supply lamps of even two volts, giving 2 c.p. As the filament in this latter type of lamp is metallic throughout, the risk of breakage is greatly reduced, and the lamps will withstand even rough handling, which is of special importance when the lamps are used for lighting motorcars, etc., where great vibration, jolting, and jerking has to be taken into account.

IPSWICH MUNICIPAL FINANCE.

The following report by Mr. Frank Ayton, the engineer and manager of the Ipswich electric supply and tramways departments, has been considered by the Corporation, and it has been decided to adopt his recommendations given below. The report, addressed to the chairman and members of the Electric Supply and Tramways Committee, reads as follows:

Gentlemen,—By the direction of the chairman, I beg to submit a report as to what charge, if any, should be made against the revenue of each department to cover the upkeep and renewal of plant. In the first place, it may be said that there is no legal necessity to charge against profits more than interest charges and loan redemption instalments. The statutory clauses dealing with the allocation of tramway and electric supply revenue are attached to this report. If the life of each portion of plant coincided with the period granted for the loan, there would be no necessity to consider any other provision for upkeep and renewal than that given by the compulsory repayment of capital by instalments or by sinking fund, for when the time arrived at which the asset had to be replaced the original borrowing powers, as far as related to it, would be set free for a fresh loan to cover the new plant.

Unfortunately, the period of the loan does not in every case represent the true life of the asset. Where this is so, correct accountancy demands that provision should be made each year, by a charge against revenue, of such an amount that the sum accumulated at the end of the useful life of the asset, with the addition of the sum accumulated by the loan sinking fund, or the total of the loan repayments, shall be equal to the original capital outlay on the asset. In other words, the Corporation should so arrange that, at the time when the asset requires replacing, they shall be able to replace it without recourse to the rates or the application for further borrowing powers. But as to the latter, it should be understood that there is little likelihood of either the Local Government Board or the Board of Trade granting further borrowing powers for the renewal of an asset the original loan for which has not been entirely repaid. This is quite clear from the information obtained by Prof. Laurence R. Dicksee, F.C.A. (professor of accounting in the University of Birmingham), who said, in his report to the Corporation of Bristol on the question of the proper provision for renewals: "I have been informed by the Local Government Board that 'it is their general practice, when sanctioning loans for works which will be in substitution for works on which there is an outstanding debt, to exclude from the sum to be sanctioned the amount of the outstanding debt on the superseded work.'"

The period granted for the loans represents the equated life of the estimated lives of the various portions of the plant. Some portions, such as buildings, foundations, etc., are estimated quite correctly to last much longer than the period of the loan, other portions to last for a shorter period. It might, therefore, be assumed that when the time came to replace some short-lived asset, the Corporation would be able to get new borrowing powers to replace it on the basis of having, on the whole original loan, repaid a larger amount than represented by the cost of the said asset. In regard to this, I prefer to quote the opinion of so learned an authority as Prof. Dicksee, who says: "In the case of those assets whose working life is estimated to be shorter than the loan period, an additional provision is necessary, and such excess as there might be in respect of the other (long-lived) assets would not be available to meet this deficiency." It seems perfectly clear, therefore, that if the annual loan repayment amounts to as much as the correct charge for upkeep and renewal, no further charge is required on this account, but if, on the other hand, the annual loan repayment instalments are insufficient for that purpose, a further provision should be made annually to cover the deficiency.

In dealing with the plant of the electric supply and tramways undertakings, it must be borne in mind that some portions, such, for instance, as car trucks, will by gradual renewal of parts be so kept up that they will last the period of the loan, although when that time arrives no part may be recognisable as having originally formed a portion of the truck as it was purchased. Renewals of parts are charged against revenue as repairs. It is clear, then, that such an asset, although it will entirely wear out by parts some time before the loan period expires, will be kept up out of revenue, so that no further charge for upkeep and renewal than that provided by the statutory loan repayment is necessary.

Dealing first with the electric supply undertaking. The original loan was granted for a period of 25 years. The additional loan since obtained for No. 8 set, No. 5 boiler, extension mains, etc., is for 20 years. I am of opinion that, as long as the plant is kept in first-class condition, there is no need, at the present time at any rate, to make further provision for depreciation. This department has without a doubt a good future before it, and it can be left to the future profitable years to provide for any discrepancy which there may be between the estimated and the actual life of each portion of plant. It would most certainly be wise, as soon as any surplus is available, to establish a reserve fund which would cover such a contingency as this, as well as providing against loss by accident, by decrease of revenue, or by an abnormal rise in the price of coal in any one year. It will be seen, on reference to the clause in the electric lighting order dealing with the application of revenue, copy of which is attached, that such a fund is mentioned. The only part of the plant which I have any fear about not lasting a reasonable time is our boiler plant, which, owing to the extremely hard water, is working under unfavourable conditions as regards long life. It might be advisable for this reason to install a water-softening apparatus, which, apart from adding to the life of the boilers, would no doubt soon pay for itself by increased efficiency and decreased cost of cleaning.

With regard to the tramways undertaking, the original loan for which is on a 40-year basis, with 15 years for the 10 new cars, the question of upkeep and renewal is both important and serious. The largest expenditure is on the permanent way, and there is not the slightest doubt but that the rails will have to be

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renewed at least twice during the life of the loan. Opinions differ widely as to the life which can be expected from steel tramway rails working under electric traction conditions. In such places as Glasgow and Leeds, where there has been the longest experience, there have been other severe local conditions connected with abnormally heavy vehicular traffic in the streets which have militated against a long life for the rails. It would not be fair, therefore, to go by the experience of these cities in estimating a life for the Ipswich track where conditions are somewhat more favourable. An exhaustive inquiry into this question was made not long ago by the International Tramway Association, and the replies from a large number of tramway systems all over Europe were presented in tabular form at the congress of the association held at Milan in 1906. An examination of the replies shows that the general estimate of the life of a rail over which the traffic is fairly light—that is, not less than every five minutes—would average out at about 15 years, and that where traffic is heavy the life would be about 10 years. The only portion of the Ipswich system which carries a service having a less headway than five minutes is that between Cornhill and Major's Corner, but as there is a long portion between Whitton and the railway bridge, and also the Burrell-street and Bath-street lines, which are little used during a large part of the year, I feel justified in putting the estimate for the life of the whole of the rails at 15 years. Points and crossings at junctions will have to be renewed at an earlier date, and in my estimate as to the cost of renewing the permanent way I have made provision for this. I have also allowed for the expense of keeping the cars running, where possible, by a temporary track while the reconstruction is being carried on. As to the overhead equipment, I consider the posts and section boxes, if kept well painted, should last the term of the loan. The wires, switchgear, etc., are renewed from time to time out of revenue, and consequently no further allowance is necessary. Underground cables should also last the full term.

In regard to cars, it is not, perhaps, absolutely necessary to make any allowance at the present time, though I should consider it a wise policy for the Corporation at the first opportunity, out of any surplus there may be on any year's working, to put aside something to cover any abnormally heavy cost of renewing parts. As I have pointed out, we are continually renewing the undertrucks and gear by parts out of revenue under the heading of repairs and maintenance. The heavy cost will come when the car bodies have to be renewed. These should cost somewhere about £100 each if built by ourselves. It may be taken that buildings will certainly outlive the loan period. Tools and fixtures will be renewed from time to time out of revenue.

It, therefore, comes to this: that in about 15 years from the beginning, or say April 1, 1904, or 11 years from April 1 next, the Corporation should have in hand for the reconstruction of the track such a sum as would (with the money which would be obtainable by reborrowing under the usual terms of sanction in like cases—viz., such part of the original loan relating to the track as had been repaid at the time) amount to £42,500, my estimate of the requirements for that purpose. The amount of loan repaid will be £10,408. There, therefore, remains to be provided from revenue the sum of £32,092.

In considering this matter of upkeep and renewal, I have made no allowance for antiquation, and I admit that in ignoring it my policy is a debatable one. Our plant is, however, comparatively modern, and although standardisation and finality has by no means been reached, I am of opinion that any improvements introduced will not make for such a gain in efficiency as would warrant the Corporation, during the life of the loan, in displacing any of the power station plant before it is worn out. The same remarks apply more or less to the tramways plant.—I am, gentlemen, your obedient servant,

FRANK AYTON, Engineer and Manager.

IPSWICH CORPORATION ELECTRIC LIGHTING ORDER, 1897.

Copy of Clause re Application of Revenue.

All moneys received by the undertakers in respect of the undertaking, except (*a*) borrowed money, (*b*) money arising from the disposal of lands acquired for the purposes of this order, and (*c*) money not of the nature of rent received by them in respect of any transfer under the provisions of this order, shall be applied by them as follows:

1. In payment of the working and establishment expenses and cost of maintenance of the undertaking, including all costs, expenses, penalties, and damages incurred or payable by the undertakers consequent upon any proceedings by or against the undertakers, their officers, or servants in relation to the undertaking.

2. In payment of the interest or dividend on any mortgages, stock, or other securities granted and issued by the undertakers in respect of money borrowed for electricity purposes.

3. In providing any instalments or sinking fund required to be provided in respect of moneys borrowed for electricity purposes.

4. In payment of all other their expenses of executing this order not being expenses properly chargeable to capital.

5. In providing a reserve fund if they think fit for setting aside such money as they may from time to time think reasonable, and investing the same and the resulting income thereof in Government securities or in any other securities in which trustees are by law for the time being authorised to invest other than stock or securities of the undertakers, and accumulating the same at compound interest until the fund so formed amounts to one-tenth of the aggregate capital expenditure on the undertaking, which fund shall be applicable to answer any deficiency at any time happening in the income of the undertakers from the undertaking, or to meet any extraordinary claim or demand at any time arising against the undertakers in respect of the undertaking, and so that if that fund is at any time reduced it may thereafter be again restored to the prescribed limit, and so from time to time as often as such reduction happens.

The undertakers shall carry the net surplus remaining in any year and the annual proceeds of the reserve fund when amounting to the prescribed limit to the credit of the local rate, as defined by the principal Act, or at their option shall apply such surplus or any part thereof to the improvement of the district for which they are the local authority or in reduction of the capital moneys borrowed for electricity purposes.

Provided always that if the surplus in any year exceed 5 per centum per annum upon the aggregate capital expenditure on the undertaking the undertakers shall make such a rateable reduction in the charge for the supply of energy as in their judgment will reduce the surplus to the said maximum rate of profit, but this proviso shall only apply to so much of the undertaking as shall for the time being remain in the hands of the undertakers.

Any deficiency of income in any year not answered out of the reserve fund shall be charged upon and payable out of the local rate.

IPSWICH CORPORATION TRAMWAYS ACT, 1900.

Copy of Clause re Application of Revenue, etc.

The Corporation shall apply all money received by them on account of revenue in respect of their tramway undertaking in manner and in the order following—that is to say:

1. In payment of the working and establishment expenses and cost of maintenance of the undertaking (including the maintenance of so much of the roads in which the tramways are laid as is required to be maintained and kept in good repair and condition by the promoters of tramways by Section 28 of the Tramways Act, 1870).

2. In payment of the interest on moneys borrowed by the Corporation for the purposes of the undertaking.

3. In providing the requisite appropriations, instalments, or sinking fund payments for the purpose of the undertaking.

4. In extending and improving (if the Corporation think fit) any works for the purpose of the undertaking.

5. In providing a reserve fund (if the Corporation think fit) by setting aside such money as they think reasonable and investing the same and the resulting income thereof in statutory securities and accumulating the same at compound interest until the fund so formed amounts to the maximum reserve fund for the time being prescribed by the Corporation not exceeding a sum equal to one-fifth of the aggregate capital expenditure for the time being by the Corporation upon the undertaking, which fund shall be applicable to answer any deficiency at any time happening in the income of the Corporation from the undertaking or to meet any extraordinary claim or demand at any time arising against the Corporation in respect of the undertaking, or for payment of the cost of renewing any part of the tramways of the Corporation or of the works connected therewith, and so that if that fund be at any time reduced it may thereafter be again restored to the prescribed maximum, and so from time to time as often as such reduction happens: Provided that resort may be had to the reserve fund under the foregoing provisions, although such fund may not at the time have reached or may have been reduced below the prescribed maximum.

And the Corporation shall carry to the borough fund so much of any balance remaining in any year of the income of their tramway undertaking (including the interest on the reserve fund when such sum amounts to the prescribed maximum) as may in the opinion of the Corporation not be required for carrying on the undertaking and paying the current expenses connected therewith. Any deficiency in the revenue of the tramway undertaking of the Corporation shall be immediately made good out of the borough fund.

A COLONIAL ELECTRICITY UNDERTAKING.

City of Launceston.

From far-off Tasmania comes the annual report of the electrical engineer of the city of Launceston undertaking, and we must congratulate Mr. R. J. Strike, who took over the manage-

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ment of the concern from Mr. Wm. Corin in May last, and all concerned on the very efficient condition in which it is placed. An analysis of the accounts may prove of interest to all interested in similar undertakings in Great Britain. The expenditure on capital account during the year 1907 amounted to £3,353. Of this amount £648 was part of balance due to contractors for three-phase plant. The total capital expenditure to Dec. 31, 1907, is £164,197. The number of consumers is large—3,175 in all—and an expenditure of £11,663 on consumers' meters has been incurred.

As regards the three-phase plant, £30,000 has been spent on the change over from single-phase, and the capacity has been increased from 560 kw. to 1,200 kw. In 1903, the last year when single-phase was wholly in use, the earnings from power were only £537. During 1907 the revenue from this source was £1,835, an increase of £1,298, leaving, after deducting increased maintenance charges, a net increase of £1,201. It will thus be seen that the power supply is earning a sum which, if capitalised, would be almost sufficient to pay the whole of the cost of the change to three-phase, for £1,201 capitalised at 4·4 per cent. would give £27,295, thus leaving only £2,705 (out of the £30,000) expended for the extra 640 kw. plant capacity.

The total revenue for the year was £16,286, as against £14,934. 10s. 6d. for 1906, an increase of £1,351. The increase in revenue from lighting is 2·86 per cent. over last year, the increase in revenue from power is 67·43 per cent., and from heating 20·05 per cent. The expenditure for the year shows an increase of £910. 12s. 7d., the principal items of which are: A.N.A. Exhibition, £109 (actual expenditure only); fittings, motors, and other apparatus on rental, £292; meters, £100; private arc lamps, £60; mains, £228. Since 1903 the revenue has increased by 52·34 per cent. and the expenses 46·7 per cent., while the ratio of expenses to receipts has dropped 3·5 per cent. Now that the undertaking is in its twelfth year of working, the maintenance charges on the distributing system are commencing to make themselves felt. The revenue from street lighting was £2,434 for 357,878 units, which is equal to a charge of 1·633d. per unit. In 1895 the city was lighted by 247 gas lamps at £5. 7s. 6d. each per annum = £1,473. There are now 432 incandescent lamps and 175 arc lamps; the latter reduced to the same equivalent as the incandescent lamps brings the total to 1,116 at a cost to the citizens of only £2,434. Launceston is exceptionally well lit, and lamps have been erected in positions which would ordinarily have been considered in a general system of street lighting. This was done, says the report, with the object of reducing the police expenditure when they were under municipal control. The police, however, having been centralised, the Council loses the benefits anticipated; but the Corporation's expenditure continues, and the Government reaps the advantage of the same. The department practically supplies three or four policemen. The balance carried to net account is £8,770, an increase of £375. Interest and contributions to sinking funds have increased by £135, leaving an actual surplus on the year's working of £1,557. The following figures are of interest: units generated, 1,722,380; units used at power station, 17,000; units lost in transmission, 127,820; units supplied from sub-station, 1,577,560; units accounted for, 1,330,140; units lost in mains, transformers, meters, etc., 247,420. For the first time in the history of the undertaking the units sold are over one million. The total costs have also decreased by 0·211d., or 12·7 per cent., per unit sold. The maximum load reached was 680 kw., or 907 e.h.p., being an increase of 86 e.h.p. over the maximum load for 1906.

The report concludes with an interesting paragraph on Osram and tungsten lamps. After pointing out that the saving in consumption would pay for the increased cost of these lamps, it continues as follows: "It must not be forgotten that it is not at present anticipated to produce a lamp consuming less current than the ordinary 5-c.p. or 8-c.p. carbon-filament lamp. Consequently, users of lamps of this power cannot expect to reap any benefit other than an increase in light. The Corporation have obtained a few of these lamps, and they are available to the public at cost price, or are supplied free on the usual basis of lamp renewals to an equivalent in money value, but it must be distinctly understood that owing to the manufacture of these lamps being in its early stages the duration of life cannot be definitely stated, but with increased experience I have no doubt that this difficulty will be overcome. The tests we have made so far have been very satisfactory, the lamp maintaining its original candle-power to within a few per cent. after about 1,000 hours' burning; and, while some may burn out prematurely, I see no reason why the same results should not be obtained in ordinary use as in testing. Another advantage with the new lamps is that they will decrease the demand upon the plant for the same lighting, thus virtually increasing its capacity. With the street incandescent lamps alone we can, while increasing the candle-power 67 per cent., save more than 50 per cent. of their present demand on the station, and the same applies to consumers. Lamps from 16 c.p. upwards will eventually be replaced by lamps of the new type, thus not only decreasing the maximum demand, but reducing the cost to the consumer. I might mention that, owing to the success of these lamps, there is at present a little difficulty in obtaining quick deliveries, but this will, I hope, disappear as soon as arrangements for their manufacture on a large scale are completed. I notice that there is a tendency among users of light to install lamps of large candle-power in their residences, on the supposition that one cannot have too much light. This is a mistake, as the iris of the eye contracts when subjected to brilliant illumination in order to prevent too much light entering. This contraction, however, is limited, and if, in spite of it, too much light does reach the pupil, the eye suffers accordingly. This fact is now being generally recognised in England and America, and a new profession has arisen—that of illuminating engineer, whose services are requisitioned to advise clients regarding the proper illumination of their premises. Strong lights should be carefully placed, and, if necessary, suitable shades used to screen the light direct from the eye."

PUBLICATIONS RECEIVED.

"ELEMENTARY MANUAL ON APPLIED MECHANICS," by Prof. A. Jamieson. Eighth edition. London: Charles Griffin and Co., Limited, Exeter-street, Strand, W.C. Price, 3s. 6d. Among the revisions and additions made in this edition of his popular text-book the author has included definitions of electrical engineering terms and units.

"SUBJECT-MATTER INDEX ON MINING, MECHANICAL, AND METALLURGICAL LITERATURE FOR THE YEAR 1902." Edited for the North of England Institute of Mining and Mechanical Engineers by Mr. M. Walton Brown, secretary. Published by the Institute, Newcastle-on-Tyne. Price, 42s.

Bulletin of the Société Belge d'Electriciens, April, 1908. Vol. XXV.

Bulletin of the Imperial Institute, South Kensington, S.W., vol. vi., No. 1. Price, 1s.

Proceedings of the Royal Society of Edinburgh, vol. xxviii., Part 3. Edinburgh: Robert Grant and Son, 107, Princes-street; and London: Williams and Norgate, 14, Henrietta-street, Covent-garden, W.C. Price, 4s. This issue includes a contribution by Mr. James G. Gray, B.Sc., and Mr. A. D. Ross, M.A., B.Sc., "On a Sensitive State induced in Magnetic Materials by Thermal Treatment."

Journal of the Institution of Electrical Engineers, April, vol. 40, No. 188. London: E. and F. N. Spon, Limited, 57, Haymarket, S.W. Price, 5s. Contains a portrait of the late Lord Kelvin, and a few brief notes of his career by Dr. Silvanus P. Thompson. The contributions, with reports of discussions, include: "The Development of Turbo-Generators," by Dr. R. Pohl; "Cost of Electrical Power for Industrial Purposes," by Mr. J. F. C. Snell; "Magnetic Oscillations in Alternators," by Mr. G. W. Worrall; and "The Commercial Aspect of Electric Power Supply," by Mr. W. B. Woodhouse.

FORTHCOMING EVENTS.

FRIDAY, MAY 8.

Physical Society.—At 8 p.m., in the Physics Laboratory of the Royal College of Science, Imperial Institute-road, South Kensington: "A Modified Theory of Gravitation," by Dr. C. V. Burton; "An Examination of the Formulæ for the Grading of Cables," by Mr. C. S. Whitehead; "Illustrations of Geometrical Optics," by Mr. R. M. Archer.

Association of Engineers-in-Charge.—At 8 p.m., annual meeting at St. Bride's Institute.

TUESDAY, MAY 12.

Faraday Society.—At 8 p.m., meeting at the Institution of Electrical Engineers, 92, Victoria-street, S.W.

Institution of Electrical Engineers (Glasgow Local Section).—At 8 p.m., annual meeting and discussion on Messrs. Handcock and Dykes's paper.

THURSDAY, MAY 14.

Institution of Electrical Engineers.—At 8 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C., "Switchgear Control Apparatus and Relays for Alternating-Current Circuits," by Dr. C. C. Garrard.

Iron and Steel Institute.—At 10.30 a.m., annual meeting at the Institution of Civil Engineers. At 7 p.m., annual dinner at Hotel Cecil.

FRIDAY, MAY 15.

Iron and Steel Institute.—At 10.30 a.m., annual meeting at Institution of Civil Engineers.

SATURDAY, MAY 16.

Birmingham and District Electric Club.—At 7 p.m., at the Colonnade Hotel, New-street, Birmingham, "Electrical Porcelain," by Mr. H. W. Brady."

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PERSONAL.

Simplex Conduits Limited inform us that they have opened new premises at 16, Corporation-street, Manchester, and 72A, Waterloo-street, Glasgow.

Messrs. Eversheds and Vignoles have appointed Mr. S. Thomas Pemberton, of Council Chambers, 109, Colmore-row, Birmingham, as agent for the Midland Counties. He will have his headquarters in Birmingham, and his district will embrace the counties of Warwick, Worcester, Nottingham, Derby, Leicester, Stafford, and Shropshire.

The employés in the electrical department of Messrs. Vickers, Son, and Maxim held a second successful dance at the Vestry Hall, Burngreave, on the 29th ult., when a large number spent an enjoyable evening.

The following assistant engineers in the electricity department of the Fulham Borough Council have received increases of salary: Mr. H. Ellis, from £130 to £136. 10s.; Mr. T. Welch, from £130 to £136. 10s.; Mr. E. Haywood, from £117 to £123. 10s. Mr. N. A. Chesterfield, the chief clerk, has received an increase of £10, making his salary £190, and Mr. F. White, the assistant mains superintendent, has had his salary increased from £125 to £130 per annum.

The Accrington Corporation have increased the salary of the assistant electrical engineer, Mr. A. Clegg, from £150 to £165 per annum, with a further increment of £10 next year.

The Wimbledon Borough Council have increased the salary of Mr. H. Tomlinson Lee, borough electrical engineer, from £400 to £500 per annum; that of Mr. R. Torpy, deputy electrical engineer, has been increased from £200 to £225, and Mr. R. Klitz, mains superintendent, has received an increase of £25, making his salary £200 per annum.

ELECTRICAL ENGINEERS (LONDON DIVISION).

Orders for week ending Saturday, May 16.

MONDAY, MAY 11.—"A" Coy.—Infantry drill, 6 p.m.*

TUESDAY, MAY 12.—"B" Coy.—Infantry drill, 6 p.m.*
Medical inspection for recruits, 6 p.m.

THURSDAY, MAY 14.—"C" Coy.—Infantry drill, 6.30 p.m.*

FRIDAY, MAY 15.—"D" Coy.—Infantry drill, 7 p.m.*

* Practice for the drill cup competition.

Men who have not signed on in the Territorial Force can do so on their Company night.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

COMPANIES' MEETINGS AND REPORTS.

MARCONI WIRELESS TELEGRAPH.

The eleventh ordinary general meeting of Marconi's Wireless Telegraph Co. was held on the 30th ult. at River Plate House, Finsbury-circus, E.C., Sir Charles Euan-Smith, K.C.B., C.S.I., chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report, expressed regret for the long delay that had occurred since the shareholders were last called together and since a statement of the situation and financial position of the Company was placed before them. Continuing, he said: The directors, in delaying the calling of the general meeting and the issue of the accounts, have really acted in what they considered to be the best interests of the Company. Up to the middle of last year political considerations mainly weighed with them in deferring the publication of any details connected with the Company's position. The question as to the ratification of the Berlin Convention and the extent to which this ratification would be accepted by foreign Governments was still unsolved, and when his Majesty's Government finally announced their intention of proceeding to ratify the convention, Mr. Marconi was on the point of solving successfully the question of Transatlantic communication. The Board, with their former experiences before them, considered it advisable that a thorough and practical trial of Transatlantic work should take place, in order that they might be able to state to the shareholders, once and for all, that the main object of their enterprise had really been achieved. This took some time, and there was then the delay that ensued before the whole of the details necessary for the preparation of the report and balance-sheet could be collected from the many distant quarters which contribute to the revenue of the Company. We hope and anticipate, however, that such a delay is not likely to occur again, and that in future we shall be able to call you together and issue our annual report and balance-sheet each year. Before making such remarks as may be necessary in connection with the report and balance-sheet that has been submitted to you, I should like briefly to put before you what is the view of the Board as to the present situation of your Company, and as to what has been done during the past years of its existence. Our business divided itself into three principal departments: (1) Transatlantic wireless telegraphy; (2) maritime or ship-to-ship and ship-to-shore service; (3) manufacture of apparatus. The Board regard this period as having been spent in building up these three main branches of our system so that they should be permanently placed on a safe and promising commercial basis. This they claim to have now been achieved, and they can look back with satisfaction to the many difficulties that have been overcome, and to the countless obstacles that have been successfully surmounted. It will be acknowledged that the vast field which Mr. Marconi's genius opened up to our enterprise was, regarding it from a commercial standpoint, at first entirely unexplored. The development of the system had to be achieved inch by inch with a corresponding percentage of failures, which necessitated retracing certain parts of the road which was leading to success. Experience had to be bought. The powerful opposition of those whose interests were regarded as being placed in jeopardy should the Marconi Co. be successful had to be met, as it was, of course, active on every side. And, lastly, the conferences which were held on the Continent at Berlin plunged us into a sea of embarrassment. Negotiations had to be initiated and carried out in many countries of the world with public governments and private interests. Subsidiary companies had to be formed, and the general public had, to a certain extent, to be educated as to the main features of all that is comprised in a world-wide system of wireless telegraphy. As to the cable companies, their opposition to our enterprise was, and is, of course, perfectly natural. We have no grounds for complaint in this respect. Nevertheless, a study of their history in its early stages may afford consolation to our shareholders, who have as yet received no dividends. It was not till nine to ten years after the first cable was laid that even a minimum of success was achieved. But the memory of the early difficulties and struggles of the first cable company cannot but afford encouragement to ourselves in the reflection that, like it, we have had to pass through troublesome times, and may look forward to find corresponding and substantial success. But the past, with all its difficulties, its obstacles, and its disappointments, may now be regarded as finished and done with. We have now, however, laid the foundation of future success on a sound and firm basis. The tremendous achievement of regular Transatlantic communication is an accomplished fact. Wireless telegraphic communication with the United States of America is now as easy, and when the contemplated improvements are completed will, we believe, be as rapid and as easily available as that carried on by the cable companies, the difference being that we hope to accomplish the service which they render to public at a little more than 50 per cent. of the present cost. The record of the Transatlantic wireless service during the past few months carried conviction on these heads, and demonstrates its ensured potentiality. Henceforward all the efforts of your directors will be concentrated on turning to profitable account the enormous advance in all branches, and especially in the trans-oceanic service. The multiplication of facilities is now merely a matter of expenditure, which, as compared with the results that should be realisable from this multiplication and completion of our system, may be regarded as trivial and insignificant. It is, therefore, in a spirit of confidence, based, as they believe, on real and practical grounds, that the directors consider themselves fully justified in soliciting the further support of the shareholders and of the general public for the purposes of exploiting the immense resources that have recently been opened up and of securing substantial returns. The present stage is one that emphatically calls for the active and practical development of the world-wide business which we believe to be ensured to the Company by reason of its valuable agreements and concessions secured in various parts of the globe. The extent of the benefits which will accrue to the shareholders depends on the adequacy and even still more on the celerity with which the Company is placed in possession of the necessary means to reap the harvest which awaits the sickle, and also to the extent of the area over which their operations can be conducted. It is essential to lose no time in occupying the vast area that lies open to our efforts.

With these remarks, gentlemen, I will now proceed to the consideration of the report. First as to the balance-sheet. The Board have every reason to be satisfied with the reception which the report and balance-sheet has received at the hands of the public and the Press, and with the appreciation which has been given to the immense amount of work that has been actually achieved. The Company have, nevertheless, been subjected to some criticism insomuch as no profit and loss account was issued with the balance-sheet, as has been done on two or three former occasions. But there are very special reasons for their withholding the profit and loss account on this occasion. They acted on the advice given, after prolonged consideration, by their solicitors and auditors. As a matter of fact, we had, by the sale of shares and in other ways, realised an apparent net profit of over £32,000, which has been put back into the capital account. Further, as the balance-sheet and report will be looked upon as forming the basis for the issue of fresh capital for which we are now requesting the sanction of our shareholders, it was considered advisable not to put anything before the public which could in any way be regarded as laying claim, up to the present, to making regular profits. This was the reason which mainly influenced the decision of the Board, and which we hope the shareholders will appreciate. The other items of the balance-sheet on which I should like to make some remarks are as follows: The paragraph as to Transatlantic communication is, I think, so full that it needs very little elaboration from me. I would, however, mention that the rough estimate given as to the results of the working of the contemplated English-American service will receive much fuller expansion in the prospectus which will shortly be issued to the public and shareholders for the increase of capital, in which it will be demonstrated with such skill and clearness as is possible in an enterprise of this character that the working of our business and of the Transatlantic stations on each side of the ocean should result in the realisation by the Marconi Wireless Co. of profits far more than sufficient to pay the interest both on the proposed preference shares and on the existing ordinary shares. The progress that has been made in our ship-to-shore business in connection with what is now an established Marconi wireless exchange has been constant. If you will look at the map we

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issued you will see at a glance the network of wireless communication which we have established on the North Atlantic. In the opinion of the directors there is not the slightest doubt that the ships using the exchange would, if we had the freedom to develop our business undisturbed, increase to an enormous extent for the benefit of the shipping world of all nations alike. But the governments looked at the maritime wireless business from another point of view, and, led by Germany, opposed the organisation we had established.

The policy that I have endeavoured to explain above, as far as possible, of letting bygones be bygones and of turning our attention entirely to the possibilities of the future is dealt with in the paragraph headed "Intercommunication." At the time of the last conference in Berlin and for many months afterwards, your Board undoubtedly felt themselves aggrieved as to the action taken under the direction of his Majesty's Government in regard to the conference and their acceptance of the principles of international communication, and in consequence, prompted by sincere conviction, our policy for a long time was to endeavour to impress on the various Government departments the injury which we considered this acceptance by the Government had done and was doing to public interests, in addition to the prejudice that we ourselves had received therefrom. The persistence with which we endeavoured to gain from the authorities concerned their adherence to the view which we put before them was pushed to a point at which it became evident to us that it must cease. We made no practical business progress in gaining any adherence to the policy which we wished to see prevail, and the great majority of the directors on the Board arrived, at a given period, at a decision that this policy should now cease, and that we should no longer maintain an attitude of opposition to the Government departments which had this one single and fatal defect—that it stopped all business in connection with them, was very expensive, and in the end was becoming highly prejudicial to the best interests of the Company. This was very much the case also with Lloyd's. The Board, therefore, considered it was in the Company's best interests to notify the Government that, whatever their own convictions might have been, they wished to adopt a course of action that would place them more *a rapprochement* with the Government departments, lead to a *detente* of the strained relations, and lay the ground for substantial and profitable results. This change, which took place in February last, after prolonged consideration, has been productive of promising results. We have indicated to the Postmaster-General our acceptance, under certain provisoes, of the principle of intercommunication, and the Post Office, on their side, have acquiesced in and promised their most favourable consideration and support to several very important matters which we consider as material to our welfare, and which, as I believe we shall now receive the support of the Post Office, the Colonial Office, and the Admiralty, is thus securing compensating sources of revenue, and laying still more firmly the foundation of our future prosperity. The Foreign Office has also recently accorded us their support in a matter of great importance in a foreign country, which has secured for us another most promising field of action. These facts, taken in conjunction with the recommendations made by the Select Committee as published in the report, acknowledge our right to be pioneers of practical wireless telegraphy, and recommend generous treatment and place us, as we may well hope, in a strong position with the Government. We trust that our shareholders will approve of what has been done in this matter of policy. Fighting is an excellent thing as long as one fights for some purpose, but to continue running one's head against a brick wall cannot, from any point of view, be considered a wise permanent policy. I may add that the general terms in which I have just intimated the friendly intentions of the Post Office have been embodied in a letter from the Postmaster-General, which lays down in so many words his willingness at once to enter upon a favourable consideration of many of the points which we submitted for his consideration.

As to our general progress throughout the world, the report has, I think, made it clear that we are now securing profitable business all over the face of the globe. America, Canada, South America, France, Italy, Russia, Belgium, and China all come to us for apparatus and installations, and we feel from the very nature of the business that the field is almost limitless in its profitable opportunities. Indeed, the Board is convinced that within a short time the adoption of a system of wireless communication will become obligatory on every recognised State or nation. As we believe our system to be the best, we are sure that we shall secure at least a large proportion of business offered. Our manufacturing station at Dalston is splendidly equipped and designed to meet all foreseen demands, and our training school for teaching wireless telegraphy is accomplishing all that we hoped for when it was first installed. In Paris, I may mention that since the beginning of the year 1907 a receiving office has been opened at the headquarters of La Compagnie Française Maritime et Coloniale de Telegraphie sans Fil, 35, Boulevard des Capucines, where messages can be handed in for transmission by wireless telegraphy to passengers on board such ships at sea as may be fitted with our apparatus. The French company accepts these telegrams and transmits them to their destination, whether for a short or long distance, by means of the coast stations which the Marconi Wireless Co. has established in England, Canada, and the United States. This arrangement is one of considerable public utility, and is much appreciated by the French public, as the number of messages handed in and paid for shows a continuous and encouraging increase. As to Lloyd's, our relations with this great association have now been placed on so satisfactory a footing that we hope to avoid in the future the litigation that has been not infrequent in the past. We trust, if possible, by friendly communication to settle any points about which we may differ. I need not tell you that as regards Trinity House and the Board of Trade, we trust that the installations of our system on the Trinity lightships which is there reported may and should receive great expansion. We think that nothing could be more useful on a lightship than the Marconi apparatus, which can deal so instantaneously and effectively between shore and ship.

Mr. Marconi, who is possessed of high abilities as a business man in addition to his scientific attainments, offered, until a suitable business manager had been found, to carry on the management of the Company, in addition to his own scientific work, in succession to Mr. Cuthbert Hall. So far he has been singularly successful, and since his assumption of office has succeeded in effecting considerable economies in the administrative staff. It is not, of course, intended for one moment that Mr. Marconi should be permanently burdened with the conduct of the ordinary business details, as his assistance is most needed in the scientific supervision of the affairs of the Company. As soon as a suitable business manager can be found he will be relieved of his duties as managing director. I am glad to be able to announce that he has signed a fresh agreement with the Company whereby we have secured his services as technical adviser for a further period of three years. It is with great regret that the Board had to acquiesce in the decision of Mr. Bannatyne that he is compelled to retire from the Board. Mr. Bannatyne's health was mainly responsible for this decision. I should like, before passing to the question of the increase of capital which will form the subject of a resolution, to ask you to join in a vote of thanks to Mr. Marconi and the executive staff here and abroad, and to the staffs of our various associated companies, for the energy and zeal and abilities with which they have, one and all, worked for the prosperity of the Marconi wireless companies. As you are aware, we have the majority control in all of these subsidiary companies. Mr. Marconi has been untiring in the efforts which have resulted in his securing a reputation that is honoured and respected throughout the world. In furthering our business he has crossed the Atlantic no fewer than 45 times, and he is entirely wrapped up in the interests of the Company. The staff have one and all worked with zeal and success, and it is but just that their services should be fully acknowledged.

Mr. Marconi, who seconded the adoption of the report, intimated that the working of the Transatlantic service during the past 7½ months had in every way confirmed the view which he had held for a long time—viz., that wireless telegraphs can furnish and will furnish a new and economical method of communication with America and other distant countries. For some months past the majority of their messages and communications had been carried across the Atlantic during the daytime, and no interference whatever with the working of the ship-to-shore communications had been caused by the operation of the powerful long-distance Transatlantic stations. Though no special attempt had been made so far to work at a high rate of speed, he had been informed that a speed of 24 words per minute had been achieved. With slight modifications, a speed of at least 30 words a minute could be obtained. Soon each station would be able to send at the same time as it received messages. If this was applied to Transatlantic stations, it should double their effective rate of telegraphing. In reference to long-distance communication, he said the Italian Government had entered into an agreement for the construction of high-power stations in Abyssinia, while it was hoped that a communication might be carried out for ordinary post office or commercial service between England and Italy. In conclusion, he expressed the belief that wireless telegraphy was destined to become an indispensable aid to civilisation in affording a new and economical means of communication with countries at a great distance as well as with ships at sea.

An extraordinary meeting was afterwards held, when the Chairman moved that the capital of the Company be increased to £750,000 by the creation of 250,000 preference shares of £1 each, conferring the right to a fixed cumulative preference dividend at the rate of 7 per cent. per annum, with participation in additional profits under certain conditions.

Mr. H. Jameson Davis seconded the resolution, which was carried unanimously without discussion.

SWANSEA TRAMWAYS.

The sixty-seventh ordinary general meeting of the Swansea Improvements and Tramways Co. was held last week. Mr. C. G. Tegetmeier, the chairman, presided.

The Chairman, in moving the adoption of the report and statement of accounts, said the road mileage worked last year was the same as in the preceding year, and it was satisfactory to find their traffic receipts had increased by £3,941. The readjustment of fares which came into effect on July 1 last year benefited their receipts on an average about one-fifth of a penny per passenger. Repairs and maintenance had cost £6,293, or £895 more than in the preceding year. The power and running expenses had been practically the same, although in the last six months the expenditure was £461 higher than in the corresponding six months of 1906. The amount payable to the Corporation of Swansea for the extensions which were constructed by them and leased to the Company was £7,271. 5s. 10d., the same as in the preceding year, but it represented nearly 7 per cent. on the amount expended by the Corporation on the work. That was a high rate to pay, and, as far as the extensions were concerned themselves, he did not think there was much, if any, margin of profit left, but they benefited considerably by the increased traffic which the extensions had induced over the older portions of the system. In the administration and general expenses there was a reduction of £262. After the payment of debenture and other interests, which amounted to £2,786, there was a surplus on the year's working of £11,530, compared with £9,039 for the preceding year. For the first half of the year there was paid on the preference shares £1,299, and £1,000 was carried to reserve and depreciation fund, and out of the remaining profits they had placed £2,500 to provision for renewals with the view of providing a special fund to meet extraordinary expenditure of renewals and reconstruction. After the charge on the profit and loss account, they had, with the amount brought forward, a

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balance of £8,731 for distribution, and recommended that £2,000 should be placed to reserve and depreciation fund, which would then stand at £23,858, and would allow, after the payment of a half-year's dividend on the preference shares, the payment of a dividend for the year of 3 per cent. on the ordinary shares. This was the first year they had been able to recommend a higher dividend than 2½ per cent. on the ordinary shares, which had been paid since the electrification of the lines. It would be seen that there was a net profit on their working of £11,350, and of that they had set aside £3,500 to strengthen their financial position. The amount so set aside was equal to 3 per cent. of the whole share capital of the Company, and they would be able to reduce their floating liabilities by £3,963. Since the close of the year they had instituted a parcels delivery system in connection with their ordinary service of cars. They were discussing with the Swansea Corporation an arrangement for repaving the whole of High-street with wood blocks.

Mr. BOND seconded the motion, which was carried.

BARNSLEY ELECTRIC TRACTION.

The seventh annual meeting of the Barnsley and District Electric Traction Co. was held last week in London, Mr. E. Garcke presiding.

The report showed total revenue £9,065, and expenditure £7,455, including £408 placed to provision for renewals account, leaving a profit of £1,609. 16s. 6d. Adding £452 brought forward, the available balance was £2,062; £250 was placed to depreciation and reserve, £350 to sinking fund for the redemption of loans and mortgages, £1,200 preference dividend, and £262 carried forward. It had been decided to create a provision for renewals account, setting aside out of revenue a minimum of ½d. per car mile for this purpose. The total capital expenditure up to the end of 1907 amounted to £67,403, including £421 expended during the year. Since the closing of the accounts an issue at par had been made of £1,000 in 4½ debenture stock and £2,000 in 6 per cent. preference shares of £5 each. The sum received from this issue had been employed in liquidating a portion of the debt owing on capital account. There was a satisfactory increase of £279 in traffic receipts compared with the previous year, but the expenses were higher owing chiefly to the cost of overhauling the cars and their electrical equipment. The net result showed an increase of £26. 19s. 11d. over 1906. An application had been made to the Corporation for a revision in the price at present charged the Company for electrical energy, but up to the present they had not acceded to the request, and the directors were considering what further steps should be taken. The Company had joined the British Electrical Federation, which had been formed by various electric traction and lighting companies for the purposes of co-operation and joint action in matters of common interest.

The CHAIRMAN, proposing the adoption of the report, said the revenue for the year showed an improvement, notwithstanding the very bad weather experienced, and the expenses of working were less.

The report was unanimously adopted.

BRITISH WESTINGHOUSE ELECTRIC.

The eighth annual general meeting of the shareholders of the British Westinghouse Electric and Manufacturing Co. was held on Monday at Hamilton House, Victoria-embankment, E.C., Mr. J. Annan Bryce, M.P., the acting chairman, presiding.

The CHAIRMAN, in moving the adoption of the report, referred at the outset of his remarks to the bearing of the recent financial crisis on the fortunes of their Company. He was glad to be able to state that the Westinghouse Machine Co. had already, as from March 31, been relieved from its receivership and had been restored to its stock holders. In the case of the Electric Co., negotiations were proceeding to the same end. In order to provide for the future needs of their busines without the assistance of the American companies, they called their debenture stockholders together in December last, and a resolution was passed authorising the creation of £300,000 prior lien debentures at a rate of interest not exceeding 6 per cent. This amount of debentures had been created, and £250,000 had been placed at the price of £98 per cent. A prolonged negotiation with the receivers of the Electric and Machine Companies resulted in their agreeing to take Traction and Power Securities Co.'s shares at par for the amount shown in the balance-sheet to the credit of those companies—namely, £186,374—to which had since been added a further amount for interest. The whole amount had been liquidated by the transfer of a corresponding amount of those shares at par. He pointed out that the position of the shareholders was in no respect made worse by the issue of the prior lien debentures, which would be used to the extent of £123,000 in paying off bankers' loans, and, as regards the balance, in providing further working capital. The arrangement under which the indebtedness of the American companies had been cleared off by the transfer of Traction and Power Securities Co.'s shares at par released £186,000 of capital hitherto invested in securities. Turning to the balance-sheet of Dec. 31, 1907, with regard to the first item on the debit side—capital authorised and issued, £1,875,000—this was the paid-up capital of the Company as reduced by the writing off of £1,375,000 in accordance with the resolution passed at the last meeting, to which the sanction of the Court was given in July of last year. The next figure, £1,241,353 4 per cent. mortgage debenture stock, remained the same as before. Loans from bankers against securities, £123,052. 10s., had already been reduced by over £100,000 out of the proceeds of the prior lien debenture issue, and the balance would be paid off as instalments on that issue were paid. The amount at present was about £10,000. American Westinghouse Co.'s £186,374. 7s. 2d. had been liquidated by the transfer of Traction and Power Co.'s shares as mentioned above. nterest accrued on debenture stock and loans had since been paid off. Sundry creditors, £145,240, was in respect of accounts outstanding for supplies, etc., of which some £40,000 were in respect of extensions on contracts, the payment of which was not yet due. This item amounted last year to £230,999. 4s. 11d. Reserve for employers' liability was £5,588. 4s. 10d. Owing to the very heavy rate which the insurance companies required them to pay for undertaking their liability under the Workmen's Compensation Act, they came to the conclusion, some two years ago, that it would be in the interests of the Company to take its own risk so far as the works employés were concerned, and they therefore created a reserve fund at a rate per cent. on wages paid considerably less than that demanded by the insurance companies. So far the result, as shown by the figure standing to the credit of that account, had been satisfactory. Coming to the credit side of the balance-sheet, the item purchase money of patents, goodwill, etc., represented the reduced amount of ordinary shares. The expenditure of £4,358. 8s. under building account had been authorised by the directors for improvements calculated to reduce current expenses. The cost of maintenance of the works, as also of the machinery, plant, tools, etc., had exclusively been charged against revenue as before. Stock and material on hand and in process of manufacture was carefully reviewed at the time of the capital reduction, and, in so far as could be ascertained at that time, a conservative allowance was made for obsolete stock and material, both finished and unfinished. There were, however, certain unsettled matters then outstanding which had since been cleared up, and the final accounts of transactions prior to the year 1907 showed the necessity for the further provision of £17,000, which appeared in the profit and loss account for the period under review. It was satisfactory that more than 80 per cent. of the expenditure on completed work on contracts had been met by receipts on account, and that the item of sundry debtors was about £27,000 less than a year ago, notwithstanding a material increase in business. Shares and debentures in other companies since the date of the balance-sheet had been reduced by the liquidation of the debt of the American Westinghouse Companies. More than 95 per cent. of this item was represented by holdings in the Traction and Power Securities Co. and in the Clyde Valley Electrical Power Co., the former being largely interested in the Mersey Railway, which was a constantly improving property. The Clyde Valley Co. had made decided progress since since the last report, and the directors had good hopes of the future prosperity of this undertaking. The trading profit of £92,339. 9s. 5d. showed a marked improvement over the last yearly accounts—namely, those of July 31, 1906—when the trading profit was only £7,567. Now they had been able to provide for not only debenture interest and the interest on bank loans, etc., but had been able to provide certain sums for depreciation of stock, material on hand and in process of manufacture, leaving a balance of £11,341. 5s. 1d. to be carried forward. During the year 1907 departmental trading accounts had been kept, and each department of the works, so far as the accounts are concerned, had been run as a separate business. This had enabled the directors to review the business in detail, with the result of economies and special efforts toward improvement, which heretofore had not been practicable. A great improvement was shown both in the volume of orders and in the reduced cost of manufacture. The output per £1 of pay roll had steadily increased, or, in other words, with a 2 per cent. lower pay roll more than 10 per cent. additional value of apparatus had been produced. Slightly more had been expended on maintenance of buildings than in the previous year, but the economies in the maintenance and operation of machinery and tools had resulted in a saving of more than £10,000. Further reductions in salary list and general expenses resulted in an additional saving of about £26,000. Selling expenses were rather higher than in the preceding year, owing to an increase in office expenses abroad, but the percentage of cost of selling to the amount of orders booked had been less than the preceding year. The total increase of shipment for the 12 months, as compared with the preceding year, was about 17 per cent. The business in prime movers, both gas-engines and turbines, had been considerable, and the uniform success of their new gas-engines encouraged the directors in the belief that this branch of the business would continue to increase and prove profitable. With a view to improved efficiency and economy in manufacture, many important lines of apparatus had been redesigned during the year in order to meet the severe competition, both at home and abroad. The export business had shown considerable increase, and new agencies had been established in various quarters of the globe. The arrangement entered into as regards South America, and reported at the last annual meeting, had proved satisfactory. Several contracts had been taken on the Continent in co-operation with the French Westinghouse Co., and additional business from this source was anticipated. The orders showed an increase of more than 30 per cent. over the preceding year. So much had lately appeared in the Press regarding the condition of electrical industries in Great Britain that he did not need to dilate on the question. Competition was certainly more severe than ever, and prices had been on a descending scale during the year, notwithstanding the high prices of raw materials. At this moment trade was decidedly slack, with little prospect of revival until after the summer months. The directors were meeting this situation, so far as they could, by continuing their efforts to increase the volume of business and at the same time to effect economies in working so far as was consistent with the maintenance of the organisation in an efficient state. He could not, he added, conclude without alluding to the loss which the Company had suffered by the death of the illustrious Lord Kelvin, who had acted as technical adviser of the Company since its foundation.

Mr. J. H. LUKACH seconded the motion, which was unanimously adopted.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS AND LIGHTING.

The report of the South Metropolitan Electric Tramways and

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Lighting Co. for 1907, to be presented to the meeting on the 11th inst., states that there has been expended during the year on capital account the sum of £40,580, making the total expenditure to Dec. 31 last £486,800. The total revenue for the year amounted to £51,370. After deducting all expenses chargeable to revenue, including £6,000 for interest on debenture stock and providing for payments to local authorities under agreements amounting to £1,230, there remains a surplus of £8,477, making, with £339, the balance brought forward from the last account, a total of £8,816 which the directors recommend should be appropriated as follows: to the dividend on the preference shares for the year (already paid), £8,386; to be carried forward, £430. Traffic receipts derived from the working of the tramways and light railways amounted to £41,413, being an increase of £23,688 over those for the previous year, when the tramways and light railways were being opened in sections, consequently no useful comparison is yet available. The bad weather experienced throughout the year, and especially during the summer months, has very adversely affected the traffic receipts. The through service of cars between Penge and Croydon was established on June 24, 1907, under the terms of the agreement with the Croydon Corporation referred to in the last report. The increased traffic receipts on the Penge section indicate that the facilities thus provided have been appreciated by the public. The extension of the London County Council system to the Company's terminus at Tooting has resulted in increased traffic receipts on the Croydon to Tooting section. The directors inaugurated a parcels express delivery on the system on April 6, 1908. Gross receipts from the electrfcity supply section of the undertaking amounted to £7,371, as compared with £5,435 for the previous year. After deducting depreciation in respect of battery sold amounting to £469, there is a balance of £2,975, as compared with £2,671 for the previous year. The installations connected to the mains at Dec. 31 represent the equivalent of 43,657 8-c.p. lamps, an increase of 59 per cent. over the previous year. The number of consumers connected to the mains at Dec. 31 was 603, as compared with 472 for the previous year.

SLOUGH AND DATCHET ELECTRIC SUPPLY.

The fifth annual report of the Slough and Datchet Electric Supply Co. for the year ended Dec. 31, 1907, states that the capital expenditure at the end of the year 1906 was £43,391. 14s. 3d., and during last year a further sum was expended on capital account amounting to £1,494. 10s. 4d., bringing the total up to £44,886. 4s. 7d. The following table shows the progress of the Company, the equivalent of 1,746 additional lamps of 8 c.p. having been connected last year:

	Lamps and motors connected.	Units sold.	Profit.
1903	3,126	32,637	£605
1904	5,608	139,402	1,333
1905	8,605	142,433	1,473
1906	11,326	253,041	2,436
1907	13,072	250,248	2,222

The total net profit available for distribution is £2,756. 6s. 5d. Out of this the directors purpose setting aside £750 to the depreciation fund, and the shareholders will be asked to vote £300 to the directors for their services. The directors recommend that out of the remaining net profit a dividend of 3½ per cent., less tax, be declared, and that the balance be carried forward. The directors greatly regret to have to report the death of their valued colleague, Captain C. C. Higgins, one of the first directors of the Company. Mr. H. R. de Salis, A.M.I.C.E., has been unanimously elected by the directors to a seat on the Board. The mains, works, plant, and machinery have been maintained in an efficient condition out of revenue. The directors retiring in rotation are Messrs. R. A. Bosanquet and A. A. Somerville, who, being eligible, offer themselves for re-election.

WINDSOR ELECTRICAL INSTALLATION.

The twelfth annual report of the directors of the Windsor Electrical Installation Co. for the year 1907 states that the number of lamps and motors installed at Dec. 31, 1906, was equivalent to 39,262 of 8 c.p. During the year 2,909 were added, bringing the total to 42,171 at the end of the year 1907, of which 3,498 represent the motor power. The capital expenditure at the end of the year amounted to £83,954. 4s. 4d., being an increase during 1907 of £1,427. 11s. 1d. The profit for the year (including £170. 3s. 8d. brought forward) was £4,929. 11s. 6d., to which the directors have added £250 from the dividend equalisation fund, making a total of £5 179. 11s. 6d. From this the following sums have to be deducted: debenture interest, £835; depreciation, renewal, and reserve fund, £1,000; dividend on 5 per cent. preference shares, £950; directors' fees, £300; leaving a balance available for dividend on the ordinary shares of £2,094. 11s. 6d. Out of this the directors recommend that a dividend of 4 per cent., less income tax, be paid on the ordinary shares, and that the balance of £194. 11s. 6d. be carried forward. The directors retiring in rotation are Mr. E. Riley and Sir William Shipley, and, being eligible, offer themselves for re-election.

NATIONAL ELECTRIC CONSTRUCTION.

The report of the National Electric Construction Co. for 1907, to be submitted to the meeting on May 11, states that the gross profit for the year is £29,776, and deducting expenses of administration, etc., there remains a balance of £18,116, to which has to be added £2,343, the balance carried forward at Dec. 31, 1906, making a total of £20,460. The directors recommend that there be placed to reserve £3,000; that expenses of and discount of debenture issue, £4,487, be written off; that there be reserved against capital charges on town lighting installations, £1,200; transferred to debenture redemption fund £1,550; reserved to cover doubtful debts £500, and set aside against depreciation £673, leaving to carry forward £9,047. The depression which prevailed during the year under review appears to be passing away, and it may now be possible to finance some of the concessions secured before the depression set in. Negotiations are in progress to this end, and the directors anticipate that arrangements to enable at least two of the concessions to be dealt with will shortly be completed. Should these hopes be realised, the directors will take into consideration the declaration of an interim dividend. The debenture issue referred to in last year's report was successfully placed, and the directors recommend that the expenses connected therewith should be written off. The annual premium on the sinking fund policy for the redemption of the debentures at maturity, which is being provided for out of profits, should be sufficient for depreciation in the future, unless circumstances make it necessary for special provision to be made in respect of any particular asset.

DIESEL ENGINE.

The report of the Diesel Engine Co. for the year ended March 31, 1908, to be presented at the meeting on the 14th inst., states that the credit balance of profit and loss account is £20,721, to which has to be added £3,488 brought forward, making a total of £24,210. The sum of £10,000 will be required to pay the proposed dividend of 10 per cent., and the directors suggest placing £7,000 of the balance to the general reserve account, thus increasing this reserve to £10,000, and carrying forward £7,209. The directors congratulate the shareholders upon the prosperous position which the Company has now attained, and which appears to fully justify their anticipations last year. The number of orders has been well maintained, and many of these are repeat orders, which is the best indication of the satisfaction given to the users of the Company's engines. The value of the orders carried over on March 31, 1908, to the current year is considerably greater than of those carried forward at the same date last year. These orders all show a profit, the greater part of which will be for the benefit of the current year's business. During the past year the directors have thought it desirable to appoint Mr. W. T. Batho, who has been in the Company's service almost since its beginning, as manager in place of Mr. Browett. Mr. Browett being so well known in the engineering and electrical trades, it was considered to be in the Company's interest that he should devote his time to following up inquiries with a view to obtaining orders. He is now engaged in this undertaking and bringing to public notice the many advantages and great savings that can be effected by the use of Diesel engines. Since the last ordinary general meeting Mr. Carl Jeppe, to the great regret of his colleagues, has reluctantly resigned his seat on the Board, owing to private business causing him meantime to take up his residence abroad. The directors do not at present propose to fill the vacancy.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The report of the Eastern Extension, Australasia, and China Telegraph Co. for the half-year ended Dec. 31, 1907, states that the gross receipts, as shown in the revenue account, amounted to £304,416, against £296,393 for the corresponding half-year of 1906. The working expenses, including £26,069 for maintenance of cables, absorb £154,203, against £139,549 for the corresponding period of 1906, leaving £150,212. From this is deducted £19,770 for income tax payable in England, interest on mortgage debenture stock, and other extraordinary expenditure, leaving as the net profit for the half-year £130,442. After adding £74,947 brought forward from the previous half-year, there is an available balance of £205,389. One quarterly interim dividend of 1½ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1907. The sum of £50,000 has been transferred to the general reserve fund, and £20,389 carried forward. Several partial renewals of the Company's cables have been effected during the half-year, and the cost, amounting to £28 846, has been charged against the general reserve fund. Since the close of the year the Company's new direct cable between Java and the Cocos Islands has been successfully laid and opened for traffic.

LISBON ELECTRIC TRAMWAYS.

The report of the Lisbon Electric Tramways for the year ended Dec. 31, 1907, to be presented at the meeting on the 15th inst., states that the result of the Company's operations for the past year, after deducting interest and amortisation due on the debentures of the Companhia Carris de Ferro de Lisboa, and after the payment of £25,000 for interest on the debentures of this Company and the payment of London office expenses and directors' remuneration, shows a net profit of £92,803, which, added to £15,711 brought forward, gives a balance of £108,514. From this amount £35,000 has been placed to depreciation, and after writing off £9,077 from this account for renewal of permanent way the balance to credit of depreciation reserve account amounts to £135,922. This reserve is indispensable, and, indeed, still further increase is necessary in view of the fact that the track and plant generally have been in constant use for many years and will now require renewals from time to time. The amount of £5,000 has been added to the credit of exchange reserve account, making the total of this account £20,000. After providing for the above, an available balance of £68,514 remains, out of which the usual prefer-

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ence dividend amounting to £25,533 has been paid, and the directors now recommend the payment of a dividend of 5 per cent. for the year 1907, amounting to £29,709 on the ordinary share capital of £594,188, leaving £13,271 to the credit of profit and loss to be carried forward. The political unrest and financial depression throughout the country, together with the effect of the abnormally bad weather during the year, have combined to check that steady increase of traffic which the Company might otherwise have expected. Operating expenditure also shows a considerable increase due to the enhanced price of coal and other supplies; but, notwithstanding these drawbacks, the operations of the Company during the past year have practically maintained the satisfactory figures of the previous year. Capital expenditure has amounted to £72,271, mainly on additional machinery, rolling stock, cables, and the electrification of the lift on the Elevador Do Carmo. The lease of the Elevador Do Carmo, entered into in the previous year, has resulted in a fair return being earned on the expenditure incurred.

EASTERN TELEGRAPH.

The report of the Eastern Telegraph Co. for the half-year ended Dec. 31, 1907, states that the revenue amounted to £595,482, from which are deducted £198,228 for the ordinary expenses, and £63,526 for expenditure relating to maintenance of cables, depreciation of spare cable, sundry differences in exchange, and income tax payable abroad, leaving £333,727, to which is added £41,651 brought from the preceding account, making a total available balance of £375,378. After providing for income tax payable in England, interest on mortgage debenture stock, and dividends on the preference stock, which in all absorb £82,583, there remains £292,794, out of which the directors have placed £7,000 to the reserve fund for maintenance ships, and £70,000 to the general reserve fund, and have paid an interim dividend of 1½ per cent. on the ordinary stock, amounting to £50,000. The directors now recommend a final dividend on the ordinary stock of 1½ per cent. and a bonus of 2 per cent., amounting together to £130,000, free of income tax, and making, with the three previous payments on account, a total distribution of 7 per cent. for the year ended Dec. 31, 1907. It is proposed to carry forward the balance of £35,795.

POTTERIES ELECTRIC TRACTION.

The report of the Potteries Electric Traction Co. for the year ended Dec. 31, 1907, states that there has been expended on capital account during the year an amount of £3,880, principally on doubling portions of the permanent way. The total revenue for the year amounted to £111,670, being an increase of £2,404. After deducting all expenses chargeable to revenue, including £11,381 for debenture and other interest, there remains a surplus of £27,874. To this has to be added £616 brought forward, making a total of £28,491. The directors recommend to place to renewals fund £3,500, to place to depreciation and reserve account £2,500, a dividend at the rate of 4 per cent. per annum on the ordinary shares, and to carry forward £441. The depreciation and reserve account will then stand at £19,000. During the year £13,773, as compared with £7,765 in 1906, has been expended on the improvement, renewal, and repair of the permanent way, of which £6,299 has been charged against the year's revenue, and £7,474 to the renewals suspense account, in regard to which a fund was created at the last general meeting. An application is being made for parliamentary powers to double the existing lines from time to time where the Company may require.

WESTERN TELEGRAPH.

The report of the Western Telegraph Co. for the half-year ended Dec. 31, 1907, states that the revenue amounted to £353,814, and the working expenses to £126,862. After providing £16,000 for debenture stock interest and £4,464 for income tax, there remains £206,487, to which is added £6,864 brought forward, making a total of £213,351. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £120,000 to the general reserve fund, £5,000 to the maintenance ships reserve fund, £10,000 to the marine insurance fund, and £10,000 to the land and buildings depreciation fund, there remains £5,972, which is carried forward. The amount of £100,000 has been appropriated from the general reserve fund as a provision to meet the market fluctuations on investments. The directors regret to report the death of their colleague, Mr. John Coppen, on Nov. 20, 1907. Mr. John Gordon has been appointed to the vacancy.

NEW COMPANIES REGISTERED.

Safety Light.—Registered April 22. Capital, £150,000 in £1 shares. Objects: to adopt a certain agreement (the parties to which are not named), to acquire and turn to account inventions, processes, patents, brevets d'invention, licences, concessions, rights, and privileges, and to carry on the business of electrical engineers, producers of electric light or power, gas makers, vendors and suppliers, water-supply engineers, founders, toolmakers, etc.

Liens Registered.

Yenesei Copper Co., Limited, London, E.C.—Lien April 23, £45,000 debentures, part of £100,000. Amount previously issued, £15,000. Trustees: A. G. Tershoff and P. B. Litwin. Property charged: undertaking and all property, present and future.

British Westinghouse Electric and Manufacturing Co., Limited, London, W.C.—Trust deed dated April 10 for securing a series of £300,000 6 per cent. prior lien debentures of £100 each. Trustees: Merchants' Trust, Limited. Property charged: lands and works situated at Trafford Park, Manchester, together with fixtures, fixed plant, and machinery, subject to certain charges, also on other assets for the time being, present and future, including uncalled capital.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Aberdare.—The District Council have decided to install the electric light throughout the district.

West Bromwich.—The Town Council have decided to extend the electricity mains to Gold's Hill at an estimated outlay of £1,374.

Wednesbury.—The Local Government Board have sanctioned the borrowing of £7,107 by the Town Council for the provision of a plant for generating electricity.

Kendal.—In connection with the Corporation electricity supply there were 730 units of electricity used last quarter over and above the corresponding quarter last year.

Tythegston.—A joint committee has been appointed by the Tythegston and Pyle Parish Councils to consider a scheme for electrically lighting the district.

Stafford.—The output of electricity from the electricity works for the past month shows an increase of 8½ per cent. as compared with the corresponding period of last year.

Walsall.—The Local Government Board will hold an inquiry on May 15 into the application of the Corporation for sanction to borrow £4,000 for the purposes of their electricity undertaking.

Beckenham.—An inquiry will be held by the Local Government Board on May 19 into the Council's application for sanction to borrow £5,107 for the purposes of their electricity undertakings.

Newcastle-on-Tyne.—The City Council have decided to draw the attention of the gas company to the existence of so great a proportion of sulphur in the gas supplied as to be prejudicial to health.

Canada.—In the Saskatchewan Legislative Assembly the Provincial Government announced that the Bell Telephone Co. were willing to sell their system in the province to the Government.

Acton.—The proposal of the Acton Electricity Committee to charge a meter rent of 2s. 6d. per quarter on the electricity meters has been deferred until after the expert has advised the Council on the whole scheme.

British Electric Calibrated Fuse Co.—This firm ask us to announce the transfer of their head office from London to Harpenden, where all communications should be addressed, and where all orders will be executed.

Hull.—The Corporation Electric Lighting Committee have authorised the purchase of a site in Buckingham-street for a sub-station for the nominal sum of £50. The estimated cost of the equipment of the sub-station is £10,000.

Gourock.—The Board of Trade have revoked the Gourock Electric Supply Order, 1901, as confirmed by the Electric Lighting Orders Confirmation (No. 8) Act, 1901, as to the whole of the area of supply, as from April 13, 1908.

Calcutta Electric Supply Co.—The directors have decided, subject to audit, to recommend the payment of a final dividend at the rate of 9½ per cent. per annum for the half-year ended Dec. 31, 1907, making 8 per cent. for the year.

Major's Insulating Varnishes.—Messrs. Major and Co. desire us to announce that they have closed their branch establishment at Elland-road, Leeds. All correspondence will now be dealt with and business transacted from their head office, Sculcoates, Hull.

Aston.—The report of the Electricity Committee upon the past year's operations of the department show that a profit of £3,127 has been made. The receipts for current show an increase of £4,737, notwithstanding the increase in price of coal, which absorbed £370.

Accrington.—The Electricity Committee have resolved to provide a water-cooling tower to deal with 150,000 gallons per hour, with the necessary foundations and enlarged dam, and to make application to the Local Government Board for sanction to borrow £1,400 to defray the cost.

Kensington.—The Borough Electricity Committee are recommending the provision of lowering contact gear for the electric arc lamps situated in certain streets, owing to the great risk to which the Council's workmen are at present subjected in being required to ascend and work from an extension ladder when cleaning, repairing, or placing carbons in the lamps.

Swansea.—The Electricity Committee has lately been considering suggestions with a view to the development of the commercial side of the electricity undertaking of the borough, and a report on the subject by the engineer (Mr. Prusmann) will be considered at next Wednesday's meeting. The balance-sheet is now almost completed, and it is stated that it will show a substantial improvement on previous years.

Bridlington.—The Council have resolved to purchase a Koismoid time checker for use at the electricity works at a cost of £12. The town clerk having reported that the Property Committee were willing to contribute £150 towards the cost of a Tirrill regulator, to be installed at the electricity works, it was resolved that the Electricity Sub-Committee and the borough electrical engineer inspect Tirrill regulators in use at Grimsby and Lincoln.

Loch Lomond.—The Post Office authorities have just completed the laying of a new cable across Loch Lomond between Luss and

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Rowardennan, with the view of giving telegraphic facilities to the latter place Hitherto telegrams have either had to be ferried across from Luss or sent by road from Inversnaid, some seven or eight miles distant from Rowardennan. This makes the second cable in the loch, the other being between Inverbeg and Inversnaid.

Aberdeen.—The Admiralty propose to erect a wireless telegraphy station at Stoneywood, but it is not known definitely where the station will be situated. The Electricity Committee of the Aberdeen Town Council had proposals from the Admiralty before them at their last meeting with reference to a supply of electricity for the proposed station, but the committee decided to make no recommendation till it could be seen whether the laying of cables to Stoneywood would be remunerative.

West Bromwich.—The Electricity Committee of the Corporation report that the sales of current only for the year ended March 31, 1908, amounted to £12,877. 14s. 3d., as compared with £12,871. 8s. 5d. for the previous year. The sales of energy for tramway traction had decreased by £134. 15s. 11d., but this loss had been more than balanced by an increase of £53. 13s. 5d. in sales for private lighting, and of £387. 8s. 10d. in sales for motive power, or a total of £441. 2s. 3d.

South Darley.—The Postmaster-General has written to the Urban District Council, in reply to a request for a telegraph office, that he had caused inquiry to be made respecting the number of telegrams at Wensley, and he found that the business was not large and the circumstances were not such as would warrant the additional expense in providing the facility. He regretted he could not grant a telegraph office. The Council have decided to make another application to the Postmaster-General.

Deal.—At the last Town Council meeting the clerk read a letter from the Board of Trade with reference to the Sandwich, Deal and District Electric Lighting Order, 1903. The Kent Electric Power Syndicate, to whom the order was granted, were required to complete the works within two years from the commencement of the order. The syndicate having failed to do so the Board were of opinion that the order should be revoked, and they asked for the Council's observations in the matter. The Council decided to take no action.

Stroud.—At the last meeting of the Council a letter from the Board of Trade asking the Council for an expression of opinion with regard to the revocation or otherwise of the order obtained by the Gloucestershire Electric Power Co. in 1904 for the lighting of the district was considered. The Clerk said that nothing had been done in the matter because it had been found impossible to raise the necessary capital, and the question now arose as to whether the order should be revoked or not. The Council decided in favour of the revocation of the order.

Conference of Electricians.—The President of the Board of Trade has appointed a committee, consisting of Mr. G. R. Askwith, K.C., Sir John Gavey, C.B., Dr. R. T. Glazebrooke, R.S., Major R. P. A. MacMahon, F.R.S., Major W. A. J. O'Meara, R.E., C.M.G., and Mr. A. P. Trotter, to prepare a programme for the consideration of the delegates to the international conference on electrical units and standards to be held in London in the ensuing autumn, and to make arrangements for the reception and assembly of the delegates. Mr. M. J. Collins, of the Board of Trade, will act as secretary to the committee.

Wolverhampton.—At the last meeting of the Board of Guardians the clerk read a letter from the Midland Electric Corporation for Power Distribution suggesting that it might be cheaper for the Board to purchase electricity in bulk rather than to generate their own. The Clerk said on receipt of the communication he wrote to the borough electrical engineer at Wolverhampton asking if they were in a position to supply as a competitor. Mr. Shawfield replied in the negative, as the workhouse was outside the borough. The subject was referred to the House Committee.

Stock Exchange. — Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Newcastle-upon-Tyne Electric Supply Co.'s provisional certificates for a further issue of 50,000 ordinary shares of £5 each (issued at £6 per share), fully and partly (£3) paid, of which £2 is capital and £1 premium, and 50,000 5 per cent. preference shares of £5 each, fully and partly (£2) paid. The committee has further been asked to allow the Calcutta Tramways Co.'s further issue of 3,176 5 per cent. cumulative preference shares of £5 each, fully paid, to be quoted in the official list.

Taunton.—Mr. H. R. Hughes, Local Government Board inspector, held an inquiry on Tuesday with reference to an application by the Taunton Town Council for sanction to raise a loan of £2,000 for the purposes of electric lighting. The town clerk gave particulars as to the outstanding loans, etc., and said it was thought that the present proposed loan would carry the electric light concern over the next three years. The borough electrician was also questioned. The inspector remarked that the Town Council had no power to borrow money for the purchase of arc lamps to be hired by shopkeepers. The decision of the Local Government with regard to the loan will be communicated to the Council in due course.

Northallerton.—An alarming gas explosion occurred on May 14 at the Northallerton savings bank. Two large windows were blown out, together with parts of the front wall, and the inside was wrecked. Fortunately no one was injured, few people being about at that hour, though several occupiers of caravans in the May horse fair in the vicinity experienced shocks. The bank manager (Mr. Thomas Boddy) and his family live on the premises, but he was away at the time, and the other members of the family were at the rear of the building. The room above the bank was wrecked. A leakage of gas had been noticed on the previous evening, and the gas officials were on the spot attending to it when the explosion occurred.

Amble.—At the Urban District Council meeting it was reported that the Lighting Committee had under consideration a report and estimate submitted by the surveyor for lighting the street lamps by electricity, the scheme being aerial lines and the initial cost £1,000. The annual expenditure would be: repayment of loan with interest over 20 years, £54; current supplied to 100 lamps, £25; other maintenance, £50—total, £229. The committee recommended that the local gas company be approached as to their terms for supplying gas for street-lighting purposes, and when to hand consideration is to be given to both methods.

Edmundson's Electricity Corporation.—In explaining to the debenture holders on the 6th inst. the necessity for their assent to a scheme for issuing prior lien debentures, Mr. Tuckett said that the supply of electricity to small towns demanded the most careful attention to detail and the most rigid economy, but there was no reason to suppose that the business could not be made to realise moderately satisfactory profits. They foresaw capital requirements to the extent of £250,000 within the next four years, of which £50,000 could be contributed out of profits, leaving £200,000 to be raised by means of prior lien debentures. There was much discussion as to the advisability of allowing any charge to be placed ahead of the existing debentures Finally, the meeting was adjourned till Thursday next to enable the bondholders to confer with the directors as to the proposal.

Middlesbrough.—A considerable decrease in the electric power supply to the shipyards in consequence of the strike was reported at the last meeting of the Corporation Electric Lighting Committee. The engineer (Mr. H. M. Taylor) stated that the units sold last month were 81,701, against 119,758 for the corresponding month of April last year. The works cost was £554, against £689 last year, and the profit was £526, exclusive of interest and redemption, against £661. In answer to the chairman, the engineer stated that the falling off was owing to the strike at the shipyards. After some conversation respecting the subsidence of the electric plant buildings of the Corporation in Marsh-road, it was decided to improve the foundations as recommended by the engineer at an estimated cost of £1,000. It was agreed to accept Messrs. Callender and Co.'s tender, amounting to £1,642, for a new cable.

Wrexham.—At a meeting of the Electricity Supply Committee on the 15th ult. the electrical engineer submitted his monthly report, including the following statement: connections and supplies—used for tramways, 12,743 units, March, 1908; used for lighting, etc., 41,509 units—total units generated, 54,252; new consumers connected, 3. It was resolved that a special rate be charged for outdoor arc lighting to consumers who take a supply of energy for lighting the interior of their premises, such charge to include the supply of carbons to the ordinary type of arc lamps and the care of same. The town clerk reported that the Council at a meeting held on the 31st ult. adopted the minutes of the proceedings of this committee at a meeting held on the 25th ult., subject to the sum of £3,850 being substituted for £3,500 in a motion relating to the proposed application to the Local Government Board for sanction to the borrowing of money for the provision of an additional steam set and economiser at the electricity works. The report was adopted.

Burnley.—Mr. W. O. E. Meade-King attended at the Burnley Town Hall on the 1st inst. to conduct an inquiry on behalf of the Local Government Board into the Town Council's application to borrow £26,460 for the purposes of the electricity undertaking. Mr. Rothwell, deputy town clerk, explained that of the amount required £9,360 was for extension of the boiler-house, £10,000 for extension to electricity mains and for house service connections, and £7,100 for generating set and pump. Mr. Starkie, the electrical engineer, informed the inspector that the extensions were necessary because of the increased demand for electricity and the insufficiency of the plant to cope with any emergency. It was expected that the extensions would cover 10 years' progress. During the past winter the maximum load for lighting and traction was 1,480 kw., and this only left 500 kw. as a stand-by, and meant, in the event of the 500-kw. plant becoming unavailable, all the other available plant would be demanded. In the event of a breakdown during next winter of one of the larger sets of generators, the station would be prevented from coping with the demand unless additional plant was installed. There was no opposition to the application.

York.—In their monthly report the Electricity Committee of the City Council refer to the recent Local Government Board inquiry and to the suggestions made by the inspector on that occasion. The inspector suggested that the Corporation should apply for power to borrow certain sums for main extensions, etc., so as to obviate the money on such items being drawn from the bank before sanction was obtained. In view of this suggestion, the committee recommend the Council to apply to the Local Government Board for sanction to the borrowing of the following sums for main extensions, etc., which it is estimated will be required during the next two years or so—viz.: for main services, £900; main extensions, £5,000; meters, £500; motors, £800; making a total of £7,200. The committee also state that they have again considered the request of the secretary of the Municipal Employés' Association that the enginemen, etc., at the electricity works should be granted an increase in their present wages. The city electrical engineer has been instructed to obtain from other towns similar to York particulars of the wages paid to the men employed at the electricity works in such towns, to enable the committee to better consider the question.

Nelson.—The electrical engineer states that the Corporation electricity department has made a profit of £591. 0s. 8½d. for the year instead of £408. 1s. 2d. as estimated, allowing £250 for relief of rates and £341. 0s. 8½d. for the reduction of the debt on the old works. Owing to the new assessment on this department, the amount to be provided to meet the rates for the current year was just double

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the amount paid last year, £524 being required for this purpose alone. Considerable repairs were found necessary to the engines, but the dynamos have run as satisfactorily as ever. Owing to the increased output for light and power purposes, it will be necessary to fix two larger wattmeters on the switchboard before next winter. The applications for new supplies, both for motive power and lighting, have been a very satisfactory feature during the past year. The day load is steadily increasing, and the demand for power will doubtless increase each year, seeing that the use of motors is more commonly understood and appreciated than was the case a few years ago. The table shows that the units sold had increased as follows: lighting, 119,270 in 1903 to 263,544 in 1908; motive power, 6,371 to 54,055; tramways, 176,422 to 295,669; light railways, 170,611 in 1904 to 239,794; and contract, 18,400 in 1903 to 19,472; and total units from 320,463 in 1903 to 872,534.

Manchester.—The Electricity Committee of the Corporation have adopted their estimates of income and expenditure for the current year. The accounts continue to show satisfactory results, the surplus for the year just ended, after meeting interest and sinking fund charges and providing £40,000 for prospective renewals of plant (instead of £30,000 as estimated in April, 1907), being £18,177. Of this surplus £10,000 went as arranged in aid of rates and the balance to the reserve fund. The results would have been even better, to the extent of about £9,000, but for the high price of coal. To the Tramways Committee current had been supplied at 1·15d., instead of at 1·26d. per unit as in 1906-7, representing a saving of £13,520. A further reduction in the traction price is probable in the year now commenced. The estimates for the ensuing year enable the committee to promise another grant of £10,000 in aid of rates, and this despite the fact that there will be temporarily a considerable reduction of income from lighting consumers, owing to lower prices which came into operation at Christmas last. This loss will, it is expected, be more than counterbalanced by the accession of new lighting business because of the lower prices. On capital account the committee estimate that they will need £143,500 in order to meet the rapidly growing demands for lighting and power and, to a lesser degree, for traction purposes.

Stoke-on-Trent.—The electrical engineer presented his monthly report to his committee on the 2nd inst., in which he stated that during March 40,143 units were supplied, an increase on the corresponding period of last year of 123 per cent., and that the number of consumers now on the books was 354, representing a total of 15,341 32-watt lamps for lighting and heating and 622½ h.p. in motors. The committee recommended that the tender of Messrs. Willans and Robinson, of Rugby, for the supply and fixing complete of a new steam generator and condenser, at the price of £2 265, be accepted, and that a contract be entered into with them therefor; also that the tender of Messrs. Babcock and Wilcox for the supply and fixing complete of a new water-tube boiler, at the sum of £1,410, be accepted, and that a contract be entered into with them therefor. There were some other requirements, including £212 for meters from the Reason Manufacturing Co. The electrical engineer reported on damage which had been occasioned to the Basford feeder and apparatus by the workmen of the Potteries Electric Traction Co., and on the negotiations which had passed between him and the company on the subject. The committee recommended that the town clerk be instructed to make application to the company for the cost of repairing the damage, and that he be authorised to take legal proceedings to recover such cost, if necessary. The report was adopted by the Council.

Liverpool and District Electrical Association.—On Saturday, May 2, a large party of the above association, by kind permission of Mr. J. S. Harmood Banner, paid a visit to the Pearson and Knowles Coppull Collieries, by 1.45 p.m. train from Lime-street Station to Wigan, at which point they were met by the firm's manager, Mr. Lowe. A journey was then made by electric car to Standish, where conveyances awaited the party and conveyed them to the collieries. After all had changed into suitable clothing, and had been supp'ied with the all-important miner's lamp—which, by the way, is sealed and lighted electrically—the party divided into two portions, one going down No. 1 shaft and the other down No. 2 shaft. However, on arrival down below, instead of the inky darkness which was expected, it was found that the main passages were all well illuminated with electric light, and were in better condition for walking than many of the roads in the suburban districts of Liverpool. Much interest was shown in the haulage plant, the haulage being performed by an endless wire rope driven by a pair of 18in.-cylinder engines, 3ft. stroke. The party proceeded right to the site of working operations, and, of course, each had to secure a piece of coal, mined by himself. The mines are ventilated by a Walker Indestructible fan, 22ft. diameter and 8ft. wide, with a double inlet, and judging by the experiences of the visitors the ventilation is excellent. On coming to the surface again, an inspection was made of the boiler-house, containing eight Lancashire boilers, 30ft. by 8ft., 100lb. pressure, the winding engines, screening plant, electric plant for light and power, and the workshops, etc. The party were then thoughtfully provided with tea, which was much enjoyed, after which a very sincere vote of thanks was proposed to Mr. J. S. Harmood Banner and his able manager (Mr. Lowe) and staff for the very kindly way in which the association had been received and entertained. Mr. Samuel Frith, the association's hon. secretary and treasurer, in putting the proposition, spoke very warmly on the subject, as did also Mr. R. L. Myer, who seconded. Mr. Lowe, speaking on behalf of the colliery, expressed regret at the unavoidable absence of Mr. John Knowles, but stated he had much pleasure in accepting the vote of thanks, and it was great satisfaction to them that everyone had been so pleased with the visit. The party were then driven back to Wigan, and arrived in Liverpool in good time, after spending one of the most interesting and enjoyable days, and with a feeling of the utmost goodwill towards the Pearson and Knowles Colliery Co.

TRACTION.

Rio de Janeiro.—The Rio de Janeiro Tramway, Light, and Power Co. announce an issue of £3,500,000 second mortgage debentures.

Kidsgrove.—The Urban District Council have decided to petition the Potteries Electric Tramways Co. to reduce the fares from Goldenhill to Tunstall.

Brisbane Electric Tramways Investment Co.—Traffic receipts of the Brisbane tramways for the month ended April 30 amounted to £14,460; corresponding week last year, £12,659—increase, £1,801.

Lisbon Electric Tramways Co.—In their report for the year 1907 the directors recommend a dividend of 5 per cent., together with the transfer of £5,000 to exchange reserve, raising it to £20,000, leaving £13,271 to be carried forward.

Newport.—The total receipts of the Newport Corporation tramways for the week ending May 2, 1908, were £646. 11s. 9d., as compared with £604. 7s. 1d. for the corresponding week of last year. The number of passengers carried was 154,881.

South Metropolitan Electric Tramways and Lighting Co.—The accounts for the year 1907 show that after providing for debenture interest, preference dividend, and all other administration expenses a sum of £430 remains to be carried forward.

Kirkcaldy.—The Tramway Committee of the Town Council have agreed to recommend that cheap fares should be inaugurated on Wednesday afternoons between Kirkcaldy and Leven. This is likely to prove very popular with golfers and others.

Buenos Ayres and Belgrano Electric Tramways Co.—The receipts for the week ending April 29, 1908, converted to gold, were £3,667, against a total of £3,718 for the corresponding week of last year. Aggregates from Jan. 1, 1908, £64,094; corresponding period last year, £63,750—increase, £344.

Coventry Electric Tramways Co.—The directors of the Coventry Electric Tramways Co. announce a dividend of 3½ per cent. (7s. per share) for the year, carrying £3,900 to reserve for depreciation and £114 forward. The directors propose to apply £4,000 in reducing the company's indebtedness to New General Traction Co.

Middlesex.—The County Council's opposition to the London United Tramways Bill, 1908, is directed against the proposal to the laying of a tramway over King Edward VII. Bridge (Kew Bridge). The Kew Bridge Act, 1898, expressly provides that it shall not be lawful for this to be done without the consent of the Council.

Accrington.—At a meeting of the Council the question of revising the tram service on the Burnley-road length was considered, and the mayor suggested that in substitution of the present service the experiment should be tried of giving a half-hourly service on certain days, and a quarter-hour service on busier days during the week, and this course was unanimously agreed to, the mayor being authorised to settle the revised time table.

Nelson.—As a result of the year's working of the tramways department of the Corporation, instead of an estimated loss of £159. 0s. 2d., there was a favourable balance of £22. 9s. 11d. During the year the car miles run were 204,746; units used, 239 794; units per car mile, 1·17; average miles per car per annum, 34,124; passengers carried, 2,060,712; receipts per car mile, 8·63d.; passengers carried per car mile, 10·06; and times population carried, 54·23.

Aberdeen.—The Electricity Committee of the Town Council have had under consideration the renewal of the agreement for the supply of electricity to the Aberdeen Suburban Tramway Co., but, after discussion, have unanimously agreed that the price to be charged should be fixed by an arbitrator to be appointed by the Board of Trade. The monthly statement shows that 518,459 units were generated at the electric station during March, being an increase of upwards of 55,000 units as compared with March of last year.

Stalybridge.—At the monthly meeting of the Stalybridge, Hyde, Dukinfield, and Mossley Joint Tramways Board, the Chairman of the Finance Committee said the loss for the past year was a little over £10,000—a considerable reduction on previous losses. Next year they might hope for still better results. It was satisfactory to know that this loss compared well with £16,000 in two former years, and £14,000 in another year. They had turned the corner, and they could look forward to success and prosperity in the near future.

Pontypridd.—At a meeting of the Electricity and Tramway Committee of the Pontypridd District Council, the electrical engineer and manager (Mr. J. E. Teasdel) reported substantial increases in the receipts derivable from both the electric lighting and tramway departments. During the past month the receipts from the former amounted to £580. 5s. 11d., as compared with £499. 17s. 9d. for the corresponding month of last year. The receipts on the Treforest and Clifynydd section gave an increase of nearly £100. The Trehavod section showed an increase of £271. 5s. 10d. The committee resolved to apply for tenders for the construction of three additional cars.

Dumbarton.—Messrs. J. G. White and Co., the contractors for the county tramways, have made capital progress with their work, although much hindered by the wet weather they encountered in the early stages. The track is practically completed between Dumbarton and Alexandria, and the Board of Trade have been asked to fix an early date for the inspection of this section. Whenever that necessary preliminary has taken place the line here will be thrown open for traffic. The precise date of this inauguration will likely fall in the second week of May. The Dumbarton burgh tramways are to be linked up with the county line, and meantime Mr. J. P. M'Mahon, late manager of the Northampton tramways, and who has been appointed manager to the Dumbarton Burgh and County Tramways Co., has taken up his duties in the county town.

Coventry.—The annual accounts of the Coventry Electric Tramways Co. show that during the past year the traffic receipts have been £29,000 and the net earnings £10,700, or £1,400 more than in the

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previous year, and £4,000 more than two years ago. The divisible balance, after mortgage bond interest had been paid, is £8,500, and the directors recommend that the profit should be applied as follows: £3,900 to reserve for depreciation, £4,550 dividend at 3½ per cent., £113 carried forward. The company's resources will thus permit of a further sum of £4,000 being applied in reduction of the company's indebtedness to the New General Traction Co. The balance-sheet shows an expenditure of £10,000 during the year on construction and equipment, which brings the total capital expenditure up to £197,600. The total maintenance and working expenses of the year were £21,000.

Belfast.—At the weekly meeting of the Tramway and Electrical Committee on the 4th inst., Sir Robert Anderson presiding, a lengthy communication was read from the Cavehill and Whitewell Tramway Co. on the proposed arrangements for the latter to get running over the lines of the Corporation, so as to give a through service from Whitewell to the centre of the city, the route being through one of the best residential suburbs of the city. The company asked the Corporation to rent the system for four years, pay 3½ per cent. on the purchase price of £60,000 arranged for last year, but which fell through in Parliament, and some other details. It was finally resolved to recommend that a through service be established, the company to receive the receipts on their end of the route, and the Corporation the receipts on their end, on the basis of a 3d. fare, provided that the Corporation be at liberty to purchase the undertaking at £60,000 within the next five years.

Stoke-upon-Trent.—At the meeting of the Highway Committee, the town clerk reported on the further action taken by the clerk of the Staffordshire County Council and the town clerk of Hanley on behalf of the local authorities in opposition to the Potteries and North Staffordshire Tramways (Amendment) Order, and that it was now proposed that the County Council should seal a separate petition and the local authorities a joint petition against the Bill, of which the committee approved. The town clerk also submitted draft of a clause which the company were prepared to insert in the order to endeavour to meet the objections of the local authorities, but which the County Council did not consider satisfactory, and of which the committee also did not approve. At a special meeting of the Highway Committee, the town clerk reported on an interview he had had with the clerk to the County Council, and submitted draft clauses which they were endeavouring to get inserted in the Tramways Amendment Order. He also submitted draft of the petition against the Bill. The Council sanctioned the action of the committee.

Dundee.—At a joint meeting the Tramways and Finance Committee of Dundee Town Council resolved that £1,000 per annum, beginning with the ensuing financial year, shall be applied from the free tramway earnings to the common good fund. As the tramway revenue exceeds £27,000, this allocation at 3½ per cent. has already been earned. The Corporation Tramway Committee at their last meeting had under consideration the fixing of fares for the year ensuing from Whitsunday. The manager submitted a provisional estimate. It set forth that the working expenses for the ensuing year would be £16,248, for general expenses £4,215, for repairs and maintenance £7,376, and for power expenses (current being charged at 1½d. per Board of Trade unit) £11,718. The total working expenses were put at £39,557, interest at £9,400, income tax on property at £350, sinking fund at £6,100, depreciation on machinery and plant at £1,650, and the proposed contribution to the common good at £1,000—a total charge of £58,057. The revenue from receipts, advertising, and from parcel traffic was estimated to total £62,002, leaving a balance of £3,945 to be applied to the renewal fund in place of the sum of £7,305 allowed by the assessor of railways for the year dealt with. Having regard to these figures, the committee decided to recommend that the fares should remain as at present. In view of the fact that the ½d. stage between High-street and the first stopping place on the Ferry-road section was shorter than the run on other routes, it was decided to recommend that the first stage be extended to Wallace-street, leaving the second stage, between Dens-street and Springhill, as at present. In connection with the first ½d. stage on the Perth-road, Mr. Speed, the convener, moved that it be extended as from High-street to Small's-wynd to Airlie-place. It was stated that the run in question was by no means the shortest in the system, and that any change would involve a loss of traffic. The proposal failed to find support and was allowed to drop. A remit was made to the manager to report upon contemplated improvements on the Downfield service.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Ilford.—The Urban District Council invite tenders for the supply of feeder cable. Tenders by May 12.

Tarragona.—Tenders are invited for the erection of an electricity generating station. Tenders by May 31.

Bedford.—Tenders are invited for the supply of coal for the electricity works. Tenders to the Town Clerk by May 15.

Frankfort-on-Maine.—Tenders are invited for the supply of incandescent electric lamps for one year. Tenders by May 16.

Queensland.—The Postmaster-General invites tenders for battery glassware, etc., battery material and chemicals. Tenders by June 1.

Leipzig.—Tenders are invited by the Municipality for the supply of two 2,500-kw. alternating-current generators. Tenders by May 13.

South Australia.—The Postmaster-General invites tenders for telephone material, telephone instruments, and telephone switchboards. Tenders by June 3.

Sofia.—Tenders are invited for the installation of electricity in mines. Particulars from the Director of Mines and Minerals. Tenders by June 19.

Brussels.—Tenders are invited for the supply of underground conduit electric cable by the Société Nationale des Chemins de Fer Vicinaux. Tenders by May 27.

Hackney.—The London County Council invite tenders for electrically wiring and fitting the tramways car-shed at Mare-street, Hackney, N.E. Tenders by May 12.

Adelaide.—Tenders are invited by the Municipal Tramways Trust, Adelaide. for the supply, delivery, and laying of underground electric cables. Tenders to the Chairman by June 23.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Darlington.—The Corporation invite tenders for the supply of a Lancashire boiler and superheater. Specification, etc., from the Borough Electrical Engineer. Tenders to the Town Clerk by May 11.

Oban.—The Town Council invite tenders for the carrying out of alterations at the electric lighting station. Tenders to Mr. Alexander S. Black, town clerk, Municipal Buildings, Oban, by May 9.

Birkenhead.—The Corporation invite tenders for the supply of coal to the electricity generating stations. Particulars from Mr. W. Wyld, borough electrical engineer and tramways manager. Tenders by May 11.

Dover.—Tenders are invited for the supply of coal for use at the electricity works between June 1, 1908, and July 31, 1909. Particulars from the Borough Electrical Engineer. Tenders to the Town Clerk by May 18.

Salford.—Tenders are invited by the Electricity Committee for the supply and erection of cooling towers, pumps, etc., at the electricity station, Pendeton. Particulars from the Borough Electrical Engineer. Tenders by May 25.

Walsall.—The Electric Lighting Committee invite tenders for the supply and erection of condensing plant, including surface condenser, air pumps, cooling tower, and water purifier. Tenders to the Town Clerk by May 29. See advertisement.

Southend.—The Corporation invite tenders for the supply and delivery of about 150 tons of rails, B.S. section. Particulars from Mr. Ernest J. Elford, C.E., borough engineer. Tenders to Mr. William H. Snow, town clerk, by May 16.

New South Wales.—Tenders are invited by the Postmaster-General for eight tons wire, hard-drawn copper (400lb. per mile), 1½cwt. tape binding, copper (200lb. per mile), 1,300 insulators, best white porcelain, large. Tenders by June 10.

Bermondsey.—The Borough Council invite tenders for the supply and erection of one boiler, one steam dynamo, one condenser, and cooling tower at the electricity and destructor works. Tenders to the Town Clerk by May 18. See advertisement in last issue.

London, S.W.—The London County Council invite tenders for 175 double-deck car bodies, swing bolster trucks, and complete electrical equipments for overhead trolley, surface-contact, and underground conduit systems of electric traction. Tenders by May 9.

Belfast.—Tenders are invited for the supply of five iron lattice-built electric light masts, 70ft. high from the ground line, with suitable base, for the Belfast Harbour Commissioners. Tenders to Mr. W. A. Currie, secretary, Harbour Office, Belfast, by May 13.

Brynooch (Wales).—The Main Colliery Co., Neath Abbey, invite tenders for the erection of a power station at Brynooch. Plans, etc., may be seen at the offices of Mr. J. Cook Rees, architect, Neath. Tenders to Mr. Henry T. Wales, Main Colliery Co., Neath Abbey.

Victoria.—Tenders are invited for the following for the Postmaster-General's Department: 2,600 jacks, in strips of 20; 1 mile 64-wire switchboard cable; 50 3-conductor cords, 7ft. long, for "B" boards; 96 3-part plugs, and 66 listening and ringing keys. Tenders by June 9.

Johannesburg.—Tenders are invited for a refuse destructor plant. Specification, etc., may be obtained from Messrs. E. W. Carling and Co., St. Dunstan's-buildings, St. Dunstan's-hill, London, E.C. Tenders to the Town Clerk, Municipal Offices, Plein Park, Johannesburg, by June 10.

West Bromwich.—The Town Council invite tenders for the installation of a modern refuse-destroying plant at their electricity works, Black Lake, West Bromwich. Particulars from Mr. Albert D. Greatorex, borough engineer and surveyor, Town Hall, West Bromwich. Tenders by May 9.

Uxbridge.—Tenders are invited for the necessary wiring and tubing, fittings, lamps, etc., for the electric lighting of four new blocks of buildings now in course of erection at their hospital, for the Uxbridge Joint Hospital Board. Tenders to Mr. William L. Eves, F.R.I.B.A., architect, 54, High-street, Uxbridge, by May 14.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors, 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

Edinburgh.—The Corporation invite tenders for the electrical installation for lighting, heating, and power at the College of Art, Edinburgh. Specification, etc., can be obtained at the office of Mr. Frank A. Newington, engineer, Electricity Supply Station, Dewar-place, Edinburgh. Tenders to the Town Clerk, City Chambers, Edinburgh, by May 14

Rio de Janeiro.—Tenders are invited for the supply of new lighting apparatus and accessories for the lighthouse on Raza Island. Tenders will be opened on June 2 in the Ministry of Marine (Secçao de Pharóes) at Rio de Janeiro. No deposit is required. Further particulars may be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

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Bristol.—Tenders are invited by the Electrical Committee for (*a*) direct-current works power distribution boards at the Avonbank electricity works; (*b* extra high-tension and low-tension sub-station switchgear for Shirehampton; (*c*) direct-current power switchgear for supply to the Avonmouth Docks; (*d*) extension of galleries at the Avonmouth electricity works. Tenders for (*a*) and (*c*) by May 11 and for (*b*) and (*d*) by May 18. See advertisement.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 2,000 tons of steel girder tramway track rails and fastenings required for the electrification of further portions of the Council's tramways; also alternative tenders for supply and delivery of about 5,000 tons of track rails and fastenings. Particulars from the chief engineer to the Council, Mr. Maurice Fitzmaurice C.M.G., at the County Hall, Spring-gardens, S.W. Tenders by May 19.

RESULTS OF TENDERS.

Hackney.—The Electricity Committee recommend the acceptance of the tender of J. Hudson and Co. for the supply of 2,000 tons of coal for the electric station.

Fulham.—The Electricity Committee recommend the acceptance of the tender of Siemens Bros. for the supply of 100 electric meters - *i.e.*, 50 each of three and five ampere size—at a cost of 29s. each.

Southampton.—The tender of West's Gas Improvement Co., Manchester, at £558, has been accepted for the supply and erection of a coal and ash conveyor at the Corporation electricity supply station.

Metropolitan Asylums Board.—The tender of W. J Fryer and Co., of Bravington Works, Paddington, has been accepted for the installation of electric lighting, etc., at the South-Western Hospital and Ambulance Station for the sum of £3,434.

Aberdeen.—The Electricity Committee recommend the acceptance of the tender of the British Insulated and Helsby Cables, Prescot, Lancashire, amounting to £3,575. 15s., for the supply of electric cables in connection with the Cults electric station.

Bristol.—The Electrical Committee have accepted the tender of the Bedminster, etc., Collieries, Limited, for the annual supply of coal to the Avonbank electricity works; also the tender of W. Cowlin and Son for the construction of one 150,000-gallon soft-water storage tank at Avonbank for £645.

Stoke-on-Trent.—The Town Council have accepted the tenders of Willans and Robinson, of Rugby, for the supply and fixing of a new steam generator and condenser at the price of £2,265; Babcock and Wilcox for the supply and fixing of a new water-tube boiler for the sum of £1,410; British Insulated and Helsby Cables for street box fittings (150 sets), £12. 10s., and for house service cut outs (150 sets, £46. 10s.; and that of the Reason Manufacturing Co. for 100 meters, £212.

Littleborough.—Messrs. Marple, Leach, and Co. have secured the contract for the complete equipment of the new mill being erected by the Tyne Ring Spinning Co. at Littleborough, near Manchester. This equipment consists of a complete generating plant, including a 1,200-kw. three-phase steam turbo-generator at 50 cycles, 400 volts; a pilot lighting set; condensing plant with electrically-driven pumps; two 400-h.p. three-phase induction motors at 485 r.p.m.; two 100-h.p. motors at 360 r.p.m.; one 50-h.p. motor at 360 r.p.m., and a number of smaller motors. The contract includes the supply, delivery, and erection of the whole plant, including the wiring throughout. This section of the work, however, Messrs. Marples, Leach, and Co. will sublet to local contractors.

OPENINGS FOR CONTRACTORS.

ABERAVON—Workhouse, Margam District Council.

ABERDARE—Hall, schoolrooms, outbuildings, etc., Trustees Siloa Welsh Independent Chapel.

ABERDARE—Ten houses, Monk-street Building Club.

AINSWORTH—Additions, Ainsworth Church (£600), Ecclesiastical Commissioners.

ALBERTA—Carnegie free library in Calgary (£10,000).

ALTON — Enlargement, Normandy-street Council School, County Education Authority.

AMMANFORD—Public lighting (£1,000), District Council.

ANSLOW—Council school, Staffs Education Committee.

ANTRIM—Alterations and additions, Crumlin Dispensary and medical officer's residence, Guardians.

ASHFORD (MIDDLESEX) — School, West District-road, Middlesex Education Committee.

ASHFORD — Council school, Woodthorpe-lane, Kent Education Authority.

AYR—Dwelling-house, Virginia Gardens-road (£3,500); alterations, buildings, Main-street, Mr. A. M. Turner; alterations, buildings, Cathcart-street (£150), Trustees, Ayr Junior Conservative Club; office, etc., New-street (£100), Messrs. R. Armour and Sons; store, office, etc., Beresford-lane (£150), Mr. H. M'Quiston.

BALLYKEEL—Teacher's residence, Rev. J. Mitchell, Anahilt.

BALSALL HEATH—Fire station, Mosely-road, Town Council.

BANSTEAD—Church, Burgh Heath (£5,000), Ecclesiastical Commissioners.

BARGOED—Secondary school. Mr. D. Pugh John, architect.

BARNSTAPLE—Residence, Pilton Lawn. Mr. J. C. Southcombe, architect.

BARNSTAPLE—Additions, St. Mary Magdalene (£1,725).

BARTON—Block of houses, Darwell-avenue, Barton-road, Mr. J. C. Owen.

BEDLINOG—Secondary school, Bargoed Education Committee.

BELFAST—School, Tates-avenue. Mr. T. Houston, architect.

BELFAST—Electric light masts, Harbour Commissioners.

BERMONDSEY, S.E —Boiler, dynamo, etc., Borough Council.

BERMONDSEY, S.E.—Disinfecting station, Borough Council.

BERWICK—Parochial hall (£2,000), Churchwardens.

BETHNAL GREEN, E.—Conveniences, Meath Gardens, Architect's Department, 19, Charing Cross-road.

BIRKENSHAW — Sawmills, engine and boiler houses, Mr. R. F. Rogerson.

BIRMINGHAM—Electricity undertaking (£251 285), Town Council.

BISCOT—Mission church at Leagrave, Vicar.

BISHOPSTEIGNTON—Wesleyan chapel (£1,000).

BISHOP'S STORTFORD—Secondary school, Essex and Herts Education Committees.

BLACKPOOL—Church, Wesleyan Trustees.

BOCKING—Elementary school, Church-street, Education Committee.

BOWBURN—Elementary schools, Durham Education Committee.

BRADFORD—Alterations, laundry, etc., City Hospital, Leeds-road, Town Council.

BRADFORD—Extension, technical college (£12,000), City Council.

BRENTWOOD—Extension to grammar school, Essex Higher Education Committee.

BRIDGWATER—Additional wing to school, Blake-street, Committee, Art and Technical School.

BRIDLINGTON—Alterations, houses, Mr. J. Robinson; bungalow, Carr-lane, Messrs. R. Musk and Son.

BURGH HEATH—Church (£5,000), Ecclesiastical Commissioners.

BURY—Weaving shed, Vulcan Mill Co.

CAMBERLEY—Temporary school, Surrey Education Committee.

CAMBORNE—Church, congregation of United Methodist Free Church.

CANNING TOWN, E.—Additions, Canning Town School, West Ham Education Authority.

CANTON—Parish hall (£1,649), Churchwardens of St. Catherine.

CARDIFF—New wing, Y.M.C.A. buildings.

CARDIFF—Three houses, Clive-road, Canton, Mr. R. Davies.

CARMARTHEN—Renovation, shire hall (£1,695), County Council.

CARRICKMACROSS - Housing scheme (£37,620), Rural District Council.

CARSHALTON—Public offices (£1,640), Mr. J. Day.

CASTLE GATES—Congregational church, Coton-hill.

CATANIA—Portland cement factory, local company.

CHATHAM—Secondary school (£10,000), Kent Education Authority.

CHATHAM—Nurses' quarters, workhouse, Guardians, Medway Union.

CHELMSFORD—Alterations and additions to Chelmsford Essex Hospital and Dispensary, Building Committee.

CHINGFORD—Elementary school (£5,642), Essex Education Committee.

CHISLEHURST - Depôt, chapel, mortuary, and other buildings at cemetery, Urban District Council.

CHOBHAM - Elementary school, Surrey Education Committee.

CLARKSTON - Additions to Caldercruise School, School Board.

CLEETHORPES—Additions and extensions to Ellison-street School, Lindsey County Council.

CLITHEROE—Extensions to public hall, Clitheroe Public Hall Co.

CLONES—Housing scheme (£15,284), Rural District Council.

COLNE—Electricity purposes (£4,170) Town Council; scheme for baths to be erected at Swan Croft (£7,400).

CORK—Thirty-seven houses, Mr. J. Cotter, Rural District Council Offices.

COWDENBEATH—Houses, Stenhouse-street, Mr. W. Stewart.

CROYDON — Alterations, offices, Brighton-road Schools, Education Committee.

DAIREAUX—Scheme for electric lighting the town, local company.

DARTFORD—Extensions, Livingstone Cottage Hospital.

DARWEN—Six houses, Higher Croft Estate, Mr. J. L. Crumblehulme.

DONCASTER—Rebuilding Ram Hotel. Messrs. W. H. Wagstaff and Son, architects.

DOVER—Temporary infants' school, Pier district, Town Council

DOVERCOURT—Second portion Congregational Church (£1,800).

DUNDALK—Alterations and improvements, workhouse, Guardians.

DURHAM—House and shop, Bowburn, Mr. T. Burns; rebuilding two houses, Hett, Messrs. J. and T. Pickering.

DUTHILL—Church, congregation of United Methodist Free Church.

EARDISLEY—House, Almeley Crossing, G.W.R. Co.

EARLEY—Parish room (£425), Churchwardens St. Peter's Church.

EAST ARDSLEY—Six houses, Mr. A. K. Blackburn.

EAST BARNET—Mortuary, East Barnet Urban District Council.

EASTBOURNE—Additions to Stafford House, Upperton-road, convert same into municipal secondary school, Education Committee.

EAST HAM—Extensions and additions to secondary school (£3,000), Essex Education Committee.

ECCLES—Four houses, Clarendon-crescent, Mr. A. Neil; 12 houses, Berkley-street, Mr. T. Fletcher; nine houses, Tindal-street, Peel Green, Mr. A. J. Eggington; shop, Barton Hall Engineering Works, Gorton-street, Peel Green.

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EBBW VALE—Church, Arnoury-street, Trustees of Tabernacle Congregational Church.
EDINBURGH—House, New Pentland, Edinburgh and District Water Trustees.
EDINBURGH—Electrical installation, College of Art, Town Council.
ELHAM—Additional accommodation, workhouse, Guardians.
ELLAND—Six houses, Woodhouse-lane, Mr. F. Beaumont.
ERITH—Forty-eight houses Hurst road, Mr. W. Egerton; workshop, Pier-road, Messrs. J. T. Jarvis and Sons.
ERPINGHAM—Infirmary ward (£1,000), Board of Guardians.
EXETER—Restoration work to tower, Exeter Cathedral (£7,500).
FENCE HOUSES—Twenty-eight houses, Lambton Collieries, Limited.
FERMOY—Housing scheme (£9,200), Rural District Council.
FINCHLEY—Six houses, Stanhope-avenue, Messrs Glanville and Co.; five shops and houses, Cornwall House Estate, Mr. F. Carter; 10 houses, Cornwall-avenue, Mr. F. Wood; two houses, Arden-road, Mr. C. W. Scott.
FINZEAN—House, Woodend, Mr. J. Christie; addition to offices, Boghead, Mr. J. Greig.
FRAMWELLGATE—Additions, club, Framwellgate Moor Workmen's Club.
FRIMLEY—Cottage hospital, Hospital Committee.
FURNESS VALE—Church, Ecclesiastical Commissioners.
GAINSBOROUGH—Institute, St. John's (£1,500).
GARNDIFFAITH—Institute and hall, Urban District Council.
GLENCOE (ONTARIO)—Electric plant to supply light and power, Municipal Council.
GLOUCESTER—Extensions to electricity mains (£2,000).
GLYNCORRWG—Fifty houses, Glyncorrwg Colliery Co.
GODALMING—Six houses, Godalming Co operative Society.
GOREY—Housing scheme (£7,340), Rural District Council.
GORGIE—Corn market, Edinburgh Town Council.
GRANGEMOUTH—Higher-grade school, Grangemouth Parish School Board.
GRAYS—Additional school accommodation, Essex Education Committee.
GREENOCK—Sanatorium (£1,033), Parish Council.
GRINDLEFORD—Parish Church (£8,000), Churchwardens.
GUILDFORD — Receiving wards, porter's lodge, etc., Board of Guardians.
GUISELEY—Enlargements, parish church (£6,000), Churchwardens.
HACKNEY, E.—Wooden bandstand, London Fields.
HADLEIGH—Elementary school, Essex Education Committee.
HAMSTERLEY—Primitive Methodist church, Trustees.
HARBY—Elementary school (£1,660), Notts County Council.
HARDOI—Extensions to district jail (Rs.10,000), Indian Government.
HARROGATE—Enlarging bathing establishments (£12,000), Town Council.
HASLAND—House and shop, Birdholme, Mr. T. Wilcoxon.
HASLINGDEN—Buildings, Prinny Hill, Town Council.
HEALING—Elementary school, Lindsey County Council.
HELENSBURGH—Extensions to premises, Colquhoun-square, Crown Authorities.
HENZADA—Residence for superintendent of police (Rs.11,400), Burma Government.
HOUNSLOW—Iron building, Zoar Chapel, Staines-road, Rev. J. E. Flegg; villas, School-lane, Mr. T. Hiscocks.
HUDDERSFIELD—Houses, Almondbury Bank, Mr. E. W. Lockwood.
HULL—Warehouse, Ropery-street, Messrs. A. Sanderson and Co.; offices, Alfred Gelder-street, Town Council.
HULL—Mission church, Beverley-road, Trustees of the Christian Science Church.
ILFORD — Roman Catholic school, Church-road, Manor Park, to accommodate 300 scholars.
INVERNESS—Two houses, Beauford-road, Mr. T. Munro.
ISLEWORTH—Six villas, Kilmorey-gardens, Mr. H. J. Moyle; three houses, Talbot-road, Mr. A. Harris.
KEIGHLEY — Six semi-detached cottages, Morton Banks, Keighley Industrial Co-operative Society; stores, etc., Worth Valley Tool Works.
KINLOUGH—Rebuilding Kinlough School, Select Vestry.
LANCASTER - Extensions, Storey Technical Institute, Town Council.
LANCHESTER—House and shop, Langley Park, Mr. W. Villson.
LECKHAMPTON—Sanatorium (£8,500), Birmingham Town Council.
LEICESTER—Masonic hall (£8,000). Mr. H. H. Thomson, architect.
LEICESTER—Additions, town hall (£8,500), Town Council.
LINCOLN—Infectious diseases hospital (£1,300), Corporation.
LISMORE—Housing scheme (£19,947), Rural District Council.
LITTLE COATES—Elementary school, Lindsey County Council.
LITTLE CUMBRAE—School, Largs School Board.
LIVERPOOL—Newexchange, South John-street, National Telephone Co.
LLANDYSSUL—Public hall, Urban District Council.
LLANSAMLET—Chapel, Peniel Green, Calvinistic Wesleyan Methodists.
LOCHORE—School, Ballingry School Board.
LUTON—Wesleyan Methodist chapel, Dunstable-road (£814); chapel, Dallow-road (£864), Trustees.
MAIDSTONE—Electricity undertaking (£18,400), Town Council.
MACCLESFIELD—Improvement and extension scheme, Brunswick Chapel (£2 500), Wesleyan Methodists.
MANCHESTER—Restoration work at cathedral (£2,000).
MANNINGHAM—Branch library (£4,000), Town Council; public conveniences, Rawson-square (£515).
MARKET RASEN—Elementary school, Lindsey County Council.
MERTHYR—Alterations, County Court, Town Council.
MERTHYR TYDFIL—Alterations, judges' court, etc., Town Council.
MEXBOROUGH—Elementary school (£4,320), West Riding Education Committee.
MILNSBRIDGE—Three houses, Radcliffe-road, Mr. J. Ainley.
MILTON—Alterations, Butts Council School, Kent Education Committee.
MONTON—Four houses, Crawford-street, Messrs. Meadowcroft and Lombers; 12 houses, Crawford-street, Messrs. Sudlow and Bannister.
MORLEY (YORKS)—Preaching-room, Banks Hill, Wesleyan Chapel Trustees.
MORTON—Alterations to school (£660), Lindsey County Council.
MOSCOW—Housing scheme, City Council
MYNYDDISLWYN—Council offices, District Council.
NANTWICH—United Methodist Free church (£2,700), Trustees.
NAVAN—Scheme for lighting the town with electricity, Urban District Council.
NEWBURY—Three houses, Gloucester-road, West Fields, Mr. H. S. Benn; six houses, Kingsbridge-road, Mr. W. R. Allee; motor-house, J. Porter, Esq; eight houses, Kingsbridge-road, Mr. C. New; two houses, Russell-road, Mr. F. Gibbons; house, St. John's-road, Jas. Buchanan, Esq.
NEWCASTLE-UNDER-LYME—Sunday schools, St. Paul's parish.
NEWTON ABBOT — Enlargement of isolation hospital, Hospital Committee.
NEW PENTLAND—House, Edinburgh Water Trustees.
NOTTINGHAM—Recreation rooms at Bulwell and Sherwood car-sheds, Tramways Committee.
NOTTINGHAM—Chancel aisle in church, Churchwardens St. Mary's Church.
NUNEATON—Public abattoir (£1,800), Town Council.
OBAN—Alterations, electric lighting station, Town Council.
OSWALDTWISTLE—Council school, Stanhill Education Authority.
OVER HEDGE—Primitive Methodist chapel. Mr. Smithson, Leeds, architect.
OXFORD—Additions, police station, Commissioners of Public Works.
PATELEY BRIDGE—Wesleyan chapel (£2,000), Trustees.
PENDRYN—Additions, Welsh Calvinistic Chapel, Trustees.
PENRHYNDEUDRAETH — Boiler-house and workhouse. Mr. T. Roberts, architect.
PONTYPRIDD—Three villas, Mr. J. E. Sprackett.
RADSTOCK—Two houses, Wells road. Plans passed by Urban District Council.
RAMSGATE—Re-erection, chief post office (£11,000), Commissioners of Public Works.
RAWTENSTALL—Electricity undertaking (£34,000), Town Council.
RAYLEIGH—Elementary school to accommodate 240 scholars, Essex Education Committee.
REDDITCH—Extensions, secondary school, Higher Education Committee.
RICHMOND—Ten houses, Artichoke-alley, Town Council.
ROMFORD—Elementary school to accommodate 280 scholars, Essex Education Committee.
ROSYTH—Explosive factory, Admiralty.
ST. ERME—Restoration of parish church, Ecclesiastical Commissioners.
SALTERHEBBLE—Wesleyan chapel and schools, Stafford square.
SALTLEY—Pumping station, Saltley Works (£2,950), Birmingham Drainage Board.
SCARBOROUGH—Public conveniences (£550), Town Council.
SEATON—Two houses near Seaton Beach Hotel, Messrs. E. Harbottle and Son.
SHAW—Additions, house, Shawside, Mr. W. Taylor.
SHOTTON—Vestry to Shotton Church (£500), Rector.
SHREWSBURY—Secondary school, Shropshire Education Committee.
SITTINGBOURNE—Alterations, Holy Trinity School, Board of Education; Council school, Kent Education Authority.
SKEGNESS—Elementary school, Lindsey County Education Committee.
SOUTHAMPTON—Additions, grammar school, Argyle-road, Corporation Education Committee.
SOUTHEND—Four houses, Sunningdale-avenue, Dr. Vallance; house, Boscombe-road, Mr. F. Fuller; house, Eastwood-road, Mr. B. E. Parkes; two houses, Boscombe-road, Mr. E. Leaney; two houses, Glenwood-avenue, Mr. E. E. Everett; two houses, Westborough-road, Mr. C. H. Jerrard; two houses and shops, Westborough-road, Mr. W. Squire; six houses, Beedell-avenue, Mr. J. T. Overall; house and studio, Leigh-road, Messrs. Bailey and Bullen; house and motor-house, Drake-road, Mr. G. H. Thorley; extensions, borough sanatorium, Town Council.
SOUTH KILLINGHOLME—Elementary school, Lindsey County Council.
SOUTH SHIELDS—Tower added to St. Michael's Church (£812).
SOUTHWARK, S.E.—Engine-house block at fire brigade headquarters London County Council.

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STAFFORD—Extensions, Corporation-street Council School (£6,200), enlargement North-street Council School, Education Authority.

STAINES—Five shops, Links Estate, Mr. C. W. Calcot; two shops, Woodthorp-road, Mr. A. Francis.

STANLEY—Two houses, Bircham-street, South Moor; two houses, Mitchell-street, South Moor. Plans passed by Council.

STOCKPORT—High school, Beech-road, Cale Green (£11,000), Education Committee.

SWANSEA—Shop, Wind-street, Messrs. Fitt Bros. and Davies.

TANDRAGEE—Methodist manse. Mr. Walley, architect.

TEDDINGTON—Additions, St. Alban's Church, Rev. A. M. Cazelet.

TENDRING—Cottage homes for children, Board of Guardians.

THOLTHORPE — Alterations and additions, Council school, North Riding Education Committee.

THORNTON-IN-CRAVEN—Mission church (£3,000).

THORNTON-LE-DALE—Wesleyan church and schools. Mr. A. Lambert, architect.

THURLBY—Alterations, Thurlby Grove House, Mr. G. Ancients.

TILBURY—Enlargement and alterations, Chadwell-street St. Mary's Schools, Essex Education Committee.

TINGLEY—Wesleyan Sunday school (£1,300), Trustees.

TIPTREE—Elementary school, Education Authority.

TRELAW—Memorial hall. Messrs. Evans and Williams, Pontypridd, architects.

TYNEMOUTH—Additions to hospital at workhouse, Guardians.

UXBRIDGE—Electric lighting of four new blocks of buildings, Joint Hospital Board.

WALSALL—Manual instruction centre, etc., Walsall Education Committee.

WALTHAM—House, etc., Stone-street, Mr. W. Langford.

WALTHAMSTOW—Factory and spirit-room, Blackhorse-lane, Micanite and Insulator Co.; 12 houses, Beech Hall-road, Mr. O. H. Watling; five houses, Mr. F. B. Amos; studio, Westbury-road, Mr. R. A. Briggs; addition to school, Raglan-road, Mr. S. J. Moulds; dairy and stables, Forest-road, Mr. W. A. Lewis; house, Worcester-road, Mr. F. Mayhew.

WARBOROUGH—Additions, Council schools, Surrey Education Committee.

WATFORD—Shop and offices, Aldenham-road, Mr. J. Rodwell; two houses, Hempstead-road, Messrs. Clark Bros.; two villas, Kingsfield-road, Mr. J. Freshwater; two houses, Field-road, Mr. Wright; five houses, Judge-street, Mr. J. Russell; two houses, Sussex-road, Mr. Sutton.

WESTCLIFFE-ON-SEA—Church, Crowstone-road, Ecclesiastical Commissioners.

WIGAN—Alterations, Bricklayers' Arms, Hallgate, Oldfield Brewery Co.

WINTON—Nineteen houses, Anson-street, Mr. F. C. Gill.

WOKING—Extensions, elementary school, Surrey Education Committee.

WOLSTANTON—Improvements, Silverdale Council Schools (£145), Council.

WOOLER—Mart, Wooler Livestock Auction Mart Co.

WORTHING—Elementary school, Ham-road, Broadwater, Education Committee.

PROVISIONAL PATENTS, 1908.

APRIL 24.

8929. Improvements in telephone circuits for use in combination with automatic apparatus for indicating or recording at a distance changes of level of water, or other fluids in reservoirs, tanks, or tideways, or of gasholders or other structures or articles. William McWhirter and Anthony Clark McWhirter, 212, Holm-street, Glasgow.

8934. Improved electric block system and apparatus for railways and tramways. Walter Henry Edridge, and Fortuné Justinien and Saint Charles Pradel, trading as Pradel and Justinien, 21, Great St. Helens, London.

8941. Improvements in or relating to magneto machines chiefly for the ignition of internal-combustion engines. John Dalrymple Bell, 18, Hertford-street, Coventry. (Application for patent of addition to No. 20986/07.)

8962. Improvements in insulated electric conductors, contacts, and the like. Edward Neville Bray and Bray, Markham, and Reiss, Limited, 18, Southampton-buildings, London.

8968. Improvements in installations for electrically controlling railway points or the like. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, London. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

8972. Improvements in generators for high-frequency electric currents. John Groeme Balsillie, Clan House, Surrey-street, London.

8984. Improved telegraphic instrument. George W. Hunter, 6, Lord-street, Liverpool.

8986. Improvements in or relating to electric telegraphy and telephony. Sidney George Brown, 7, Southampton-buildings, London.

8991. Improvements in and relating to electric arc lamps. The Electrical Company, Limited, and Franz Schaefer, 83, Cannon-street, London.

8996. Contrivance and apparatus for storing the heat furnished by a source of electricity. Société Anonyme L'Electricité Moderne, 22, Southampton-buildings, London. (Date applied for under Section 91 of the Act, April 6, 1908, being date of application in France.) (Complete specification.)

APRIL 25.

8997. Improved means for ventilating or cooling laminated iron cores carrying a magnetic flux whose principal or only component is a simple alternating flux. Archibald Reith Low, 121, West George-street, Glasgow.

9008. Improved illuminated electrically-operated apparatus for displaying advertisements, announcements, and the like, day and night. Arthur Richardson, 116, Trewhitt-road, Heaton, Newcastle, Durham.

9022. Improvements in the construction of electric condensers. Edouard Deniéport, 100, Wellington-street, Glasgow. (Date applied for under Section 91 of the Act, Sept. 30, 1907, being date of application in France.) (Complete specification.)

9033. Improvements in or relating to commutating dynamo-electric machines. Valere Alfred Fynn, 18, Blessington-road, Blackheath.

9042. Improvements in or relating to electrodes for the application of high-frequency electric currents. Rowland Houghton, Stuart House, Edward's-terrace, Cardiff.

9077. Improvements in insulating wire conductors for electric currents. William Edward Lake, 7, Southampton-buildings, London. (Paul Schröder, Germany.) (Complete specification.)

9080. Improvements in secondary batteries or accumulators. Walter Wardle, 55, Market-street, Manchester.

APRIL 27.

9090. Improvements in insulating machines for electrical apparatus. Joseph Fitzalan Simpson and Arthur Whitten Brown, 23, King-street West, Manchester.

9097. Improved holders for tungsten filaments in electric lamps. Deutsche Gasglühlicht Akt.-Ges. (Auerges), 55, Chancery-lane, London. (Date applied for under Section 91 of the Act, Feb. 13, 1908, being date of application in Germany.) (Complete specification.)

9099. Trolley for electric railways and tramways. Alfred Wermann, 115, Cannon-street, London. (Complete specification.)

9128. Improvements in flexible stands for supporting electric and other lamps. Frank Grant Grimler and Henry A. Neyland, 53, Chancery-lane, London. (Complete specification.)

9133. Improved electromotor. Ida Mary Hawkins, 19, Holborn-viaduct, London.

9146. Improvements in and relating to electric transformers. Akt.-Ges. Brown, Boveri, und Cie., 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, April 26, 1907, being date of application in Switzerland.) (Complete specification.)

APRIL 28.

9156. Improved device for opening and closing an electrical circuit, more particularly intended for testing the ignition of multiple-cylinder internal-combustion engines. Frederick Herbert Wynne, 1, Imperial-buildings, East Croydon, Surrey.

9195. Improvements in automatic electric lifts. Charles George Major, Edwin Charles Stevens, and Percy Herbert Stevens, Janus Works, Queen's-road, Battersea, London.

9203. Improvements in and relating to signalling apparatus for electric railways and tramways. Percival John Pringle and George William Green, 323, High Holborn, London.

9222. Improvement in electric arc lamps. Charles Augustus Carpenter and Oscar Thomas Banks, 49, Mortimer-street, London.

9229. Improvements in and relating to electrically-controlled clocks. Walter Thomas Giles, 4, South-street, Finsbury, London.

9231. Improvements in electrical railway signalling systems. William Hogan Lewers, 51, Pathfield-road, Streatham, London.

9232. Improvements in electrical railway signalling systems. William Hogan Lewers, 51, Pathfield-road, Streatham, London.

9237. Improvements in and relating to devices for protecting transformers, cables, and other electrical apparatus. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, April 29, 1907, being date of application in Germany.) (Complete specification.)

APRIL 29.

9254. Improvements in electricity integrating meters. Rankin Kennedy, 60, Norse-road, Scotstoun, Glasgow.

9257. Improvements in incandescent electric lamps. James Cochran, 17, St. Ann's-square, Manchester.

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9241. Improvements in electric arc lamps. Adrian Denman Jones, Hartham Works, Hartham-road, Holloway, London. (Application for patent of addition to No. 3060/07.)

9266. Improvements in or relating to electrical contact breakers for use on internal-combustion engines. Sydney Slater Guy, High-street-chambers, Coventry.

9288. Improvements in electricity meters for use in connection with the charging and discharging of storage batteries. Hermann Aron, 47, Lincoln's-inn-fields, London. (Complete specification.)

9289. Improvements in multiple tariff electricity meters. Hermann Aron, 47, Lincoln's-inn-fields, London. (Complete specification).

9291. Improvements in and relating to electromagnets. Maximillien Kotyra, 47, Lincoln's-inn fields, London.

APRIL 30.

9323. Improvements in mechanical connectors for electric cables. John Stratton and Ernest Alexander Claremont, 4, Bloomsbury-square, London. (Complete specification.)

9324. Improved arc lamp covering. Robert Thomas Vigar, High-street, Caterham, Surrey.

9335. Improvements in electrical and attendant arrangements for controlling the locking and unlocking of railway carriage and other doors. Frederick Brown and Robert James Rudall, 5, John Dalton-street, Manchester.

9360. Trolley head for electric tramcars. Jesse Orlando Millard, 192, Peel Green-road, Patricroft, Manchester. (Complete specification.)

9362. Improved suspending device particularly applicable for use with gas, electric, or other lamps. William Howard Chipperfield, 149, Strand, London.

9405. Improvements in plates for electrical accumulators. Léonard Mériguet, 53, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on May 14.)

1907.

1292. Converting direct into alternating currents by means of the electric arc. Ruhmer.

8742. Electrical controllers or switches. Oppermann.

8951. Distribution of electricity. Davy.

8999. Machines or apparatus for reproducing in ordinary characters telegraphic or other messages or intelligence in the form of perforations in a tape. Creed and Coulson.

9576. Method of and apparatus for starting electromotors and regulating their action. Thursfield.

11165. Electrical distribution. Highfield.

12139. Manufacture of filaments for electric lamps. Planchon.

12585. Apparatus for telegraphing type-printed messages. Haar.

12712. Means for obtaining unidirectional electric current from spark coils. Miller.

13891. Apparatus for treating liquids electrolytically. Tate.

14162. Apparatus for igniting gas electrically. Plumstead, and Newton and Lawrence, Limited.

14368. Automatic telephone switches. Lake. (Charles M. Thompson Company.)

15171. Method of insulating sheet metal and other electric conductors. British Thomson-Houston Company. (General Electric Company.)

16166. Supplying of current to electric motors in series systems. Highfield.

16500. Electric self-winding clocks. Lake. (Sanford.)

16531. Supports for the filaments of electric incandescent lamps. British Thomson-Houston Company. (General Electric Company.)

17046. Application of electricity for stimulating vegetable growth. Newman and Lodge.

18101. Process for the manufacture of electric insulating materials, also suitable for building purposes. Wunner'sche Bitumen-Werke Ges. (Date applied for under International Convention, April 29, 1907.)

21007. Electromotors. Allison. (Behan.)

21827. Single-phase series alternating-current commutator motors. Latour. (Date applied for under International Convention, Oct. 3, 1906.)

22085. Electric batteries. Schwarzwalder.

23199. Arc lamps. Timar and Von Dreger. (Date applied for under International Convention, Sept. 4, 1907.)

26920. Electrical locking apparatus for railway signals. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

26937. Coin-operated apparatus for controlling the supply of electricity. Evans.

27783. Means for making electrical joints or connections. Denny. (Eastgate and Horn.)

1908.

898. Bearings for electromagnetic sparking machines. Firm Robert Bosch. (Date applied for under International Convention, Sept. 23, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
—— Ord., 1,125,000	1 ..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	11/16-13/16
—— Ordinary, Nos. 1 125,000	1 ..	3/16-5/16
British Aluminium Co., Ordinary, 2 001-40,000	5 ..	3⅜-3¾ xd
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4¼-4⅜ xd
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	4¼-4⅜
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3⅜ 4¼ xd
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	101-104
—— 5½ per cent Loch Leven Deb. (Reg.). Red., 1-3 000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-6⅝
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	93 98
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275,001-475,000	3 ..	⅛-¼
—— 4 per cent. Mortgage Debenture Stock	100 ..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2 ..	0-¼
—— Non. Cum., 6 per cent., Pref.	2 ..	3/16-7/16
—— 4½ per cent. 1st Debenture Stock	100 ..	74-79
—— 4½ per cent. 2nd Debenture Stock	100 ..	59-64
Callender's Cable, Debentures	100 ..	106½-108½
—— Ordinary	5 ..	1⅛-1⅛
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	¼-¼
Crompton and Co.	3 ..	1⅝-1⅞
—— 5 per cent Debentures	100 ..	92-96
Dick, Kerr and Co., Ordinary, 1.250 000	1 ..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99 261	3 ..	¾-1
—— "A" Shares, 01-017,139	5 ..	1½-2¼
—— 5 per cent. Debentures	100 ..	85-87
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112,100	2 ..	¼-½
—— 7 per cent. Cumulative Pref.	2 ..	1¼-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red	100 ..	75-80
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅞-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	87-90
W. T. Henley's Telegraph Works, Ordinary	5 ..	10¼-11½
—— 4½ per cent. Preference	5 ..	4 - ⅜
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15¼-16½
—— 4 per cent. Debentures	100 ..	98-100
National Electric Construction Co., 1-170,000	1 ..	3/16-7 16
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	30-32
—— 4 per cent. Bonds	100 ..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	8-9

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price £
Adelaide Electric Supply Co., 6 p c. Cum. Pref., 1-10,000	5 ..	5⅛-5½
Bournemouth and Poole, Ordinary	10 ..	10¾-11¼
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	10-10¼
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	10¼-11
—— 4½ per cent. Debenture Stock, Red.	100 ..	104-105
Bromley (Kent) Electric Light and Power Co.	5 ..	4¼-5 xd
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	94-97
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	6⅞ 7¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-60,000	5 ..	6⅞ 7¼
—— Nos. 80,000-100,000	5 ..	6⅞ 7¼
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	89-93
—— 7 per cent. Cum. Pref. Stock	$100 ..	107-109
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅞ 4½
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	4¼- ⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p c Cum. Pref., 1-40,000	5 ..	3¾-4¼
—— ditto (1903) 40,001-80,000	5 ..	4⅜-4⅝
Chelsea Electricity Supply	5 ..	3-3½
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	9¼-10½
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-126
—— 4½ per cent. 2nd Deb. Stk., Red.	100 ..	101-104
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,630	50 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	3-3⅜
—— 5 per cent. Preference, 1-50,000	5 ..	4¼-4⅜
County of London Elec. Supply, Ordinary	10 ..	7⅜-8¼
—— 6 per cent. Cum. Pref.	10 ..	10⅜-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Rd.	100 ..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅛-¼
—— 6 per cent. Cum Pref.	5 ..	¼-1
—— 4½ per cent. First Mort. Deb.	100 ..	55-60
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	75-78 p c.
Electric Lt. & Traction Co. of Aust., 6 p c. Cm. Pf., 1-30,000	5 ..	2¼-2⅜
—— 5 per cent Debenture Stock, Rd.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	91-94
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4⅜-½
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5 ..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	95-98
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	90-93
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 .	3/16 5/16
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5 ..	7⅛-8⅜
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100 ..	96-99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5 ..	1-1⅛
—— 6 per cent. Pref.	5 ..	4⅛-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	89-92 xd
Metropolitan Ordinary, 100,001-200,000	5 ..	4⅜-5⅛
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	107-111
—— 4½ per cent. Cum. Pref.	5 ..	4⅜-5⅛
—— 3½ per cent. Mortgage Debenture, Red	100 ..	85 90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000	— ..	76-78 p c.
Mexican Light and Power Co., Capital Stock	$100 ..	4⅛-4⅜
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14 000 ($1,000)	— ..	75-78
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	— ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	5⅜-5⅛
—— do., 57,010-75,000	5 ..	5⅜-5⅛
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5 ..	5⅛-5⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5⅛-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)....	5 ..	5⅛-5⅜ xd
Notting Hill Electric Lighting	10 ..	11½-12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅛ 6⅜
—— 4 per cent. Debenture Stock	100 ..	94-98
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120 507	1 ..	⅛-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	⅛-1
—— 5 per cent. Debenture Stock, Red.	100 ..	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5 ..	4⅜ 5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5 ..	4⅜-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	102-104 p c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	⅛-1⅛
—— 4 per cent. Debenture Stock	100 ..	70-74
South London. Ordinary	5 ..	2⅜-2⅞ xd
South Metropolitan Electric Light and Power, Ord.	1 ..	⅛-⅜
—— 7 per cent. Cum Pref.	1 ..	1⅛-1⅜
—— 4½ per cent. 1st Mort. Deb.	100 ..	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7⅛-8⅛
—— 7 per cent. Pref.	5 ..	6⅛-7
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1⅜ 2⅛
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	1⅜-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100 ..	87-90
Westminster, Ordinary	5 ..	7⅛-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 .	4⅜-5⅛

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5 ..	6⅛ 6⅜
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	7⅛-8⅛
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	136-141
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	104-107
Barcelona Tramways, Ord., 1-20,000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	—
—— 5 per cent. Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅜-⅝
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1 ..	11/16-3/16
Birmingham and Midland Trams., 4½ p. c 1st Db. Stk., Red.	100 ..	93-96
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10 ..	10-10⅛
—— 4½ per cent. Deb. Stock, Red.	100 ..	93-95
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3⅜ 3⅛ xd
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅛-4⅞ xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	98-102
British Columbia Electric Railway Co., Old Def.	100 ..	129-132
—— Ord. Pref.	100 ..	111-115
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	107-111
—— 4½ per cent. 1st Mt. Debs., Nos. 1 6,250, of £40 each	40 ..	99-102
—— 4½ per cent. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord. 1-300,000 & 60 001-90,000	10 ..	1⅛-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	3⅜ 4⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	90-95
—— 4½ per cent 2nd Deb. Stock	100 ..	69-73 xd
Bueno Ayres and Belgrano Trams	5 ..	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110-116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	95-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	98-102
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	91-94
Calcutta Tramways, Ord., Nos. 1-137,610	5 ..	6-7 xd
—— 5 per cent. Cum. Pref., Nos. 1 30.000	5 ..	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	103-106
Cape Electric Tramways, Nos. 1-480,000	1 ..	3,16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4⅛-4⅜ xd
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	97-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	88-91 xd
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12⅛-13⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12⅛-13⅛
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	94-97
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	80-85
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	⅜-1⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £236,500 2nd Mort. Deb. Stock	— ..	—
—— £83,130 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	1-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 ..	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	90-95
London United Tys. (1901), 5 per cent. Cum. Pref.	10 ..	6⅜-7⅜
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	80-85
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 ..	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4⅛-5
——4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1 ..	1/32-5/32
—— 5 per cent. Cum Pref., 500,001-1,000,000	1	11/16-13/16
—— ½ per cent. Deb. Stock, Red.	100 ..	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	86½-87½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	⅛-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	⅛-⅛
—— per cent Cum Pref., 300,001-545 000	1 ..	⅛-⅛
—— per cent. Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4⅜-5⅛
—— per cent. Cum. Pref., 1-10,000	10 ..	9⅛-10⅛
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-20,000	5 ..	5⅛ 5⅜
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100 ..	129-134
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-12,000	$500 ..	96⅛-98⅛ p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅛-1
—— 4 per cent. Deb Stock, Red. 1940	100 ..	76-80
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100 ..	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5 ..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	74-77
—— 4 per cent. Pref.	100 ..	84-86
—— " " deferred	100 ..	54-57
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100 ..	100-103
City and South London, Consolidated Ordinary	100 ..	39-41
—— 4 per cent Debenture Stock	100 ..	100-103
—— 5 per cent. Pref. Stock '91	100 ..	113-116
—— " " " '96	100 ..	112-115
—— " " " '01	100 ..	110-113
—— " " " '03	100 ..	106-109
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10⅛
—— Ordinary, 1-50,000	10 ..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent Profit-Sharing Secured Notes	— ..	36-40
—— Deposit Receipts	— ..	35-40

Telegraphs and Telephones.—

Name.	Amount paid.	Last price.
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Coll. tr. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1 000 ..	85 87
Anglo-American Telegraph Co., Ordinary	100 ..	55-58
—— 6 per cent. Preferred Ordinary	100 ..	99-101
—— Deferred Ordinary	100 ..	13⅜-14¼
Anglo-Portuguese Telephone Co., 5 per cent 1st Mort. Deb. Stock, Red.	100 ..	98½-101⅛
Chili Telephone Co., 1-44,000	5 ..	7-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	86-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	7⅛-8⅛ xd
—— 10 per cent Preference, 1-6,000	10 ..	15⅞-16⅞ xd
Direct Spanish Telegraph Co., Ordinary	5 ..	3⅛-3⅜
—— 10 per cent. Cum. Preference	5 ..	8-9
—— 4½ per cent. Debs., 1-600	50 ..	99½-102⅛
Direct United States Cable Co.	20 ..	13¼-14
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	99½-101⅛
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	98½-100½ xd
Eastern Extension, Australasia and China, 1-300,000	10 ..	13-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	100-102
Eastern Telegraph Co., Ordinary Stock	100 ..	131-136
—— 5½ per cent. Preference Stock	100 ..	84-87
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102 xd
Great Northern Telegraph Co. (of Copenhagen)	10 ..	29-31
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100 ..	99½-101½
Indo-European Telegraph Co.	25 ..	55-56
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	29/32-1 1/32 xd
—— 5 per cent. Preference, 1-86,492	1	15/16-15/16 xd
National Telephone, Preferred	100 ..	107½-109½
—— Deferred Stock	100 ..	108½-110½
—— 6 per cent. Cum. First Pref.	10 ..	10¾-12⅛
—— 6 per cent. Cum. Second Pref.	10 ..	10¾-12⅛
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅜-5⅝
—— 5½ per cent. Deb. Stock, Red.	100 ..	98-100
—— 4 per cent. Deb. Stock, Red.	100 ..	101½-103½
Oriental Telephone and Electric Company	1 ..	1⅜-1⅝
—— 6 per cent. Cum. Pref.	1 ..	1⅜-1⅝
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6-6⅜
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅜-5⅜
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	98½-101½
West India and Panama Telegraph Co., Ordinary	10 ..	9/16-11/16
—— 6 per cent. Cum. 1st Preference	10 ..	8⅛-8⅜
—— 6 per cent. Cum. 2nd Preference	10 ..	8⅛-9
—— 5 per cent. Debs., Red., 1-800	100 ..	101-104
Western Telegraph Co., 1-207,950	10 ..	13⅛-13⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	100-102

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week. Ending	1908.	1907.	Increase or decrease. Week.	Current year.	Miles of track open. 1908.	1907.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	April 29	1,208	1,252	− 43	− h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	May 2	262	240	+ 21	—	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 2	3,070	2,500	+ 570	+13,193	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 3	1,034	1,038	+ 46	+ 224	23·53	25·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	April 25	6 8'6	5,642	+ 1,174	—	56½	54½	,, 31	18 557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 29	850	961	− 11	+ 58	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 30	480	4'6	− 6	+ 795	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	May 3	2,287	2,211	+ 76	+ 921	42	42	March 31	111 294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	April 29	1,526	1,511	+ 5	− 338	29¼	24¾	,, 31	83,663	13,503,610	1,765,088	1·48	11·37	2,860	7·28
Bradford Corporation	May 2	4,478	4 426	+ 52	− 812	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 3	825	775	+ 50	+ 212	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1 09	10·49	2,844	7·4
Bristol Tramway Company	,, 1	4,763	4,736	+ 27	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 2	1,200	1,160	+ 40	—	19¾	19¾	,, 31	62,699	11,967,458	1,205,830	1·31	12·48	5,825	8·21
Burton Corporation	,, 3	278	270	+ 8	—	9⅞	8½	,, 31	15,576	3,383,527	421,317	1·07	8 87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	May 2	154	72	− 18	+ 45	8·5	8·5	Dec. 31	10 254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 2	5,786	6,089	− 303	− 3,876	6	6	,, 31	349 298	43,057,997	1,279,698a	1·85	62 29a	55,357	35·22a
Charing X, Euston, & Hamp. Ry.	,, 2	3,230	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 3	3,121	2 905	+ 216	+ 6,141	9	6½	h June 30	82,456	10 048,780	—	—	—	—	—
Colchester Corporation	April 29	164	121	− 17	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 30	434	448	− 14	− 481	15½	15½	Dec 31	25,032	5,966,364	891,998	—	6·74	—	4·78
Croydon Corporation	May 1	1,323	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502 408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 1	223	261	− 38	—	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	April 25	212	191	+ 21	− 158	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	May 1	115	99	+ 16	+ 58h	6¾	6¾	—	—		—	—	—	—	—
Dublin U.T.	,, 1	5,151	5 162	− 11	+ 752	54¼	48¾	—	—		—	—	—	—	—
Dundee City Tramways	April 8	1,144	1 195	− 51	—	22	22	May 15	57,672	15 554,905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	May 2	794	976	− 82	− 183	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 2	17,135	17,369	− 174	+15,463h	177½	169	May 31	887,381	224,063,098	20,350,367	95	10·47	5,035	5·21
Gloucester Corporation	April 29	238	228	+ 10	—	15	15	March 31	15,033	3,182,111	579,896	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	May 2	5 405	4,205	+1,200	+28 741	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	April 14	1,413	1,283	+ 130	—	52·574	37	,, 31	77,996	18,899,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	May 2	1,506	1,443	+ 58	+ 68	35½	35	,, 31	81,196	15 252,150	1 804,745	1·52	10·79	2,770	5·94
Hull Corporation	,, 2	2,363	2,395	− 31	− 121	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	April 25	475	423	+ 12	—	10½	10½	,, 31	26,499	6,586,754	615,117	89	9 58	2,225	6 5
Ilkeston Corporation	,, 29	120	121	− 1	− 15	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 29	261	235	+ 26	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1,73	4 95
Lancashire United Tramways	,, 29	1,111	1,080	+ 31	+ 1,050	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 25	6 797	6 089	+ 708	+ 323	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5·58
Leicester Corporation	May 2	2,179	2 139	+ 40	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	April 25	10,885	10 515	+ 370	− 1,774	104	104	Dec. 31	563,793	122,094,528	12 115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	May 3	1,446	1,525	− 79	− 309h	9 25	6·65	June 30	77,568	10 957,148	1,102,809	—	—	—	—
London County Council	April 18	31 974	28, 96	+2 982	+ 8,161	98	98	March 31	1378,014	314,227,090	30,130 297	1·05	10 98	—	8 56
Lowestoft Corporation	May 2	159	140	+ 19	+ 135	3½	—	Sept. 30	11,009	2,622,922	343,190	1 03	7·9	2,156	6 39
Maidstone Corporation	April 30	150	100	+ 50	—	3½	2	March 31	5,913	1 186,566	157,050	1 14	8 6	2,956	6·2
Manchester Corporation	May 2	14,407	13 620	+ 787	+ 5,118	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 2	8,632	8 125	+ 507	+17 255	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 3	15,668	15 6 3	+ 55	+ 2,531	25½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 2	132	110	+ 8	− 120	2¾	2¾	March 31	7,709	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 2	3,850	4 035	− 535	− 2 189	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 2	646	604	+ 42	+ 41	14½	14½	,, 31	32,421	7,760,403	772 753	1 03	10 01	1.525	6·87
Oldham Corporation	—	—	—	—	—	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12 53	2,603	7·259
Portsmouth Corporation	Mar. 28	1,460	2,086	− 626	—	28½	28½	,, 31	98,911	20,668 825	2 199,823	1·15	10 79	—	—
Reading Corporation	—	—	—	—	—	13½	13½	,, 31	32,661	8,170 179	918,825	96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	April 28	4,469	4,322	+ 147	− 715	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	·0
Sheffield Corporation	,, 26	5,642	5,444	+ 198	− 1,698	65½	65¾	March 25	276,907	73,966,299	6,804,656	898	9 767	4,174	
Southampton Corporation	,, 29	858	899	− 40	+ 55	18	18	,, 31	49,185	9,437,296	1,143,085	1·25	10·71	—	7 7
Southend-on-Sea Corporation	,, 29	311	277	+ 34	—	9	9	,, 31	20,076	4,431,728	390,578	1 07	12 33	3,155	6 75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248 656	—	9 464	—	4·849
Sunderland Corporation	May 3	1,050	1,385	− 335	− 1,426	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	April 30	286	133	+ 153	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	May 2	844	761	+ 83	+ 13	12 68	12·43	‡ ,, 31	42,810	8,312,592	850,906	—	11·53	—	—
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,965 296	429 785	—	10 724	1,989	6·95
West Ham Corporation	April 30	1,924	2,178	− 254	− 1,152	14·7	14·7	,, 31	182,881	35,802 836	2,556,854	·769	10·96	4,407	6·79
Wolverhampton Corporation	,, 29	827	778	− 49	—	20	20	,, 31	43,823	9,276,023	966,133	—	10 886	2,159	6·095

* 1905-6 figures. ‡ 1907-8 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE

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ELECTRIC POWER IN INDIA.

If one considers the location of the prominent industries in the United Kingdom, it is interesting to note that the existence of water power has frequently determined the site of large factories which have been for years steam driven. The oldest of all such industries is the cornmill, and in the corn growing areas all the small streams have been utilised for driving millstones. The cloth and cotton mills also depended one hundred years ago on water power, which has since been found quite inadequate to deal with the enormous developments of these industries. When one turns to countries, like India, which are still dependent on agriculture, there is not the demand for such large quantities of power per head of population as is the case in the United Kingdom. The water power available in the mountainous districts is enormous, and the problem confronting the civil engineer is where to find the user of the vast power he sees running to waste. It is in this that Major de Lotbiniere has been so successful. He recognised the advantage which electricity gave in enabling the power from a waterfall to be transmitted over large distances to places where there is a demand for it. Thus in the Cauvery scheme, for which he was primarily responsible, the distance of one hundred miles between the waterfall and the Kolar goldfields was spanned with ease, with the result that the cost of power for driving the stamps in these gold mines was reduced 50 per cent. One must admire not only the engineering success of the scheme, but also the enterprise of the Maharajah of Mysore, who accepted expert advice and backed the scheme financially. The State of Mysore now receives substantial income from power which was absolutely wasted before, and, as we noted in a recent issue, the Maharajah has given a large sum to the Indian Institute of Science, which will help the spread of similar enterprises in India. The latest scheme, which is described in this week's issue, and which is now approaching completion, is distinctly novel in many respects. The Jhelum River in Kashmir is being harnessed by Major de Lotbiniere by works which will ultimately develop 20,000 h.p. In this case there are no goldfields to be supplied, and from the report we do not hear of any large mining operations within the district. A certain amount of the power developed will be utilised in the silk industry for heating purposes. The bulk of the power, however, is to be utilised for reclaiming lands higher up the river which are now permanently waterlogged or subject to destructive floods. This is due to a large extent to the over-grazing of the mountains forming the watershed of the river, and the consequent washing away of soil from the mountain slopes. The debris thus carried down the river has blocked up the bed of that part of the course above the Woolar lake. An extensive scheme of electric dredging has been recommended by the above engineer, and is now in a fair way towards commencement. The fleet of electric dredgers now launched in this part of the river will be supplied with power from a 60,000-volt floating sub-station. We do not know how many years' work there is before this fleet, but Major de Lotbiniere's report speaks of 100,000 acres of good land to be reclaimed ultimately. In fact, the River Jhelum will be made to correct by its superfluous energy in one part the damage done by its want of fall in an upper section. A glance at the map of India, from which we reproduce a small portion showing the present scheme, will convince any engineer that there is abundant water power available. The glacier-fed rivers in the north give that constancy of flow which prove so valuable in Switzerland and Italy, and we feel sure that there is a splendid field for those engineers who have organising

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ability and can either connect up these water powers to existing industries or start new industries in which cheap power is the great desideratum.

BATH.

The future of the Bath Corporation electric light works has been somewhat uncertain. The Corporation have been unable to make their undertaking pay—a fact which must by no means be attributed to the policy of municipalisation, but, if anything, to mismanagement in the early stages—and have sought to rid themselves of it in a manner most advantageous to themselves, rather than to reorganise the undertaking, and place it on a profit-making basis. Being predisposed to sell the undertaking, the Corporation last year resolved to entertain a purchase scheme submittted to them by Mr. Schenk on behalf of a syndicate. The terms of the proposed purchase seemed fair to the Corporation. They were to get back the capital expended, together with a bonus of £10,000, and a further bonus of £10,000 on the undertaking becoming vested in the company in perpetuity, or, instead of the latter bonus, an annual supply of £450 worth of current free of charge for public lighting purposes. The accumulated sinking fund of £28,316 was to remain the property of the Corporation, and the net profit on the transfer was likely to amount to £50,000. But there was even more than this in store for the fortunate ratepayers. The terms provided for extension of plant, mains, etc., and for a reduction in the price of public lighting. But even the best-laid schemes are likely to go astray, not excepting that one submitted to the Bath Corporation. When the time arrived for the materialisation of the scheme it was found that the necessary money with which to carry it out was not available, and as the stringency of the money market did not relax, Mr. Schenk discovered (on Oct. 2, 1907) that it would be difficult for him to complete the bargain on a cash basis by the date fixed (Oct. 31, 1907). Faced with this difficulty, the Corporation decided to consider alternative proposals from Mr. Schenk. These proposals have now been made, and, after consideration by a sub-committee, are being recommended to the Council for acceptance. The essential difference between the terms as now formulated and the terms of purchase to which the Council gave their consent last year is that, instead of the purchase money being paid down in cash, the amount is to be paid by a substantial instalment and by annual sums extending over a period of thirty years. It is also proposed to supply the Corporation free of cost electrical energy to the value of £1,000 per annum, subject to a reduction to £500 per annum in the event of the company failing to obtain the transfer of the undertaking in perpetuity. The offer seems alluring. But what if the company have failed to secure the necessary capital at the end of thirty years? Nor is there sufficient safeguard against the failure of the company to maintain its annual instalments. There is absolutely nothing to guarantee that the difficulty of obtaining money, which hindered Mr. Schenk even beginning to carry out his original scheme, may not again be encountered either during or at the end of the thirty years—which is the period of lease—when it will tell more heavily against the public interests than it would before the period had commenced. There seems to be many grave objections to leasing the undertaking. If the Corporation do not wish to carry it on themselves, then they should take steps to sell it outright. The only satisfactory alternative to an outright sale is to make the best of the concern. The Corporation can secure money just as easy as anyone else, and by sound management, and by energy, skill, enterprise, and ability can very well place the undertaking on a profitable basis.

CENTRAL-STATION ENGINEERS.

It is our lot to visit many central stations and to hear criticisms upon their condition and management. It is singular, however, to find so little variation in the criticism. The same old platitudes hold good everywhere, and the surprise comes when aught that is new is heard. To our minds much of the thoughtless criticism is not only incorrect, but it is in very bad taste. Take a station erected and equipped fifteen or twenty years ago. Listen at a meeting and hear the impertinent remarks about its antiquity, about its costliness, about its mediocrity. Its responsible engineer is condemned because the charge per unit is too high; everything in and out of the station is compared with the most recently built and equipped station of the largest size and in the very best locality for cheap fuel that the critic can find, and the critic is conceited enough to sit down after his speech as if he had done something wonderful for the controlling authority. Quite recently we heard the expression of the view that Eccles was to be the best-lighted town in the country. Mr. Angus, the responsible electrical engineer, has to organise and to live up to the wish of his Council. Is it fair, is it just for some irresponsible individual who ignores quantity and quality of light to fling about figures for comparison with places where such views do not prevail? The fact of it is that figures analysed are food for the minds of experts, and are a curse when indiscriminately handled by those who do not understand them. Almost as recently Mr. Tomlinson-Lee had to discuss his organisation when criticised adversely. He could, but did not, retort that for nine-tenths of the adverse criticism the critics were themselves at fault and wholly to blame. The stations built and equipped fifteen or twenty years ago were so built and equipped according to the knowledge and experience obtained at that time, and it is not to be expected that they contain the exact kind of apparatus which is designed according to the accumulated experience of to-day. Really there are exceedingly few people in a position to determine what is best for electrical work. At the moment it is almost impossible to say what the ultimate effect will be of the large use of metal-filament lamps. Is power to be the first object and lighting the aside—or what? Most of the morals attached to criticism read that 'tis better to wait before acting. That shows the shallowness of knowledge, for unless we utilise to the utmost the results of present experience we shall never get further experience or a step in progress. Electrical work has followed the normal lines. It was tried freely and fully, and the experience gained led to improvements which are introduced into recent undertakings; and so it must go on. The best now will not be twenty years hence, and we certainly wish those who utter criticism upon this or that undertaking would consider the trend of their observations, and not be in too great a hurry to condemn or to cause a flutter of excitement.

TUNGSTEN LAMPS.

The Siemens and Halske Company is now taking up tungsten lamps. One of the methods patented by this company is to heat ammonium tungstate to about 300deg., whereby ammonia is given off. After treatment for a certain time the product obtained is boiled for a short time in a limited amount of water, whereby a tough paste, which is as sticky as glue and can be formed into filaments, is produced.

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THE KELVIN LECTURE.

BY PROF. SILVANUS P. THOMPSON, F.R.S.

(*Concluded from page 567.*)

Submarine telegraphy was "in the air." John and Jacob Brett had pioneered the project for a Dover-Calais cable, and in 1851 Crampton successfully united England and France. In 1853 Holyhead and Howth were connected by Mr. (later Sir) Charles Bright, and these were followed by the Dover-Ostend and longer cables. Atlantic telegraphy became the dream of the telegraph engineer. Cyrus W. Field in 1856 negotiated a cable across the Gulf of St. Lawrence, this connecting Newfoundland to the American continent. The Atlantic Telegraph Company was formed, with capital mostly subscribed in England, to promote the great enterprise to join Ireland to Newfoundland. Field, Brett, Bright, Statham, and Wildman Whitehouse were the chief promoters—Bright was engineer, Whitehouse (a retired medical man) electrician. In a pamphlet issued by the company in July, 1857, narrating the preliminary proceedings, the names of Jno. Pender, of Manchester, and Prof. Thomson, of "2, The College, Glasgow," are included in the list of the directors, and the statement is made that "the scientific world is particularly indebted to Prof W. Thomson, of Glasgow, for the attention he has given to the theoretical investigation of the conditions under which electrical currents move in long insulated wires, and Mr. Whitehouse has had the advantage of this gentleman's presence at his experiments, and counsel, upon several occasions, as well as the gratification resulting from his countenance and co-operation as one of the directors of the company." This is one side of the matter. The other side is that Mr. Whitehouse had at the British Association meeting in 1856 read a paper challenging the law of squares, and declaring that if it was true Atlantic telegraphy was hopeless. He professed to refute it by experiments, the true significance of which was disposed of by Thomson in two letters in the *Athenæum*. He pointed out that success lay primarily in adequate section of conductor, and hinted at a remedy (deduced from Fourier's equations), which he later embodied in the curb signal transmitter—namely, that the coefficient of the simple harmonic term in the expression for the electrical potential shall vanish. In December, 1856, he described to the Royal Society his plan for receiving messages—namely, a sort of Helmholtz tangent galvanometer with copper damper to the suspended needles, the deflections being observed by watching through a reading telescope the image of a scale reflected from the polished side of the magnet or from a small mirror carried by it. As we all know, he abandoned this subjective method for the objective plan, in which a spot of light from a lamp is reflected by the mirror upon a scale. There is a pretty story, which is believed to be true, that the idea of thus using the mirror arose from noticing the reflection of light from the monocle which, being shortsighted, he wore hung round his neck with a ribbon.

The story of the Atlantic cable, of the failure of 1857, of the brief success of 1858, has so often been told that it need not be repeated here. Thomson, after the failure of the first attempt, was called upon to take a more active part. He had discovered, to his surprise, that the conductivity of copper was greatly affected—to an extent of 30 or 40 per cent.—by its purity. So he organised a system of testing conductivity at the factory where the additional lengths were being made, and was put in charge of the test-room on board the "Agamemnon" in 1858. Whitehouse was unable to join the expedition, and Thomson, at the request of the directors, undertook the post of electrician-in-charge, without any recompense, though the tax on his time and energies was very great. After various disheartening mishaps, success crowned their efforts. Throughout the voyage Thomson's mirror galvanometer had been used for the continuity tests and for signalling to shore, with a battery of 75 Daniell's cells. The continuity was reported perfect, and the insulation had improved on submersion. On Aug. 5 the cable was handed over to Mr. Whitehouse and reported to be in perfect condition. Whitehouse at once abandoned the Thomson mirror instruments and began working with his own special patented apparatus, using heavy relays and a special transmitter with induction coils. He sent in no report to the directors for a week while he made ineffectual attempts with bigger induction coils to get his apparatus to work. After more than a week the reflecting galvanometer and ordinary Daniell cells were resumed, and then clear messages were interchanged; but the insulation was found to be giving way, and on Oct. 20, after 732 messages had been conveyed, the cable spoke no more. It had been destroyed through Whitehouse's bungling use of induction coils nearly 5ft. long working at some 2,000 volts!

Of the part played by Thomson in the next eight years in preparation for the cables of 1865 and 1866 there is not time to speak. Suffice it to say that throughout the preparations, the preliminary trials, the interrupted voyage of 1865, when 1,000 miles were lost, the successful voyage of 1866, when the new cable was laid and the lost one recovered from the ocean and completed, Thomson was the ruling spirit whose advice was eagerly sought and followed. On his return he was knighted for the part he had played so well. He had in the meantime made further improvements in conjunction with Cromwell Varley. In 1867 he patented the siphon recorder and, in conjunction with Fleeming Jenkin, the curb transmitter. He was consulted on practically every submarine cable project from that time forth.

Thomson's activities during the sixties were immense. Beside all this telegraphic work he was incessant in researches. He had undertaken serious investigations on the conductivity of copper. He was urging the application of improved systems of electric measurement and the adoption of rational units. When in 1861 Sir Charles Bright and Mr. Latimer Clark proposed the names of ohm and volt, based on the centimetre-gramme-second absolute system, Sir William Thomson gave a cordial support; and on his initiative was formed the famous committee of electrical standards of the British Association, which year by year has done so much to carry to perfection the standards and methods of electrical measurement. He was largely responsible for the international adoption of the system of units by his advocacy of them at the Paris Congress in 1881 and in subsequent congresses. He was an uncompromising advocate of the metric system and lost no opportunity of denouncing the "absurd, ridiculous, time-wasting, brain-destroying British system of weights and measures." His lecture in 1883 at the Civil Engineers' may be taken as a summary of his views, but it gives only a partial glimpse of his activities. So early as 1851 he had begun to use the absolute system, stimulated thereto by the earlier work of Gauss and Weber. The fact that terrestrial gravity varies at different regions of the earths' surface by as much as half of 1 per cent. greater accuracy than this is required. "For myself," he said, "what seems the shortest and surest way to reach the philosophy of measurement — an understanding of what we mean by measurement, and which is essential to the intelligent practice of the mere art of measuring—is to cut off all connection with the earth," and so he imagined a traveller with no watch, or tuning fork, or measuring rod, wandering through the universe trying to recover his centimetre of length and second of time, and reconstructing thereupon his units of standard from the wave-length of the yellow light of sodium, and the value of v, the velocity of light, from experiments on the oscillations in the discharge of a Leyden jar.

Amongst the activities of these fruitful years was a long research on the electro-dynamic qualities of metals—thermo-electric, thermo-elastic, and thermo-magnetic. These formed the subject of his Bakerian lecture of 1856, which occupies no fewer than 118 pages of the reprinted "Mathematical and Physical Papers." He worked hard also at the mathematical theory of magnetism. Faraday's work on diamagnetism had appeared while Thomson was a student at Cambridge. It established the fact that magnetic forces were not mere actions at a distance between supposed poles, but actions dependent on the surrounding medium, and Thomson

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set himself to investigate the matter mathematically. Faraday and Fourier had been the heroes of Thomson's youthful enthusiasm, and while the oldest mathematicians shook their heads at Faraday's heretical notion of curved lines of force, Thomson had, in 1849 and 1850, developed a new theory with all the elegance of a mathematical disciple of Poisson and Laplace, discussing solenoidal distributions by aid of the hydrodynamic equation of continuity. To Thomson we owe the terms *permeability* and *susceptibility*, as familiar in the consideration of the magnetic properties of iron and steel. He continued to add to and revise this work through the sixties and seventies. In 1859-60 Thomson was studying atmospheric electricity, writing on it in Nichol's *Cyclopædia*, and lecturing on it at the Royal Institution. For this study he invented the water-dropping collector, and vastly improved the electrometer, which developed into the elaborate forms of the quadrant instrument and other types described in the British Association report of 1867. During this work he discovered the fact that the sudden charge or discharge of a condenser is accompanied by a sound. He also measured electrostatically the E.M.F. of a Daniell's cell, and investigated the potentials required to give sparks of different lengths in air.

And as if this were not enough to have in hand, he embarked with his friend Prof. Tait on the preparation of a text-book of natural philosophy. There was at that date no satisfactory work to put in the hands of students, and he must supply the need. At first a short pamphlet of propositions on statics and dynamics, culled by Prof. John Ferguson from these lecture notes, was printed for the use of students. He had told Helmholtz of his purpose, and in 1862 Helmholtz wrote him: "Your undertaking to write a text-book of natural philosophy is very praiseworthy, but will be exceedingly tedious. At the same time I hope it will suggest ideas to you for much valuable work. It is in writing a book like that that one best appreciates the gaps still left in science." The first volume of Thomson and Tait's "Treatise on Natural Philosophy" was published in 1867; the second only in 1874, when it appeared that Helmholtz's hopes were just. For in approaching the subject of electricity the gaps still left were found to be such that whole new mathematical researches were necessary before vol. ii. could be finished. Thomson's contributions to the theory of elasticity are no less important than those he made to other branches of physics. In 1867 he communicated to the Royal Society of Edinburgh his famous paper "On Vortex Atoms." Helmholtz had published a mathematical paper on hydrodynamic equations of vortex motion, proving that closed vortices could not be produced in a liquid perfectly devoid of internal friction. Kelvin seized on this idea. If no such vortex could be artificially produced, then if such existed it could not be destroyed. But being in motion and having the inertia of rotation, it would have elastic and other properties. He showed that vortex rings (like smoke rings in the air) in a perfect medium are stable, and that in many respects they possess the qualities essential to the properties of material atoms—permanence, elasticity, and power to act on one another through the medium at a distance. Though he seemed at the end of his life to doubt whether the vortex atom hypothesis was adequate to explain all the properties of matter, the conception remains to all time a witness to his extraordinary powers of mind.

In the winter of 1860-61 Thomson met with a severe accident. He fell on the ice when engaged at Largs in the pastime of curling and broke the neck of his thigh. For several months he had to lie on his back, and it was at this time that he adopted the famous green note-books which ever afterwards were the companions of his days. The accident left him with a slight limp for the rest of his life.

In 1870 Lady Thomson, whose health had been failing for several years, died. In the same year the University of Glasgow was removed from the site it had occupied for over three centuries to the new and splendid buildings on Gilmore Hill, overlooking the Kelvin river. Sir William Thomson had a house here in the terrace assigned for the residences of the professors, adjoining his laboratory and lecture room. From his youth he had been fond of the sea, and had early owned boats of his own on the Clyde. For many years his sailing yacht, the "Lalla Rookh," was conspicuous, and he was an accomplished navigator. His experiences in cable laying had taught him much, and in turn he was now to teach science in navigation. First, he reformed the mariner's compass, lightening the moving parts to avoid protracted oscillations, and to facilitate the connection of the quadrantal and other errors arising from the magnetism of the ship's hull. At first the Admiralty would have none of it. Even the Astronomer Royal condemned it. "So much for the Astronomer Royal's opinion," he ejaculated. But the compass is now all but universally adopted both in the Navy and in the mercantile marine.

Dissatisfied with the clumsy appliances used in sounding, when the ship had to be stopped before the sounding line could be let down, he devised the now well-known apparatus for taking flying soundings by using a line of steel piano wire. He had great faith in navigating by use of the sounding line, and once told me—*à propos* of a recent wreck near the Lizard, which he declared would have been impossible had soundings been regularly taken—how once, in continuous fog, he brought his yacht all the way across the Bay of Biscay into the Solent, trusting to soundings only. He also published a set of tables for facilitating the use of Sumner's method at sea. He was vastly interested in the question of the tides, not merely as a sailor, but because of the interest attending the mathematical treatment in connection with the problems of the rotation of spheroids, the harmonic analysis of their complicated periods by Fourier's methods, and their relation to hydrodynamic problems generally. He invented a tide predicting machine, which will predict, for any given part, the rise and fall of the tides, which it gives in the form of a continuous curve recorded on paper, the entire curves for a whole year being inscribed by the machine automatically in about four hours. Further than this, adopting a beautiful mechanical integrator, the device of his ingenious brother, Prof. James Thomson, he invented a harmonic analyser—the first of its kind—capable not only of solving differential equations of any order, but of analysing any given periodic curve and exhibiting the values of the coefficients of the various terms of the Fourier series. Wave problems always had a fascination for him, and the work of the mathematician Poisson and Cauchy on the propagation of wave-motion were familiar studies. In his lectures he used to say, "The great struggle of 1815," and then paused, while his students, thinking of Waterloo, began to applaud, "was not that fought out on the plains of Belgium, but who was to rule the waves, Cauchy or Poisson?" In 1871 Helmholtz went with Sir Wm. Thomson on the yacht "Lalla Rookh" to the races at Inveraray. Together they studied the theory of waves, "which he loved," says Helmholtz, "to treat as a race between us." Returning, they visited many friends. "It was all very friendly," and, wrote Helmholtz, "unconstrained. Thomson presumed so much on his intimacy with them that he always carried his mathematical note-book about with him, and would begin to calculate in the midst of the company if anything occurred to him, which was treated with a certain awe by the party." He possessed, indeed, the faculty of detachment, and would settle quietly down with his green book almost unconscious of things going on around him. On calm days he and Helmholtz experimented on the rate at which the smallest ripples on the surface of the water were propagated. Almost the last publications of Lord Kelvin were a series of papers on "Deep Sea Ship Waves," communicated between 1904 and 1907 to the Royal Society of Edinburgh.

In 1874, on June 17, Sir William Thomson married Miss Frances Anne Blandy, of Madeira, whom he had met on cable-laying expeditions. Lady Kelvin, who survives him, became the centre of his home in Glasgow and the inseparable companion of all his later travels. He built at Netherall, near Largs, a beautiful mansion in the Scottish baronial style, and though he latterly had a London house in Eaton-place, Netherhall was the home to which he retired when he withdrew from active work in the University of Glasgow.

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Throughout the seventies and eighties Sir William Thomson's scientific activities were continued with untiring zeal. In 1874 he was elected president of the Society of Telegraph Engineers, of which, in 1871, he had been a foundation member and vice-president. In 1876 he visited America, bringing back with him a pair of Graham Bell's earliest experimental telephones. He was president of the mathematical and physical section of the British Association of that year at Glasgow.

With the advent of electric lighting at the end of the seventies Thomson's attention was naturally attracted to this branch of the practical applications of science. He never had any prejudice against the utilisation of science for practical ends. "There cannot," he wrote, "be a greater mistake than that of looking superciliously upon practical applications of science. The life and soul of science is its practical application; and, just as the great advances in mathematics have been made through the desire of discovering the solution of problems which were of a highly practical kind in mathematical science, so in physical science many of the greatest advances that have been made from the beginning of the world to the present time have been made in the earnest desire to turn the knowledge of the properties of matter to some purpose useful to mankind." And so he scorned not to devise instruments and appliances for commercial use. His electrometers, his galvanometers, his siphon recorders, his compasses, had been made by James White, optician, of Glasgow. In this firm he became a partner, taking the keenest commercial interest in its operations, and frequenting the factory to superintend the construction of apparatus. New measuring instruments were required. He set himself to devise them, designing potential galvanometers, ampere-gauges, and a whole series of standard electric balances for electrical engineers. Lord Kelvin's patented inventions were very numerous. Without counting in those since 1900, taken mostly in the name of Kelvin and James White, they number 56. Of these 11 relate to telegraphy, 11 relate to compasses and navigation apparatus, six relate to dynamo machines or electric lamps, 25 to electric measuring instruments, one to the electrolytic production of alkali, and two to valves for fluids. He was an independent inventor of the zig-zag method of winding alternators, which the public knew under the name of Ferranti's machine, which was manufactured under royalties payable to him. He was interested even in such details as fuses and suspension pulleys with differential gear by which incandescent lamps can be raised or lowered.

He gave evidence before a parliamentary committee on electric lighting, and discussed the theory of the electric transmission of power, pointing out the advantages of high voltages. The introduction into England in 1881 of the Faure accumulator excited him greatly. In his presidential address to the mathematical and physical section of the British Association at York that year he spoke of this and of the possibility of utilising the powers of Niagara. He also read two papers, in one of which he showed mathematically that in a shunt dynamo best economy of working was attained when the resistance of the outer circuit was a geometric mean between the resistances of the armature and of the shunt. In the other he laid down the famous law of the economy of copper lines for the transmission of power. Helmholtz, visiting him again in 1884, found him absorbed in regulators and measuring apparatus for electric lighting and electric railways. "On the whole," Helmholtz wrote, "I have an impression that Sir William might do better than apply his eminent sagacity to industrial undertakings; his instruments appear to be too subtle to be put into the hands of uninstructed workmen and officials. . . . He is simultaneously revolving deep theoretical projects in his mind, but has no leisure to work them out quietly. So far as that goes, I am not much better off!" But he shortly added, "I did Thomson an injustice in supposing him to be wholly immersed in technical work; he was full of speculations as the original properties of bodies, some of which were very difficult to follow, and, as you know, he will not stop for meals, or any other consideration." And, indeed, Thomson had weighty things in his mind. He was revolving over the speculations which later in the same year he was to pour out in such marvellous abundance in his famous 20 lectures in Baltimore "On Molecular Dynamics and the Wave Theory of Light." These lectures, delivered to 26 hearers, mostly accomplished teachers and professors, were reported verbatim at the time, and reprinted by him with many revisions and additions in 1904. Of this extraordinary work, done at the age of 60, it is difficult to speak. Day after day he led the 26 "coefficients" who sat at his feet through the mazes of the solid-elastic theory and the spring-shell molecule, newly invented in order to give a conception how the molecules of matter are related to the ether through which light waves are propagated. All his life he had been endeavouring to discover a rational mechanical explanation for the most recondite phenomena—the mysteries of magnetism, the marvels of electricity, the difficulties of crystallography, the contradictory properties of ether, the anomalies of optics. While Thomson had been seeking to explain electricity and magnetism and light dynamically or as mechanical properties, if not of matter, at least of ether, Maxwell had boldly propounded the electromagnetic theory of light, and had drawn all the younger men after him in acceptance of the generalisation that the waves of light were essentially electromagnetic displacements in the ether. Thomson had never accepted Maxwell's theory. It is true that in 1888 he gave a nominal adhesion, and in the preface which, in 1893, he wrote to Hertz's "Electric Waves," he himself uses the phrase "the electromagnetic theory of light, or the undulatory theory of magnetic disturbance." But later he withdrew his adhesion, preferring to think of things in his own way. Thomson's Baltimore lectures, abounding as they do in brilliant and ingenious points, and ranging from the most recondite problems of optics to speculations on crystal rigidity, the tactics of molecules, and the size of atoms, leave one with the sense of being a sort of protest of a man persuaded against his own instincts, and struggling to find new expression of his thoughts so as to retain his old ways of regarding the ultimate dynamics of physical culture.

One characteristic of all Lord Kelvin's teaching was his peculiar fondness for illustrating recondite notions by models. Possibly he derived this habit from Faraday; but he pushed its use far beyond anything prior. He built up chains of spinning gyrostats to show how the rigidity derived from the inertia of rotation might illustrate the property of elasticity. The vortex atom presented a dynamical picture of an ideal material system. He strung together little balls and beads with sticks and elastic bands to demonstrate crystalline dynamics. This use of models to assist abstract thought by a concrete presentment of it has become characteristic of the tone and temper of British physicists, of none more than of Lord Kelvin. Where Poisson or Laplace saw a mathematical formula, Kelvin with true physical imagination discerned a reality which could be roughly simulated in the concrete, and throughout all his mathematics his grip of physical reality never left him. Indeed, Lord Kelvin, being a highly-accomplished mathematician, used his mathematical equipment as a tool. He remained its master, and did not become its slave.

To the last Lord Kelvin took an intense interest in the most recent discoveries. Electrons, or "electrions," as he called them, were continually under discussion. He prided himself that he had read Rutherford's book on "Radio-Activity" again and again. He objected, however, *in toto* to the notion that the atom was capable of division or disintegration. In 1903, in a paper called "Aepinus Atomised," he reconsidered the views of Aepinus and of Father Boscovich from the newest standpoint, modifying Aepinus's theory to suit the notion of electrions.

After taking part in the British Association meeting of 1907 at Leicester, where he entered with surprising activity into the discussions of radio-activity and kindred questions, he went to Aix-les-Bains for change. He had barely reached home at Largs in September when Lady Kelvin was struck down with a paralytic seizure. Lord Kelvin's misery at her helpless condition was intense. He had himself suffered for 15 years from recurrent attacks of facial neuralgia, and in 1906 underwent a severe operation. Under these he had visibly aged, and Lady Kelvin's affliction found him little able physically to sustain the

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anguish of the stroke. He wandered distractedly about the corridors of his house, unable at last to concentrate his mind on work in hand. A chill seized him, and, after about a fortnight of prostration, he sank slowly and quietly away.

He was buried in Westminster Abbey with national honours on Dec. 23, 1907. The sympathies of all of us go out to Lady Kelvin, who with such assiduous devotion tended his declining years.

Honours fell thick on Lord Kelvin in his later life. He was president of the Royal Society from 1890 to 1894. He was raised to the peerage in 1892. He was one of the original members of the Order of Merit founded in 1902, was a grand officer of the Legion of Honour, and held the Prussian order Pour le Mérite. In 1904 he was elected chancellor of the university where he had held the chair of natural philosophy for 53 years. He had celebrated his jubilee with unusual marks of world-wide esteem, and finally retired in 1899. He was a member of every foreign academy, and held the honorary degrees from almost every university.

In politics he was, up to 1885, a broad Liberal, but, as was natural in an Ulster man, became an ardent Unionist on the introduction of the Home Rule Bill. He once told me that he preferred Chamberlain's plan of Home Rule with four Irish Parliaments, one in each province.

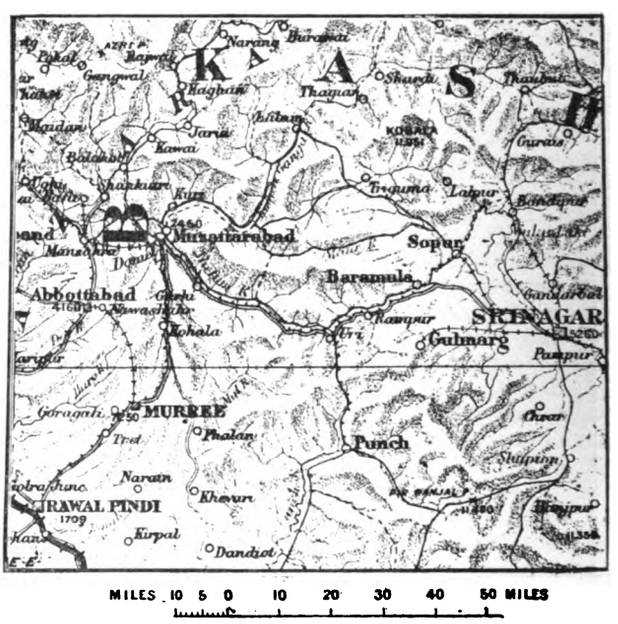
In religion Lord Kelvin was an Anglican—at least, from his Cambridge days—but when at Largs attended the Presbyterian Church. His simple, unobtrusive, but essential piety of soul was unclouded. He had a deep detestation of ritualism and sacerdotalism, which he hated, heart and soul, in all its forms, and he denounced spiritualism as a loathsome and vile superstition. His profound studies had led him again and again to contemplate a beginning to the order of things, and he more than once professed a profound and entirely unaffected belief in Creative Design.

Kind-hearted, lovable, modest to a degree almost unbelievable, he carried through life the most intense love of truth and an insatiable desire for the advancement of knowledge. Accurate and minute measurement was for him as honourable a mode of advancing knowledge as the most brilliant or recondite speculation. At both ends of the scale his pre-eminence in the quest for truth was unchallenged. If he could himself at the end of his long career describe his own efforts as "failure," it was because of the immensely high ideal which he set before him. "I know," he said on the day of his jubilee, "no more of electric and magnetic force, or of the relations between ether, electricity and ponderable matter, or of chemical affinity than I knew and tried to teach my students in my first session." Yet which of us have not learned much of these things because of his work? We of this Institution may well be proud of him, proud that he was one of our first members, that he was thrice our president, and that as our president he died. We shall not look upon his like again.

THE KASHMIR POWER SCHEME.

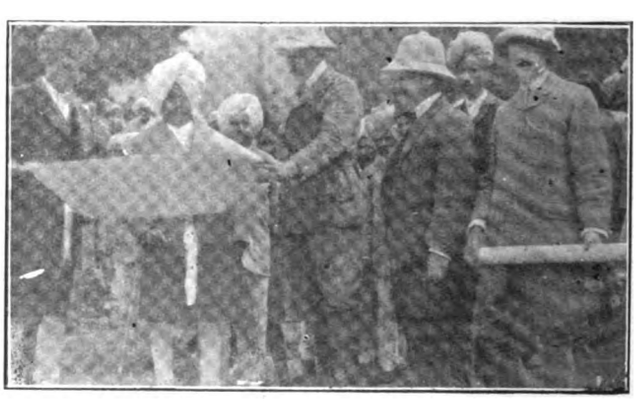
By the hoof of the Wild Goat up-tossed
From the cliff where She lay in the Sun
Fell the stone.
To the Tarn where the daylight is lost
So She fell from the light of the Sun
And alone.

At first sight there is no possible connection between the above extract from Rudyard Kipling's introductory verses to one of his stories and an electric power scheme of 5,000 h.p. in Kashmir. From a report of Major de Lotbiniere, C.I.E., R.E., to the Kashmir Durbar one finds the connection, which is somewhat as follows: The Jhelum River, which is to be harnessed to produce 20,000 h.p., is fed by the glaciers on the North-Western Himalayas. After passing through Srinagar, the capital of Kashmir, the river enters a plain on its way to the Lake Woolar. In this plain the gradient of the river bed is exceedingly small, and the country has suffered for many years from floods which have done an enormous amount of damage. These floods have become prevalent only during comparatively recent years, and are said by Major de Lotbiniere to be due to the vast herds of goats which are annually allowed to graze on the hillsides. The State charges the owners of the goats for grazing rights the low sum of about 1s. 4d. per year per 100 goats. The result has been that the hillsides have been cleared of grass and undergrowth, the scanty soil is loosened by the goats, and the "stones thus spurned" are carried down the river and have caused the silting up of the bed. Attempts have been made by hand labour to improve the channel between



Map of a part of Kashmir showing the districts served by the Jhelum Power Scheme. Rawal Pindi may be supplied in the future, and an electric railway runs up the valley.

Srinagar and Baramoola, a distance of about 40 miles, but the 15 miles of the river course thus dealt with could not be properly deepened by hand labour. There is no coal in Kashmir, and the use of large quantities of wood as fuel for steam-dredgers would have aggravated the trouble above mentioned by still further denuding the country-side of verdure. When the success of the Cauvery power scheme which supplies the Kolar goldfields with cheap power had been proved, Major de Lotbiniere was asked to report to the Kashmir Durbar as to the possible developments within that State. In the Cauvery scheme, as described in our issue of Oct. 31, 1902, the power



H.H. the Maharajah of Kashmir at the Power Station. Major de Lotbiniere, C.I.E., is the next on the right to His Highness.

obtained was transmitted 100 miles to the gold mines, and reduced the cost of a horse-power per year to 50 per cent. of what it had been with steam engines with coal at 19s. per ton. In Kashmir there does not appear to be a similar demand for electric power from an established industry, but the above-named engineer conceived the novel idea of making one part of the river rectify the faults of another part. His report was adopted, and the chief use of the first plant to be laid down at Rampur will be used to supply electric dredgers which will deepen the river bed above. Besides preventing or minimising the damage from floods, this will drain 100,000 acres of good land which is now lying

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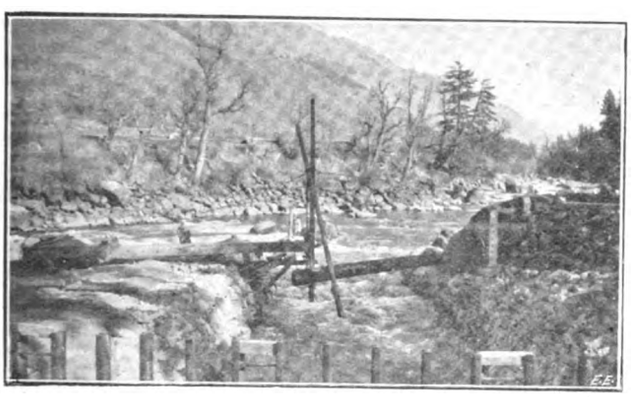
useless. Power is also to be used for heating in connection with the silk industry, and a certain amount of electric lighting will be done in Srinagar and other places. It is not improbable that in the future supply may be carried to Rawal Pindi.

We are indebted to the *Bombay Gazette* for the following descriptive account of the works, which, with the accompanying photographs, has been sent us by a prominent member of the staff.

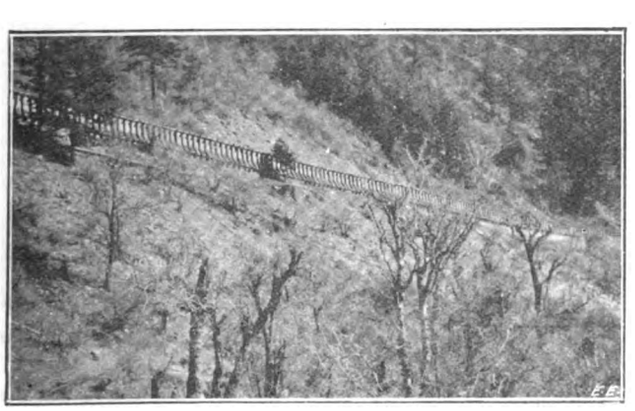
As the result of preliminary investigations (1904) and survey work extending over several months, Major de Lotbiniere recommended the harnessing of the Jhelum in the vicinity of Rampur, shown on the accompanying map,



Draught Channel or Intake immediately above the Head Works (looking up stream).

where the conditions were found to be more favourable than at any other point. The river here falls at the rate of about 70ft. per mile, thus affording a working head of 400ft. with a supply channel of less than seven miles, natural features at the same time providing other requisite essentials in the form of suitable sites for the forebay and power-house, etc. Rampur is, furthermore, very centrally situated as regards that portion of the Jhelum River exploitable for power development, and is but 15 miles below Baramoola and 55 from Srinagar.

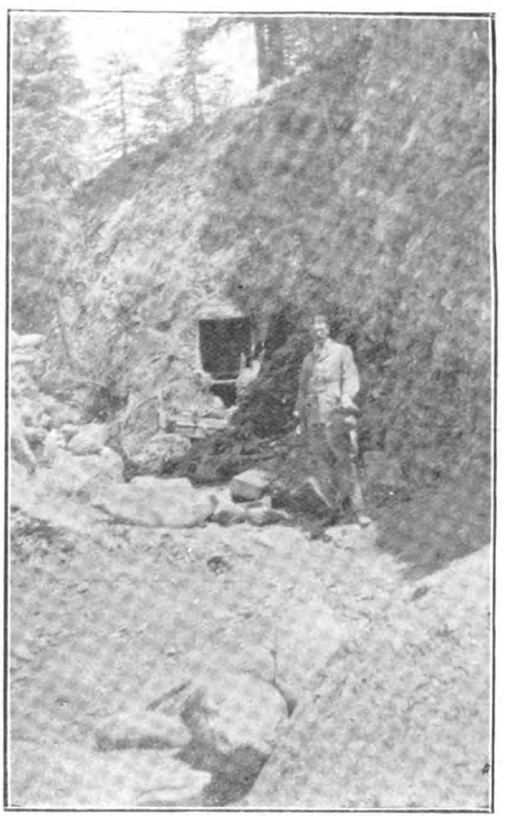
Preliminaries having been settled and Major de Lotbiniere's proposals and recommendations accepted, the services of that officer were placed at the disposal of the Kashmir Durbar by the Government of India early in 1905, and by the end of May work upon construction had actually commenced. It was decided to at once construct river and channel works of capacity sufficient for the



Wooden Flume on Hillside.

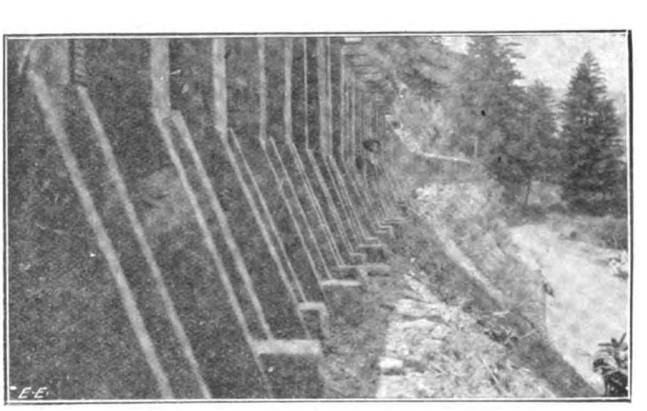
development of 20,000 h.p., with the power house containing accommodation for about half that quantity, the first installation to comprise four units of 1,000 kw. each, about 5,300 h.p. in all, and future extensions or installations to be added as required. The head work or intake is situated opposite the ancient temple on the Jhelum Valley road at Baniar, and the supply channel (6½ miles) runs thence, *viâ* Rampur and Chananwari, to the power station at Mohora. This channel, which has a capacity of nearly 600 cubic feet per second, consists of about 9,000ft. of masonry-lined duct through boulder soil, the remaining portion (25,000ft.) taking the form of the rectangular wooden flume of the type ordinarily used in America. The adoption of wooden flume (of deodar, so prolific in Kashmir) on so large a scale is necessitated by the nature of the hillsides along which it runs, thus leaving the engineers no other alternative.

The construction of this channel and flume presented many difficulties, all of which have apparently been most



Tunnel No. 5.

successfully overcome. In the comparatively short length of 6½ miles there are some 30 chains of deep cut and cover, six rock tunnels aggregating 2,100ft., five aqueducts of 80ft. span over streams and deep gorges, several minor aqueducts and several protective works against avalanches in the shape of heavy cribwork overshoots, snowsheds, etc. Owing to steep hillsides above, it has been necessary to roof the channel and flume practically from end to end to preclude all possibility of earth, etc., being carried into



Exterior of Wooden Flume above the Cart Road.

it. A large settling or silt basin has been provided as near the head works as possible, through which the channel flows. Here the velocity of the water will be reduced from some 8ft. to less than 1ft. per second for about 10 minutes, which should efficiently clear the supply of silt during periods of turbidity in the river A small suction dredger will clear the bed of the basin, which is 4ft. below that of the channel, as required. Through the rock tunnels, encountered on the flume line, the water will, in cases where the rock is perfectly sound, be passed direct, but where this is not the case the wooden flume will be carried continuously through them. It may be mentioned in

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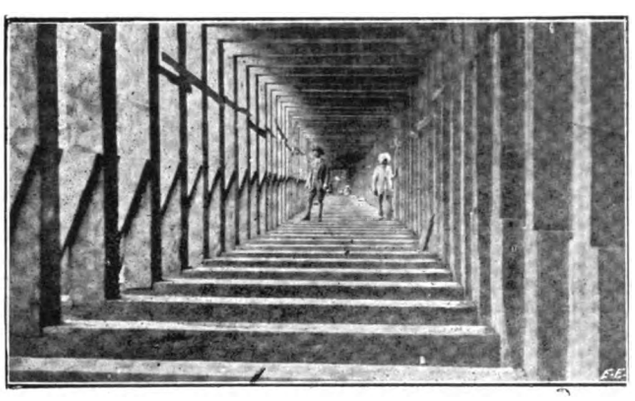
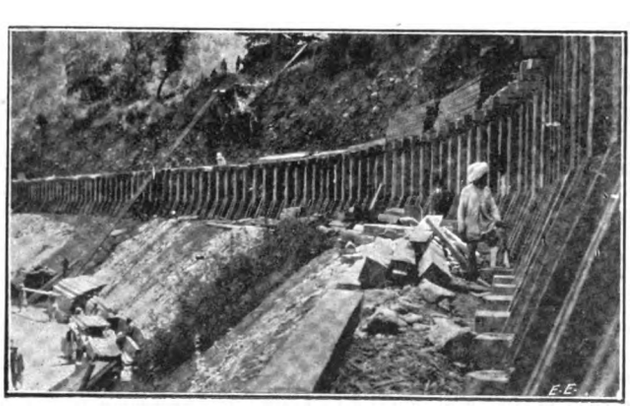
passing that the quantity of deodar timber used in the construction of the wooden flume will be about 650,000 cubic feet. This, together with the poles for the transmission line, has all been obtained from the local forests.

The grade of the channel, which is constant throughout, is 1·05ft. per 1,000, or about 5½ft. per mile, the river here meanwhile falling at the rate of over 70ft. per mile, as already stated. The dimensions of the masonry-lined channel are 11ft. width and 8½ft. to 9½ft. depth, those of the wooden flume being 8ft. 4in. and 8ft. 6in. respectively. Depth of flow at full supply for 20,000 h.p. will be 8ft. Arrived at Mohora the channel debouches into the forebay, a kind of regulating tank situated on the lower steps of a piece of tableland, overlooking and some



Interior of Wooden Flume.

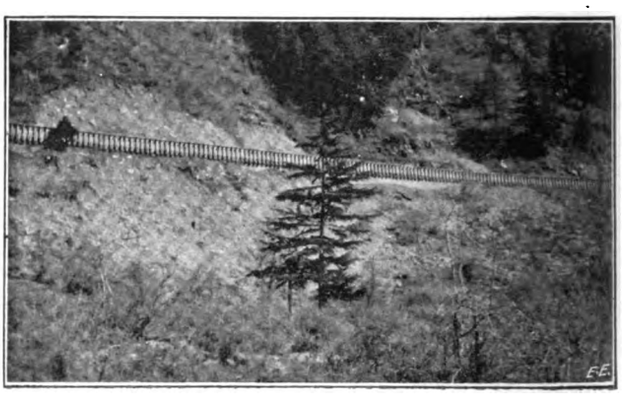
450ft. above the Jhelum at this point. The forebay contains the usual compartments isolating each pipe inlet, ample waste weir sill, over which all surplus water passes to an adjacent nullah on the flank, and thence to the river again below the power-house, and grids of iron bars effectually intercept all floatable matter and prevent their ingress to the inlets. Through the outer or front wall of the forebay and down the face of the steep hillside the steel pipes or penstocks convey the water to the wheels in the power-house, before reaching which they pass beneath the main cart road. The pipes, of which there are four, are of riveted and welded steel, the diameters 36in. and 30in. at top and bottom of the lines respectively, and length of each approximately 750ft., the fall or head being 400ft.



Another Section of the Flume.

The water having done its work upon the wheels, to which the generators are directly coupled, passes through short tail races below the floor to a common spill channel and thence to the rapids, some five chains beyond the downstream end of the power-house. The latter is an imposing structure in granite and red brick, standing between the cart road and the left river bank, from the edge of which it is about 150ft. inland. It is a double-gabled building, about 190ft. by 86ft. and 60ft. in height. It has a self-contained workshop and travelling crane of 25 tons capacity. The transformers, as well as the generators, are located in this building, all switchboards and regulating apparatus, etc., being accommodated on a gallery 20ft. above main floor level. Each of the four units now being installed comprises a 1,000-kw. generator, made by the General Electric Company of America, coupled direct to an Abner Doble needle-nozzle waterwheel of the improved Pelton type, the latter being of 1,765 h.p. Two exciters, with their direct-coupled waterwheels, and a motor-generator set, with six transformers, complete the present installation.

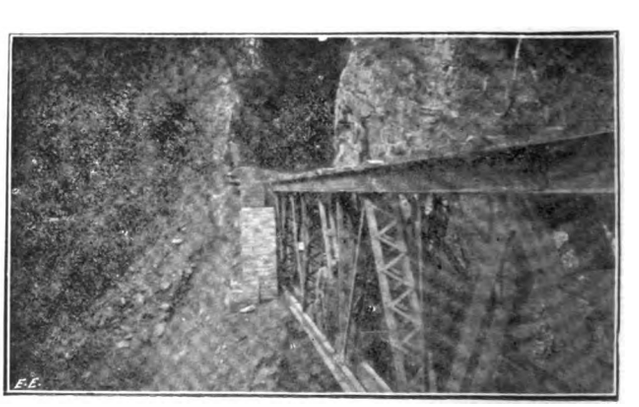
The transmission line, now well advanced, consists of a double line to Baramoola (21 miles), and single line for the present thence to Srinagar, a further distance of 33 miles. The pole structures are of the gallows type, each comprising two verticals 35ft. in length with two cross-arms. These are spaced on an average at 250ft. apart, and carry a telephone line on a small cross-arm, suitably placed below the lower main cross-arm. The tortuous course of the river necessitates many crossings, of which there are some



Wooden Flume on Hillside.

14 in the 21 miles of line between Mohora and Baramoola. Thence to Srinagar the valley opens out, and the country traversed is comparatively easy. Substantial wire nets have been constructed below the line wires at every point where these cross the public road for the prevention of accident from a falling wire.

The system is for alternating current, three-phase, frequency 25, delivered at 60,000 volts, the generated voltage being 2,300. The pressure (60,000) is the highest at present in use upon long-distance transmission in India. The transformers have, however, been designed for delivering at 30,000 or 60,000 volts as may be required, and it is probable that for some time to come the system will be worked at the lower voltage.



80ft. Boom to carry the Wooden Flume over a gorge to Tunnel No. 6. There are five of these aqueducts on the flume line.

The sub-station at Srinagar, which is located in the State silk factory enclosure, is almost finished. Here the voltage will be reduced to working limits by means of the usual step-down transformers. The sub-station at Baramoola is somewhat of a novelty, being a floating one, so designed to enable it to follow the dredging fleet as required, the power being received and distributed by means of flexible cables from the feeder lines on the river bank to the transformers in the floating sub-station, and thence to the dredgers themselves. The whole of the power available from the first installation will be absorbed by the requirement of the dredging operations and those of the State silk factory, where the electric current will be used for heating the filature basins, of which there are several thousands in use. This latter is an interesting and unique feature of

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the scheme, inasmuch as it is the first time that electric heating has been adopted in the silk industry in any part of the world, and the same may be said as regards the operating of the huge dipper dredge, which will also be the first of its kind to be so actuated. The lighting of Srinagar will, it is understood, be shortly taken up, but this, of course, is quite a side issue, and will utilise but a comparatively insignificant amount of power from that available.

Baramoola has for the last eight months presented a scene of extraordinary activity, and the hulls of the whole dredging fleet, some 14 vessels in all, are now nearly completed, and most of them already in the water. Meanwhile the plant and machinery to be installed in them has been regularly arriving at site. The dredging operations, which will extend for a distance of over 20 miles, commencing from just below Baramoola, will, it is anticipated, so improve the *régime* of the Jhelum as to reclaim some 100,000 acres of highly fertile land, which under existing conditions is almost perpetually inundated, and so practically useless. Oil and woollen mills are among the other industries likely to follow the establishment of cheap power in the State in the near future. Nothing appears to have been definitely settled with regard to the Kashmir Railway, but this must come, and that at no distant date, when, as we have been already assured, H.H. the Maharajah is anxious to see this most essential improved communication within his territories.

Masonry Lined Channel nearing Forebay.

The Power House.

The cost of the power scheme will, it is understood, be about 50 lakhs, and the increase of revenue due to the dredging operations alone will, if anticipations are realised, afford the State a good return upon the outlay.

Now as to the staff who have assisted Major de Lotbiniere in this great scheme. Lieutenant J. C. Hunter, the resident engineer, held the same important position during the construction of the Cauvery power installation, but in this case he has had to face problems far more difficult than those presented by the Cauvery work. The treacherous nature of the hillsides, the heavy winter snows and avalanches, and the labour difficulties all tended to render the execution of the work most arduous. Mr A. C. Jewett, the electrical engineer, is also a Cauvery veteran, and has found his experiences in Mysore mild in comparison with his present task. The construction and equipment of the dredging fleet are under the superintendence of Mr. L. A. Desy, C.E., a Canadian, whose experience and proficiency in dredging work have already won him a high position in Canada.

In conclusion, his Highness the Maharajah of Kashmir is to be heartily congratulated on the enterprising spirit he has shown in embarking upon these gigantic undertakings, embracing as they do the latest developments of modern science. We trust the results will fulfil to the utmost his most sanguine expectations, and prove a lasting benefit to his subjects.

TRANSATLANTIC WIRELESS TELEGRAPHY.*

BY G. MARCONI.

(Concluded from page 661.)

The stations at Clifden and Glace Bay are not complete, and the necessary duplication of the running machinery has not yet been executed, but, nevertheless, communication across the Atlantic has never been interrupted for more than a few hours since the commencement of commercial working on Oct. 17 last. There have, however, been several serious interruptions at Clifden due to the unreliability of the land lines connecting Clifden to the ordinary telegraph system. On one occasion one of these interruptions lasted from 5.20 p.m. to 10.30 a.m., a duration of 17 hours; and on another occasion the land telegraph wires were struck by lightning and disabled for 12 hours. There have also been recorded numerous other interruptions of shorter duration, which resulted in delays to private and Press messages. Further delays have also been caused through interruptions on the land lines connected with the Canadian station. During the first months, on account of imperfections in the auxiliary apparatus connected principally with the operating keys and switches, only a fraction of the available transmitting power was used. In consequence of this the speed of transmission was slow, and short interruptions somewhat frequent. Many of these have difficulties now been overcome, and in a few more months, when it should be possible to utilise the full power available, a very much greater speed and efficiency is likely to be attained. The messages can now be transmitted across the Atlantic by day as well as by night, but there still exists certain periods, fortunately of short duration, when transmission across the Atlantic is difficult, and at times ineffective unless an amount of energy greater than that used during what I might call normal conditions is employed. Thus, in the morning and evening when, due to the difference in longitude, daylight or darkness extends only part of the way across the Atlantic, the received signals are weak, and sometimes cease altogether.

It would almost appear as if illuminated space possessed for electric waves a different refractive index to dark space, and that in consequence the electric waves may be refracted and reflected in passing from one medium to the other. It is, therefore, probable that these difficulties would not be experienced in telegraphing over equal distances from north to south, or *vice versâ*, as in this case the passage from daylight to darkness would occur almost simultaneously in the whole of the medium between the two points. In the same manner a storm area in the path of the signals often brings about a considerable weakening of the received waves, whilst if stormy conditions prevail all the way across the Atlantic no interference is noticeable. Electric wave shadows, like sound shadows, may be formed by the interference of reflected waves with the direct waves, whereby signals may be much less effective or imperceptible in the area of such electric wave shadow. In the same manner as there exist periods when signals across the Atlantic are unusually weak, there exist other conditions, especially at night, which make the signals abnormally strong. Thus on many occasions ships, and stations equipped with apparatus of a normal range of 200 miles, have been able to communicate over distances of over 1,000. This occurred recently when a ship in the English Channel was able to correspond with another in the Mediterranean. But the important factor about wireless telegraphy is that a service established for a certain distance shall be able to maintain reliable communication over that distance. The erection of long-distance stations for the purpose of telegraphing across the Atlantic met at the outset with the severe criticism of a certain important section of the English technical Press, which, although one would imagine existed for the purpose of encouraging and promoting the progress of electrical science and industry, always seemed more inclined to champion the particular interests of the cable companies.

Without wishing to enter into any controversy on this point, I venture to predict that some of the statements published with

* Lecture given before the Royal Institution, Friday night, March 13, 1908.

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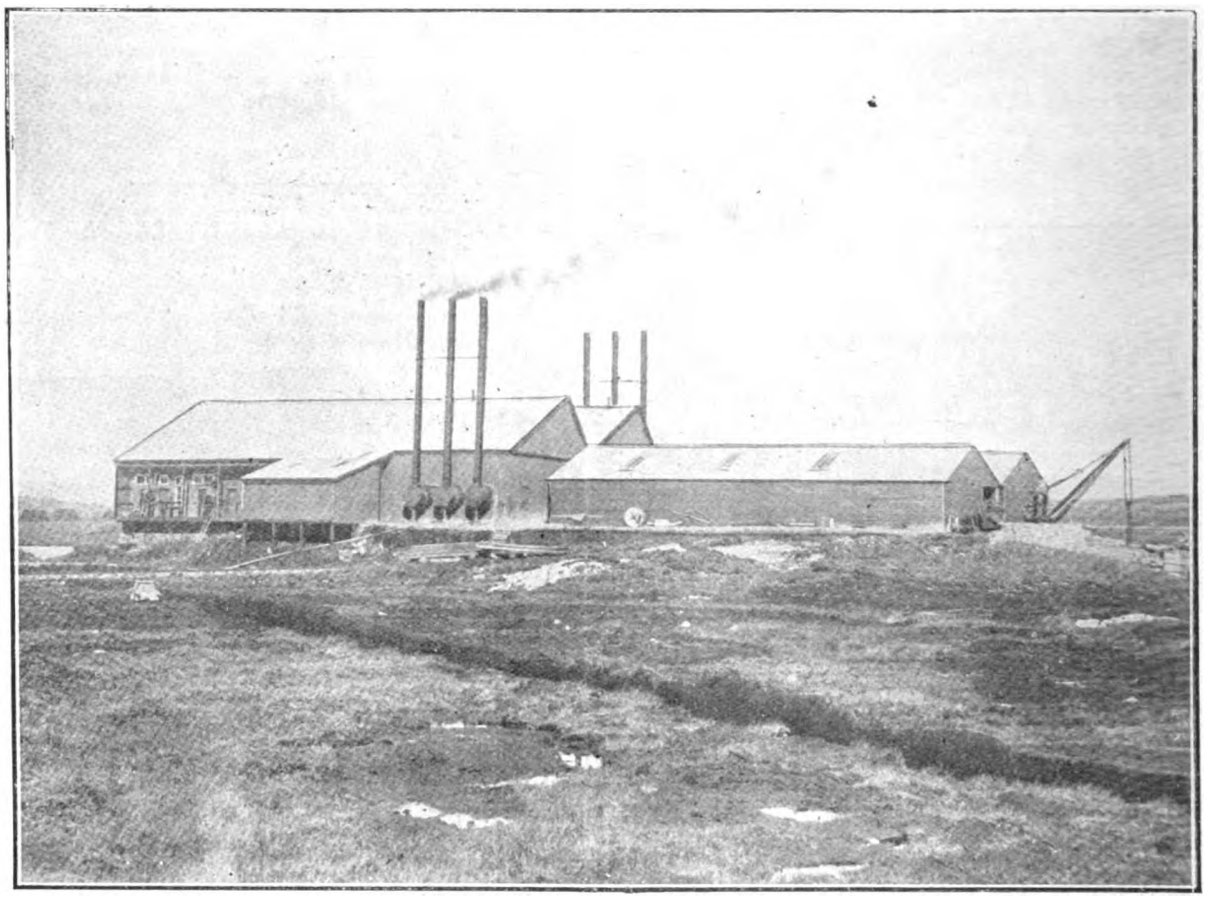
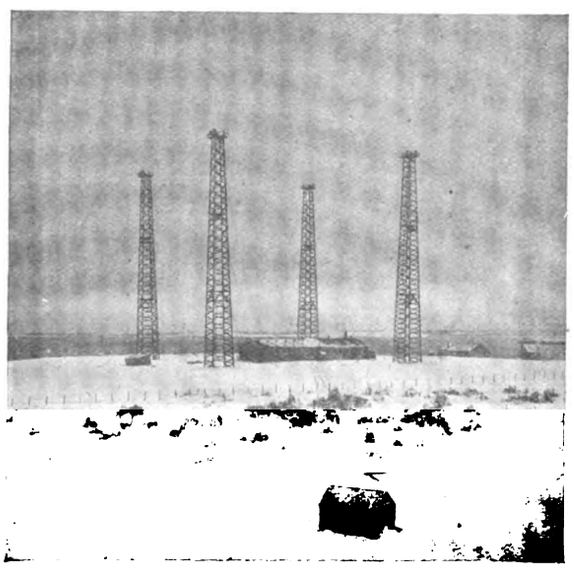
reference to long-distance wireless telegraphy will make very amusing reading in a few years to come. I am here reminded of an anecdote related to me about Michael Faraday. He had been displaying what appeared to be clumsily-made rings or coils which, as we all now know, were the forerunners of the present-day dynamo. It appears that someone, pointing to the



The Engine House at the Clifden Transatlantic Signalling Station.

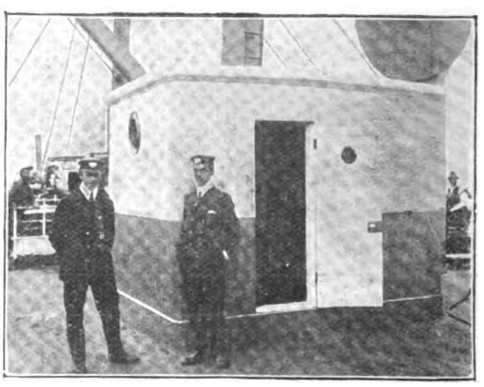
coils, asked whatever could be the use of such apparently useless articles. Faraday's answer was in the form of a question: "What is the use of a baby?" he said. The analogy is, of course, not quite applicable to wireless telegraphy at the present day. This new method of communication is no longer an infant, but has now reached the stage of



The Cape Breton Station.

vigorous youth, and is fast approaching manhood. Long-distance stations are now in course of erection in many parts of the world, the most powerful of all being that of the Italian Government at Coltano, and I have not the slightest doubt but that telegraphy through space will soon be in a position of affording communication between distant countries at cheaper rates than can be obtained by any other means.

As to the practicability of wireless telegraphy working over long distances such as that separating England from America, there is no longer need for any doubt. Although the stations have been worked for only a few hours daily, 119,945 words of Press and commercial messages had been transmitted across the ocean by this means up to the end of February last since the service was opened. The best judges of a service are those who have made use of it, and, amongst newspapers, the chief users have been the *New York Times* and the London *Times*, which have already publicly expressed their opinion of this new method of communication. I might mention that recently I received by wireless from the *New York Times* a message of which the following is an extract: " . . . during the five months since it opened in October last . . . the *Times* has received from its correspondent in England and on the Continent news dispatches totalling



The Marconi Cabin on s.s. "Minnetonka."

68,404 words, sixty-eight thousand four hundred and four words, promptly and efficiently transmitted by your system.—*N. Y. Times.*" Whether the new telegraphy will or will not injure or displace the cables is still a matter of conjecture, but in my opinion it rests a good deal on what the cables can do in the way of cheaper rates. It is not, as some appear to imagine, either the business or the wish of those concerned in the development of wireless telegraphy to injure the cable industry. They are endeavouring at present to demonstrate the new method is not only valuable for shipping, but that it should be also regarded as a new and cheaper method of communicating with far distant countries.

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Whatever may be the view as to its shortcomings and defects, there can be no doubt but that wireless telegraphy across the Atlantic has come to stay, and will not only stay, but continue to advance. Cable telegraphy across the Atlantic was subjected at the commencement to a series of discouraging failures and disappointments, but whatever its difficulties, I think I am not unjust in saying that it enjoyed one advantage over wireless telegraphy—namely, that it was free from the natural hostility of vested interests representing over 60 millions sterling, now invested in cables, which rightly or wrongly consider long-distance telegraphy as menacing their interests. In seven years the useful range of wireless has increased from 200 miles to 2,500. In view of that fact, he will be a bold prophet who will venture to affirm what may not be done in seven years more. I shall not presume to say that at the present moment the wireless telegraph service between London and New York is as efficient and as rapid as that supplied by the cables. For nearly 50 years the Transatlantic cable organisation has been in existence, and there are now 16 cables working across the North Atlantic, so that in the case of a breakdown of one cable the traffic is sent by one of the others. Moreover, long experience has served to bring their land-line connections to a high state of perfection. Nevertheless, I am convinced that if there were only one cable and the present wireless service, interruptions would be more frequent and much more serious in the case of the cable than in that of wireless. We have only to look towards those parts of the globe, such as India, South Africa, and so forth, where trans-oceanic communication is dependent upon only one or two cables, and the force of my remarks will be more readily appreciated. The cases of delay in regard not only to commercial messages, but also to Government dispatches, are only too frequent, as no doubt you have observed from time to time in the daily Press.

Among many people there seems to be a rooted conviction that wireless telegraphy is not suitable for the handling of code or cipher messages. Whatever gave rise to this idea I do not know, but I wish to emphasise that it is purely fictitious. Code messages can be sent just as well by wireless as by ordinary methods of telegraphy. I need hardly say that most of the wireless messages passing between warships are now expressed in code, as are likewise the majority of the commercial messages handled by the Clifden and Cape Breton stations. I do not wish to claim that wireless telegraphy is infallible, and although errors do sometimes occur, it is absolutely certain that, having regard to the London and Montreal service, most of the mistakes can be traced to the land-line telegraph transmission between London and Clifden, and between Glace Bay and Montreal. I find, however, that probably the greatest ignorance prevails in regard to what is termed "tapping," or intercepting wireless messages. No telegraph system is secret. The contents of every telegram are known to every operator who handles it. It is incorrect to suppose that anyone can at will pick up wireless messages. On the other hand, it is easy for anyone knowing the Morse code to step into most telegraph offices and read off the messages by the click of the instruments. Further, it is practicable, but illegal in this country, to make arrangements so that messages which pass over a telegraph line can be read by persons who are not operating the line at all. It is also expensive to erect a tall pole or tower and fix up all the instruments which are necessary before wireless messages can be taken in, and, moreover, such proceeding is contrary to the law of the land.

It should be remembered, too, that any ordinary telegraph or telephone wire can be tapped, and the conversation going through it overheard, or its operation interfered with. Results published by Sir William Preece show that it is possible to pick up at a distance on another circuit the conversation which may be passing through a telephone or telegraph wire. At Poldhu, on a telephone connected to a long horizontal wire, the messages passing through a Government telegraph line a quarter of a mile away can be distinctly read. In a paper on his method of magnetic space telegraphy, Sir Oliver Lodge mentions an occasion on which he was able to interfere, from a distance, with the working of the ordinary telephones in the city of Liverpool. Many instances can be enumerated showing that electric light and tramway power stations have interfered with cables and land lines. Nevertheless, there are penalties attached to the tapping of a telegraph wire, and it ought to be as well known that since the passing of the Wireless Telegraphy Act there are penalties involved if any wireless stations are erected or worked without the consent of the Postmaster-General. Possibly you may expect me to say something about systems other than my own, and, although I should like to do so, the time at my disposal will not permit me even to give a full and proper description of my own apparatus. Many others are carrying out important researches in the field of wireless telegraphy and wireless telephony, and I sincerely hope that efforts in the development of a difficult branch of science may meet with success proportionate to their labours.

In conclusion, I may say that I am very confident that it is only a question of time, and that not a very long time, before wireless telegraphy over great distances, possibly round the world, will become an indispensable aid to commerce and civilisation.

A CURIOUS IONISATION EFFECT IN A VACUUM TUBE.

The following curious effect was discovered in the course of some experiments with the electrodeless discharge by Mr. H. A. Perkins, and are described by him in a paper read before the American Physical Society. A tube about 20cm. long and 1cm. diameter, having electrodes sealed into its two ends, was exhausted to what is popularly known as a "white vacuum." This tube was surrounded by a narrow metal ring of a diameter slightly larger than the tube, and the ring was connected to one terminal of a transformer, the other terminal of the transformer being earthed. When the transformer was giving an E.M.F. of 550 volts or over and a frequency of 60 cycles, the tube showed a marked luminescence, and a direct current flowed through a galvanometer connected in series with the tube. The terminal of the tube nearest the exciting ring was always positive. The current was very small when the ring was near the end of the tube, but increased rapidly as the ring neared the centre. At the centre it reversed in direction, coming rapidly to another maximum just behind that point, and then fell rapidly away as the ring neared the far end of the tube.

A battery inserted in series with the tube could greatly increase these currents or reverse them according to the direction of its E.M.F., and this effect as well as the preceding seemed to indicate much greater ionisation when the ring was near the centre of the tube. An electrostatic voltmeter connected to the terminals of the tube indicated its largest values when the ring was nearest one end, these values diminishing to 0 at the centre; but the time required for it to reach a steady reading was very great when the ring was near one end, and the larger voltages were obtained, thus apparently indicating a much feebler ionisation in that position. To account for these phenomena, a theory, depending on the difference of speed of the ions, has been partly worked out, which accounts satisfactorily for the polarity of the tube, and gives an equation roughly approximating to the current curve obtained.

PHENOMENA OF MERCURY-VAPOUR LAMPS.

A United States patent issued to Richard Kuch, of Hanau, Germany, describes some interesting phenomena of mercury-vapour lamps. The inventor states that on increasing the E.M.F. impressed on the lamp far beyond the point hitherto tested an unexpected change takes place. The curve of efficiency of the lamp then changes its direction and the efficiency will quickly rise, so that its value will be far more favourable than the most favourable values hitherto attained for a low electric potential. The consumption reduces to 0·17 watt per candle-power, and no limit appears to have been as yet reached in this reduction. The electric potential of the lamp was in this case increased up to about 25 or 30 volts per centimetre of the length of the column of light; in other words, it was from 25 to 30 times that potential which has hitherto been employed for attaining the most favourable efficiency. This entirely unexpected behaviour of the gas or vapour electric lamps with mercury electrodes the inventor explains by the following theory: For a certain potential of the lamp the light furnished by the radiation of the luminescence of the dissociated mercury vapour is supplied by a further radiation, presumably that of the temperature in consequence of the temperature increasing with the specific weight of the vapour. The radiation of the temperature produces a rapidly increasing efficiency, which compensates for the decrease of the efficiency of the radiation of the luminescence, and, moreover, it produces a very considerable improvement in the total efficiency. The inventor states that a lamp for 110 volts need be only 6cm. in length, as compared with the usual 50cm.

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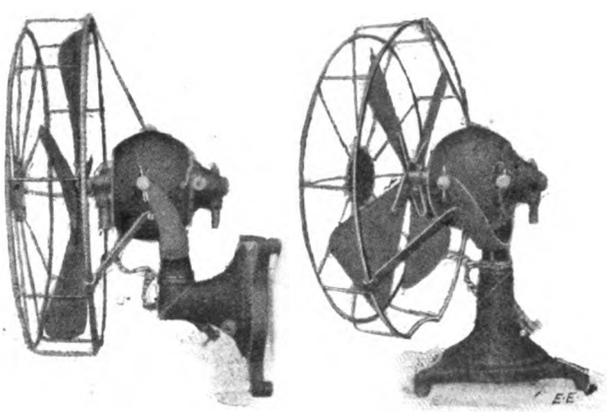
ELECTRIC FANS.

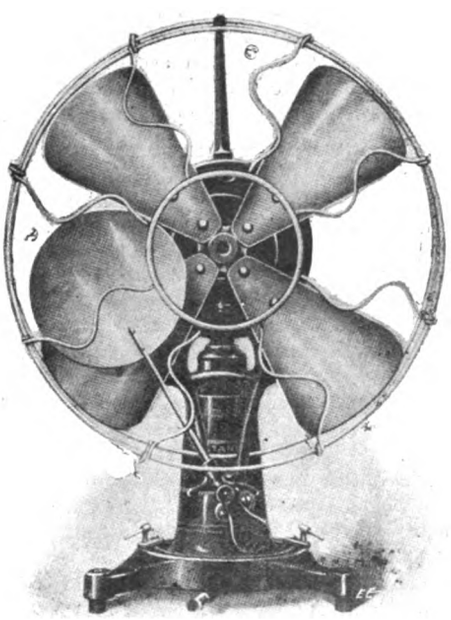
Some Season's Specialities.

The vagaries of summer to which we have in the past been accustomed by no means tend to stimulate an extraordinary demand for cooling and ventilating devices. Adversely though this fact may affect trading in such devices, it has by no means arrested the enterprise of makers of electric fans and of motors for driving them. Both in design and construction have these developed to



"Hawthorn" Fan Motor as Bracket Fan and Desk Fan (Western Electric Co.).

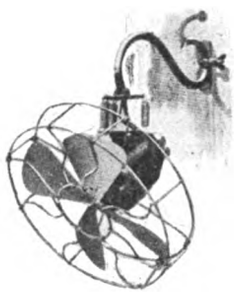
a remarkable degree, the productions of to-day being characterised by utility, neatness, and economy. The patient enterprise of the manufacturers of and dealers in this class of goods deserves at last to be rewarded with a successful season. Happily, some hopeful symptoms are not lacking. Although the spring of this year has in every way lived up to its reputation for fickleness, it has also brought a fair amount of sunshine, so that we are prepared to pin our faith to those prophets who have forecasted a favourable season (in spite of the fact that the thermometer has even of late stood uncom-



"Victor" Oscillating Fan Motor (Western Electric Co.).

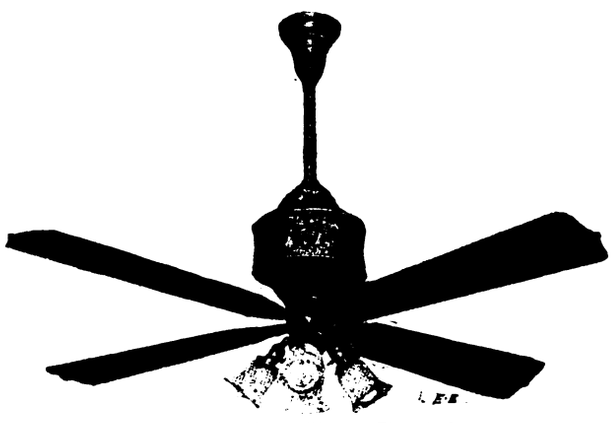
fortably near to freezing point). Moreover, the country will this year witness a very large influx of foreign visitors on account of the many exhibitions that are to be held, and London in particular will profit thereby. True, our guests will not come to these shores to buy ventilating fans; but hotels, restaurants, boarding-houses, theatres, and places of popular resort are likely to be very crowded, so that the demand for temperature-reducing devices is sure to be great. In view of these facts, it is appropriate to turn to the manufacturers of electric fans to ascertain what particular features distinguish the fans for 1908, and to find out in what way they propose to meet the demand which may this year be reasonably anticipated.

One of the leading firms of manufacturers—the Western Electric Company, North Woolwich, London—have developed in addition to their well-known types, which remain essentially the same as hitherto except that slight modifications have been made so as to give the public the benefits of the latest improvements, the "Hawthorn universal fan motor" and the "Victor oscillating fan motor," both of which types deserve to be especially noted on account of their modernness. The "Hawthorn" fan embodies not only all of the desirable features of the old desk and bracket fans, which have in the past earned such



Telephone-Booth Motor, 4in. Fans (Western Electric Co.)

an enviable reputation, but also has many new and distinctive features. The design of this type fan is such that it can be easily converted into a desk or bracket type without the use of an adapter. The blades are pitched so that a maximum efficiency is reached, which greatly increases its usefulness. The motor is spherical and entirely enclosed—a construction which does not permit of the collection of dirt and dust. The armature is of the slotted type, substantially constructed, and has a commutator so designed as to withstand long and continuous service. The field coils are elliptical in shape, machine-wound, and especially insulated for the service. The brush-holders are of the cartridge type, designed to avoid the possibility of excessive brush pressure on the commutator, and fitted with carbon brushes. The fan is designed so that the brushes may be adjusted, inspected, or renewed without removing the bearing bracket. An arrangement of a switch in the base permits of the following speeds: 1,480 r.p.m,



Ceiling Fan Motor (Western Electric Co.).

1,100 r.p.m., and 750 r.p.m. The rheostat is constructed of an iron spool, heavily coated with porcelain, upon which is wound the best quality of German-silver wire embedded in and completely protected by a coating of white enamel. The motor is mounted on trunnions, which permit of 20deg. depression and 15deg. elevation. The base construction allows the fan a rotation of 120deg. in a horizontal direction.

Under many conditions the most satisfactory cooling effect may be obtained from a fan of the propeller type by so arranging it that, instead of delivering its volume of air in a fixed direction, it is kept moving from side to side, so as to distribute and constantly change the air currents of the room. This side-to-side motion is produced in the "Victor" fan by unsymmetrical reaction of the air, due to the presence in its path of the brass vane shown in illus-

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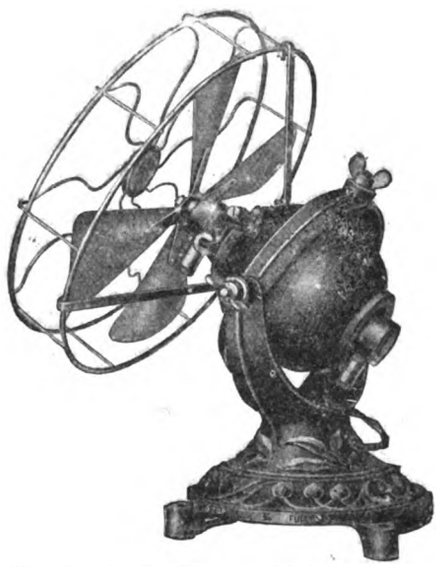
tration. This vane automatically changes its position at the end of each oscillation and reverses the motion of the fan. It is claimed that for the first time in the history of oscillating fans there is here being presented a practical oscillating fan for use on alternating-current circuits.

In telephone booths, where space is limited, or for installation on light partitions subject to vibration, the spring-suspended telephone-booth fan motor is especially desirable. By means of the spring suspension, vibration is eliminated, and the operation of the motor rendered noiseless. The bracket is hollow, to receive supply wires, and can be screwed to the wall or partition. Although this motor uses little current, it will move a large volume of air. This fan can be used on either direct or alternating current without inserting special resistance in the circuit.

We have not the space to refer here to various types of ceiling and other fans produced by the Western Electric Company. Suffice it to say that the stocks of these are large and cover a wide range of sizes.

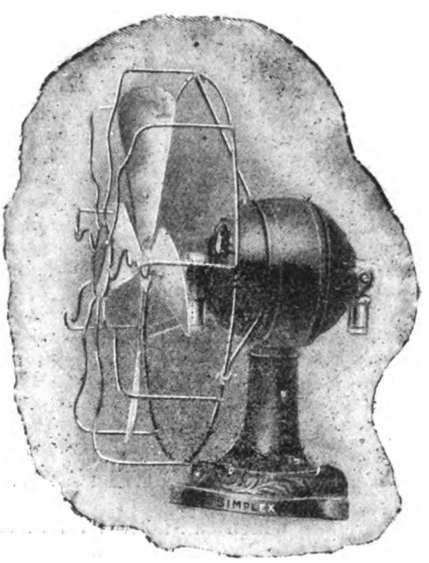
Turning now to other makes, the "Stellite" A.P. fan is among the first to call for notice. The "Stellite" fans are British made—they are manufactured by the Electric and Ordnance Accessories Company, Limited, Stellite Works, Cheston-road, Aston, Birmingham—and are designed and constructed to pass the stringent tests of the British Admiralty. Each fan combines in itself the distinctive



"Stellite Trunnion Fan (Electric and Ordnance Accessories Co).

features of the desk, trunnion, and bracket types. In other words, the "Stellite" A.P. fan is equally suitable for use on table, floor, desk, wall, or ceiling, and by a simple adjustment the current of air may be sent in any required direction. This is done without the addition or exchange of any parts and without the use of a single tool, it being only necessary to loosen the fly nuts. The frame consists of a handsome pedestal of soft grey cast iron, with a gimbal ring of the same material. The pedestal is fitted with rubber feet to absorb vibration and prevent damage to polished surfaces. The gimbal has brass fittings. The field cores are cast in one piece with the motor body, thus forming an unbroken magnetic circuit. The commutator is of hard-drawn copper, and the slots of the armature are carefully lined with insulating material. Double silk-covered high-conductivity copper wire is used for the armature and field windings, and before and after taping all coils are impregnated under vacuum pressure with an insulating compound, rendering them impervious to moisture, and ensuring perfect insulation. The carbon brushes are self-regulating, and the armature bearings, of phosphor bronze, are fitted with wick-feed lubricators. The starting switch and speed regulator are fitted inside the base, the resistance consisting of wire coils wound on non-hygroscopic porcelain. Spring catches ensure the switch being left central on the respective stops. We should add that these fans are made in two sizes, 12in. and 16in. diameter. In addition to the type of fan described above, the Electric and Ordnance Accessories Company, Limited, make desk, bracket, port-hole, and cabin fans, all of which embody the most modern improvements.

We pass on to the Simplex Conduits, Limited, 113-117, Charing Cross-road, London, W.C., where we find a high-class selection of electric fans for the forthcoming season. which are manufactured for continuous and alternating current (single and three phase), or for working from cells and representing—as is usual with all electrical goods with the "Simplex" trade mark—the highest possible efficiency as regards design and working. We are enabled, through the courtesy of the Simplex Company, to give our readers some details of the construction of these fans. In the case of continuous-current fans the field frame is of round shape, cast iron, of high magnetic permeability, protected by a highly-finished thick coat of enamel. The field coils are securely wrapped with tape, and are form wound of silk-covered wire, the whole being protected by a heavy coat of shellac varnish. These coils are always subjected to a severe test at 1,000 volts before leaving the works. The armature of the iron-clad type is built up of thin iron stampings, drum wound, and the windings insulated from contact with all metal surfaces. Hard-drawn copper is used for the commutator, turned up true and round; this, combined with the fact that the brushes are of graphite carried in special brush-holders, giving even and firm pressure, prevent sparking. Self-aligning bearings are provided on all Simplex fans, and that essential for quiet



"Simplex" Fan (Simplex Conduits, Limited).

running—lubrication—is amply provided for by means of automatic oil-cups which, when once filled, will give efficient lubrication throughout the entire season. Speed regulation is obtained by means of a switch and rheostat concealed in the base of the fan; these are equally well made as the other details of the fans, and a burn-out is a most unlikely contingency. The guards of all fans are of stout brass, and the blades heavily nickel plated, carefully balanced to prevent the motor from vibrating.

Alternating-current fans are throughout, unless otherwise specially stated, of the induction type, which although of a necessity somewhat more expensive are sometimes to be preferred, being entirely free from some of the objectionable qualities of drum-wound armatures on alternating-current circuits. The armature is constructed of soft-iron laminations assembled on a brass spider and held between copper discs at each end of the core. It is carefully made to size so as to reduce the air-gap between stator and rotor to a minimum, which is essential if efficiency is to be obtained. The speed regulation on fans generally covers about 300 r.p.m.; for example, on 12in. fans it is 1,400, 1,300, 1,100, and so on. Most types are supplied with 10in., 12in., and 16in. diameter blades. The standard finish is of black enamel, relieved with gold lines, and all types can be relied upon to withstand rough usage with a minimum of attention.

Although differing somewhat in the purposes to which they may be put from any of the fans which we have hitherto described, those manufactured by Messrs. F.

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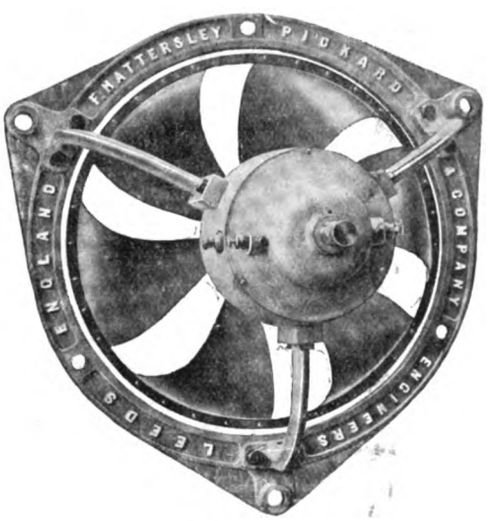
Hattersley Pickard and Co., 15, King-street, Leeds, are of sufficient interest to deserve prominence. These fans, a type of which is represented in the illustration, have proved very effective for ventilating, removing dust, fumes, etc. It will, no doubt, interest our readers to know that Messrs. F. Hattersley Pickard and Co. are now fitting their fans for running off alternating-current circuits with a new type of single-phase induction motor which is self-starting for all sizes, and, instead of requiring a complicated starting switch, an ordinary tumbler lamp switch is sufficient. This simplifies the starting and working of the fans to such an extent that they are practically "fool-proof." As will be seen from the illustration, the blades of these fans are carefully designed on correct scientific principles, and are suitable for moving large volumes of air against considerable resistances, such as are met with in extracting vitiated air, fumes, or dust from rooms, etc. We understand that these fans have been supplied largely throughout the country and abroad for the ventilation of public buildings, concert rooms, offices, banks, restaurants, universities, schools, etc, with thoroughly satisfactory results.

The fans introduced this season possess many notable features, which are in the main well represented by the makes described above. In another issue we will present descriptions of types introduced by other well-known



Ventilating Fan (F. Hattersley Pickard and Co.).

makers, the design of which call no less for attention than do the foregoing.

MUNICIPAL BUILDING AND PUBLIC HEALTH EXHIBITION.

This is truly a year of exhibitions, many of which are making an important bid for the support of the electrical trade and industry. It is not surprising, therefore, that the Municipal Building and Public Health Exhibition—the first of its kind—which was held at the Agricultural Hall, and which closed on Tuesday last, was not richer in electrical exhibits. Several of the exhibits were, however, of electrical interest, and the whole served to give some idea of the advances which have been made in electric lighting and electric traction, matters of no small importance to the municipal engineer.

In the matter of traction almost all systems were represented, and types of the two forms of surface contact—the mechanical and the magnetic—both of which have made their appeals to municipal requirements, were on view. In the domain of traction, Messrs. Mountain and Gibson were well to the fore. Among their exhibits were a "M. G." No. 3 L centre-bearing traction truck, fitted with a cast-steel swing bolster supported by springs carried on a spring plank, suspended by swinging links from the channel steel transoms. The side frames of this truck are of cast steel. Attached to the bolster is a hinge, upon which is mounted the lower half of the centre swivel plate, and the upper half, attached to the car body, works upon this, and is fitted with a king-pin at the fulcrum point. The truck is fitted with driving wheels of a large diameter, and with trailing or pony wheels of a small diameter, in order to give the maximum traction effect, and the truck is so designed as to allow a large percentage of the weight to be borne by the driving wheels. The improvements are mainly in the general structure of the truck, in order to get rigidity and accuracy in building, and also to provide an entirely new system of brake rigging adapted to the use of the magnetic brake in conjunction with the hand-operated wheel brakes. When the magnetic brake comes into action the wheel brakes are automatically put into use. During the past two years the London County Council have ordered this type of truck for 750 of their cars.

Another interesting exhibit by the same company was Whittaker's sand gear. An advantage possessed by this sand gear is the impossibility of the hopper itself becoming choked and preventing the sand from flowing freely, also the certainty with which the valve will close and prevent waste. A continuous flow of sand is obtained by keeping the pedal depressed. The maximum rate of flow can be adjusted with ease by means of the screwed end of the connecting rod, which should be regulated so that the foot pedal is depressed to its fullest extent when the valve is opened sufficiently far to give the rate of flow desired. Erection of the gear can be easily and cheaply carried out. As the hoppers themselves carry the bearing for the cross-shaft and the springs, only the hoppers themselves and the foot pedal bracket require attaching to the car body, and the general construction is such that only a small amount of space is taken up by the various fittings. This gear is, therefore, specially adapted for fitting to existing cars. The only parts which are likely to require variation are the cross-shaft and connecting rod, and the former only requires cutting to a suitable length and drilling for the split pins, while the latter, being adjustable, can be quickly welded up to an approximate length. The platform gear is arranged so that a foot pedal is fitted at both ends of the car and is not removable; thus there is always a certainty of the gear being ready for action, and a driver's memory is not called into play when "changing ends." By the removal of the split pin, however, the pedals can be removed and replaced if preferred.

Messrs. Boulton and Paul, Norwich, had a large display of pumps and machinery of interest to sanitary engineers, noticeable among which was a 1·8-kw. portable paraffin-electric generating set arranged for direct current at 65 volts, to supply 90 tantalum lamps alight at one time. This plant was specially adapted for driving motor pumps, air compressors, etc., on breakdown jobs. The Chloride Electrical Storage Company, Limited, showed samples of the "Chloride" accumulator, one of the distinguishing features of which, as we pointed out in an article on the subject the other week, is the employment of the patent wood separator with which all the cells exhibited were equipped. The exhibit of electrical sterilisers by the Lahmeyer Electrical Company, Limited, was one of great interest, as it showed the great advance which has been made in the commercial use of ozone as supplied to sterilising water and air. The sterilising apparatus as shown was capable of an output of 60 gallons per hour of thoroughly sterilised water.

BRITISH ASSOCIATION DUBLIN MEETING.

There has just been issued a circular announcing the seventy-eighth annual meeting of the British Association for the Advancement of Science, which will be held in Dublin from Wednesday, Sept. 2, to Wednesday, Sept. 9, 1908, under the presidency of Mr. Francis Darwin, M.A., M.B., LL.D., F.R.S., who will deliver an address to the association at the inaugural meeting in the Royal University of Ireland on Wednesday, Sept. 2, at 8.30 p.m. The presidents of the sections include: Section A (Mathematical and Physical Science), Dr. W. N. Shaw; B (Chemistry), Prof. F. S. Kipping; F (Economic Science and Statistics), Mr. W. M. Acworth; G (Engineering), Mr. Dugald Clerk; L (Educational Science), Prof. L. C. Miall. The arrangements include visits to large industrial establishments, and the principal works and factories in the Dublin district will be open for inspection.

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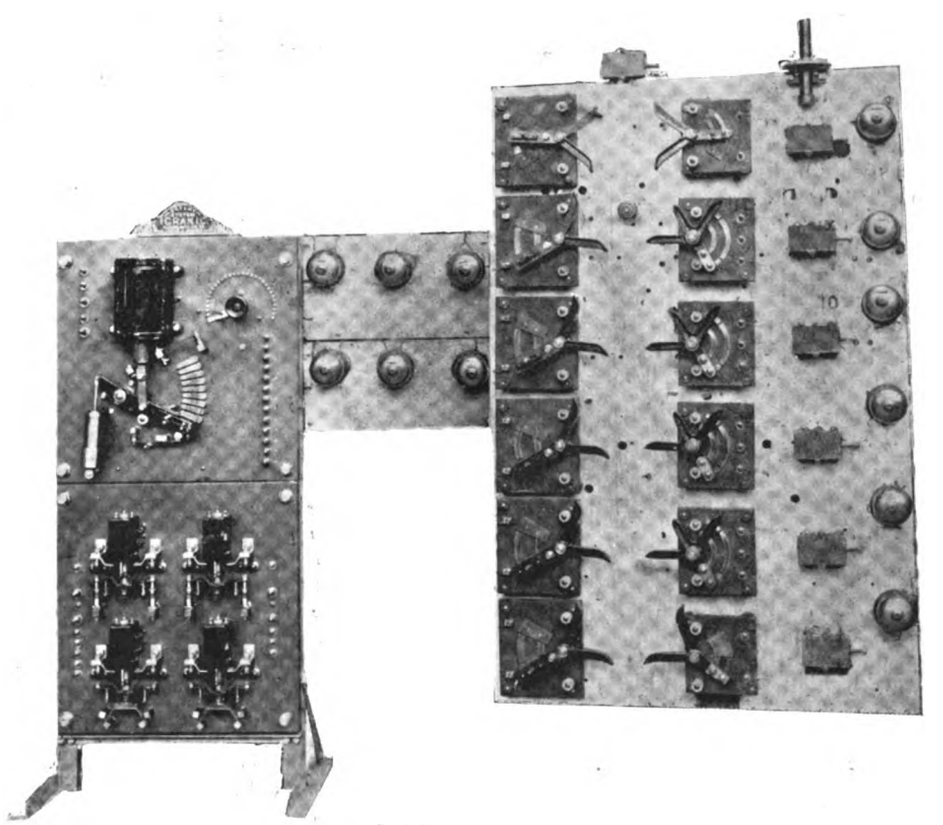
PUSH-BUTTON LIFT CONTROL.

Electric lifts are coming more and more into favour in this country, and in many cases are considerably cheaper than the hydraulic type both as to first cost and as to operating costs. A feature of many large buildings that have recently been erected, and that are now in course of erection, is the installation of electric lifts. The increasing adoption of electric lifting apparatus in hotels, office premises, large houses, and buildings of a height of several storeys is in no small measure due to the fact that the operating machinery requires much less spaces than does hydraulic machinery. It is more efficient, and does away with the necessity for expert operators. The last-named feature, an important one in popularising the employment of electric lifts, is even eclipsed in importance by the introduction of automatic control apparatus which does not require any attendant, and which renders the lift available at any time of the day or night.

An important development in this direction is seen in the "Igranic" push-button lift controller which is being manufactured by Messrs. the Adams Manufacturing Company, Limited, of London and Bedford. The illustration shows a complete "Igranic" controller for a six-floor lift, mounted together roughly on a board for testing purposes. It consists of a control panel mounted in a convenient form so as to stand upon the floor, six patent magnetic push buttons which are intended to be mounted inside the car, six patent magnetic push buttons which are intended to be mounted one upon each floor at each entrance to the lift, and also six tappet reversing switches and six tappet switches to ensure accuracy of stopping. There are also seven gate switches, one for each gate giving access to the lift, and one for the gate of the car itself, as well as a floor switch and a small emergency push button, which can be used by the passenger to stop the lift instantly at any position in case of emergency. The tappet reversing switches, as well as the tappet switches for accurate stopping, are operated by the travel of the car itself, so that the operation of this lift is entirely automatic, and does not require the intervention of an attendant at all. By this system the attendant is dispensed with and released for other work. The passengers operate the lift themselves, and their time is not wasted waiting for the attendant. The method is very simple, and accidents are impossible, because the human faults of carelessness and forgetfulness have no chance of operating.

To call the car, the passenger presses a button just as if ringing a bell. If not already in use, this causes the car to come to the passenger, stop opposite to him, and unlock the gate for him to enter. Having entered and closed the gate behind him, he presses a button inside the car which is labelled to correspond with the floor to which he wishes to travel. This causes the car to travel to that floor, where it stops, and unlocks the gate for the passenger to alight. When he has alighted and closed the gate, the lift is at the disposal of any other passenger.

The advantages of this method of control are, therefore, obvious. Not only is no attendant required and the lift available at any time, but it cannot be started while any gate is open, nor can any gate be opened unless the car is opposite to it. The lift cannot be operated from the outside while anybody is in the car, thus the passenger has sole control of its operation. Moreover, in case of emergency the passenger can stop the lift instantly by pressing the emergency button, and can start it again at his pleasure But the lift will not start again until the passenger actually starts it.



Push-Button Lift Control.

THE LONDON POWER BILLS.

The Select Committee of the House of Lords appointed to consider the three London Electricity Bills now before Parliament opened its sittings on Thursday, May 7. The committee consists of Lord Cromer (chairman), Earl Lytton, Lord Saunderson, Lord Lamington, and Lord Welby. The Bills in question are the London Electric Supply, the London and District Electricity Supply, and the London (Westminster and Kensington) Electric Supply. The committee decided to take the London and District Electricity Supply Bill first.

Mr. J. D. FITZGERALD, K.C., who appears as leading counsel for the promoters of this Bill, said in his opening address that the Bill proposed to incorporate a company with authority to construct a large generating station on the banks of the Thames at Barking, and to supply from that station electricity in a large area, comprising the whole of the county of London and adjoining districts in Essex, Middlesex, Kent, and Surrey. The objects were to

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supply companies or local authorities who had already obtained provisional orders for the supply of electricity to their own districts, and to supply electricity for power purposes. He said there was no doubt that enormous advantage would accrue to the whole population of London from a cheap supply of electricity generated at a large station in the manner proposed. The general result of the Electric Lighting Acts was that London was now parcelled out between 13 companies and 16 local authorities. The promoters of this Bill submitted that this scheme, if sanctioned by Parliament, would give a cheap supply in bulk of electricity for power purposes throughout the area which they proposed to supply. In this area at the present time there were 66 generating stations, 29 different systems of generating, and 18 different systems of supply. In these circumstances a cheap supply was out of the question. Two factors in a cheap supply were a supply of cheap water-borne coal and an unlimited supply of water for condensing purposes. Both of these conditions would be complied with at Barking. The other condition was that the electricity must be generated on a large scale. So large was the demand for supply in bulk to authorised undertakers and to power users in London that electricity would be produced under this scheme on such a scale that the cost would be reduced to a minimum. None of the existing companies were capable of giving the supply that was proposed in this Bill. In many cases their stations were badly situated, and in others the plant was obsolete. The capital expenditure per kilowatt capacity in the case of existing companies appeared to be £47·5 and in the case of local authorities £34·2, giving an average of £40·85 per kilowatt. In a station such as the promoters of this Bill proposed to create the cost per kilowatt would be from £10 to £12. The first object was to be in a position to supply electricity in bulk to existing authorised undertakers, companies, and local authorities. The authorised undertakers need not take the supply unless they wished to do so, but the promoters believed they would be able to produce electricity at a price that would induce them to take it. They also contemplated the supply of electricity for railways, tramways, canal, and navigations. At the present time the price at which existing companies in the area supplied for power purposes varied from 2·47d. per unit to 1d. per unit. The two companies that produced at the lowest rate were the St. James's and Pall Mall Company and the Westminster Company. Their supply was taken mainly for lighting purposes, and so far as they were concerned electricity for power purposes was merely a by-product. The price at which local authorities supplied power in bulk varied from 2·53d. per unit to ·95d Even the latter was considerably in excess of the price to be charged under this Bill. The prices set out in the schedule of the Bill were maximum prices, and he was informed that they were the lowest prices that had ever been put before Parliament in relation to the supply of electricity. The schedule of charges was as follows: (*a*) For a supply of alternating current untransformed at the rate of a fixed sum of £3 per annum per kilowatt of maximum power required to be supplied, and in addition a sum of 0·25d. per unit for all units supplied to such consumer; (*b*) for a supply of transformed alternating current at the rate of a fixed sum of £3. 10s. per annum per kilowatt of maximum power required to be supplied, and in addition a sum of 0·3d. per unit for all units supplied to such consumer; (*c*) for a supply of direct current at the rate of a fixed sum of £4. 10s. per annum per kilowatt of maximum power required to be supplied, and in addition a sum of 0·33d. per unit for all units supplied to such consumer. The Bill provided that the promoters should not supply electrical energy to a power user whose maximum demand did not exceed 250 kw. without the consent of the authorised distributors, provided that the authorised distributors were prepared to supply such power user at a price which did not exceed the price at which the promoters were willing to supply to such authorised distributors by more than 1 per cent. in respect of each 10 kw. or part of 10 kw. by which the maximum demand of such power user fell below 250 kw. That provision would give a fair profit to the authorised distributors. There was also a clause providing for the purchase of the undertaking by the County Council, a joint committee, or other local authority at the end of 42 years, or at the end of each successive period of 10 years after the expiration of 42 years. If the undertaking was purchased at the end of 42 years the price would be the amount of capital which had been certified by the Board of Trade to have been properly expended, and if the profits during the whole period had not amounted to 6 per cent., such additional sum as would bring up the dividend for the whole period to 6 per cent. From the amount that was to be paid would be deducted the then value of the insurance fund, the reserve fund, and the sinking fund, and no allowance would be made to the company for compulsory purchase, or goodwill, or prospective or future value of the undertaking. If the company had been able to pay 6 per cent. during the whole period, there would be no addition for dividends; and if they had been able to pay substantial sums into the insurance, reserve, and sinking funds the price to be paid would be diminished *pro tanto*. If the purchase took place at the end of a subsequent period of 10 years, there would be no question of dividend. The price then would be the capital expended minus the insurance, reserve, and sinking funds. The capital asked for in the Bill was £4,500,000, with one-third borrowing powers, a total of £6,000,000. The promoters believed that, if the Bill passed substantially in its present form, there would be a reasonable probability of making a good investment, and the whole of the capital would be raised.

At the conclusion of Mr. Fitzgerald's address the committee adjourned.

Mr. H. F. PARSHALL, consulting electrical engineer, was the first witness called on Friday, and was examined by Mr. G. J. Talbot, K.C. He said that the supply of electrical energy in London was far from efficient or up to date, either in the employment of capital or economy of generating electricity. As matters stood at present, the various bodies now supplying electricity in London could not co-operate. So many modifications would have to be introduced that linking up was not practicable. For the cheap generation of electricity there must be a new central source of supply. The capital cost of linking up would be the same as for a new scheme, but the annual expenses would be much greater. There would be no necessity to "scrap" the best of the existing electricity stations if the present scheme were approved. Under this scheme they would be able to get a bulk supply cheaply, and at the time of the greatest demand would have their own machinery to fall back upon. The present scheme should have the support of authorised distributors, because they would be able to get a bulk supply more cheaply than they could generate for themselves, and would thus be able to develop their business more rapidly. It had been suggested that it was unwise to place reliability in a single source of supply. The station would be so designed, however, that no danger need be apprehended on that score. In this they were fortified by experience, for many large towns were supplied from one station, and had no trouble. On the question of the possible extension of the use of electricity in the Metropolis, witness said there were power users who did not now use electricity, but who might take from 200,000 kw. to 300,000 kw. per annum under the conditions offered by the promoters. He considered that the site at Barking for a station was admirable, and one station would be sufficient for a considerable time.

The committee then adjourned.

On Monday Lord CROMER said that, after consultation with his colleagues, he desired to put a few general questions. In the event of anything occurring to destroy the supply from the proposed Barking station under the scheme of the London and District Electricity Supply Bill, would the whole of London be plunged into darkness, supposing the other undertakers took their electricity in bulk from the proposed company? For instance, if this country were engaged in a naval war, and the mouth of the Thames were temporarily unguarded, would it be possible, he asked, for the enemy to cut off the entire supply of electricity, or would there be some means of making temporary arrangements? There was also the possibility of a local disturbance—for instance, an Anarchist's bomb—which might destroy the supply. The committee also wished to know whether there was any

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provision in the existing law which made it a penal offence to cut off the supply of electric light to a town by a strike.

Mr. FITZGERALD, K.C., explained that in all large generating stations of the kind proposed there was a number of units of generation, and the destruction of one unit did not affect the other. There might be half a dozen units to fall back upon in the event of the machinery breaking down in one. But when they came to the case of ships of war coming up the Thames, landing a force, and taking possession of the generating station, of course the works could be completely stopped.

The CHAIRMAN: And the whole of London deprived of light and power?

Mr. FITZGERALD said, inasmuch as generating stations were required to be in a position where they could be easily served with coal and water, if the hypothetical ships of war were able to destroy one station they could destroy more than one. The proposal in another of the Bills before the committee to erect one station at Greenwich and another at West Ham would not meet the point. The same might also apply to outrages by Anarchists. A strike would affect two, three, or four stations just as much as it would affect one.

Mr. BALFOUR BROWNE, K.C. (for the London Electric Supply Joint Committee), said that neither New York, Paris, nor Berlin were dependent upon one generating station. When there was a strike in the South Metropolitan Gas Company's works there was no strike in the Commercial Company or Gaslight and Coke Company. As to the Criminal Law Amendment Act, it applied to strikes in the case of gas and water, but not to electricity.

The cross-examination of Mr. PARSHALL was then opened. In reply to Sir Ralph Littler (for the city of London, who desire to be left out of the area of supply), Mr. Parshall admitted that the scheme could be carried out without including the City, though there were a large number of factories who would desire a supply.

Mr. Balfour Browne asked Mr. Parshall whether, if the existing companies could meet every demand, there was any need for this Bill?—Witness said there was, and added that the proposed company could still save the companies £100,000 a year by supplying them in bulk.

Mr. Balfour Browne pointed out that the proposal of his Bill was to utilise as far as possible the existing large stations. Could not that be done more quickly than by erecting a new one?—Mr. Parshall expected it could. Replying to other questions, he said his support to the Bill was given as an engineer, and he had nothing to do with getting the promoters together. The promoters of this Bill were not the promoters of the Bill of the Administrative Company a session or two ago. This was an entirely new Bill. The financial arrangements were in the hands of Mr. Owen Hugh Smith.

The committee adjourned.

Mr. Parshall was still under cross examination on Tuesday.

Mr. Wedderburn, K.C. (for Croydon Corporation), asked the witness if the company were seeking to attempt hereafter to get lighting orders in the areas of corporations who had already got those powers. The reply was in the negative. Mr. Blennerhassett, K.C., cross-examined Mr. Parshall with the object of securing for Westminster City Corporation the continuance of their right to purchase the undertakings of the various companies who now supply their area with electricity. Mr. Saunders (for Islington) urged that the purchase clause of the Bill was precisely the one first proposed in the Administrative Bill and rejected by Sir James Kitson's Committee.

The re-examination of Mr. Parshall was conducted by Mr. J. D. Fitzgerald, K.C., on Wednesday. He said it was not true, as had been suggested, that if this Bill passed the owners of existing electricity undertakings would have to "scrap" their works. He only pointed out that they could do so, and by taking a bulk supply under this Bill would effect a considerable saving. There was a precedent for expecting this scheme to be a success, because the Tyneside Power Company had paid a dividend of 8 per cent. for years, and out of revenue had reconstructed their works. The Yorkshire Company was also doing well.

Mr. ROBERT HAMMOND, consulting engineer, who acted with Mr. Parshall in preparing the scheme, then gave evidence. He said that the idea that the problem of giving London cheap electricity might be solved by linking up stations so that their extra plant might be available at certain times did not commend itself to him. What was wanted was a clean sheet. The present scheme would do for London what Niagara had done for the district round it. He described the way in which the promoters had made their calculations, and said that the present cost of 12 months' generation of electricity in London was £1,387,989, divided between local authorities (£515,605) and companies (£872,384). The estimated prices of the promoters showed an annual saving of £640,072. It would be more economical for a company to take its future supply in bulk from the promoters than to extend its works.

The committee adjourned till to-day (Friday).

THE ELECTROLYTIC THEORY OF THE CORROSION OF IRON.*

BY ALLERTON S. CUSHMAN.

The work that I am going to speak about has been presented also to the American Society for Testing Materials, and has been published in a bulletin of the Department of Agriculture. As I have no new contribution to make to day, I shall attempt to be as brief as possible in putting the subject before you.

In considering the corrosion of iron it is important to remember that iron is a metal which readily combines with or dissolves nearly all the other elements. With possibly one or two exceptions, there are no elements that do not either dissolve in or combine readily with iron. It is also unique in the fact that very small quantities of impurities suffice to entirely change its physical characteristics. On account of this fact metallurgists scrutinise the hundredth of a per cent. of some of the principal impurities that are generally associated with this metal. This is particularly true, for instance, of the element phosphorus. It is so important to modern metallurgy that the amount of phosphorus should be controlled in certain forms of steel that an animated discussion is going on at the present time between certain interests as to the control of the amount of phosphorus that steel shall carry, and the question at issue amounts to no more than a few hundredths of 1 per cent.

Manganese is also an element which is nearly always associated in modern metallurgy with iron and steel. Manganese decreases the electrical conductivity of iron, and as the percentage of manganese, starting from zero, rises, the electrical resistance increases up to a certain specific maximum. You will see that if the presence of manganese in iron raises the electrical resistance, any change in the distribution of the manganese means that there will not be a constant electrical conductivity throughout its mass, or on any given surface. One who is familiar with the methods of modern metallurgy knows that the manganese is added for certain specific purposes, not as a rule quantitatively, but in accordance with the views of the ironmaster who has control of the mill or furnace. Moreover, the manganese is usually added by throwing lumps of ferro-manganese into the molten metal, either in the furnace itself or in the ladle into which it has been poured. Chemists know the extreme care that has to be taken in order to get uniform mixtures of substances in the course of chemical operations. In the large scale of metallurgical processes, even if it were possible to take great care in the mixing, it still happens that when iron is cooled from the molten state, segregation takes place—that is to say, the impurities, although they may have been thoroughly mixed in the molten mass, do not remain homogeneously distributed after the metal is cooled.

For these reasons we must remember that in studying iron and steel from the standpoint of their stability, under the conditions of service, we are not dealing with homogeneous pure metal. It is not difficult for an electrochemist to believe that when such material is immersed in, or even brought into contact with, an

* Paper read before the American Electrochemical Society.

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electrolyte electrolysis will take place upon the surface, and thereby induce rapid corrosion. It is probable that the corrosion of all metals is more or less due to electrochemical action. Before metals can be attacked at ordinary temperatures in the presence of water they must first pass into solution, and in passing in solution become ionised. This is true of copper, zinc, lead, and the other metals that suffer corrosion.

In accordance with the conceptions of Nernst and the modern theory of solutions, all metals have a certain solution pressure which will operate until counterbalanced by the osmotic pressure. Iron, however, appears to differ from the other metals in one important respect. The corrosion of iron does not take place evenly and uniformly over the surface. On the contrary, it is a matter of common observation that iron corrodes rapidly at certain weak points, the effect produced being known as pitting. That this effect is produced by local electrolysis would hardly be doubted, even if it were not possible to demonstrate it by the use of the ferroxyl indicator.

Early in this investigation the writer observed that whenever a specimen of iron or steel is immersed in water or a dilute neutral solution of an electrolyte to which a few drops of phenolphthalein indicator has been added, a pink colour is developed. If the solution is allowed to stand perfectly quiet, it will be noticed that the pink colour is confined to certain spots or nodes on the surface. The pink colour of the indicator is a proof of the presence of hydroxyl ions, and thus indicates the negative poles.

Since phenolphthalein shows only the nodes where solution of iron and subsequent oxidation cannot take place, Dr. W. H. Walker suggested the addition of a trace of potassium ferricyanide to the reacting solution in order to furnish an indicator for the ferrous ions whose appearance marks the positive poles. If iron goes into solution, ferrous ions must appear, which, with ferricyanide, form the well-known Turnbull's blue compound. Going a step farther, Walker suggested stiffening the reagent with gelatin or agar-agar, so as to prevent diffusion and preserve the effects produced. For this combined reagent, which indicates at one and the same time the appearance of hydroxyl and ferrous ions at opposite poles, the writer has suggested for the sake of brevity the name, "ferroxyl." If the reagent has been properly prepared, the colour effects are strong and beautiful. In the course of a few days the maximum degree of beauty in the colours is obtained, after which a gradual deterioration sets in.

(To be continued.)

AN ELECTRIC FURNACE FOR DRILL SHARPENING.

The electric furnace in use in the Witwatersrand mines, a description of which has already appeared in these columns, seems to be fulfilling the claims that were made for it. The results secured in a recent stope drill competition, organised by the *South African Mining Journal*, have certainly tended to corroborate what has been said regarding the importance attaching to the quality and sharpening of steels by this process.

It is interesting to estimate, from the figures given by our contemporary, the actual saving which results from the employment of this furnace. The cost of sharpening bits under the system hitherto prevailing, including coal expenses, may be placed at 2d. per drill. Adding to this the cost of hauling and steam consumption, the expenses per drill per day may be placed at 3d. The cost of an A.E.G. electric furnace using 13 units per eight-hours shift at a price of ·7d. works out at 6s. 7d. per day. Adding to this the costs of the salt and black and white wages, the cost comes out at about 2d. per drill per day, and with comsumption of steel taken into account the cost is probably about 2·5d. Under ordinary circumstances 2,500 steels would be used on the Village Deep per day, but using better class steel with the electric furnace 30 per cent. less would be sufficient—say, 1,750 drills. Some idea may be obtained from the above of the economy which the A.E.G. furnace represents for one mine alone. For the whole Rand the annual saving should amount to a very large sum indeed. There are at the present time about 2,380 rock drills in operation on these fields, and it is calculated that each large development machine uses 20 drills per day, whilst the smaller stoping drills employ 15.

RONTGEN-RAY TUBES.

Prof. Albert C. Geyser, of Cornell University, announces that he has perfected a Röntgen-ray tube in the use of which there is no danger of serious X-ray burns. In the experiments which resulted in the tube, Dr. Geyser is stated to have experienced some painful burns which have disfigured his hands, the injuries almost necessitating amputation. The tube is made of a heavy lead glass so that no rays are emitted, except through a flint glass window, which corresponds in size to the lesion to be treated. The connecting wires are encased in glass insulators to prevent sparking on any part of the patient while under treatment. The flint glass window is situated at the end of a projection, and must be in direct contact with the lesion, thus furnishing a ground and doing away with the air space, which, it is stated, "would otherwise be a dielectric between the tube and the patient. When a tube is brought into direct contact with the patient only the ionising effect of the X-ray is exerted on the tissues, and this effect is all that is needed to furnish the most brilliant therapeutic results."—*Electrical World.*

CORPS OF ELECTRICAL ENGINEERS.

We learn that the movement in connection with the electrical engineers required for the Territorial Army is making considerable progress in Birmingham. Three companies are being raised in Birmingham by Mr. J. F. Lister, who will be in command with the rank of lieut.-colonel. The three companies being raised are to be known as Southern Wireless Company, Southern Cable Company, and Southern Airline Company. The Wireless Company will be commanded by a captain and the Cable and Airline Companies each by a major. These officers will be responsible for their own companies on mobilisation.

The companies will be what are known as "army troops," and on mobilisation they may not necessarily be attached to the Birmingham regimental district.

The period of annual training is from eight to fifteen days, the August bank holiday week being included. The place of training has not yet been fixed, but in all probability it will be Salisbury Plain.

We hear that about 150 men have already been attested, and no difficulty is anticipated in raising the required number—namely, 500. Several well-known members of the local section of the Institution of Electrical Engineers have been offered and have accepted commissions in this new unit.

PUBLICATIONS RECEIVED.

"PRACTICAL INDUCTION COIL CONSTRUCTION," by John Pike. London: Percival Marshall and Co., 26-29, Poppin's-court, Fleet-street, E.C. Price, 1s. net.

"MOTORING ANNUAL AND MOTORISTS' YEAR-BOOK, 1908," edited by V. B. and E. Kenealy. From the offices of *Motoring Illustrated*, 11, Arundel-street, Strand, London, W.C. Price, 2s. 6d. net.

"MANUEL PRATIQUE DE GALVANOPLASTIE ET DE DEPOTS ELECTROCHIMIQUES," by Dr. André Brochet. Preface from M. Haller. One volume, 424 pages, with 148 illustrations. Price, 5fr. Librairie L-B. Baillière et fils, 19, rue Hautefeuille, Paris.

"STEAM-ELECTRIC POWER PLANTS," by Frank Koester. London: Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. Price, 21s. net. This is a practical treatise on the design of central light and power stations and their economical construction and operation.

APPOINTMENTS VACANT.

Draughtsman, Ferranti, Ltd., Hollinwood. See advertisement.

Traveller for the Midlands to represent manufacturers of electric lighting accessories and switchgear. Applications to J. H. Tucker and Co., King's-road, Hay Mills, Birmingham. See advertisement.

Stock Exchange.—The Stock Exchange Committee have ordered the Urban Electric Supply Co.'s further issue of £75,000 4½ per cent. first mortgage debenture stock to be quoted in the official list.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

FORTHCOMING EVENTS.

FRIDAY, MAY 15.

Iron and Steel Institute.—At 10.30 a.m., meeting at the Institution of Civil Engineers.

SATURDAY, MAY 16.

Birmingham and District Electric Club.—At 7 p.m., at the Colonnade Hotel, "Electrical Porcelain," by Mr. H. W. Brady.

WEDNESDAY, MAY 20.

Royal Meteorological Society.—At 4.30 p.m., 70, Victoria-street, S.W., "Observations on the Colour of Lightning, 1903-1907," by Mr. Spencer C. Russell.

THURSDAY, MAY 21.

Institution of Electrical Engineers.—At 8 p.m., at the Royal Society of Arts, John-street, Adelphi W.C., "Recent Progress in Tungsten Metallic Filament Lamps," by Mr. H. Hirst.

FRIDAY, MAY 22.

Physical Society.—At 5 p.m., in the physics laboratory of the Royal College of Science, Imperial Institute-road, South Kensington, "On the Spectrum Top" by Mr. G. P. Sexton; "On the Coefficient of Diffusion," by Mr. B. W. Clack; "On the Production of Small Alternating Currents of Variable Frequency suitable for Telephonic and other Measurements," by Mr. B. S. Cohen.

SATURDAY, MAY 23.

Junior Institution of Engineers.—Visit to Avonmouth Dock works and electricity works, Bristol.

ELECTRICAL ENGINEERS (LONDON DIVISION).

Orders for week ending Saturday, May 23.

MONDAY, MAY 18.—"A" Coy.—Infantry drill, 6 p.m.

TUESDAY, MAY 19.—"B" Coy.—Infantry drill, 6 p.m.

Medical inspection for recruits, 6 p.m.

THURSDAY, MAY 21.—"C" Coy.—Infantry drill, 7 p.m.

FRIDAY, MAY 22.—"D" Coy.—Infantry drill, 7.15 p.m.

Men who have not signed on in the Territorial Force can do so on their Company night.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

The Electrical Power Storage Company, Limited, 4, Great Winchester-street, London, E.C., have issued a revised price-list of cells and accessories for electric light installations; "moting" cells for electric cars, launches, etc.; miners' electric safety lamps, instruments, etc.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TELEPHONE RATES.

SIR,—Mr. H. Laws Webb tells us in your issue of May 1 that he has previously pointed out that the "scientific" unit in telephone service is the "minute-mile"—some time ago it was the "message mile." Furthermore, we learn that it is but for some trifling "practical" considerations that a telephone company does not adopt the "scientific unit," but charges the "single call"—a thing that resembles the "scientific" unit as the polar bear resembles a butterfly.

Indeed, the "message rate" is an entirely misleading term, inasmuch as the effective call is rather far from being a "message," and the message is far from being useful only to the calling subscriber.

If we can "scientifically" neglect the enormous differences: duration of conversation, time, length of line (in certain limits), interest of the subscribers, as we are forced to do in using the single effective call rate, there is no scientific need whatever to count and charge a single call, causing an expense several thousand times less than the above-named neglections.

Owing to these inevitable neglections, a graduated flat rate is the really scientific manner to deal with the different traffic of the various kinds of telephone subscribers. For in science nobody measures by millimetres if the inevitable error in the single measurement attain to metres and more.—Yours, etc.,

J. BAUMANN,
Editor, *Zeitschrift für Schwachstromtechnik.*

Munich, May 8, 1908.

RE QUESTION 1,059.

SIR,—With regard to the above question, may I be allowed to point out that I have actually carried out the tests precisely from the book stated, the results of which I have before me, and naturally used a "large" amount of the symbols and wording given there in my notes.—Yours, etc.,

OSCAR DINERMAN.

INCREASING THE SPECIFIC RESISTANCE OF METALLIC FILAMENTS.

A note in the *Electrical World* on a method of H. Kuzel for increasing the specific resistance of a metallic filament of tungsten, etc., by producing a solid solution of boron or silicon or carbon in the metallic filament. For this purpose the tungsten filament is brought into contact with a limited and relatively small amount of boron or silicon or carbon and heated to white heat. It absorbs the boron, etc., but the metallic surface remains as bright as before. The electric specific resistance may be increased in this way to three, four, ten or more times its former value. While the consumption in watts per candle-power is not changed, the colour of the light emitted by the filament is changed. For instance, a tungsten filament the resistance of which has been increased by carbon is of golden or orange tinge, while if the resistance is increased by means of boron the light has a green tinge.

INSTITUTION AND SOCIETY NOTES.

Glasgow Local Section.

The eighth annual report of the committee of the Glasgow Local Section of the Institution of Electrical Engineers records the progress made during the past session. Six papers were read, but the committee points out that the number submitted by members has been unusually small. It reminds members that one of the principal objects of the local sections consists in the reading of papers at general meetings, and that, consequently, some effort may be expected from the membership for the adequate supply of communications. The number of members increases steadily and satisfactorily, though the increase of this session is smaller than that of the previous year. The number stands at 294 (against 279 for last

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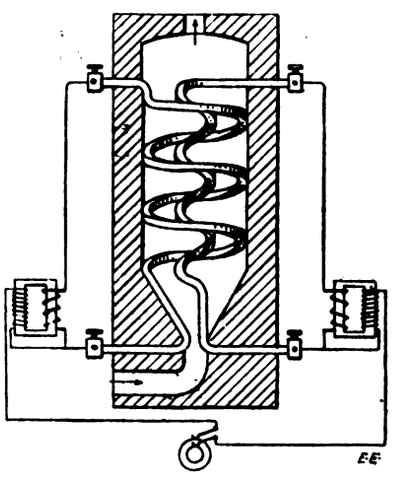
year), and is made up as follows: members, 49; associate members, 116; associates, 44; students, 85. The constitution of the committee is as follows, those gentlemen against whose name there is an asterisk being the committee's nominees: chairman—*Mr. W. W. Lackie; past chairmen—Mr. J. M. M. Munro, Prof. F. G. Baily; vice-chairman—*Mr. S. Mavor; chairman of students' section—Prof. Magnus Maclean; hon. secretary and treasurer—*Mr. James E. Sayers; members—Messrs. C. Day, F. Newington, J. S. Nicholson, J. K. Stothert, W. M'Whirter, J. Taylor, *R. Robertson, *E. G. Tidd, *J. Robertson.

ELECTRIC GAS APPARATUS.

The accompanying illustration shows an apparatus for treating gases by means of electric arcs, for which, according to the *Electrical World*, a United States patent was recently issued to Mr. A. J. Peterson. The apparatus is so arranged that the gas is acted upon by a large number of arcs, each arc being forced upward by electrodynamic action. In order to render the latter action as effective as possible the current which reaches



the arc is passed through series transformers, so that the secondary currents bear a certain large ratio to the arc current; the secondary circuits, which are used as the electrodes, are spirally wound with the same pitch, but with different diameters. During operation the arcs run along the spirals and act upon the gas at many points. It is claimed that the compounds obtained by reason of the ionising action of the arcs are thus prevented from being again dissociated.

PERSONAL.

Mr. P. J. Sullivan, the chief superintendent of the telegraph and telephone departments at the Birmingham Post Office, has retired. He will be succeeded by Mr. J. Jinks, who has been assistant superintendent for a number of years.

Sir John Gavey, C.B., has been appointed a member of the committee to prepare a programme for the consideration of the delegates to the international conference on electrical units and standards to be held in London in the ensuing autumn.

The Glasgow Corporation have increased the salary of Mr. Dalrymple, the general manager of the tramways, from £1,000 to £1 100 per annum, and that of Mr. Goslin, electrical engineer, tramways department, from £475 to £550 per annum.

Mr. John T. Cameron, the second son of Mr. J. Cameron, the secretary and manager of the Blackpool and Fleetwood Tramroad Co., has been appointed the borough electrical engineer and deputy general manager of the Northampton Corporation tramways.

Mr. E. J. Walsh, the mains cable jointer at the York electricity works, was last week presented with a case containing one dozen fish knives and forks by Mr. Hame, the city electrical engineer, on behalf of the staff and employés of the destructor and electricity works, on the occasion of his marriage.

Mr. G. Lloyd Jones, resident engineer, West Ham electricity and tramways department, has had his salary increased from £260 to £280 per annum, with a further increment of £20 at the expiration of 12 months. The salary of Mr. McKenzie, the station foreman, has been increased from £3. 10s. to £3. 15s. per week.

The local branch of the Electrical Contractors' Association (Incorporated) held their first annual meeting at the Grand Hotel, Leicester, on the 5th inst. The honorary officers and committee were unanimously re-elected, and the financial statement for the year ending April 30, 1908, showed that the treasurer had a balance in hand of £22. 14s. 7d. After the annual meeting the whole of the members sat down to dinner. The honorary secretary, Mr. L. G. Tate, of London, was present both at the meeting and at the dinner, and was well received, as the local members are taking the deepest interest in the welfare of the association.

COMPANIES' MEETINGS AND REPORTS.

NATIONAL ELECTRIC CONSTRUCTION.

The ordinary general meeting of the National Electric Construction Co. was held on Monday, Mr. L. B. Schlesinger, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report, said the past year had been one of great financial depression, and it had been practically impossible to raise capital for industrial enterprises, particularly those connected with the electrical industry. Having regard to all the circumstances, the directors did not think that the results of the past year were unsatisfactory, notwithstanding that, owing to the commitments of the Company, they recommended that the balance to the credit of profit be brought forward to next year's accounts. The balance was sufficient to pay a 5 per cent. dividend, and the possibility of an interim dividend later on was indicated in the report. At Musselburgh the weather had again been against pleasure traffic, and, in addition, there had been a strike of the Company's employés, which had resulted in a loss of profit to the estimated amount of £1,200. A reduction in the dividend on the preference shares from 6 per cent. to 2 per cent. was the result, although as the preference shares were cumulative the balance would ultimately come back to shareholders. There had been negotiations in connection with the raising of the capital required to construct the extension of the tramways to Port Seton, but the financial depression, combined with the poor results of the undertaking for last year, had made it, so far, impossible to raise the necessary capital. He was confident, however, that when the extension was built the ordinary shares, of which they held some 20,000, and which were not valued, should be of considerable value. He was glad to say that the Torquay contract had now been completed, the Torbay road line having been opened for traffic just before the Easter holidays. The receipts on the completed system had, so far, been excellent, averaging about 12·18d. per car mile. Given reasonably good weather, the undertaking should earn a large revenue. With regard to the Mexborough and Swinton tramways, the results to date had satisfied the Board that there was a large travelling population, and that the investment should be a profitable one to the Company. Unfortunately, however, a great deal of trouble had been experienced with the Dolter surface-contact system, and they had decided to have the overhead installed. The orders for the materials had been placed, and the work would be put in hand at once, with the view of having a considerable portion of the system equipped and ready for the Whitsuntide holiday. This was the first Dolter surface-contact system installed in this country, and, as a result of the experience there, the systems at Hastings and Torquay had been considerably improved, so that in both these towns the system appeared to be a success. With regard to the Rhondda undertaking, the largest one in which they were interested, the works would have been completed some months ago had not unforeseen obstacles arisen which delayed its completion. He referred to the opposition of the Taff Vale Railway Co., which resulted in two arbitration cases and, finally, appeal cases; but in all instances the decision was against the railway company, with costs. Last year they were successful in securing a Bill for the electrification and extension of the tramways in Oxford, and in this connection they had to acquire the present horse tramway undertaking, which had been in existence for many years. Satisfactory terms had been arranged with the horse tramway company, under which they took, in satisfaction of the purchase price, shares in a tramway syndicate which was now being formed. The capital of the syndicate would be sufficient to acquire the horse tramways, pay the costs of obtaining the Act, arbitration expenses, etc., and the syndicate would make a small profit when the finance of the company formed to build the new tramways had been arranged. The profits from the working of the horse tramway should be sufficient to pay a dividend at the rate of 5 per cent. or 6 per cent. per annum on the capital of the syndicate until the electrification work was taken in hand. The construction of the tramway between Dewsbury and Ossett, in Yorkshire, was now in hand, the capital being provided by the local authorities. Turning to the accounts, he said that the management and expenditure was £7,743, compared with £6,820 last year, an increase of about £923; but, having regard to the nature and volume of the business of the Company, this expenditure must still be considered exceptionally low. With regard to the credit side of the profit and loss account, the revenue from free-wired installations, £2,563, compared with £2,667 for the previous year, a small decrease of £104. The discount and expenses of the debenture issue had been written off and £3,000 had been placed to reserve, which brought the latter up to £15,000. In conclusion, he said that last year's results, with no dividend recommended, might be disappointing to the shareholders, but they had suffered along with other electrical contractors from the financial depression, which made it impossible to raise capital for schemes upon which they and other contractors had to a great extent to depend for earning a satisfactory dividend for the shareholders. There were signs of an improvement, although it would, he was afraid, be some time yet before capital could be raised even for the best of schemes.—Mr. W. H. FOWLER seconded the motion, which was carried unanimously.

UNDERGROUND ELECTRIC RAILWAYS.

An extraordinary general meeting of the Underground Electric Railways Co. of London was held on Monday for the purpose of considering a reorganisation scheme formulated by the Board. Sir Edgar Speyer presided. He said the Company had had to contend with a variety of adverse factors, which, in their combination, had the most injurious effect on the enterprise. They had been hampered by unfavourable money and investment markets. Then they had experi

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enced considerable delays in completion, which had added considerably to the expenditure on interest during construction. Thirdly, instead of having the support and assistance of local authorities, who, in other countries, invariably lent active help to enterprises of this character, they had to face large extra expenditure due to the requirements imposed on them in Parliament and otherwise, by the action of those local authorities, all tending to make tube railway enterprise more costly than it need have been. They had suffered in common with other undertakings by the introduction of the new competition of motor 'buses, and also by the very formidable competition at very low fares of the rate-aided tramways of the London County Council. The assessment for rates and taxes had been equally severe, and in his opinion, unwarranted. Fortunately for London, but unfortunately for the shareholders, of whom his firms were the largest, they had been too sanguine. Their experts had been wrong. Some of the criticism made in the Press had been perfectly fair, and the experts had been over-sanguine concerning the development of London traffic, and had not fully appreciated the difference between London and New York and Chicago. London at the present time was supplied with transportation facilities which, if properly co-ordinated, could form the most perfect and expeditious system in the world, and a paying one, but that goal had not yet been reached. It seemed, however, only logical to assume that the uncommercial period through which they had been passing would soon come to an end. It was not business to sell one's wares at a loss, and this was what the transportation companies of London were doing at the present time. The fact was that the fares to be charged by omnibuses, railways, and tramways were still in an experimental stage. A set of persons charged solely with the business of thinking out the problems of London locomotion was needed. The chairman then detailed the financial scheme, which, in his judgment, was fair, and the best that could be devised in the circumstances. The proposed scheme provided for the issue of £1,000,000 of 5 per cent. prior lien bonds, due Nov. 1, 1920, which would be underwritten at 93 per cent. While it was cold comfort, indeed, in the great losses they had suffered, to reflect that they had contributed to the performance of a great work for London, the future was not without promise. He moved the necessary resolutions, which Lord George Hamilton seconded, and which were carried unanimously.

EASTERN TELEGRAPH.

The half-yearly ordinary general meeting of the Eastern Telegraph Co. was held on Tuesday, the chairman (Sir John Wolfe-Barry, K.C.B.) presiding.

In moving the adoption of the report, the CHAIRMAN said that the aggregate receipts for messages during the half-year under review compared favourably with those for the corresponding period for 1906. After dealing in detail with the accounts, he referred to the international telegraph conference now sitting at Lisbon. He said that nearly all the countries in the world were represented at this conference by officials appointed by the various Governments, and although delegates of the telegraph companies were invited to express the views of their companies upon the different questions under discussion, they were not permitted to vote on any subject. In debates on future action they had, therefore, to depend upon the justice of their case and the arguments which they would be able to bring forward, combined with the submission of facts and figures which their representatives, owing to their great experience in such matters, were able to submit to the deliberations of the conference. These, together with the support of their own Government representatives, ought to result in solutions of questions affecting cable telegraphy in a manner fairly satisfactory to the companies, as also to the interests of the public. He pointed out that while the directors of the Company had always been prepared to meet the reasonable demands of the public for reductions in tariff, the carrying capacity of cables was limited, and if tariffs were reduced beyond a certain point, the work not only became unremunerative, but would actually entail a loss to the Company. Therefore, in the event of future demands on them to make any further reductions of tariff, they must look to the Governments concerned to assist them either by the extension of the standard revenue system which had been found to work satisfactorily for Indian and South African traffic, or by some other method which may be mutually beneficial.

The MARQUESS OF TWEEDDALE, K.T., seconded the motion, which was unanimously agreed to.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The second ordinary general meeting of the Kalgoorlie Electric Power and Lighting Corporation was held on the 6th inst., Mr. Roger W. Wallace, K.C. (chairman of the Company), presiding.

In moving the adoption of the report, the CHAIRMAN referred to the fact that the reconstruction of the Company had been effected without involving a reduction of the amount of capital, but involving, rather, an increase in the amount of capital given to the shareholders. The effect was that all the difficulties had been cleared away, and the directors were now in a position to ask the shareholders to agree with them in recommending that a dividend at the rate of 5 per cent. per annum be paid on the ordinary shares for the six months ending June 30 next. The trading account for 1907 was a record one. The plant was in a very much more efficient condition now than it was before, and the directors proposed to put down a new unit, which would enable them to reduce the expenses still further in connection with the production of their electricity. They started by putting another £7,500 aside as provision for depreciation and renewals, and the new unit which would be put in would add to the efficiency of the plant. One of the difficulties with which they had had to contend as a supply company was that gentlemen from Germany, this country, and elsewhere were always devising new means of producing power and holding out to the mineowners some new arrangement which would produce power at a reduced cost—an arrangement which might be new in Australia, but which had probably been known here for some time. From the very start the Board had always been most anxious to investigate every novelty, so that they might be in a position to adopt it at the earliest possible moment. Gas-engines had recently been proposed for use in Western Australia, but in the use of means of producing power it was most essential that they should take into consideration the conditions of the climate, temperature, dust storms, fuel, etc. All these conditions made it imperative for the technical advisers to exercise the greatest acumen in selecting the kind of plant useful for a particular district. He thought that in Australia there would be a great future for gas-engines, but in their own case they came to the conclusion many years ago that gas-engines would not be suitable for work on the Kalgoorlie field. Since then many people had been over to Australia advising different companies to use gas-engines on the assumption that they would reduce the cost of power, but the hopes held out could not be realised, and when anyone tried to pin them down and get them to sign a contract they were generally astute enough to get out of it. In some instances, however, some of the Company's customers had not realised the pitfalls that they had been led into. Those were some of the difficulties with which they had to deal. They wanted to get as much business as would enable them to charge a low price and make a fair profit. Those were the conditions on which they carried on the Company, and so far they had been successful in declaring a dividend on the ordinary shares.

Mr. E. POPE seconded the resolution, which was carried unanimously.

KALGOORLIE ELECTRIC TRAMWAYS.

The fourth ordinary general meeting of the Kalgoorlie Electric Tramways was held on the 6th inst., Mr. Allen H. P. Stoneham (the chairman of the Company) presiding.

In moving the adoption of the report, the CHAIRMAN said the gross receipts for the year were £48,008, compared with £51,379 in the previous year, showing a falling off of £3,000. The falling off in receipts was not due to any falling off in the output of Kalgoorlie, for the output of gold was progressing, and the town, no doubt, had entered on a period of commercial and economic prosperity. The decrease in receipts was consequent on the decrease in the number of men employed, owing to improved methods of mining, the installation of more up-to-date machinery, and the consequent non-employment of inefficient workmen. The wages which the Company had to pay to their employés maintained the same high level, and although it seemed natural that in times of depression wages should fall, they had not fallen in Kalgoorlie. The wages of their employés on the tramways averaged from 1s. 1½d. to 1s. 3d. per hour. He thought they could congratulate themselves on the steps that were being taken towards the repayment of interest and sinking fund on debentures. The amount set aside for the service of the debentures was £15 000 annually. He said that the traffic returns for the first three months of the current year showed a decrease of £394, and the operating expenses were £135 more. The permanent way was kept in a good state of efficiency.

Mr. OLIVER WETHERED seconded the resolution, which was carried unanimously.

POTTERIES ELECTRIC TRACTION.

The ordinary general meeting of the Potteries Electric Traction Co. was held in London on Tuesday last, Mr. G. F. M. Cornwallis West, chairman of the Company, presiding.

In moving the adoption of the report (*Electrical Engineer*, May 8), the CHAIRMAN said that, in spite of the fact that the past year, during the summer months, was one of continued wet weather, the traffic receipts, including parcels, had increased, as compared with last year, from £94,877 to £97,416, being an increase of £2,539 without any increase in the route mileage. The number of passengers carried showed an increase of 517,309, the total number being 19,665,634. There had been a substantial decrease in the power and running expenses, the figure, including parcels expenses, showing a reduction of over £700. Repairs and maintenance had increased, the figures being £18,216 last year, as against £16,250 the year before. Of this amount, £13,700 had been expended on permanent way, of which £6,300 had been charged to the year's revenue. Considerable increase in expenditure on repairs and maintenance of the rolling-stock had also been incurred, the increase having risen from £7,810 in 1906 to £9,324 in 1907. A large proportion of this increase was due to the unfortunate snowstorm about Christmas, 1906, and the expenses of which fell upon the past year. These figures had nothing to do with the renewals suspense account, but were sums which had actually been spent out of revenue on the property. During the year the average number of men employed on permanent-way repairs and renewals alone had been 63 per week, and 30,000 superficial yards have been relaid out of a total of £175 000. The sum placed to renewals suspense account, plus the £6,299 already referred to, represented no less than 1·03d. per car mile. Administration and general expenses had slightly increased, but for the first time for some years a reduction was to be recorded in the amount paid in rates. There was a small reduction in the item of insurances. On the question of insurances, he said the third-party insurance was now done entirely by a committee of the British Electric Traction Federation. Only £3,880 had been spent on capital account, chiefly for doubling the line in the Brick Kiln-lane, which cost the Company £1,830, and £400 had been expended in the conversion of one of the motor omnibuses to a motor char-à-banc. The manager and the Board had come to the conclusion that there was better scope in the district for motor traction by catering for pleasure traffic than for a regular service of

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closed 'buses. The omnibuses had, therefore, been converted, and showed promise of giving a fair return on the expenditure. The balance of capital expenditure was accounted for by natural line extensions and improvements. The overdraft at the bank had increased by £20,333. It was, he said, impossible for the Company to issue shares at a discount, and the issued capital precluded any further issue of debentures. The arrangement made with their bankers for a loan against the security of their holding in the North Staffordshire Tramways Co. had been extended. The directors proposed putting £3,500 to the renewals suspense account. This, with the credit balance brought down from last year, would make a total of £4,523, and £7,474 had been expended during the year on this account. This would show a debit carried forward to next year of £2,951, but, on the other hand, the estimated expenditure under this heading for this year was only £2,550, or about one-third of what was spent last year. This estimate was very carefully considered. Assuming, therefore, that similar amounts were placed within the next two years to this account, the amount should be wiped out in four years.

Mr. STEPHEN MEAR seconded the motion, which was unanimously adopted.

SOUTH STAFFORDSHIRE TRAMWAYS.

The report of the South Staffordshire Tramways (Lessee) Co. for the year ended Dec. 31, 1907, states that the total revenue, including a dividend at the rate of 3 per cent. on the preference shares of the South Staffordshire Tramways Co., amounted to £49,786, against £43,741 for the preceding year. The expenditure (including rental of lines and other payments to local authorities, repairs and maintenance of track, and interest on loans) amounted to £45,562. The profit for the year amounts to £4,223, add amount brought forward £611—£4,835. Deduct debenture interest £1,668, deduct amount placed to renewals account £500—£2,168. 11s. 9d.; balance available for distribution, £2,667. The directors propose to apply this amount as follows: to be placed to sinking fund, £700; to payment of a dividend at the rate of 6 per cent. per annum on the cumulative preference shares for the six months ended Jan. 15, 1905, £1,500; to be carried forward to next year's account, £467. The expenditure on capital account in respect of the reconstruction of the tramways in Tipton, Darlaston, and Wednesbury amounted to £34,088, of which £18,392 has been recovered from the South Staffordshire Tramways Co. in accordance with the agreement of May 25, 1905. The Birmingham and Midland Tramways advanced on loan against security a total amount of £32,000, which was expended in payment of the balance on reconstruction, in repaying the loan of £9,000 to the South Staffordshire Tramways, and reducing the bank overdraft and sundry creditors by £11,345. The amount advanced by the Birmingham and Midland Tramways has been reduced by £2,083 since the close of the year. There is an amount of £6,271. 8s. 2d. to be received from the Dudley Corporation in respect of the cost of reconstruction and electrical equipment of the portion of tramway in Dudley, as mentioned in the last report, which will be credited to capital account when received. All the old steam tramways have now been reconstructed, and are working by electric traction, except a small section of about a quarter of a mile in Wednesbury, which is not worked. The expenditure includes an increase of over £1,700 for interest on loans from the Birmingham and Midland and South Staffordshire Tramways Companies, and arrangements will be made as soon as possible with the Birmingham and Midland Co. for the conversion of the existing loan into debenture stock.

CALCUTTA ELECTRIC SUPPLY.

The report of the Calcutta Electric Supply Corporation for the year 1907, to be presented at the meeting on the 22nd inst., states that the gross revenue amounted to £103,360, compared with £89,242 in 1906. The working costs were £46,084, compared with £39,065 in the preceding year. This increase in working costs is due chiefly to the large increase in the cost of coal. In order to meet the constantly increasing demand for electricity, the directors recently offered to the shareholders for subscription 20,000 5 per cent. preference shares of £5 each. These have all been subscribed and allotted. During the year the sum of £19,016 has been expended in the renewal of mains, which amount has been charged to the depreciation and renewals account. The directors being of opinion that the time had arrived when the Company should manage its own business, they determined the agreement of the managing agents as at Dec. 31 last. Offices have been opened at 8, Dalhousie-square, Calcutta, and Frank Rawson, Esq., C.M.G., has been appointed agent and manager of the Company. The net profits for the year amount to £57,275, to which has to be added the balance brought forward from last year, £4,230, and after deducting the interim dividend at the rate of 6½ per cent. per annum paid in November, 1907, and other items, there remains an available surplus of £44,850. The directors recommend that £17,000 be placed out of the profits to the credit of the depreciation and renewals account and a final dividend at the rate of 9½ per cent. for the half year on the ordinary share capital, making with the interim dividend 8 per cent. for the year, the balance, £5,305, being carried forward.

CALLENDER'S CABLE AND CONSTRUCTION.

The twelfth annual report of the directors of Callender's Cable and Construction Co. states that the accounts for the year ending Dec. 31, 1907, show a balance at the credit of profit and loss account for the year's working (after providing for income tax) of £60,453. 16s. 9d. The balance carried forward at the end of 1906 was £56,722. 3s. 9d., and from this the extra remuneration of £1,200 voted to the directors in respect of 1906 has to be deducted, making the balance brought forward from 1906 of £55,522. 3s. 9d., making together £115,976. 0s. 6d. From this must be deducted: interest on debenture stock, £13,500; dividend on preference shares, £10,000; appropriation for depreciation of buildings, plant, and machinery, £11,118. 10s. 9d., leaving an available balance of £81,357. 9s. 9d., which it is proposed to deal with in the following manner: (1) by the payment of a dividend on the ordinary shares at the rate of 10 per cent. per annum, clear of income tax, being 10s. per share, whereof 5s. was paid on Nov. 1, 1907, and 5s. will be paid on May 30, 1908, £17,500; (2) by the payment of a bonus of 5s. per share, to be paid also on May 30, 1908, £8,750; (3) by placing to suspense account, £10,000; (4) by carrying forward to next year's account, £45,107. 9s. 9d. The directors are of opinion that this result, although not so favourable as that of the previous year, must in view of the conditions which prevailed in 1907 be considered as highly satisfactory. Various causes have rendered the operations of the Company difficult and less remunerative than in previous years. The almost prohibitive price of metals and the stringency of the money market are too well known to need more than casual reference from the directors. The most pronounced factor in restricting business in heavy mains has been the abnormal price of copper which prevailed in the first eight months of last year, leading to the temporary abandonment of nearly all new enterprise in electrical supply, and to the curtailment of extensions of existing networks in every direction. This was not confined to the home trade, as diminished orders were observed in almost every area throughout the world in which the Company carries on its business. The continuing downward trend of the market offered no inducement to consumers to undertake new work or to fill up their deplenished cable stock. The recent return of copper to its average price came after the season was at an end, and it may, therefore, be said that practically the whole of the Company's business during the past year consisted of extensions which were absolutely necessary in connection with electrical supply stations already in existence. The subsequent stringency in the money market has delayed that improvement in business which might otherwise have been expected, and has caused difficulties in other directions, one large firm with which the Company has had dealings for some years past having been forced into liquidation. Their business is in course of reorganisation, but, in order to provide against any possible loss, the directors have placed a sum of £10,000 to suspense account. Energetic measures have been taken to extend the Company's connections in the Colonies and abroad. The business in Germany has been consolidated, and the Company has been registered under German laws with its headquarters in Hamburg. Excellent results have already attended this step. In spite of the continued depression in every branch of engineering the factories both at Erith and at Leigh are fairly well employed. The appliances at the factory at Erith and at the Anchor Works at Leigh have been thoroughly overhauled, with the result that the plant and machinery at both factories are in first class order in every respect. A great improvement has been made in the working of the Anchor Co.'s business. The rubber trade has been much increased, and a satisfactory profit has been made on that company's operations. The directors refer with deep regret to the loss which the Company has sustained since the last general meeting of two of the members of the Board, Sir David Evans having died on Aug. 14 and Mr. W. O. Callender on March 14 last. Mr. W. O. Callender was a director by virtue of a special article of association, and there is no vacancy caused by his death. The directors have appointed Mr. John Varley to fill the vacancy caused by the death of Sir David Evans. The director retiring by rotation is Mr. Charles McEuen, and he, being eligible, offers himself for re-election. Sir J. Fortescue Flannery has been appointed a trustee for the debenture stockholders in the place of the late Sir David Evans.

AUCKLAND ELECTRIC TRAMWAYS.

The tenth annual report of the Auckland Electric Tramways Co. for the year ended Dec. 31, 1907, states that the total revenue for the year from all sources was £140,451. 19s. 9d., compared with £132,364. 17s. 1d. for the previous year. The traffic receipts, which amounted to £137,718. 9s., show an increase of £7,381. 9s 9d. over the previous year. After deducting all expenses chargeable to revenue, including £14,255 for interest on the debenture stock of the Company, and providing for the rental and percentage of profits payable to the Auckland City Council, amounting to £3,567. 11s. 1d., and setting aside £10,000 to meet depreciation, there remains a surplus of £29,722. 7s. 9d. The amount payable to the Auckland City Council—viz., £3,567. 11s. 1d.—has been arrived at on the basis referred to in the last report. The expenses include expenditure on repairs and maintenance, amounting to £20,350. 10s. 8d. as compared with £16,915. 6s. 5d. during 1906. In addition the sum of £18,726. 7s. 7d. has been expended on renewals and charged to depreciation account. A large portion of the latter amount was in connection with the reconstruction of the track in Queen-street, which has now been completed. Including the amount brought forward from last account, £3,101. 10s. 9d., there is an available balance of £32,823. 18s. 6d., which the directors recommend should be applied as follows: to reserve fund for general purposes, £10,000; to pay a dividend at the rate of 6 per cent. for the year on the preference shares (of which £1,408. 8s. 11d. was distributed in 1907, the balance having been paid in the current year), £2,658. 8s. 11d.; to pay a dividend at the rate of 6 per cent. per annum on the ordinary shares, £18,000; balance to be carried forward, £2,165. 9s. 7d. It will be observed that £2,658. 8s. 11d. is payable out of the profits of the past year as dividend on £50,000 6 per cent. preference shares of £1 each, which were issued early in the year for the purpose of providing capital for additional plant and rolling-stock. Nearly the whole of these shares were taken up in Auckland. The total capital expenditure during the year amounted to £71,398. 6s., making the total amount expended on the tramways £664,390. 14s., but only to a very slight extent did the increased expenditure become remunerative during the year. The directors, therefore,

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consider it prudent to reduce the dividend on the ordinary shares by 1 per cent., representing £3,000. The expenditure during the year included the acquisition of the necessary material for the Mount Eden, Mount Roskill, and Grey Lynn extensions, the construction of which is now in progress, the cost of a new generating set of 600 kw. capacity and two new boilers, which have been installed, and the purchase of large additions to the rolling-stock. The following statistics for 1907 are of interest: miles open—route miles, 19·2; single line, 6·99; double line, 12·21; number of passengers carried, 22,474,537; average receipts per passenger, 1·47d.; average expenditure per passenger, 0·88d.; proportion of expenditure to receipts, 60 per cent.; number of cars in working, 71. At the end of the year the Company had 71 cars in stock, being an increase of 11 during the year. Since then the number has been further increased by the delivery of 10 cars shipped from this country and the construction of six in Auckland, bringing the total number to 87. The Company has joined the British Electrical Federation, which is formed by various electric traction and lighting companies for the purpose of co-operation and joint action in matters of common interest. The director retiring by rotation is Mr. R. P. Simpson, and, being eligible, he offers himself for re-election. The Board have pleasure in recommending that Lieut.-Colonel Henry Burton, who has lately left Auckland to reside in this country, and who holds a considerable interest in the Company, should be elected to a seat on the Board, and that the number of directors should accordingly be increased to four.

CAPE TOWN CONSOLIDATED TRAMWAYS AND LAND.

The report of the Cape Town Consolidated Tramways and Land Co. to Dec. 31 last states that the Company was formed to take over, and has taken over, the undertaking of the late Cape Town Consolidated Tramways and Land Co. on the following basis: The shareholders of the old company, in exchange for the 450,000 ordinary shares of £1 each held by them, have received 300,000 ordinary shares of £1 each in the new company credited as paid with 17s. 6d. per share, and with a liability of 2s. 6d. per share, which has since been called up and paid to the Company in cash with the exception of £9. 18s. still outstanding at the date of this report. The £400,000 5 per cent. mortgage debentures of the old company have been exchanged for £400,000 5 per cent. mortgage debentures of the new company in the same form as those of the old company, except that for the period ended June 30, 1910, interest is only to be payable out of the profits of each year, so far as the same (if any) will extend. A further issue has been made of £50,000 debentures which were taken up at par by Messrs. Erlanger and Co. and Messrs. Wernher Beit and Co., making a total debenture issue of £450 000 redeemable at 105 per cent. in annual drawings commencing July 1, 1911. After charging London administration expenses and trustees' fees, and crediting accrued interest and transfer fees, the profit and loss account shows a debit balance of £711, which has been carried forward to debit of profit and loss account for the current year. The estate companies and the Camps Bay Tramway Co. have declared no dividends since the reconstruction of this Company. The very serious and acute depression in the property market, as well as in general business, in Cape Colony, and in Cape Town in particular, during the period under review, has rendered it impossible for the Boards of the Oranjezicht Estate, Limited, and the Cape Marine Suburbs, Limited, to effect any further realisation of the valuable building sites on these estates. In fact, there is still virtually no demand for land for building purposes in the vicinity of Cape Town. The Board, however, has confidence that on any general revival of trade in South Africa these residential estates will be among the first to feel the benefit. Meantime they are being conserved at the lowest possible expenditure consistent with maintaining the estates in fair order and condition, and ready to meet any public demand which may arise for building sites. The Camps Bay Tramway Co. have felt most severely the effects of the depression, and their accounts show a loss of £2,954. This figure includes a sum of £800 expended in legal and other charges in connection with the Kloof Line Amendment Bill. During the past year the Parliament of the Cape Colony passed the Bill referred to, granting to the Camps Bay Tramway Co. relief from operating the Kloof Nek route to Camps Bay during the winter months from May 1 to Sept. 30, except on certain stated public holidays. That route, besides being very expensive to work, is but little patronised by passengers on ordinary days during winter. Arrangements have been made to continue the winter service to Camps Bay by the Sea Point route.

NEW COMPANIES REGISTERED.

Electric Control, Limited.—Registered April 30 in Edinburgh. Capital, £6,000 in £1 shares. Objects: to carry on the business of electrical and mechanical engineers and manufacturers of and dealers in appliances and apparatus for the generation, supply, and control of electrical power, including electric motors and brakes, etc. Registered office: 177, Reid-street, Bridgeton, Glasgow.

British Simplex Motors, Limited. — Registered April 21. Capital, £12,500 in £1 shares (2,000 6 per cent. cumulative preference). Objects: to carry on the business of contractors, designers, engineers, builders, and proprietors of automobiles, motor boats, engines, carriages, and launches, etc., and to adopt an agreement with P. Piellat and O. C. Selbach. No initial public issue. Registered office: 110, High-street, St. Marylebone.

Tewkesbury Electric Light Co., Limited.—Registered May 4. Capital, £5,000 in £1 shares (2,000 preference). Objects: to acquire the interest of J. Parker under the Tewkesbury Electric Lighting Order, 1905; to adopt an agreement between the Town Council of Tewkesbury and J. Parker, and a provisional contract between the same parties, whereby the company will acquire a lease of a site for the generating station, and to carry on the business of an electric light and power company in all its branches. Minimum cash subscription, £1,000.

Electric Batteries and Carbons, Limited. — Registered April 24. Capital, £20,000 in £1 shares. Objects: to acquire and turn to account any patents, brevets d'invention, concessions, and the like conferring an exclusive right to use any invention by F. J. Gerard and L. Fiedler, and to carry on the business of engineers, electricians, manufacturers of electric accumulators, electric or other motors, motorcars, omnibuses, vans, carriages, vehicles, locomotives, dynamos, apparatus, etc. Minimum cash subscription, £100. Registered office: 709, Salisbury House, E.C.

Sylverlyte Electric Lamp Co., Limited.—Registered April 24. Capital, £2,750 in £1 shares (1,500 preferred ordinary and 1,250 deferred ordinary). Objects: to acquire and turn to account any invention relating to the manufacture of electric and other lamps, and any lenses, reflectors, or other accessories used in connection therewith, in particular to acquire the benefit of an invention referred to in an agreement with J. S. Burns, and to carry on the business of manufacturers of electric lamps, reflectors, lenses, and other articles, opticians, glass blowers, etc. No initial public issue.

Glenshiel Rubber Estates Co., Limited.—Registered April 28. Capital, £30,000 in £1 shares. Objects: to acquire from the Glenshiel Rubber Syndicate the Sungei Tankas Rubber Syndicate and J. J. Bradberry, the Glenshiel, Sungei, Tankas, and Guesdon Estates, containing about 1,620 acres, in the district of Ulu Langat, Selangor, Federated Malay States; to adopt an agreement with the said syndicates and J. J. Bradberry, and to carry on the business of planters and sellers of and dealers in rubber, guttapercha, and other gums, etc. Minimum cash subscription, 10,000 shares. Registered office: 27, Austin-friars, E.C.

Liens Registered.

Yenisei Copper Co., Limited.—Issue on April 21 of £45,000 6 per cent. debentures, part of series created Feb. 25, 1908, to secure £100,000 charged on the company's undertaking and property, present and future. No trustees. Total amount previously issued of same series, £15,000.

Guildford Electricity Supply Co., Limited.—Reissue on April 9 of £500 5 per cent. first mortgage debentures, part of series created Nov. 21, 1905, to secure £25,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £25,000.

Leicestershire and Warwickshire Electric Power Syndicate, Limited.—Issue on April 13 of a 6 per cent. debenture for £50, part of series created July 9, 1907, to secure £5,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £950.

St. Austell and District Electric Lighting and Power Co., Limited.—Issue on April 10 of £200 5 per cent. debentures, part of series created June 1, 1904, to secure £2,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £1,800.

South Metropolitan Electric Light and Power Co., Limited.—Issue on April 14 of a £10,000 4½ per cent. debenture, part of series created by resolutions of July 3, 1900, and May 6, 1904, to secure not more than the capital for the time being issued and paid up. Property charged: the company's undertaking and property, present and future, including uncalled capital (if any). Trustees: H. R. Beeton, 18, Austin-friars, E.C., and W. R Davies, 10, Moorgate-street, E.C. Total amount previous issued of same series, £255,968.

Liverpool Engineering and Condenser Co., Limited.—Particulars of £7,000 5 per cent. debentures created by resolution of April 8, 1908, and secured by trust deed dated April 2, 1901, and by supplemental deed dated April 8, 1908, have been filed persuant to Section 14 (4) of the Companies' Act, 1900. (The said supplemental deed has also been registered.) Property charged: certain freehold hereditaments and premises and the company's undertaking and property, present and future, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., 6, Castle-street, Liverpool.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Newquay.—The Council have agreed to terms for the public lighting of the Pentire estate by electricity.

Northfleet.—The Urban District Council have passed plans for the erection of an electricity sub-station for the Electricity Committee.

St. Marylebone.—The London County Council have agreed to lend the Borough Council the sum of £12,301 for electric lighting purposes.

Torquay.—The Council have decided to carry out alterations to the electricity generating station at a cost of between £5,000 and £6,000.

Harrogate.—The Council have decided to extend the electricity mains along Kent-road for a distance of 448 yards at an estimated cost of £115.

Halifax.—The Town Council have authorised the Tramways and Electricity Committee to lay new feeders for lighting purposes at a cost of £2,048.

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Elland.—The District Council have decided to make application to the Local Government Board to sanction a loan of £3,000 for electricity extension.

Loughborough.—The Town Council have in contemplation extensions to the electricity department, and are proposing to spend £2,500 upon additional plant.

Holywood.—The Council have agreed to receive representatives of several firms of electricians with reference to the proposed electric lighting of Holywood.

Shildon.—The North-Eastern Railway Co. have decided to discard the steam plant at the wagon building and repairing shops at Shildon, and to install electric power.

Devonport.—The Council have instructed the electrical engineer to equip the boilers at the generating station with mechanical stokers at an estimated cost of £1,375.

Long Eaton.—During the past month 44,599 units were generated at the Council works, being an increase of 9 per cent. over the corresponding period of last year.

Paisley.—At a sitting of the Dean of Guild Court plans for the erection of an electrical engine-house at the works of James M'Lardie and Sons, Meiklerigg, were passed.

Croydon.—The Local Government Board will hold an inquiry on May 28 into the application of the Council for sanction to borrow £13,500 for electric lighting purposes.

Stalybridge.—The Council are seeking sanction from the Local Government Board to the borrowing of £25,223 for electricity purposes, and an inquiry will be held into the application on May 28.

Walsall.—The Electricity Committee have instructed the engineer to obtain the necessary materials locally for the supply of a duplicate system of boiler feed-pipes, and to erect them with his own staff at a cost of £200.

Calcutta Electric Supply Corporation.—The number of units delivered to consumers during the four weeks ended March 27, 1908, were 407,925, compared with 305,049 units in the corresponding four weeks of 1907.

East Ham.—The Borough Electricity Committee have received a quotation from the National Telephone Co. for an extension from the telephone box to the mayor's parlour at the town hall, at a rental of 30s. per annum.

Stalybridge, Hyde, Mossley, and Dukinfield Joint Tramways and Electricity Board.—The Board have decided to leave the placing of an order for a motor and two centrifugal pumps with the chairman and engineer.

Liquidation.—The *London Gazette* announces that a general meeting of the South-Western Electrical Co. will be held at 1, Oxford-court, Cannon-street, London, E.C., on June 15, at 12 noon, for the purpose of receiving the liquidator's report.

Ammanford.—On the 6th inst., at Ammanford Council Schools, Mr. M. K. North, inspector, Local Government Board, held an inquiry into applications by the District Council to borrow £1,000 for public lighting. There was no opposition to the application.

Clacton.—The Local Government Board have asked to be supplied with certain particulars respecting the Council's application to borrow £500 for the extension of the plant at the electricity works, and the Council have agreed to hold a special meeting to discuss the matter.

Pembrokeshire.—The County Council have ordered the putting up of telephones in the town hall, Haverfordwest Castle (constabulary headquarters), Milford police station, Pembroke Dock police station, Tenby police station, and Narberth police station, at £5 each per annum.

Rochdale.—The Electricity Committee having had a report from their engineer with regard to an inquiry received for a supply of electricity to the Rochdale Union, the committee have decided to inform the Guardians that the Corporation have no authority to give such supply, because Dearnley is outside the borough.

Newcastle.—The Town Council are making application to the Local Government Board for their sanction to a loan of £700, the estimated cost of electricity extensions, made up as follows: cost of cable, bitumen, troughing, etc., £432; disconnecting box, £7. 10s.; laying in wood troughing, £140; making connections with main, £100; contingencies, £20. 10s.

Colchester.—The output of electricity from the Corporation works in units during March, 1908, was—for lighting, 79,227; traction, 39,812; used in generating station, 23,767, making a total of 142,806 against 123,916 for the same period of 1907. The number of consumers at end of March was 1,306, and the total number of 8 c.p. lamps connected, 47,370.

Heanor, Codnor, and Loscoe.—At the last meeting of the Urban District Council the clerk submitted a report from the Electric Light Special Committee, recommending that an expert be appointed to advise the Council as to the desirability or otherwise of their undertaking the supply of electricity in the district. It was decided that full details be laid before the Council before any decision was made.

Oulton Broad.—The Board of Trade have made and issued a provisional order under the provisions of the Electric Lighting Acts, 1882 to 1890, with a view to the same being included in a confirmation Bill about to be introduced into Parliament to the Urban District Council of Oulton Broad, authorising them to supply electrical energy for all public and private purposes within the urban district of Oulton Broad.

Gillingham.—The engineer has reported to the Council Electricity Committee that the equivalent of 201 8-c.p. lamps had been connected with the mains since the last meeting of the committee, and that the equivalent of 69 8-c.p. lamps had been disconnected, making a total of 22,771 equivalent in 8-c.p. lamps, with 344 consumers connected, and that applications had been received for the equivalent of 157 8-c.p. lamps.

Buralem.—The electrical engineer, Mr. A. Bremner, has submitted his report to the Corporation Electricity Committee showing that the number of units of electricity generated during the past month was 57,195, against 24,246 in the corresponding month of last year. The number of 8-c.p. lamps in use, exclusive of street-lighting, was 12,810, against 8,052 in April, 1907; and there were 95 motors in use, equalling 449½ h.p.

Derby.—At a meeting of the Council Education Committee the Higher Education Sub-Committee reported that the principal of the technical college had asked for instructions with respect to the purchase of the electrical plant already sanctioned by the committee. It was ordered that the principal be authorised to order in the first instance electrical plant at a cost not exceeding £250, after submitting the details to the chairman.

Exeter.—The City Council have decided that from July 1 the normal charge for lighting to private consumers shall be reduced from 5d to 4½d. per unit, and that the charge for power be fixed upon a scale from 2½d. to 1¾d. per unit, according to consumption, in lieu of the present scale ranging from 2½d. to 2d. per unit. They have also decided to apply to the Local Government Board for sanction to the borrowing of £8,100 for extension of mains.

The Anderton Lift.—On the 6th inst., after being closed in order that it might be converted from an hydraulic to an electrical lift at a cost of £25,000, the famous Anderton lift on the River Weaver was successfully reopened to traffic. It transfers boats bodily from the Weaver to the North Staffordshire Canal and *vice versa*, and was the first hydraulic lift in Great Britain. The new electrical scheme was invented by the River Weaver engineer, Mr. Saner.

Darwen.—There has been during the year a 10 per cent. increase in the consumption of electricity for lighting from the Corporation electricity works, but a decrease in the number of units supplied to the trams on account of the introduction of the demi-cars. The net profits on the electricity works this year was £104, as against £65 last year, an increase of £39. Certain improvements are being introduced by which the cost of production will be reduced.

Dudley.—The number of units generated at the Corporation electricity works during the past 12 months was 2,203,097, as compared with 1,991,904 last year. The tramways took 1,050,910 (an increase of 84,666), private customers 42,333 (an increase of 30,471), and motors 413,727 (an increase of £94,000). In public lighting there has also been an increase of 806 units. There have been certain necessary alterations and repairs, and the income has amounted to £12,792. This gives a gross profit of £5,985 and a net profit of £344, as compared with £68 last year.

Heckmondwike.—At the last meeting of the District Council it was stated that the electricity expenditure had exceeded the borrowing powers for that purpose by about £17,000, and that application had been made to the Local Government Board for their sanction to the outlay more than a year ago, but that that body had not yet arranged for the holding of an inquiry. A revised scale of charges for current for motive purposes, as recommended by the Electricity Committee, was approved. Hitherto the price has been 1d. per unit, subject to conditions as to quantity consumed.

Middlesbrough.—A sad affair occurred on the 10th inst. at Sir Samuelson and Co.'s ironworks, Middlesbrough. Extensive electric plant is being laid down by the Electric Power Co., and a young man named Arnold Carr, labourer, in the employ of the Electrical Power Co., was instructed to cement some high-tension potential fuses in a panel behind the switchboard in the new electric power station. The panel was "dead" at the time, but the adjoining panel was a "live" one, and deceased was found lifeless in front of this panel, having evidently come in contact with it and been electrocuted.

Swansea.—A report has been sent out to the Swansea Electric Lighting Sub-Committee with reference to an offer made by Mr. Borlase Matthews, electrical engineer, Swansea, to increase the demand for electricity locally, the Corporation to pay a percentage on the results. The borough electrical engineer in the report points out that the station has been progressive from its start, and that last year there was an increase of something like £2,000 in revenue, and altogether he does not favour the proposal, whilst at the same time he goes into details showing how the matter is already engaging his attention.

Eastry.—At a meeting of the Rural District Council a letter was read from the Board of Trade with reference to the Sandwich, Deal, Walmer, and District Electric Light Order of 1903, pointing out that the Electric Powers Syndicate were given two years to complete compulsory work prescribed by the order, and as the syndicate had failed to do so, the Board were of the opinion that the order should be revoked. Before doing so, however, the Board wished to have the observations of the Council on the subject. After a brief discussion the Council concurred that it would be advisable to allow the order to be revoked.

Fareham.—At the last meeting of the Urban District Council a recommendation was received from the Lighting Committee advising the renewal of the electric light main from the mill at Wallington to Mr. Long's lodge, as the cable was defective and insufficient for what was required of it. The recommendation provided for the laying of the main underground in bituminised and fibre conduits, a new armoured cable being obtained for the private lighting, and the present cable for the public lighting. The estimated cost of the improvement was £87, the old gas columns being employed for the public lighting. The report was adopted.

Eccles.—At the last meeting of the Public Lighting and Electricity Supply Committee of the Town Council the clerk reported the

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interview which the mayor, the borough electrical engineer, and he had had with Messrs. Korting Bros., and that it was agreed that the firm should supply and erect a large motor pump and delivery pipes at an increased cost of £35, and the committee confirmed their action. The borough treasurer having reported that the loan of £500 for the purchase of electrical motors was exhausted, it was resolved that the Council be recommended to authorise a further application to the Local Government Board for their sanction to the borrowing of £500 for the purchase by the Corporation of electrical motors to let out on hire.

Barnstaple.—A serious explosion of gas took place at the establishment of Mr. G. W. Fletcher, tailor, The Square, Barnstaple, on the 6th inst. On rising Mr. Fletcher noticed a smell of gas, and on going to the sitting-room, located above the shop, he lighted a match to apply to the gasalier. Immediately there was a terrific explosion, Mr. Fletcher being thrown to the floor with great force. Fortunately, he escaped with a slight injury to the forehead and with a trifling burn in the right hand. The furniture in the room was much damaged by the explosion, and the plate glass in the two windows of the sitting-room was blown with such force across the street that plate glass in the establishments of Mr. Shepherd (chemist) and Mr. W. Brough (confectioner) was smashed. Much glass in the rear of Mr. Fletcher's house was smashed, and the kitchen door was blown to atoms.

Morley.—The borough electrical engineer (Mr. Ellis) has reported to the Electricity Committee that the output from the electricity works for the month of March was 17,696 units, as compared with 16 395 the same month of last year, being an increase of 1,301 units. There was sold by meter 13,800 units, as compared with 13,134 the same month of last year, an increase of 666 units. The total number of lamps connected is 16,255, and there are 30 motors connected, with an aggregate of 101 h.p. The committee have carefully considered the question of revising the scale of charges for motive power, and the borough electrical engineer having submitted the scale of charges in force in neighbouring towns, they consider that the present charges and conditions in force in Morley are generally more favourable to the consumers, and the committee are, therefore, unable to recommend any alteration.

Llanelly.—At the meeting of the Urban District Council the clerk submitted an agreement with the Llanelly and District Electric Light and Traction Co. in order that it might be sealed. He explained that the various documents necessary to carry out their arrangement with the company were now complete, and the short agreement produced would enable them, as a council, to withdraw their opposition to the South Wales Power Co.'s Bill. Among other things, the agreement stated that the Council were to sell to the Llanelly and District Electric Light and Traction Co. their electric light order in consideration of the repayment to the Council of the cost incurred in getting the order. Under the agreement the company were to erect their generating station within a period of two years, and also to sell electric energy at stipulated prices. It was decided to affix the seal of the Council to the agreement.

Schorch Electrical Co.—We are informed that the well-known manufacturers of motors and dynamos for direct single, two, and three phase alternating-current motors and generators, Messrs. Max Schorch and Co., Rheydt, have opened a branch which is carried on in the name of the Schorch Electrical Co., 35, Basinghall-street, London, E.C., Mr. Walter R. Rothenberg having been appointed as general manager for the business in England and Colonies. Among the special features to be introduced we may note the complete electrical outputs for mines and collieries, high efficient alternating-current loom motors, high-voltage switchboards and oil switches, and general plant for central stations. The works in Rheydt have been established since 1881, and from a list which has been forwarded to us we understand that during the past few years about 6,000 installations, totalling 250,000 h.p., have been supplied by them.

Longton.—The number of electricity units generated at the Corporation electricity works for the five weeks ending April 23 was 18,806, against 14,247 for the corresponding period of last year, an increase of 4,559 units. During those five weeks 48 additional lamps were fixed. The extension of the Rough Close main has been completed, and 26 houses have services laid on. Communications have passed between the Electricity Committee and the Improvement Committee in reference to an estimate to provide and fix 18 flame arc lamps, with columns, brackets, insulators, together with cable and connections complete, for the sum of £383. The price quoted for an all-night supply to 18 lamps was £28 per lamp, or £504 per annum; but as the Improvement Committee wish to turn out half the number at 11.15, the reduction in price is £8 per lamp, making £72 less than the £504 quoted. The Improvement Committee have accepted the terms.

Pontypridd.—Further gratifying reports of the progress of the Pontypridd electrical undertakings were submitted at the meeting of the Electrical Committee last week. The engineer (Mr. Teasdel) stated that the revenue from the lighting department during the month was £580. 5s. 11d., as compared with £499. 17s. 9d. for the corresponding period of last year. Receipts from trams on the Treforest and Cilfynydd route amounted to £944. 18s. 1½d., an increase of practically £100 upon the corresponding month of last year. The Trehafod route showed a big increase, the figures being £575. 7s. 9d. as against £304. 1s. 11d. On the latter route the average revenue was 1s. 1·81d. per car mile, and on the Treforest 11·36d. These averages were regarded as highly satisfactory. The engineer said the traffic was developing at such a rate on the Trehafod route that they had an insufficiency of cars to meet the demand. The committee decided to invite tenders for the supply of three cars immediately.

Sutton.—The annual report of the borough of Sutton Coldfield electric lighting undertaking for the year ended March last has just been issued. Mr. T. Duesbury, engineer and manager, congratulates the department on its financial position and on the fact that as the result of the year's working there was a balance to the good sufficient not only to cover all the heavy capital charges, but to wipe out the deficit brought forward from 1907, and leave a small amount to be carried forward. This favourable result had been obtained in the face of dearer coal. The capital expenditure during the period under review was £1,204, bringing the total up to £41,308, of which sum £6,429 had been repaid. The consumption for power, heating, and cooking purposes showed an increase larger than the percentage increase for lighting. The average price for all classes of supply was 3·21d. per unit, and the cost of production was 1·51d. per unit. The gross profit, before providing for capital charges, was £2,691, or 6·61 per cent. on the average capital outlay.

Belfast.—The report of the working of the electricity department for the year ending March 31 last shows that the total output for all purposes for the year was 10,883,658 units; increase over last year, 12·7 per cent. The total revenue for the year was £57,004; increase over last year, 11·6 per cent. The revenue from the sale of energy for lighting and power purposes and motor rent shows £35,415; increase over last year, 1·7 per cent. The small increase is due to the average price per unit being reduced 16 per cent.—namely, from 2·857d. per unit last year to 2·40d. this year; and the increase in the number of units sold for these purposes being only 11·7 per cent., whereas last year the increase was 23 per cent., probably due to so many mills working short time. The price of coal was 25 per cent. more than the previous year (10s. 7·1d. to 13s. 3·3d. per ton). The cost of production has risen from ·634d. per unit to ·753d. per unit. The net profit on the year's working amounts to £8,198. 16s. 4d. This sum is to be allocated as follows: renewals suspense account, £4,000; writing off obsolete meters and time switches, £600; writing off obsolete artesian well (£100 less than cost), £800; cost of piling required at coal quay, £700; carry forward balance, £2,098. 16s. 4d. The number of consumers to March, 1907, was 1,608; number to March, 1908, 1,775—increase, 10·3.

Southampton.—At the last meeting of the Town Council the Electricity Committee reported that the town clerk had submitted a communication from his parliamentary agents enclosing copy of a letter forwarded to the Board of Trade by Messrs. Bircham and Co. to the effect that the Southampton Gaslight and Coke Co. had withdrawn their objection to the Southampton electric lighting provisional order. The electrical engineer wrote that he was informed that the works department were advertising for a new boiler of a size similar to the small ones not yet moved from the Back-of-the-Walls station, and suggesting that it was a good opportunity for getting rid of one of these boilers. The cost of the boiler when purchased was £519, and the committee recommended that it be offered to the Works Committee at £300. The electrical engineer reported that an inquiry had been received from Messrs. J. T. Williams and Sons as to the price required for the Belliss-Crompton generating set at the works, Back-of-the-Walls, and stated that the first cost was £900, and that a sum had been written off. The committee recommended that the machine be offered at £310, and the matter be referred to sub-committee, with power to negotiate and to accept an offer in the event of the price named not being entertained.

Aberdeen.—The Corporation Electricity Committee have considered correspondence with the Admiralty in regard to the supply of electricity to a proposed wireless telegraph station to be erected at Stoneywood. In this connection the committee obtained a report from the electrical engineer containing the conditions on which he suggested that a supply should be granted. The report also contained proposals for a supply to the Woodside, Old Aberdeen, and Bucksburn districts. The committee recommended that a supply be granted to the Admiralty on the terms suggested in the engineer's report, and that the question of a supply to Woodside, Old Aberdeen, and Bucksburn should in the meantime be deferred. The terms are: (1) that the supply be available within six months from the date of the Admiralty agreeing to terms; (2) that the supply be three-phase, 6,600 volts, 50 periods, transformed down to three-phase, low tension, 440 volts in Admiralty's premises—Admiralty to provide accommodation for transformers and switchgear; (3) that the charges be on a flat rate of 4½d. per Board of Trade unit for all supply—namely, heating, light, and telegraph work—consumer to guarantee payment of £350 per annum for five years; (4) that the Corporation lay down feeder cables from Ferryhill to Stoneywood, providing the Admiralty pay £1,000 towards cost of same. The Corporation to maintain, free of cost, the feeder cable, which will remain the property of the Corporation. The Council have agreed with the proceedings of the committee.

St. Annes.—Progress has marked the running of the St. Annes electricity works during the past year. Mr. J. H. Clothier, the engineer, in his report to the Council, records that up to the end of March the sale of current was 751,023 units, as compared with 717,599 for the previous year, and the consumers were 665, as against 534. The statistics now given, he says, complete the seventh year's working of the undertaking, and it is worthy of note that during the past 12 months 131 new consumers have been enrolled, which is a greater number than in any one year previously. The number of new assessments, he understands, is about 108, so that even allowing for consumers who have added heating circuits, not only must the bulk of new property have come on to the supply, but it shows that the use of electric light is spreading amongst the older property. The increase in units to private consumers has been 38,456, against 36,999 in the preceding year, which has more than compensated for the decreased output to the trams. There is also an increase in the units for street-lighting, 17 new street lamps, in addition to 10 flame arcs on the promenade, having been erected during the year. The average number of units sold per consumer is 425, against 457 in the previous year. Mr. Clothier anticipates that this drop will be accentuated with the advent of the new metallic-filament lamp, which

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can now be obtained to burn singly on 240-volt circuits. In some of the older towns the effect of this lamp is very marked, and in one instance, he believes, the price of current has been increased to make up for the shrinkage in revenue due to this cause. About 440 yards of new mains have been laid, and some 1,500 yards of old feeder and distributor mains relaid. An application has been received for a supply of electricity to the King Edward VII. School. Mr. Clothier estimates that the cost of laying suitable cables from the nearest point along the Drive to the school will be about £420, and the cost of service line on private ground 7s. per yard.

Wednesbury.—In a report the Light and Water Committee of the Corporation state that they have prepared a new schedule of charges for electric light and electric power in the borough, which is as follows: electricity for lighting—flat rates, ordinary, 4d. per unit, with ½d. discount cash—*i.e.*, 3½d. net; special agreement (business premises closing not earlier than 10 p.m. six days per week), 3½d., less ½d. cash—*i.e.*, 3d. net. Special agreement (business premises closing at 11 p.m. six days per week), 3d., less ½d. cash—*i.e.*, 2½d. net. Maximum demand system: (*a*) 6d. for first hour's daily use of maximum demand and 1½d. per unit afterwards, with a discount of ½d. per unit on the high rate units for prompt cash; (*b*) alternative, 4d. per unit for the first two hours' daily use of maximum demand and 2½d. per unit for the remainder, with a discount of ½d. per unit on high rate units for cash; rent to be paid for indicator, domestic heating, etc. Where electric lighting is in general use, 1½d. per unit up to 10s. per quarter; if above that, 1d. per unit; otherwise on power rates; meter rent to be paid. Electricity for power, etc.—unrestricted use, a flat rate of 1½d. per unit, subject to discounts for prompt cash; up to 2,000 units per quarter, discount of 5 per cent; 6,000 units, 10 per cent.; 10,000 units, 15 per cent.; 14,000 units, 20 per cent.; 18,000 units, 25 per cent.; over 18,000 units, 33 per cent.; under agreement for term of years to use a minimum of 700 units per annum per horse-power of maximum demand or installed (at option of consumer), 10 h.p. guarantee 1½d. per unit, reducing in steps to ¾d. per unit for 40 h.p. and over, with a discount of ¼d. per unit for prompt cash, making 1d. to ¾d. net. Registered hour system on a guarantee of at least £16 per annum—a flat rate of 1d. per unit for all electricity used, except in the winter months between dusk and 10 p.m., when the charge will be 3½d. per unit, with a discount of ½d. per unit for prompt cash; clock meter rent to be paid. Lighting and power combined—where the power account amounts to £8 per annum, a discount will be allowed of 15 per cent. on lighting account; £40 per annum, 20 per cent.; £60, 25 per cent.; and £80 and over, 33 per cent., all for prompt payment.

Stockport.—Mr. H. R. Hooper, an inspector of the Local Government Board, held an inquiry at the Stockport Court House on the 12th inst. into an application by the Corporation for sanction to borrow £10,500 for the electricity undertaking. The borough treasurer presented statistics of the borough as to area, population, and rateable value. The outstanding debt for electric lighting purposes was £34,606. The town clerk explained that the items included in the application consisted of a dynamo-generator, estimated to cost £3,100; a water-softening plant, £600; a water-tube boiler, £1,500; electrical feed pump, £250; 125 h.p. motor, £100; extension of mains in Chestergate, Mersey-square, Corporation-street, £2,500; erection of new offices and roof of boiler-house, etc., £2,500. The town clerk added that the electricity undertaking was started in a moderate way upon portion of the Old Millgate gasworks in 1898, and in the first instance the department was under the control of the Gas Committee, and was worked in conjunction with the gasworks, Millgate. The capacity of the station when first open was 156 kw. At the present time it was 2 008 kw. The capital expenditure had been kept at the lowest possible figure. At the present time the amount of the debt outstanding was £34,606 only. In this respect the undertaking occupied a very high rank among the electricity supply undertakings of the country. The undertaking had been steadily progressive since the commencement. The gross revenue during the first six months was £410, in 1900 it was £3,528, and during the past year £17,128. Throughout the whole of its history, with the exception of the year 1901, when there was a loss of £536, the undertaking had been a source of profit to the Corporation. During the first six months £186 profit was made. Last year a sum of £2,000 was handed over in relief of rates, £633 was contributed to the reserve fund, and £985 to the depreciation fund. It could fairly be claimed that the undertaking had been successful throughout its career. The flat rate charges for lighting was 3½d. per unit, with 5 per cent. discount for prompt payments, and for power purposes 1½d. per unit, with 5 per cent. discount for prompt payment. The office accommodation was provided in the old gas office, Millgate, but owing to the expansion of business these offices were altogether inadequate and unsuitable, and they were absolutely compelled to provide new offices. The plant and items included in the application were for the purpose of increasing the capacity of the station and rendering the station more efficient. The extension of the mains was required by the demand of new consumers, both for power and lighting purposes. A certain amount of the work to the extent of £1,013 had been executed. The borough surveyor gave particulars with regard to the offices, and said that the present offices were practically tumbling down and were unsafe and unsuitable. The electrical engineer submitted details as to plant. With regard to the water-softening plant, it was wanted to soften the river water. The softening of this water cost about ¾d. per 1,000 gallons, and the plant would save about £500 a year. The inquiry was closed.

Leeds.—At the meeting of the Corporation on the 11th inst., a letter was read from the associated firms who recently sent a deputation to the City Council with reference to the charges made by the Corporation for electric current for lighting and power. The text of the letter was as follows: "With reference to the deputation that waited upon your Council on March 4 last on the subject of the rates charged by the Leeds Corporation electric lighting department for power and light, we are instructed to say that the firms associated in that deputation note with regret that by the Corporation circular of April 2 several of the points specifically laid before the Council by that deputation have not been taken into consideration. The new scale dated April 2 certainly makes a reduction in prices charged, and for this reduction they would express their thanks. They would, however, point out that the rates proposed to be charged are very much higher than those in force in other West Riding towns. For example, taking as a basis the actual amounts of electricity used in the half-year ended March 31, 1908, by several Leeds firms, the charges under the new Leeds scale and that in force in Bradford would have been as follows:

Firms.	Units used.	Cost by Leeds new scale.	Cost by Bradford scale.
A	240,411	..... £856 9 3½	..... £676 3 3½
B	66,920	..... 238 18 3	..... 203 18 0
C	199,687	..... 711 7 9	..... 577 0 0
D	123,931	..... 576 15 0	..... 395 5 6
		£2,383 10 3½	£1,852 6 7½

The Bradford manufacturer thus has an average advantage of 22 per cent. over his Leeds competitor. They further regret that in the circular of April 2 the principle of ignoring the load factor in favour of gross quantity after a certain number of units is reached is retained, and this, as pointed out by the deputation, is unequal in its incidence, and amounts to a preferential scale, which is unjust to the smaller consumer, inasmuch as it places him at a disadvantage with a larger competitor who may be engaged in producing the same class of manufacture. They are also disappointed to note that the question of reduction in lighting as applied to power users has not been dealt with at all. They would, therefore, again respectfully urge upon you the importance of this matter, affecting as it does very large industries associated with the prosperity of the city of Leeds, and they would particularly point out that according to their knowledge many existing firms who are probable consumers are awaiting a clearly-defined statement from the Leeds City Council as to their future policy in this matter, the nature of which declaration would decide them as to whether they would take electrical energy from the city mains or not. But, in addition to this, there is the larger question of rendering Leeds a desirable centre for industrial enterprise by the provision of cheap power, an advantage already offered by neighbouring cities and districts. In view of the magnitude of the interests involved, they would respectfully urge upon you the reconsideration of this subject."

TRACTION.

Yarmouth.—The tram receipts for the past month, amounting to £1,343, are an increase of £163 upon last year, but the Caister section was not then open.

Preston.—The receipts from the Corporation tramways for the past year amounted to £38,256, the passengers carried numbered 8,460,000, and the car mileage was 906,000.

Bolton.—The municipal undertakings of the Bolton Council having been under consideration, the Tramways Committee allocated £9 743 out of the profits for the past year in relief of the rates, as compared with £9,078 in the preceding year.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending May 6, 1908, were £4,070; corresponding period, 1907, £3,742—increase, £328. Aggregate from Jan. 1, 1908, £68,164; aggregate from Jan. 1, 1907, £67,492—increase, £672.

Brierley Hill.—The Urban District Council have decided to appoint a deputation to meet the general manager of the tramways company on the question of fares to Kinver, and also with regard to the company affording the Council special facilities with regard to the watering of the main roads.

Longton.—At the last Town Council meeting it was reported by the General Purposes Committee that the common seal of the Council was to be affixed to a joint memorial by the local authorities of the Potteries in opposition to the provision of Clause 5 of the Potteries and North Staffordshire Tramways (Amendment) Order.

Rome.—A bomb was placed on the electric tramway rails near St. Peter's on the 11th inst. It exploded as a car was passing, but fortunately caused no damage. The outrage is ascribed to drivers, who are on strike as a protest against the inauguration of a public automobile service. An inquiry has been opened.

Hull.—The Hull Tramways Committee have decided upon an important extension of cheaper morning cars, and, subject to confirmation by the City Council, ½d. tickets will be issued on all routes between 5 and 9 a.m. These charges will come in operation on July 1. An effort to establish ½d. rates in the evening was defeated.

Yorkshire.—The Board of Trade has given permission for a complete service of electric tramway cars between Leeds and Bradford. The necessary alterations for a junction of the lines midway at Stanningley are in progress, and there will now, it is stated, be established a complete through service, which will present a formidable rivalry to the Midland and the Great Northern Railway Companies.

Reading.—The Tramways Committee are recommending the acceptance of an offer for the purchase of the site of the old tramways depôt and stables in the Oxford-road for £1,500. The revenue account for the year shows a gross profit on the working of £15,002, and a net profit of £3,522. During the year £249 has been paid in settle-

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ment of claims arising out of accidents. Advertising on the cars has brought in £978.

Birmingham.—On Friday last, while a car was proceeding from Small Heath to the city the trolley pole slipped from the electric wire and struck the span wire. The trolley pole and the iron standard in the centre of the car were torn away, and the conductor, who was collecting fares on the top, which is uncovered, was hurt by being jambed between the standard, the trolley pole, and the seat. Two passengers were injured.

Barton.—At a special meeting of the Rural District Council a letter was read from the clerk to Clifton Parish Council making various suggestions. Attention was called to the desirability of the extension of the tramway from the Clifton boundary to the tramway in Pendlebury. The clerk reported the matter had been under the consideration of the Salford tramways manager and Swinton District Council, and it was resolved that inquiries be made as to the position of affairs.

Tramways in the City.—The Improvements and Finance Committee of the Corporation, as the result of correspondence with the London County Council on the subject of the improvement of Bishopsgate-street between Angel-alley and the City boundary, have decided to recommend that, on the London County Council's contributing half the cost of forthwith widening the thoroughfare, no opposition should be offered to the construction of a tramway from the City boundary to Middlesex-street.

Kirkcaldy.—The Weymss District Tramway Co. have in contemplation the extension of their present system so as to secure the Dysart traffic by laying a branch line from North Lodge to the White Gates, Dysart, and continuing the same to the Kirkcaldy Hospital, where the line will join the Kirkcaldy system. The scheme is likely to be well supported by the inhabitants of Dysart. The Kirkcaldy Corporation secured powers in their Bill to run a line to Dysart, but nothing has been done in this direction.

Burnley.—The Corporation Bill, which includes the extension of the existing tramway in Manchester-road to the boundary of the borough, to extend the Rosegrove branch, and to construct a branch tramway from the Duke Bar to Harlesdyke, has been passed by the Police and Sanitary Committee of the House of Commons, and also certain street widenings. A proposal to widen the Mitre and Dugdale Bridges over the Leeds and Liverpool Canal was opposed by the canal company, who held that the Corporation should be placed under an obligation to rebuild the bridges.

Elland.—A further step was taken by the Elland District Council at their last meeting to prepare for the reception of a tramways system which is to be constructed to link together the Halifax and Huddersfield systems, *via* Elland, a company having been floated for the purpose with a capital of £125,000. It was decided that the clerk take the necessary steps to get the Local Government Board to sanction a loan of £3,000 for the extensions at the electricity works, as it is expected the new company will require current for the propelling of cars in the Elland district.

Erdington.—At the last Council meeting the chairman moved the adoption of the report of the Tramways and Electric Light Committee. He regarded it as highly satisfactory, for it showed that the working of the tramways from April 22, 1907 (when they were opened) until March 31, 1908, had resulted in a profit of £1,960. 1s. 1d., out of which they recommended that £600 be placed to the credit of the reserve fund and invested in Consols, and the balance, £1,360. 1s. 1d., to be paid to the district fund account in aid of the current rates. These propositions were endorsed by the Council.

Shropshire.—The County Council have decided to make application to the Light Railway Commissioners for a clause authorising them to advance to the North Shropshire Light Railway Co. any sum not exceeding £2,000. It is stated that if the old Potteries line, which it was proposed to reopen as a light railway, could only command the same amount of traffic as in the very year prior to its closing years ago, the working of it would give a return of 4½ per cent. The old proprietors have agreed to sell the railway for the price of an old song, and for a sum of £30,000 or £40 000 it could be put into working order again.

Lowestoft.—At the last Council meeting the Tramways Committee reported that the receipts from Oct. 1 to date amounted to £4,571. 3s. 1d., compared with £4,471. 13s. 6d. for the corresponding period the previous year. The town clerk reported that he had seen Messrs. Hawtayne and Zeden with reference to their account of £108. 11s. in connection with the East Anglian Light Railways, and that they are willing, with a view to an amicable settlement and without prejudice, to make an allowance of £20, and the committee accordingly recommend that an order be passed on the treasurer for £88. 11s. in favour of Messrs. Hawtayne and Zeden. The report was adopted.

Sheffield.—There are to be three stopping places on the new tramline between Hillsborough Bridge and Malin Bridge. On the Hillsborough section two stopping stations—West Don-street and Kelvingrove—are to be abolished, and a new stopping place is to be made a pole's length nearer the city than Kelvin-grove station. The Bower Spring stop is to be a stop "by request." The tramline between Northumberland-road and Moor Oaks-road, and between Oakbrook-road and Porter-glen is to be doubled. Tram receipts for the five weeks ended May 3 amounted to £27,430, £168 more than in the corresponding weeks of last year. Over a million passengers travelled on the Hillsborough trams.

Wednesfield.—At a meeting of the District Council Mr. Dunkley, surveyor, said that for some time there had been a general impression that the tram terminus was at present a source of danger to people driving or walking near the place. He had had one or two interviews with the borough surveyor and the tramway manager, and had suggested that they should move the terminus nearer the bridge into the corner. It would leave traffic clear both ways. The borough surveyor and the tramway manager thought that they might stop the cars in the loop nearer to Wolverhampton. The chairman said they might write to the Corporation and inform them that the Council considered stopping in the loop would be equally as dangerous as it was at present. They would like them to run into the corner by the bridge. A resolution to this effect was carried.

South Shields.—Evidence of the profitable nature of the tramway undertaking of the Corporation is afforded by the financial statement for the year ended March 31 last—the first complete year's running of the entire system. The total income for the 12 months was £29,762. 14s. 10d., and the working expenses amounted to £18,003. 4s. 6d. Included in the latter total were £7,091. 7s. 1d. for electrical power—which, by the way, is supplied from the Corporation's own works—£6,807. 0s. 5d. for traffic expenses, £2,458. 6s. 11d. for general expenses, and £1,646. 10s. 1d. for general repairs and maintenance. There is thus a gross profit of £11,759. 10s. 4d. for the year, as compared with £11,900. 16s. in the previous year, a decrease of £141. 5s. 8d. Out of this surplus, however, a sum of £5,651. 13s. 7d. has to be paid in interest on borrowed capital, and the sinking fund charges amount to a further sum of £3,223. 14s., making a total of £8,875. 7s. 7d. Making these deductions, the net balance at the disposal of the Corporation is £2,884. 2s. 9d.

Darwen.—The financial statement of the tramways department of the Corporation shows gross receipts from the main section of £12,213. 11s. 4½d., and working expenses, allowing £900 for depreciation, £8,145. 6s. 7d., showing a gross profit of £4,068. 4s. 9½d., which has been reduced, after providing for interest, sinking fund instalments, and repayments to the Public Works Commissioners amounting to £3,825. 14s., to a net profit of £242. 10s. 9½d., as compared with a net profit for the previous year of £477. 16s. 7½d. The working expenses have been £16. 18s. 2d. and interest and repayment of loans £134. 7s. 9d. more than for the previous year, whilst the gross receipts have been £83. 19s. 11d. less. The total gross receipts for the Hoddlesden section were £1,685. 19s. 7½d., and the working expenses, including £150 for depreciation, were £1,474. 4s. 1d., leaving a gross profit of £211. 15s. 6½d., but after providing for interest and sinking fund charges, amounting to £817, there is a net loss for the year of £605. 9s. 1½d., as compared with a net loss for the previous year of £594. 6s. 1d.

Wandsworth.—The Battersea Borough Council having inquired whether the committee of the Wandsworth Council dealing with the electrification of the tramways would be prepared to co-operate with the committees of the Battersea Council in recommending that it should be suggested to the County Council that the portion of the tramway from East-hill to Queen's-road should be electrified, so that when the Queen's-road tramways were electrified two through routes to London would be opened up from Wandsworth and Battersea—viz., *via* Falcon-road and Queen's-road — the Highways Committee recommended that the suggestion of the Battersea Council should be adopted, and that the London County Council should be asked to proceed with the electrification of the part of the tramway from East-hill to Queen's-road as soon as possible, leaving the remainder of the line to be reconstructed when the County Council have come to an arrangement with the Lambeth Borough Council with regard to the widening of Wandsworth road in that borough. The recommendation has been passed by the Council.

East Ham.—The Council have received a letter from the Board of Trade consenting to the proposed purchase of the tramway track belonging to the North Metropolitan Tramway Co. in Romford-road, and inquiring for what period it is desired that the repayment of the loan of £8,000 should be sanctioned. The borough engineer has submitted to the Electricity Committee a joint estimate prepared by himself and the engineer and manager for the reconstruction of the tramway track and the erection of overhead equipment in Romford-road from High-street North to Green-street, and for the paving of the margins of the highway with wood, and the committee recommend the Council to make application to the Board of Trade for their sanction to the borrowing of the sum of £9,560 in respect of the reconstruction, etc., of the tramway track and overhead equipment, and to the Local Government Board for their sanction to the borrowing of the sum of £7,240 in respect of the paving of the margins; also that advertisements be inserted in the various newspapers inviting tenders for the before-mentioned works, and that the borough engineer be permitted to submit a tender for this work.

Hertfordshire.—The construction of the light railway at Cheshunt from the county boundary to a point about 80 yards south of Queen Eleanor's Cross, Waltham Cross, is now in progress and will shortly be completed. It will be remembered that the Metropolitan Electric Tramways have entered into an agreement with the County Council to accept a lease of this line at a rent of £4. 10s. per cent. upon the amount of the capital expenditure made by the County Council in respect of the same. Beyond this rent the County Council are to receive two-fifths of the net revenue of the company in respect of the line after allowing to the company interest on their capital outlay at the rate of £6. 10s. per cent. per annum. The piece of line under construction is only about 440 yards in length, and the company have pointed out to the sub-committee of the County Council that it will be somewhat difficult to estimate what is the exact revenue of the company arising from this small piece of line, and that if it is necessary to obtain the exact figures as to such revenue a considerable amount of expense and trouble will be caused both to the company and to the County Council in analysing and apportioning the receipts. The company have, therefore, suggested that for a period of three years from the time of the line being ready for use they should pay to the County Council a fixed rent of £5 per cent. per annum upon the capital outlay made by the County Council instead of £4. 10s. per cent. per annum as previously agreed, such percentage to be in satisfaction of the rent payable to the County Council and also the share in the net

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revenue of the company to which the County Council are entitled. This arrangement to be subject to revision after three years. The sub-committee considering this arrangement would be an advantageous one to the County Council, the latter have agreed to the proposal.

Darlington.—The annual report on the working of the electricity department has been prepared by the engineer, Mr. J. R. P. Lunn. It states that the number of units sold last year by the electricity department of the Corporation, exclusive of street-lighting, showed a gratifying increase of 24¾ per cent., and the number of units sold for power, exclusive of traction, also showed a gratifying increase of over 100 per cent. The units sold for power had increased from 63,645 in 1904 5 to 489,305 for the year just ended, and a larger number of units for power was sold than for either lighting or traction. The number of motors connected with the mains is 136, or equal to a horse power of 1,020. The units sold for public lighting and traction are almost the same as last year. The total cost per unit, excluding interest and depreciation, has been reduced from ·805d. to ·742d., notwithstanding the fact that the cost of coal has increased. All the items making up the cost have been reduced, except the price of coal. There is also an increase in the revenue from £9,742 to £11,618 and of the gross profit from £6,065 to £7,186. After providing for depreciation the net profit is £2,314 this year, as against £1 410 last. Mr. Lunn recommends that the flat-rate charge for electricity used for lighting purposes should be reduced from 4d. per unit to 3½d., that the maximum demand rate for lighting be 4d. and 1½ l. per unit instead of 4½d. and 1d , and that the discount on the lighting accounts of large power consumers be the same as at the present, with a maximum discount of 40 per cent.; also that the charge to the tramways department be reduced from 1½d. to 1½d. per unit. The returns of the tramways show only an increase of £160 for the year, and more than one-half of this increase is due to receipts from advertisers. The bad summer season last year affected the returns very much, and during the last few weeks of the year the engineers' strike has also affected the receipts. Owing to the slight increase in the working expenses the deficit is almost exactly the same as last year.

Aberdeen.—The Tramways Committee at their last meeting considered the following report regarding the condition of the car rails between Kittybrewster and Woodside submitted by the burgh surveyor: "I have examined the condition of the section of permanent way lying between Kittybrewster and Woodside, and find it is in bad repair. This section of the route was laid in 1899, immediately after the acquisition of the tramways by the Corporation, and has thus been in use for over eight years. It was the first section of tramway laid down for the working of electrical cars, and was constructed with 60ft. rails and ordinary fishplate joints, and was put down before the system of anchoring the tramway rails came into vogue. I find the general tread of the rails all over is worn to the extent of about $\frac{1}{16}$in., while at the joints it is worn as much as ¼in. There is still, however, at the same rate of tear and wear about four years' life in the rails if they were lifted and relaid and properly anchored both at the joints and along the length of the rail. The joints, which have been more affected by the hammering of the cars than the rest of the rail, will require to be ground with a rail grinder so as to bring the surfaces at the joints flush with the rest of the rail. The result of the want of anchoring has been that the oscillation set up by the movement of the cars has greatly shaken the moist concrete bed in which they were originally set, and the consequence is that the rail is now quite loose along its entire length, and it is impossible to keep the paving alongside in repair. I may mention that both this section of the Woodside route and the section of the Mannofield route between Holburn-street and Mannofield were laid before the system of anchoring was introduced, but all the other routes have been anchored as they have been laid. I estimate the cost of taking up and relaying the present rails, with sufficient anchorage, both at joints and along the rail, between Kittybrewster and Woodside—a distance of 1 mile 352 yards—at £5,365, while if new rails were laid the cost would be £7,865." The committee were afterwards conveyed to Kittybrewster on the Corporation's white car for the purpose of inspecting the rails. After carefully examining the route, the committee decided not to carry out the burgh surveyor's recommendation, but instructed him to carry out the ordinary repairs, as they were of opinion that that would be sufficient for the traffic.

Halifax.—Major Cardew, R.E., and Mr. H. Graham Harris, the experts who recently conducted an inquiry at Halifax on the working and management of the Halifax Corporation tramways with regard to the safety of the public, have issued their report. The tramway system of Halifax is an overhead trolley system, working with the usual direct current at 500 volts. The total length of tramway route is 37 miles, and this represents 52½ miles of single track, a great proportion being in steep gradients, in some parts as steep as in 1 in 9. On these gradients there are many curves, some of short radius, many in the centre or busy part of the town, with streets crossing the line at right angles and much heavy traffic. On this point the report says: "Generally speaking, it may be said your tramway routes are bordering upon the limit of possible safe working by electric cars fitted with ordinary flanged wheels running on grooved rails, for not only are the gradients steep, but the hills are long and with many curves, and the exudations from the soil and deposits from the air and from other traffic frequently produce a greasy surface on the rails. Safety can only be secured, even with every possible mechanical safeguard and with the most careful regulations, by constant and unremitting attention to the maintenance of the efficiency of every working part of the cars and stock, including also that of the human element of 'drivers' and 'conductors.'" Attention is drawn to an increase in the consumption of energy per car mile shown in a previous report, also to the increase in the number of accidents. In this respect the report says, "it appears your tramway undertaking in the past has not been maintained to the 'level of perfection' which, having regard to the physical difficulties inherent to its construction and working, is essential to economy and to safety. The best construction, equipment, supervision, and manipulation are no whit too good for your requirements, and this standard of excellence, once reached, should be carefully maintained." The report goes on to make several recommendations. As to cars, the opinion is expressed that a rather longer wheel base with less overhang would conduce to safety on the steep grades on which single-deck cars would give greater security. It is suggested that single-deck cars with open sides might be purchased for use as workmen's cars, but in any case it is strongly urged that no cars with covered upper decks should be allowed on the routes with steep grades, the reason being given that the increased height of the centre of gravity is prejudicial to the efficiency of the brakes. Emphasis is again laid upon the point that all controllers should be absolutely similar, and that ample brake power should be provided in view of the exceptionally steep gradients. Among the final recommendations is the following relating to upkeep: "We would most strongly impress upon the committee the necessity for more careful attention to the upkeep and cleaning of the motors and all accessories than appears to have been exercised in the past. Numerous motors under repair were shown us in which there was evidence of damage caused by the motor having been allowed to run too long without attention. These remarks also apply to the rheostats, cut-offs, wiring, and electrical and mechanical equipment generally."

CONTRACTS FOR ELECTRICAL SUPPLIES.

Tarragona.—Tenders are invited for the erection of an electricity generating station. Tenders by May 31.

Melbourne.—The City Council invite tenders for the supply and delivery of one 500-kw. motor-generator. Tenders by July 3.

Queensland.—The Postmaster-General invites tenders for battery glassware, etc., battery material and chemicals. Tenders by June 1.

South Australia.—The Postmaster-General invites tenders for telephone material, telephone instruments, and telephone switchboards. Tenders by June 3.

Leith.—Tenders are invited for the annual supply of coal to the electricity station. Particulars from the Burgh Electrical Engineer. Tenders by May 25.

Sofia.—Tenders are invited for the installation of electricity in mines. Particulars from the Director of Mines and Minerals. Tenders by June 19.

Hanley.—The Corporation invite tenders for the supply of arc lamps and lamp columns. Particulars from Mr. C. Yeaman, the borough electrical engineer.

Dartford.—Tenders are invited for the annual supply of stores to the electricity department, including meters, service cables, etc. Tenders to the Clerk by June 9.

Brussels.—Tenders are invited for the supply of underground conduit electric cable by the Société Nationale des Chemins de Fer Vicinaux. Tenders by May 27.

Philadelphia (Durham).—The Sunderland District Electric Tramways invite tenders for painting their car-shed at Philadelphia. Tenders to the Manager by May 19.

Croydon.—Tenders are invited for the supply of sulphuric acid for one year, for the Croydon Gas Co. Tenders to Mr. W. Topley, secretary, Katherine-street, Croydon, by June 9.

Adelaide.—Tenders are invited by the Municipal Tramways Trust, Adelaide, for the supply, delivery, and laying of underground electric cables. Tenders to the Chairman by June 23.

Aberaman.—The Powell Duffryn Steam Coal Co. invite tenders for the annual supply of stores, including oils. Tenders to the Directors, 101, Leadenhall-street, London, E.C., by May 18.

Shrewsbury.—Tenders are invited for the annual supply of coal for the electricity works. Particulars from Mr. C. M. Johnston, engineer and manager. Tenders to the Town Clerk by June 5.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Madrid.—The Post and Telegraphs Department invite tenders for the exploitation of telephones in Spain. Particulars from the Direccion-General de Correos y Telegrafos. Tenders by June 1.

Kilmarnock.—The Electricity Committee invite tenders for a Lancashire boiler for the electricity works. Particulars from Mr. A. H. Burbridge, burgh electrical engineer. Tenders by May 25.

Leeds.—The Tramways Committee invite tenders for the reconstruction of a portion of tramway track in Leeds; also for the construction of a portion of track. Specifications from the General Manager.

Bradford.—The Corporation invite tenders for the supply of tramway tickets for period of not exceeding three years. The approximate consumption is 50,000,000 per annum. Tenders to the Town Clerk by May 20.

Dover.—Tenders are invited for the supply of coal for use at the electricity works between June 1, 1908, and July 31, 1909. Particulars from the Borough Electrical Engineer. Tenders to the Town Clerk by May 18.

Salford.—Tenders are invited by the Electricity Committee for the supply and erection of cooling towers, pumps, etc., at the electricity station, Pendeton. Particulars from the Borough Electrical Engineer. Tenders by May 25.

Worthing.—The Corporation invite tenders for the supply and erection of condensing plant, air and circulating pumps and piping.

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Particulars from the Resident Electrical Engineer. Tenders to the Town Clerk by May 25.

London, E.C.—The Madras and Southern Mahratta Railway Co. invite tenders for miscellaneous tools and stores and copper ingots. Tenders to Mr. E. Thornton, secretary, 46, Queen Anne's-gate, Westminster, S.W., by May 19.

Penrhiwceiber (Glam.).—The Penrikyber Navigation Colliery Co. invite tenders for the annual supply of stores from July 1, 1908, including miners' lamps and lamp glasses, electric lamps and fittings. Tenders to the Secretary by June 4.

Walsall.—The Electric Lighting Committee invite tenders for the supply and erection of condensing plant, including surface condenser, air pumps, cooling tower, and water purifier. Tenders to the Town Clerk by May 29. See advertisement.

Melbourne.—The City Council invite tenders for the supply of 1,003,800 flame and 35,000 ordinary carbons. Particulars from Messrs. McIlwraith, McEacharn, and Co. Proprietary, Billiter-square-buildings, London. Tenders by May 25.

Southend.—The Corporation invite tenders for the supply and delivery of about 150 tons of rails, B.S. section. Particulars from Mr. Ernest J. Elford, C.E., borough engineer. Tenders to Mr. William H. Snow, town clerk, by May 16.

New South Wales.—Tenders are invited by the Postmaster-General for eight tons wire, hard-drawn copper (400lb. per mile), 1½cwt. tape binding, copper (200lb. per mile), 1,300 insulators, best white porcelain, large. Tenders by June 10.

Croydon.—The Visiting Committee of the Croydon Mental Hospital, Warlingham, Surrey, invite tenders for the installation of light, telephones, and fire-alarms in three ward blocks. Particulars from the Borough Engineer. Tenders by May 20.

Bermondsey.—The Borough Council invite tenders for the supply and erection of one boiler, one steam dynamo, one condenser, and cooling tower at the electricity and destructor works. Tenders to the Town Clerk by May 18. See advertisement in last issue.

Sale of Plant.—Tenders are invited for the purchase of heating and generating plant at the Nottingham post office. Particulars from the Controller of Stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by May 25. See advertisement.

London, N.—The Great Northern Railway Co. invite tenders for the supply of various stores for 12 months from July next. Particulars from Mr. Weeks, stores superintendent, Doncaster. Tenders to Mr. Burrows, secretary, King's Cross Station, London, N., by May 25.

Victoria.—Tenders are invited for the following for the Postmaster-General's Department: 2,800 jacks, in strips of 20; 1 mile 64-wire switchboard cable; 50 3-conductor cords, 7ft. long, for "B" boards; 96 3-part plugs, and 66 listening and ringing keys. Tenders by June 9.

Handsworth (Staffs).—Tenders are invited by the Urban District Council for the supply of low-tension distributor cables, lead-covered, paper-insulated. Specification, etc., on application at the Generating Station, Soho-road, Handsworth. Tenders to Mr. H. Ward, clerk, by May 25.

Rawtenstall.—The Corporation invite tenders for the supply, delivery, and erection of two track boosters (Contract 3) and of low-tension direct-current and high-tension alternating-current switchboards (Contract 11). Tenders to the Town Clerk by May 29. See advertisement.

Johannesburg.—Tenders are invited for a refuse destructor plant. Specification, etc., may be obtained from Messrs. E. W. Carling and Co., St. Dunstan's-buildings, St. Dunstan's-hill, London, E.C. Tenders to the Town Clerk, Municipal Offices, Plein Park, Johannesburg, by June 10.

Sheffield.—Tenders are invited for the supply of coal for use at Kelham Island power station during 12 months ending June 30, 1909, for the Tramways Committee. Particulars from Mr. A. B. Fearnley, general manager, Tramways Department, Division-street, Sheffield. Tenders by May 18.

London, S.E.—The London County Council invite tenders for the manufacture and supply of two electrically-driven centrifugal pumps, etc., to be erected at the Council's electricity generating station at East Greenwich. Tenders to the Clerk of the Council, County Hall, Spring-gardens, S.W., by May 26.

Stalybridge.—Tenders are invited for the supply and delivery of stores for the Generating Station and Tramways Committee of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board. Specification and form of tender may be obtained from Mr. Robert Blackmore, chief engineer. Tenders by May 30.

Manchester.—The Tramways Committee invite tenders for the supply and delivery of (*a*) steel girder tramway rails; (*b*) steel tiebars; (*c*) tramway rail bonds. Particulars from Mr. J. M. McElroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders to the Chairman of the Tramways Committee by May 19.

London.—The London County Council invite tenders for the supply of about 2,000 tons of steel girder tramway track rails and fastenings required for the electrification of further portions of the Council's tramways; also alternative tenders are invited for the supply of 5 000 tons of track rails and fastenings. Tenders to the Clerk by May 19.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors, 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

Bootle.—The Corporation invite tenders for the supply of coal for use at the electric light station for six months ending Dec. 31, 1908, and 12 months ending June 30, 1909. Tenders, on forms to be obtained at the Borough Electrical Engineer's Office, Electric Light Station, Pine-grove, Bootle, to be delivered at the office of the Town Clerk by May 18.

Adelaide.—Tenders are invited by the Municipal Tramways Trust for the supply, delivery, and erection of rotary converters, transformers, boosters, switchboards, and equipment for converter stations Nos. 1 and 2. Particulars from Mr. W. G. Goodman, the electrical engineer, 8, King William-street, Adelaide, S.A. Tenders to the Chairman by July 14.

Southend-on-Sea.—The Corporation invite tenders for the supply and delivery of traction poles, brackets, overhead line material, and bonds for rails required in connection with the construction of about 1,600 yards of single-line track with passing places or loops. Particulars from Mr. R. Birkett, borough electrical engineer, Southend-on-Sea. Tenders to Mr. W. H. Snow, town clerk, by May 28.

Rio de Janeiro.—Tenders are invited for the supply of new lighting apparatus and accessories for the lighthouse on Raza Island. Tenders will be opened on June 2 in the Ministry of Marine (Seccao de Pharóes) at Rio de Janeiro. No deposit is required. Further particulars may be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Bristol.—Tenders are invited by the Electrical Committee for (*a*) direct-current works power distribution boards at the Avonbank electricity works; (*b*) extra high-tension and low-tension sub-station switchgear for Shirehampton; (*c*) direct-current power switchgear for supply to the Avonmouth Docks; (*d*) extension of galleries at the Avonmouth electricity works. Tenders for (*a*) and (*c*) by May 11 and for (*b*) and (*d*) by May 18. See advertisement in last issue.

London, S.W.—The London County Council invite tenders for the supply and delivery of about 2,000 tons of steel girder tramway track rails and fastenings required for the electrification of further portions of the Council's tramways; also alternative tenders for supply and delivery of about 5,000 tons of track rails and fastenings. Particulars from the chief engineer to the Council, Mr. Maurice Fitzmaurice C.M.G., at the County Hall, Spring-gardens, S.W. Tenders by May 19.

Christiania.—The Commercial Intelligence Branch of the Board of Trade are notified by his Majesty's Consul at Christiania that tenders are invited by the Norwegian State Railways for the supply of an electric light station at Kongsvinger railway station. Tenders are to be marked "Anbud paa Lysanlaeg, Kongsvinger Station," and delivered at Distriktsingeniorens Kontor, Ostbanestation II. etage, Christiania, by 3 p.m. on May 16. Copies of conditions and specification may be consulted by British contractors on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

RESULTS OF TENDERS.

Glasgow.—The Corporation have accepted the tender of Willans and Robinson for two condensers for dealing with 4,000 kw. each.

Islington.—The Borough Council have placed a contract with Willans and Robinson for one condenser for dealing with a 1,500-kw. turbine.

Southampton.—The Corporation have accepted the tender of Willans and Robinson for one condenser for dealing with a 1,000-kw. turbine.

Durban.—The tender of Willans and Robinson has been accepted by the Corporation for one condenser for dealing with 30,000lb. of steam per hour.

Sydney (N.S.W.).—An order has been placed with Willans and Robinson for one condenser for dealing with 2,000lb. of steam, for the Sydney University.

Stoke.—The tender of Willans and Robinson has been accepted by the Corporation for the supply of one condenser for dealing with a 250-kw. reciprocating engine.

Preston.—The Town Council have accepted the tender of the United Electric Car Co. for the supply, delivery, and fixing complete of five top-deck covers at £110 each.

Haslingden (Lancs.).—The Corporation have accepted the tender of Dick, Kerr, and Co. for overhead lines with tangential suspension, telephone system, and tower wagon for the electric tramways.

Buxton.—The Urban District Council have accepted the following tenders for supplies to the electricity department: Reason Manufacturing Co., meters; Callender's Cable Construction Co., cables.

Leek.—On the recommendation of the Electricity Committee the Urban District Council have accepted the tender of Mather and Platt for the supply of gas-engine and dynamo for the sum of £2,650.

Newcastle.—The Town Council have accepted the tender of Bagguley and Wood for the supply and laying of 1,010 yards of three-wire main along the Brampton and Sidmouth-avenue, amounting to £579. 10s.

Hammersmith.—The tender of the Main Colliery Co. for the supply of Graigola and Victoria coal to the electricity works for a period of three months is recommended for acceptance by the Electricity and Lighting Committee.

Stockport.—The tender of J. and W. S. Briscoe, Adswood, Stockport, has been accepted for work in connection with the taking up and relaying of permanent way in the repairs and renewals to the tramway track on the Woodley route and in Heaton-lane.

East Ham.—The Electric Lighting and Tramways Department recommend the acceptance of the tenders submitted by Middleton Bros., Livett, Frank, and Son, Pryke and Palmer, and M. G. Davies and Co. for the annual supply of engine-room stores.

Tonbridge.—The Urban District Council have accepted the tender of Siemens Bros. for 150-kw. dynamo spare armature and condenser (Bellis-Siemens set), for £976; that of Korting Bros. for pipe work

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and pumps for £314; and of the Walsall Electrical Co. for switchboards.

Hammersmith.—The Electricity Committee recommend the acceptance of the tender of Hopkinson and Co., Huddersfield, for the supply of boiler mountings for £193. 11s., and the tender of Mechan and Sons, Glasgow, at £710, for supply of iron flues, air heaters, and hot-air ducts required in connection with the scheme for the extension of plant.

Cheltenham.—The following tenders have been received for an electric light installation at the new destructor:—F. H. Bastin, 35, Albert-street, St. Paul's, £10. 6s. (accepted); H. G. Norton and Co., 416, High-street, £12. 10s.; R. Organ and Sons, 88, Winchcomb-street, £12. 15s. 6d.; H. E. Steel, Limited, High-street, £12. 19s. 8d. All of Cheltenham.

Brighton.—The Corporation have placed a contract with Siemens Bros. Dynamo Works for the supply of 15,000 16-c.p. tantalum lamps. These will be used for series burning in the majority of side streets in lieu of the carbon-filament lamps. Siemens Bros. have also recently fitted up two trains on one of the London underground electric railways with tantalum lamps.

Eccles.—The following tenders have been accepted by the Corporation for the supply of plant for the electricity works: Section A, Lancashire boiler and superheater—E. Heaton and Son, Star Boiler Works, Holt Town, Machester, £601; Section B, 210-kw. steam-engine, alternator, and exciter—Browett, Lindley, and Co., Sandon Engine Works, Patricroft, near Manchester, £1,266. 12s. 6d.

Hull.—The Corporation have accepted the following tenders for the supply of unwashed slack and hard steam coal required by the Electric Lighting Committee at their electricity works, Sculcoates-lane: A. Bannister and Co., Hull, Hickleton Main unwashed slack, 9s. 5d. per ton for six months; South Kirkby, Featherstone, and Hemsworth Collieries, South Kirkby (Barnsley seam) screened hards, 13s. 11d. per ton for 12 months.

Southampton.—The Town Council have accepted the following tenders: for the supply and erection at the electricity works, Western Shore, of a coal conveyor, West's Gas Improvement Co., Manchester; for the supply of about 50 mild-steel plates, Crossley and Davenport, Leeds, at £7. 5s. per ton; and that of Cochrane and Co., Woodside, Dudley, for the supply of cast-iron pipes to the electricity department for £92. 10s.

West Ham.—The following tenders have been accepted for annual supplies to the electricity department: engine-room stores—Angus and Co., Agency Co., Bird and Co., Pryke and Palmer, Middleton Bros., and Wiggins and Rihll; electrical fittings—Evered and Co., Electrical Co., Armorduct Manufacturing Co., British Insulated and Helsby Cables, Straus and Co., G. Braulik, General Electric Co., and Verity's Limited; indiarubber-covered wires—Armorduct Manufacturing Co., Liverpool Electric Cable Co., and Plutte, Steele, and Co.

Hammersmith.—The Electricity and Lighting Committee have received the following tenders for the supply of main switchgear:

Johnson and Phillips	£1,980	5	0
Switchgear, Limited *	2 014	10	0
Spagnoletti	2 060	0	0
British Westinghouse Co.	2 108	0	0
Cowans, Limited	2,129	0	0
Ferranti, Limited	2,981	0	0

* Recommended for acceptance.

Hammersmith.—The following tenders have been received for the supply of battery with lead-lined cells, hand reversing booster, milking booster, and switchboards:

Premier Accumulator Co.*	£939	5	0
Electrical Power Storage Co.	976	15	6
Tudor Accumulator Co.	979	0	0
Electrical Power Storage Co.	984	14	0
D.P. Battery Co.	1,003	15	0
Chloride Electric Storage Co.	1,012	6	0
Hart Accumulator Co.	1,192	17	0

* Recommended for acceptance.

Hammersmith.—The Electricity Committee have received the following tenders for steam-piping required in connection with the scheme for the extension of plant:

J. Spencer, Limited	£230	0	0
Aiton and Co.	247	0	0
J. Spencer, Limited*	255	10	0
Rosser and Russell	261	0	0
Aiton and Co.	263	0	0
Stewarts and Lloyds	289	15	0
E. Le Bas and Co.	303	0	0
Babcock and Wilcox	320	0	0

* Recommended for acceptance.

Southend.—The following tenders have been received for the construction of a concrete tank and foundations for the proposed condenser to be erected at the Corporation's electricity works:

E. and B. H. Davey (accepted)	£370	0	0
C. Wall, Limited	435	0	0
W. Hill and Co.	448	0	0
S. E. Moss and Co.	450	0	0
F. Davey	483	0	0
Muirhead and Co.	497	12	0
W. Iles	548	0	0
W. W. Pedrette	550	0	0
F. and E. Davey	587	0	0
Weber Construction Co.	600	0	0
Abbott, Hendrich, and Co.	797	0	0

Belfast.—The following tenders have been accepted for 12 months' supply (ending March 31, 1909) of the following materials, for the Tramways and Electricity Committee: engine-room stores—Riddel's, Limited, Donegall-place; packings—Turtle and Aird, 10, New King-street, and H. R. McCausland and Co., Waring-street (rags); oils—J. Clarke and Co., Corporation-street, and Turtle and Aird; rubber goods—G. MacLellan and Co., 77A, Victoria-street; firebricks and fireclay—W. D. Henderson and Sons, Waring-street; tools—R. Patterson and Sons, Bridge-street; incandescent lamps—Verity's, Limited, Hardman-street, Deansgate, Manchester; arc lamp carbons—W. Coates and Sons, Fountain-street; asbestos goods—McCausland and Co. Rest of Belfast.

OPENINGS FOR CONTRACTORS.

ABERCARN—Hall shops in connection with the Presbyterian Church of Wales.

ABERDARE—Villa. Mr. Thomas Roderick, Clifton-street, architect.

ABERDARE—Two villas, L. N. Williams, Esq.

ABERDARE—Reparation, St. Fagan's parish church, Rev. R. Jones.

ABINGDON—Manual instruction centre adjoining school (£1,245), Education Committee.

ALDERSHOT—Christian Science church to accommodate 200 people.

ALDERSHOT—Alterations to houses, York-road, Mr. Attfield; motor garage for the Aldershot and Farnborough Motor Bus Co., Halimote-road; additions to St. Joseph's Presbytery, Queen's-road, Rev. F. O. Farrell; house, Cambridge-road, Mr. F. Knight.

ALDGATE, E.—Shops, Messrs. Perry Bros.

ALRESFORD—House, Tichborne Down, Mr. R. Parsons.

AYR—Extensions to Newtonhead School, Ayr School Board.

BALLAGHADEREEN—Extensions to cathedral, Presbytery.

BALLYKEEL—Residence for teacher at Ednagonnel National School

BANGOR—Elementary school, Carnarvonshire County Council.

BARGOED—Secondary school, Gelligaer School Committee.

BARNSTAPLE—Residence, Pilton Lawn, Mr. J. C. Southcombe.

BATTERSEA, S.W.—Store, Price's Patent Candle Co., York-road.

BEAMISH—Elementary school, Durham County Council.

BELFAST—Enlargement, Purdysburn Asylum (£83,000), County Borough Council.

BIDEFORD—Alterations and additions, grammar school (£600), Education Authorities.

BIRKENHEAD—Central library (£13,630), Town Council.

BISHOP'S CAUNDLE—Chapel, Primitive Methodist congregation.

BLACKHEATH—Library (£1,500), Public Libraries Committee, Rowley District Council.

BOSCOMBE—Additions, Boscombe Council School, Board of Education.

BOURNEMOUTH—Central science, art, and technical school, Peachley site; enlargement, Moordown Girls' School, Education Committee.

BOWBURN—Elementary schools, Durham Education Committee.

BRACKLEY—Elementary school to accommodate 180 scholars, Town Council.

BREDBURY—Two houses and shop, Bent's-lane, Woodley Co-operative Society.

BRIERLEY HILL—Depôt at the rear of town hall, Urban District Council.

BRISLINGTON—Extensions, Congregational chapel

BRISTOL—Extension of lunatic asylum at Fishponds.

BRIXHAM—New school in place of Baker's Hill School, Education Committee.

BRIXTON, S.W.—Four stores, Shakespeare-road, Messrs. Gardiner and Theobald.

BROADSTAIRS—Promenade pier, Urban District Council.

BROCKLEY—Additions to The Romans, Brockley Rise, Mr. C. G. Jones.

BROMLEY—House, Sundridge-road, Mr. L. Evans; four houses, Babbacombe-road, Messrs. Hill and Gurr.

BURNLEY—Public baths, North-street (£12,500); electricity undertaking (£23,460); building, health depôt (£1,800), Town Council.

BURY—Ten houses, Bolton-road, Mr. J. Hamer; weaving shed, Rochdale-road, Vulcan Cotton Spinning and Manufacturing Co.

BUSHEY—New offices, etc., Urban District Council.

BYFLEET—New church, West Byfleet, (between £10,000 and £12,000).

CAERLEON—Proposed college for pupil teachers (£35,000), Newport Education Committee.

CAMBORNE—Church, United Methodist Church. Mr. Sampson Hill, architect.

CAMBRIDGE—Two elementary schools, Borough Education Committee.

CANNOCK—Two houses and shops, Milk-street; two houses, Green Heath.

CAPE TOWN—Factories, Town Clerk, Cape Town.

CARDIFF—Elementary school at Lonlas and improvements at Bryn Council School, Glamorgan County Council.

CARDIFF—Alterations and additions, property in Mill-lane, South Wales Model Homes.

CARDIFF—Workhouse laundry (£4,250), Guardians.

CARLISLE—Additions to George Moore Memorial Hall, Mr. J. H. Martindale.

CARRICKFERGUS—Dispensary (£340). Plans passed by Council.

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CARRICKMACROSS—Housing scheme (£37,620), Rural District Council.
CATCHGATE—Two houses. Mr. J. Cockburn, East Castle, architect.
CATHCART—Three double cottages, Main-street, St. Vincent Heritable Investment Co.
CHEADLE—Alterations, Southlow Farm, Rev. A. H. Boucher; alterations, Rakeway, Mr. D. Boulton.
CHESHUNT—Three houses, Bury Green-road, Mr. W. Waller; four houses, Dewhurst-road, Mr. W. Baker; additions, Clock House, Mr. W. C. Stace; improvements, Wheatsheaf, Proprietors.
CHESILBORNE—Elementary school (£4,000), Dorset Education Committee.
CHRISTIANIA—Electric light station at Kongsvingen, Norwegian Government.
CHURWELL—Tannery, Messrs. W. L. Ingle, Limited.
CLAPHAM, S.W.—Six shops, Lytham-road, Messrs. Dartnall and Banks.
CLAPTON, N.E.—Additions to 103 and 105, Stamford-hill, Mr. F. Bull.
CLITHEROE—Extensions, public hall, Clitheroe Public Hall Co.
COCKFIELD—Elementary school, Durham County Council.
COLCHESTER—Lunatic asylum, Essex County Council.
COLCHESTER—Grammar school (£8,600), Essex Education Committee.
CORNWALL—County offices, County Council.
CORWEN—House, Messrs. Deakin and Jones.
COVENTRY—Depot, Spon End, for the General Works and the Waterworks and Fire Brigade Committees.
COWLEY—Enlargement, elementary school, Education Committee.
CRADLEY HEATH—Free library (£2,500), Public Libraries Committee, Rowley District Council.
CREWE—Six houses, Denver-street, Mr. J. Jones.
CROWMARSH—Elementary school, Education Committee.
CROYDON—Electric lighting (£13,500), Corporation.
DARWEN—Two houses, Earnsdale-avenue, Mr. E. Brooks; additions, Grimehills School, Trustees, Grimehills Mission Church; house, Sunnyhurst, Mr. T. E. Marsden.
DARTFORD—Swimming-bath, Urban District Council.
DENMEAD—Alterations, Council school (£450), Education Committee.
DERBY—Elementary school, Kedleston-road, Education Committee.
DORCHESTER—Chapel, etc. (£2,000), Trustees, Missionary College.
DUNDEE—Alterations and additions, Harris Academy (£4,000), Dundee School Board.
DUNFERMLINE—Enlargement of school and erection of gymnasium, Burgh School Board.
DURHAM JOHNSTON—Additional school, Durham County Council.
EASTBOURNE—Workhouse, Board of Guardians.
EAST HAM—Twelve houses, Marlowe-road, Mr. J. Young; forty-seven houses, Blenheim road, Mr. W. G. Watson; coach-house and stable rear of Birchdale, Alderbrooke-road, Mr. G. Smith.
EDGWARE—Six houses, Henning-road, Mr. E. P. Wilson.
EDINBURGH—New offices, Carlton-hill, Messrs. Scott and Brown.
EGLWYSWRW—Additions, etc., Council schools, Pembrokeshire Education Committee.
ELY—Hospital (£850), Board of Guardians.
EMSWORTH—Elementary school, Hampshire Education Authority.
EPSOM—Repairs, etc., to Gynsdale, Waterloo-road, Board of Guardians.
FARNBOROUGH NORTH—Elementary school, Hampshire Education Authority.
FARNHAM—House, Alfred-road, Mr. L. H. Poole; house, Alfred-road, Mr. B. B. Riall; house, Park-road, Mr. Marden; house, York-road, Mr. Robins.
FAWBERT AND BARNARD—Alterations and additions to the County Council school, Herts County Council.
FILEY—Council school (£3,180), East Riding County Council.
FLUSHING—Three houses adjoining post office. Plans passed by East Kerrier Rural District Council.
FOLESHILL—Elementary school, County Education Committee.
FRIMLEY—Cottage hospital, Governors.
FULHAM, S.W.—Enlargement of church of St. Etheldreda (£4,000), Ecclesiastical Commissioners.
FULWELL—Elementary schools (£9,100), Durham Education Committee.
GERINISH—School and schoolmaster's house, South Uist School Board.
GIFFNOCK—Alterations to house, Busby-road, Mr. J. Mann.
GILLINGHAM—Additions, shop, Messrs. G. H. Leavey and Co.; two houses, Rock-avenue, Mr. E. F. Cobb; 10 houses, Watling-street, Mr. T. F. Cobb; four houses near St. John's-road, Mr. Richardson.
GOOLE—Infectious diseases hospital at Hook (£9,000), Goole Joint Hospitals.
GOVAN—Block of buildings, Merryflatt, Messrs. Thompson and Sandilands.
GREAT YARMOUTH—Bakery, Great Yarmouth Industrial Co-operative Society.
GRIMSBY—Alterations to Central Restaurant. Mr. G. Whyatt, architect.
GRINDLEFORD BRIDGE—Church (£2,000). Mr. E. A. Sutton, architect.
HACKNEY, E.—House, Leabourne-road, Messrs. Turner and Holditch.
HACKNEY, E.—Church institute, Messrs. L. and W. H. Patman.
HAMPDEN PARK—Church, Ecclesiastical Commissioners.
HAMPSTEAD, N.W.—Houses, Finchley-road, Messrs. Wimperis and Best.
HARDINGHAM—Primitive Methodist chapel, Messrs. Skipper and Bartram.
HARROGATE—Church (£4,100), Churchwardens.
HARROW—Secondary school, Education Committee.
HASLINGDEN—Infirmary (£32,000), Board of Guardians.
HAVERTON HILL—Elementary school, Durham County Council.
HEADINGTON—Elementary school (£2,000), Oxford Education Committee.
HEATON PARK—Repairs, etc., at the Council school, Lancs. Education Committee.
HEDNESFORD—Four houses, etc., Blackford. Plans passed by Council.
HEDON—Additions and alterations, school, East Riding County Council.
HENDON—Five houses, Bolton-road, Mr. G. W. King; two houses, Hyde-road, Messrs. G. and E. Tilley.
HEPTONSTALL—Restoration of the church of St. Thomas a Becket (£1,100), Ecclesiastical Commissioners.
HINTON—Council school, Gloucester Education Committee.
HODDESDON—Elementary school, Education Committee.
HORDEN—Enlargement of schools, Durham County Council.
HOUGHTON-LE-SPRING—House and shop, Wheeler Estate, Mr. J. C. Hudson.
HUDDERSFIELD—New works in Viaduct-street and Fountain-street, Messrs. Rippon Bros.
HULL—Sub-station, Buckingham-street (£10,000), Electric Light Committee.
HUNTLY—Rebuilding Longhill Schoolhouse (£450), Huntly School Board.
HYTHE—Additions, Quarry House, Mr. F. K. Cobbett.
ILFRACOMBE—Ten houses near Hillsborough, Mr. W. Pile.
ILKESTON—Block of schools (£1,000), Town Council.
ISLINGTON, N.—Modernising St. Mary's day school (£2,200), Education Committee.
KELTY—Alterations to business premises, Mr. A. Scobie.
KESSINGLAND—Additions to parish church (£1,250), Ecclesiastical Commissioners.
KEYNSHAM—Pavilion, Imperial Tobacco Co.
KINGSTON-ON-THAMES—Extension, workhouse, Board of Guardians.
KIRKGATE—Fire brigade station. Plans approved by the Local Government Board.
LANGLEY PARK—Elementary school to accommodate 300 scholars, Durham County Council.
LANGPORT—Board-room at union workhouse, High Ham, Guardians.
LASSWADE—Additions to Roslin and Rosewell Schools, Education Committee.
LEEK—Extensive alterations to Leek Memorial Cottage Hospital.
LENZIE—Extension, Lenzie Academy (£6,045), Combination Board.
LEWISHAM, S.E.—Four houses, Manor Park, Messrs. Scudamore and Sons; four houses, Bishopsthorne-road, Messrs. Edmondson's, Limited; 10 houses, Torridon-road; two houses, Montem-road; six houses, Muirkirk-road; office and flat, Saugley-road, Messrs. Norfolk and Prior; eight houses, Old-road; eight shops, High-road, Messrs. Hatch and Hatch.
LEYTON—School for defective children, Education Committee; six houses, Colchester-road, Messrs. Rowley Bros.; alterations, shops and houses, High-road, Mr. P. Roche; two shops, High-road, Mr. S. Kind; six houses, Dames-road, Mr. R. M. Banks; four houses, Mr. J. Amiss; mission houses and two houses, Lindley-road, Mr. F. J. Coxhead.
LINTHORPE—Sunday schools, reading-rooms, etc. (£4,000), Churchwardens, parish church.
LISMORE—Labourers' dwellings (£19,947), Rural District Council.
LLANDAFF—Residence. Mr. G. E. Halliday, architect.
LLANTWIT FARDRE—Alterations, infants' school, Glamorgan County Council.
LONDON, E.C.—Extension, premises, Royal Exchange Assurance Corporation, 47, Cornhill, E.C.
LONDON, E.C.—Buildings, Ironmonger-lane, Messrs. Holloway Bros.; shops and offices, Old Broad-street, Mr. F. C. Minter; shops, waterrooms, etc., Aldersgate-street, Messrs Colls and Sons.
LONDON, W.—Shops, showrooms, etc., Margaret-street, Messrs. Goodson and Sons; shops, showrooms, etc., Wells-street, Messrs. G. Munday and Sons.
LONLAS—Elementary school, Glamorgan Education Committee.
LOWER TUMBLE—Elementary school, Carmarthen County Council.
LUTON—Extensions to workhouse, Guardians.
LYDNEY—Enlargement, Council school (£800), Gloucester Education Authority.
MAIDENHEAD—Schoolmaster's house (£1,500), Berkshire Education Authority.
MALTON COLLIERY—Temporary school, Durham County Council.
MANSFIELD—Extension, Broomhill Schools, Education Committee.
MARKET RASEN—Elementary school, Lindsey Education Committee.
MAWNAN—House, Trevose Estate, Mr. Kyngdom.
MEIKTALA (INDIA)—Residence for deputy commissioner (Rs.20,000).
MERTHYR TYDVIL—18 houses, Twyncynon Building Club.

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MILFORD HAVEN—Additions and alterations to Co-operative Society's premises, Priory-road. Mr. A. S. Chugg, architect.
MORTLAKE—Enlargement, school, Surrey Education Committee.
MOTHERWELL—Extension, Burgh Hospital, Hospital Committee.
MOUNTAIN ASH—Elementary school, Education Committee.
MYLOR—House, Beach Cottage, Mr. E Fairburn.
NAAS—Four houses, Crosscoolharbour, Rural District Council.
NAILSWORTH—Alterations, Britannia Hotel, Proprietors.
NAIRN—Alterations and additions to Craigsnish, Mr. W. R. Davidson.
NANTWICH—Additions, police court (£375), Commissioners of Public Works.
NEATH—Extensions, laboratories, County School Governors.
NEW BRANCEPETH—Elementary school, Durham County Council.
NEWLANDS—Eleven houses, Kilmarnock-road, Mr. G. Eadie.
NEWPORT—Baths on site adjoining police station at Pill (£2,000), Town Council.
NORTHIAM—Houses, Northiam, Mr. A Comport and Messrs. Ellis Bros.
OMAGH—Labourers' dwellings (£35,101), Rural District Council.
OSWESTRY—Two houses, Oswald-road Messrs Campbell; additions, premises, Leg-street, Mr. R. Jones; warehouse, Bailey-street, Messrs. J. Minshall and Co.; three houses, Garden City, Mr. B. Taylor; additions, cottage hospital, house, Middleton-road, Trustees of the late Mr. T. P. Parry.
OUGHTERARD—Housing scheme (£7,108), Rural District Council.
PADIHAM—Three chapels in connection with enlargement of cemetery (£6,000), Urban District Council.
PAISLEY—Tenement of dwelling-houses, Castle-street, Mr. T. A. Haslett; electrical engine-house, Meikleriggs, Messrs. J. M'Lardie and Sons.
PARANA (SOUTH AMERICA).—Port works (1,539,690 dol.), Port Authorities.
PLASMARL—Four houses, Plasmarl Freehold Land Society.
PONTYPRIDD—Mortuary, Urban District Council.
POOLE—Six houses off Lucas-road, Rev. E. Hall; house, Bournemouth-road, Messrs. Hawker and Mitchell; house and sawmill, Richmond-road; house, Phyldon-road, Mr. G. Troke; house, Pembroke-road, Messrs. Smart and Wyeth.
PORTHCAWL—Two houses, Hookland-road. Plans, etc., at Nuneham House.
PURLEY—Church, Brighton-road.
PURLWELL—New church, Ecclesiastical Commissioners.
PUTNEY, S.W.—Seven houses, Langside-avenue, Mr. E. J. Partridge; 10 houses, Langside-avenue, Mr. E. Evans.
READING—New hall, University College. Messrs. Smith and Son, architects.
READING—Public conveniences, Southampton-street (£559), Town Council.
RHYDYGWERN—Improvements Council school, Glamorgan County Council.
RINGWOOD—Elementary school (£3,592), Hampshire Education Authority.
ROWBARTON—Chapel (£2,000), Local Trustees.
RYHOPE—Two houses, Thomas-street. Plans passed by Urban District Council.
RYHOPE—Elementary school, Durham County Council.
ST. ANNES—Two houses, St. Thomas's-road and All Saints' road, Mr. R. Crighton; four houses, Lime-grove, Mr. E G. Bunce; two houses, St. David's-road South, Mr. T. Seed; two houses, Cambridge-road, Messrs. Keenan and Parker; six houses, Bromley-road and Park-road, Messrs. J. Heap and Sons.
ST. ANNES—Council school (£4,000), Education Committee.
ST. HELENS—Municipal school of housewifery (£630), Education Authority.
SALFORD—Annex adjoining town hall (£14,000). Town Council.
SALTBURN—Permanent school, North Riding Education Committee.
SANDWICH—Two houses, Sandwich-road, Messrs. Turner and Waits.
SEAFORD—Enlargement of public schools, East Sussex Education Committee.
SEAHAM HARBOUR—Elementary school, Durham County Council.
SHEFFORD—Wesleyan chapel, Trustees.
SHEPSHED—Five cottages and storeroom, Trustees of John Lambert's Charity.
SHORT HEATH—House and shop, Snead-lane; house, Bloxwich-road. Plans passed by Urban District Council.
SHOTTON—Permanent school, Durham County Council.
SILSDEN—Dyeworks, Mr. Wm. North; 20 houses, Skipton-road, Executors of the late Mr. J. Tillotson.
SLAITHWAITE—Three houses, Vineyard, Crimble Clough, Mr. A. Shaw.
SOUTHFIELDS—Two houses and shops, Mr. J. E. Fisher.
SOUTHFIELDS—Laundry, Penwith-road, Messrs. W. and C. Brown.
SPENCERS WOOD—Church, Ecclesiastical Commissioners.
SPENNYMOOR—Three houses, Park-crescent, Mr. N. Bennett; alterations, premises, Mill-street, Mr. G. Harrison; warehouse, etc., Barber's-row, Mr. J. Guest; alterations, house and shop, King-street, Mr. J. Forbes.
STAMFORD BRIDGE—Elementary school to accommodate 130 scholars, Education Committee, East Riding County Council.
STALYBRIDGE—Electricity purposes (£25,223), Corporation.
STOBHILL—Infants' schools, School Board.
STOCKPORT—Extending the electricity undertaking (£10,500), Town Council.
STOKE—Alterations, workhouse, Guardians.
STOKE-ON-TRENT—Twenty-seven houses, Grove-road, Mr. W. Ball; house, Winifred-street, Mr. G. Till.
STRABANE—Twenty-two labourers' dwellings, Rural District Council.
STRANOLAR—Alterations at the National Robertson School, Mr. Raitts.
STREATHAM, S.W.—Seven houses, Thrale-road; nine houses, Moyser-road, Messrs. Antill and Squires.
SUNDERLAND—Additions, Primitive Methodist chapel, Ford, Trustees.
SURBITON—Parish hall, Mr. F. Hawkey.
SUTTON VENY—House, shop, and bakehouse, Mr. J. Lines.
SWANSEA—Operating theatre, workhouse, Guardians.
SWANSEA—Ninety-nine houses, Baptist Well Estate, Corporation Housing Committee.
TALSARNAU—Villa, Gwyrach Ynys, Mr. R. J. Morris.
TANDAGREE—Manse, Mr. Walby, Portadown.
TAUNTON—Electric lighting (£2,000), Town Council.
TETTENHALL—Parish-room, etc. (£1,700), Urban District Council.
THOLTHORPE—Alterations and additions to elementary schools, North Riding County Education Committee.
THORNTON LE-DALE—Wesleyan church and school, Trustees.
THRAPSTON—Elementary school, Northamptonshire Education Committee.
THURLBY—Alterations, Thurlby-grove House, Mr. G. Ancient.
TIVIDALE—Library (£650), Public Libraries Committee, Rowley District Council.
TOOTING—Four houses, Longley-road, Mr. S. Bootham.
TULSE HILL—Eight houses, Trinity-road, Messrs. Peachey Bros.
TUNBRIDGE WELLS—Shops, Grove Hill-road, Mr. W. Langridge; two houses, Hopwood-gardens, Mr. F. T. Baker; two houses, Culverden-avenue, Mr. E A. Wells; two houses, Culverden-avenue, Mr. Manktelow; additions, house, Gable End, Mr. E. Forbes; house, Culverden-avenue, Mr. Waters; six houses, Culverden-avenue, Mr. W. Goodwin; two houses, Culverden-avenue, Mr. W. J. Hales; two houses, Culverden-avenue, Mr. G. Goodwin.
TYTHEGSTON—Scheme for electrically lighting the district, Parish Council.
ULCEBY—Wesleyan church, etc., Trustees.
ULVERSTON—Stores, Low Mill Tannery, Messrs. Randall and Porter.
UPPER RENFREWSHIRE—Eighteen houses, Brig-o'-Lea, Neilston, Messrs. R. F. and J. Alexander.
WAKEFIELD—Wesleyan Sunday school and church premises at Westgate End, Messrs. Garside and Pennington.
WALDRIDGE—Elementary school, Durham County Council.
WALKER GATE—Buildings, infectious diseases hospital, Governors.
WALLINGFORD—Council school, Berkshire Education Authority.
WALTHAM—House, Stone-street, Mr. W. Langford.
WALSALL—Electricity undertaking (£4,000), Town Council.
WANDSWORTH, S.W.—House, Eatonsville-road, Mr. A. Wellings
WANDSWORTH—Underground convenience (£1,100), Borough Council.
WASHINGTON—Enlargement of new school (now in course of erection), Durham County Council.
WATERLOO WITH SEAFORTH—Secondary school (£18,900).
WATFORD—Development, Cassiobury Park Estate, Mr. R. Ashby.
WATFORD—Additions, museum for library purposes, Urban District Council.
WEDNESBURY—Provision of a plant for generating electricity (£7,107), Town Council.
WEST BROMWICH—Extensions of electricity mains to Gold's Hill (£1,374), Town Council.
WEST HAM—Extensions, borough lunatic asylum, Town Council.
WEYMOUTH—Residence, Carlton-road, Mr. S. Jackson.
WHICKHAM—Elementary school, Durham County Council.
WHITECHAPEL, E.—Houses, Mansell-street, Messrs. Barlow and Roberts.
WHITEHAVEN—Council school, Town Council.
WIGTON—Petroleum house, Crown and Mitre-yard, Mr. G. Pape.
WILLOUGHBY—Restoration of parish church (£1,700).
WINGATE—Three houses, North-road, Mr. J. Hays.
WINKHILL—Methodist chapel, Trustees.
WINTERBOURNE—Council school, Gloucester Education Committee.
WIRKSWORTH—Public offices (£160), Urban District Council.
WISSAGE—Children's homes (£5,920), Lichfield Council.
WOLD NEWTON—Alterations, school, East Riding County Council.
WOLVERHAMPTON—Secondary school, Education Committee.
WOODLEY—Two houses, Hill-street, Mr. W. Lucas.
WORSBOROUGH BRIDGE—Three houses, Mr. J. Habbershon.
WORTH—Two houses, Deal and Sandwich-road, house, Dover-road, Messrs. Turner and Watts; two bungalows, Mr. Hearst.
WYKEHAM—Stables and buildings, Mr. W. H. Poate.
YARMOUTH—Public conveniences (£1,500), Town Council.
YORK—City lunatic asylum (£3,000), City Council.
YORK—Electricity extensions (£7,200), Electricity Committee.

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LEGAL INTELLIGENCE.

THE RATING OF LIGHT RAILWAYS.

The hearing was concluded in the House of Lords on the 8th inst. of the appeal of the Corporation of Wakefield *versus* the Wakefield and District Light Railways Co. The question raised was whether certain lines of rails laid in certain public streets in Wakefield should, for purposes of the general district rate, be assessed at their full net annual value, or whether they should be assessed in the proportion of one-fourth only. The court of summary jurisdiction for Wakefield held that the respondents were liable to be assessed, and to pay on the full net annual value. The King's Bench reversed this decision, and held that the assessment ought to be on one-fourth only of their net annual value. This decision was afterwards affirmed by the Court of Appeal.

Without calling upon counsel for the respondents,

The LORD CHANCELLOR moved that the appeal be dismissed with costs. The only point upon which there could be any difficulty was whether the land was used as a railway. He thought the user referred to in the Act was the user of the occupier who was to be rated, and that under those circumstances the view of the Court of Appeal ought to prevail.

The rest of their lordships concurred.

SCOTT AND MOUNTAIN v. KENT COLLIERIES.

The Official Referee last week resumed the hearing of this important case. The action was brought by the plaintiffs, electrical engineers, of Gateshead, for the recovery from the defendants of the balance of the price of sets of electrical pumping plant designed and supplied by the plaintiffs for the purpose of pumping out and keeping under control the water in the pits sunk by the defendant company near Dover. Defendants alleged that two of the sets of machinery supplied by the plaintiffs were not sufficiently powerful to deal with the water met with, and that as the machinery was constructed on a faulty design, there was an extravagant consumption of coal required by the plant. Defendants' case was that, owing to the failure of the electrical plant which the plaintiffs supplied, they had suffered great loss, and counterclaimed for damages accordingly.

Mr. C. A. Russell, K.C., and Mr. Holman Gregory appeared for the plaintiffs, and Mr. Bousfield, K.C., and Mr. C. C. Hutchison for the defendants.

Among the expert evidence given on behalf of the defendants, Mr. Henry M. Sayers said that he had examined the machinery, and came to the conclusion that the motors were not capable of carrying the full guaranteed load. Mr. W. M. Mordey gave evidence as to being called in by the defendants to make a test of the generating plant and one of the electric pumps supplied by the plaintiffs. The test lasted 5½ hours, and was then stopped as the motor became dangerously hot, and it was not safe to run longer.

The hearing was again adjourned.

PROVISIONAL PATENTS, 1908.

MAY 1.

9449. Improvements in or relating to electrically-operated heating devices. Fried. Krupp Akt.-Ges. Germaniawerft, 33, Chancery-lane, London. (Date applied for under Section 91 of the Act, June 24, 1907, being date of application in Germany.) (Complete specification.)

9471. Rotory pump, electrically driven, direct connected, operating automatic and with an alarm sounding device. James Joseph O'Donnell, 508, South Third-street, Paducah Ky, United States. (Application for patent of addition to No. 8766/07.) (Complete specification.)

9479. Improvement in supporting hooks for electric glow-lamp filaments. Walter Schäffer, 31, Bedford street, Strand, London. (Date applied for under Section 91 of the Act, May 3, 1907, being date of application in Germany.) (Complete specification.)

9481. Improved system of heating by electricity and apparatus for use in connection therewith. Thomas Joseph Rorke and Edwin Rorke, 7, Southampton-buildings, London. (Complete specification.)

9501. Improvements in electric arc lamps. Henry Baggett, 88, Chancery-lane, London. (Complete specification.)

9502. Improvements in and relating to arc lamps. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, May 2, 1907, being date of application in Germany.) (Complete specification.)

9509. Improvements in electric switches. Josiah Miles, 22, Southampton-buildngs, London. (Complete specification).

MAY 2.

9518. Improvements in the electrical transmission of half-tone or line photographs. Thomas Thorne Baker, 12, Whitefriars-street, London.

9552. Improved electrical block signalling apparatus for railways. George Herbert Brown, 100, Wellington-street, Glasgow. (Date applied for under Rule 13, May 8, 1907. An invention comprised in application No. 10687/07. (Application for patent of addition to No. 2413/07.)

9537. Improvements in and relating to metallic fittings for electric continuity system. Charles Vaughan and Charles Birch, Imperial-chambers, Colmore-row, Birmingham.

9546. Improvements relating to alternating electric current induction motors. Miles Walker, Westinghouse Building, Norfolk-street, Strand, London.

9569. Improvements in or relating to electric wire poles or masts. Jules Jaeger, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, May 8, 1907, being date of application in Switzerland.) (Complete specification.)

9571. Improvements in an electrical locomotive signalling device with automatic control of the steam whistle and of the continuous brake. Josef Kordin, 40, Chancery-lane, London. (Complete specification).

9577. Improvements in and relating to dynamo-electric machines. Allgemeine Elektricitäts Ges., 83, Cannon-street, London, (Date applied for under Section 91 of the Act, May 4, 1907, being date of application in Germany.) (Complete specification.)

MAY 4.

9620. Improvements in hand-fed arc lamps. Jacob Bonn and Arthur Edward Jones, 97, Oxford-street, London.

9636. Improvements in fittings for glow lamps. Siemens-Schuckertwerke G. m. b. H., Queen Anne's-chambers, Broadway, Westminster. (Date applied for under Section 91 of the Act, June 25, 1907, being date of application in Germany.) (Complete specification.)

9637. Improvements in dynamo-electric machines fitted with commutation poles. Siemens-Schuckertwerke G. m. b. H., Queen Anne's-chambers, Broadway, Westminster. (Date applied for under Section 91 of the Act, May 16, 1907, being date of application in Germany.) (Complete specification.)

9638. Improvements in three-phase commutator machines. Siemens-Schuckertwerke G. m. b. H., Queen Anne's-chambers, Broadway, Westminster. (Date applied for under Section 91 of the Act, July 13, 1907, being date of application in Germany.) (Complete specification.)

9639. Improvements in charging and discharging switches for electric cables and the like. (Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

9640. Improvements in switching apparatus for controlling electrical machinery. Siemens Bros. Dynamo Works Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens-Schuckertwerke G. m. b. H., Germany.) (Complete specification.)

9654. Improvements in miners' electric lamps. Philip Middleton Justice, 55, Chancery-lane, London. (Deutsche Gasglühlicht Akt.-Ges. (Auerges), Germany.)

9675. Improvements in electricity meters. Evan Evans, 31, Bedford street, Strand, London. (Complete specification.)

9676. System of electromagnetic transmission. Pierre Fromaget, 53, Chancery-lane, London. (Date applied for under Section 91 of the Act, May 4, 1907, being date of application in France.) (Complete specification.)

9678. Improvements in and relating to means for insulating electrical conductors. John Farquhar Gilmore, 1, Queen Victoria street, London.

9697. Improvements in electric switches. The Thames Ironworks, Shipbuilding, and Engineering Company, Limited, and Walter Herbert Flood, 4, South street, Finsbury, London. (Complete specification.)

MAY 5.

9756. Improvements in and relating to switches for electrical circuits. John Dunlap Hilliard and Charles Edward Parsons, 77, Chancery-lane, London. (Complete specification.)

9762. Improvements in the manufacture of electrical resistances. Charles Ruzicka, 6, Staple-inn, London. (Complete specification.)

9763. Improvements in the manufacture of electrical resistances. Charles Ruzicka, 6, Staple-inn, London. (Complete specification.)

9780. Improvements relating to motors of small starting torque. Herbert Alexander Jones, the Phœnix Dynamo Manufacturing Company, Limited, and Robert Pohl, 322, High Holborn, London.

9789. Improved variable-speed gear for electric automobiles. Constantin Méranville de Sainte-Claire, 33, Cannon-street, London. (Date applied for under Section 91 of the Act, Aug. 17, 1907, being date of application in France.) (Complete specification.)

9790. Improvements in and connected with electric and other cables. W. T. Henley's Telegraph Works Company, Limited, and Joseph Henry Walter Pfiffner, 53, Chancery-lane, London.

9791. Improvements in prepayment electrical house meters. Richard Herbert White, 53, Chancery-lane, London.

9800. Electromagnetic sound-recording apparatus. Charles Logan Chisholm, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

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MAY 6.

9809. Improvements in electric arc lamps. James Henwood Dolton and Samuel Emerson Smith, 271, High-street, Lincoln.

9832. Improvements in safety fuses for switchboards. Erich Peters, 12, Poplars-avenue, Willesden Green, London. (Complete specification.)

9836. Improvements in electro-galvanising. The Cowper-Coles Galvanising Syndicate, Limited, and Sherard Osborn Cowper-Coles, 82, Victoria-street, Westminster.

9844. Improvements in or relating to automatic cut-out apparatus for electrical circuits. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, May 6, 1907, being date of application in Germany.) (Complete specification.)

9849. Improvements in or relating to electric signalling systems for railroads and the like. Alfred Julius Boult, 111, Hatton-garden, London. (Union Switch and Signal Company, United States.) (Complete specification.)

9850. Improvements in or relating to electric signalling systems for railways and the like. Alfred Julius Boult, 111, Hatton-garden, London. (Union Switch and Signal Company, United States.) (Complete specification.)

9851. Improvements in or relating to electric signalling systems for railways and the like. Alfred Julius Boult, 111, Hatton-garden, London. (Union Switch and Signal Company, United States.) (Complete specification.)

9859. Improvements in and relating to starting devices for electric motors. Martin Kallmann, 40, Kurfuerstendamm, Berlin, Germany. (Date applied for under for Section 91 of the Act, Oct. 28, 1907, being date of application in Germany.) (Complete specification.)

9862. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

9865. Switch plate for the aerial wires of electric tramways. Alfred Gislain Boon, 27, Chancery-lane, London. (Complete specification.)

9876. Improved variable-speed gear for electric automobiles. Constantin Méranville de Sainte-Claire, 33, Cannon-street, London. (Date applied for under Section 91 of the Act, Nov. 7, 1907, being date of application in France.) (Complete specification.)

MAY 7.

9900. Improvements in electric batteries. Frank Richmond, 54, Colne-road, Burnley.

9915. Improvements in connectors for electric conductors. Albert Powell, 55, Market-street, Manchester.

9930. Portable interruptor for induction coils and distributors of electrical current. Alfred Ernest Dean, 82, Hatton-garden, London.

9972. Improvements in and relating to the method of and means employed for increasing or decreasing the light given by arc or incandescent electric lamps for theatrical and analogous purposes. Leo Sunderland and Gilbert Cecil Pillinger, 165, Queen Victoria-street, London.

9977. Improvements in and relating to electrical power transmission systems. Allgemeine Elektricitäts-Gesellschaft, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, June 8, 1907, being date of application in Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on May 21.)

1906.

21347. Electric signalling apparatus. Felten und Guilleaume Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Oct. 4, 1905.)

1907.

9390. Electric vehicle or locomotive brakes. Simpson.

9434. Combination electric fuse and switch. Mainprize.

9850. Micrometers, gauges, and like measuring instruments. British Thomson-Houston Company. (General Electric Company.)

10367. Electro-deposition of iron. Cowper-Coles.

10636. Electric traction installations using contact boxes. Black and Black.

10650. Electrical apparatus for transmitting and receiving signals. Dawson and Buckham.

13882. Incandescent electric lamps. Lowden and Westinghouse Metal-Filament Lamp Company.

16051. Dynamo-electric machines. Siemens Bros. Dynamo Works and Parker.

19738. Means for controlling mechanism operating rheostats and the like. Poole.

19855. Electrical switches. Boyden.

22224. Case for electric indicators. Zander. (Held.)

1908.

1427. Space telegraphy. De Forest. (Date applied for under International Convention, Jan. 29, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅛-⅜
—— Ord., 1,125,000	1	..	⅛-⅜
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	11/16-13/16
—— Ordinary, Nos. 1 125,000	1	..	3/16 5/16
British Aluminium Co., Ordinary, 2 001 40 000	5	..	3¼-3⅜ xd
—— 7 per cent. Cum. Pref., 1-40 000	5	..	4-4¼ xd
—— "A" 6 per cent. Cum. Pref., 1-20 000	5	..	4⅜-4½
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3⅜ 4¼ xd
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	101-104
—— 5, per cent Loch Leven Deb. (Reg.). Red., 1-3,000	100	..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	6⅛-6⅜
—— 6 per cent. Cum. Pref., 1-100 000	5	..	5⅜-6⅛
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	93 98
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275 001-475 000	3	..	½-¾
—— 4 per cent. Mortgage Debenture Stock	100	..	45 50
Brush Electrical Engineering, Ordinary, Nos. 1-105 751	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	3/16-7/16
—— 4½ per cent 1st Debenture Stock	100	..	70-75
—— 4½ per cent. 2nd Debenture Stock	100	..	55-60
Callender's Cable, Debentures	100	..	106½-108½
—— Ordinary	5	..	1⅛-1 ¼
—— 5 per cent. Pref.	5	..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	¼-¼
Crompton and Co.	3	..	1 9/16-1 13/1
—— 5 per cent Debentures	100	..	92-96
Dick, Kerr and Co., Ordinary, 1 260 000	1	..	1⅛-1⅜
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	100-103
Edison and Swan United, "A" Shares, 1-99 261	5	..	¾-1
—— "A" Shares, 01-017,139	5	..	1½-2½
—— 5 per cent. Debentures	100	..	85-87
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112,100	2	..	¼-½
—— 7 per cent. Cumulative Pref.	2	..	1⅛-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100	..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock. Red.	100	..	75-80
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅜-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	87-90
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	4⅛-⅜
—— 4½ per cent. Debentures	100	..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	£8-100
National Electric Construction Co., 1-170,000	1	..	⅜-⅝
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	29-31
—— 4 per cent. Bonds	100	..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	8-9

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4⅝-5¼
Bournemouth and Poole, Ordinary	10	..	10⅜-11⅜
—— 4½ per cent. Cum Pref., 7,501-15 000	10	..	10-10¼
—— 6 per cent. Cum Second Pref., 15 001-22,500	10	..	10¼-11
—— 4½ per cent. Debenture Stock, Red.	100	..	104-105
Bromley (Kent) Electric Light and Power Co	5	..	4½-5
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	94-97 xd
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	6⅞-7⅞
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5	..	6-6⅜
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	88-92
—— 7 per cent. Cum. Pref. Stock	$100	..	106-108
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98-101
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3¼-3⅜
—— 4½ per cent. Cum Pref., 1-80,000	5	..	4⅛-⅜
—— 4 per cent. Debenture Stock, Red.	100	..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5	..	3⅜-4¼
—— ditto (1903) 40,001-80,000	5	..	4⅜-4⅝
Chelsea Electricity Supply	5	..	3⅛-3⅜
—— 4½ per cent Debentures	100	..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9¼-10¼
—— 6 per cent. Cumulative Pref.	10	..	14-15
—— 5 per cent. Debenture Stock	100	..	124-127
—— 4½ per cent 2nd Deb Stk., Red.	100	..	102-105
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	3-3⅜
—— 5 per cent Preference, 1-50,000	5	..	4¼-4⅜
County of London Elec. Supply, Ordinary	10	..	7⅜-8¼
—— 6 per cent. Cum Pref.	10	..	10⅜-11¼
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100	..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5	..	⅛-¼
—— 6 per cent. Cum Pref.	5	..	¼-1
—— 4½ per cent. First Mort. Deb.	100	..	53-58
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10 751-15,750	—	..	76-79 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2¼-2⅜
—— 5 per cent Debenture Stock, Red.	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	90-93
Folkestone Electric Supply, Ord., Nos. 1-10 000	5	..	4⅜-4½
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5	..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-13,000	5	..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	95-98
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100	..	90-93
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref. 1-150,000	1	..	3/16-5/16
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5	..	7¼-8¼
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	96-99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	8⅜-10¼

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3 ..	1-1¼
—— 6 per cent. Pref.	5 ..	4¼-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	89-92 xd
Metropolitan Ordinary, 100,001-100,000	5 ..	4¼-4⅜
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	107-111
—— 4½ per cent. Cum. Pref.	5 ..	4⅜-5¼
—— 3½ per cent. Mortgage Debenture, Red	100 ..	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1 000	— ..	76-78 p.c.
Mexican Light and Power Co., Capital Stock	$100 ..	4-½-48¼
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	— ..	75-78
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	— ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5 ..	5¼-6
—— do., 57,010-75,000	5 ..	5⅛-6⅛
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5 ..	5⅛-5⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5⅛-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s paid)	5 ..	5⅛-5⅜ xd
Notting Hill Electric Lighting	10 ..	11½-12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5¼ 6⅜
—— 4 per cent. Debenture Stock	100 ..	94-98
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120,507	1 ..	¾-1
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	¾-1
—— 5 per cent. Debenture Stock, Red.	100 ..	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20 000	5 ..	4⅜ 5⅛
—— 6 per cent. Cum 2nd Pref., 1-15,000	5 ..	4¾-5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	¼-¾
—— 4 per cent. Debenture Stock	100 ..	70-74
South London Ordinary	5 ..	2⅜-2¼ xd
South Metropolitan Electric Light and Power, Ord.	1 ..	1 1/16-1 5/16
—— 7 per cent Cum Pref.	1 ..	1⅛-1⅜
—— 4½ per cent 1st Mort. Deb.	100 ..	99-102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7¼-8¼
—— 7 per cent. Pref.	5 ..	6¼-7
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1⅜-2⅛
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	1⅜-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100 ..	87-90
Westminster, Ordinary	5 ..	7¼-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 .	4⅜-5¼

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,007	5 ..	6¼ 6⅜
—— 10 per cent. Non-Cum 2nd Pref., 260,008-280,007	5 ..	7⅛-8¼
—— Permanent 6 per cent Debenture Stock, 1888	100 ..	135-140
Auckland Elec Trams., 5 p.c. 1st Mor. Deb. Stk, Red.	100 ..	104-107
Barcelona Tramways, Ord., 1-20 000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	—
—— 5 per cent Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅜-⅝
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1 ..	11/16-3/16
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk, Red.	100 ..	93-96
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10 ..	10-10½
—— 4½ per cent. Deb. Stock, Red.	100 ..	93-95
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3¾-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4 11/16 4 15/16
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	98-102
British Columbia Electric Railway Co., Old Def.	100 ..	129-132
—— Ord. Pref.	100 ..	111-115
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	107-111
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	99-102
—— 4½ per cent. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10 ..	3⅛-4⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	88-92
—— 4½ per cent 2nd Deb. Stock	100 ..	64-68
Bueno Ayres and Belgrano Trams	5 ..	4 11/16-4¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5⅛
—— "B" 6 per cent Cm. Pf., 1-27,500	5 ..	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110-116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	95-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	98-102
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	91-94
Calcutta Tramways, Ord., Nos 1-137,610	5 ..	6-7 xd
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5 ..	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	103-106
Cape Electric Tramways, Nos. 1-480,000	1 ..	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum Pref.	5 ..	4¼-4⅜ xd
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100 ..	97-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5¼-5½
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	88-91 xd
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12¼-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	94-97
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	80-85
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14⅛
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	⅝-1⅜
—— 4 per cent. 1st. Mt. Db Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296,500 2nd Mort. Deb. Stock	— ..	—
—— £83,350 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	1-1¼
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 ..	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	6⅜-7⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	80-85
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100 .	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 ..	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4¼-5
——4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1 ..	1/32-5/32
—— 5 per cent. Cum Pref., 500,001-1,000,000	1	11/16-13/16
—— ½ per cent. Deb. Stock, Red.	100 ..	94-97
Mexico Trams. Co, Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	87½-88¾ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000	100 ..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	½-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8¾-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk	100 ..	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	½-½
—— per cent. Cum Pref., 300,001-545 000	1 ..	½-½
—— per cent. Debenture Stock	100 ..	95-96
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4¾-5¼
—— per cent. Cum. Pref., 1-10 000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5 ..	5¼-5⅜
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100 ..	129-134
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-12,000	$500 ..	97½-99½ p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	¾-1
—— 4 per cent. Deb Stock, Red. 1-40	100 ..	76-80
Sunderland District Electric Tramways, 5 p.c. 1st Mort. Debs., Red., 1-1 600	100 ..	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5 ..	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3¼-3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	74-77
—— 4 per cent. Pref.	100 ..	87-89
—— " " deferred	100 ..	54-57
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100 ..	100-103
City and South London, Consolidated Ordinary	100 ..	39-41
—— 4 per cent Debenture Stock	100 ..	99-102 xd
—— 5 per cent. Pref. Stock '91	100 ..	113-116
—— " " " '96	100 ..	112-115
—— " " " '01	100 ..	110-113
—— " " " '05	100 ..	106-109
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10½
—— Ordinary, 1-50,000	10 ..	3¼-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent Profit-Sharing Secured Notes	— ..	36-40
—— Deposit Receipts	— ..	35-40

Telegraphs and Telephones.—

Name.	Amount paid.	Last price
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	85-87
Anglo-American Telegraph Co., Ordinary	100 ..	55-58
—— 6 per cent. Preferred Ordinary	100 ..	99½-100½
—— Deferred Ordinary	100 ..	14½-15
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	98½-101½
Chili Telephone Co., 1-44,000	5 ..	7-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	84-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	7¼-8¼ xd
—— 10 per cent. Preference, 1-6,000	10 ..	15⅜-16¾ xd
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-3½
—— 10 per cent. Cum. Preference	5 ..	8-9
—— 4½ per cent. Debs., 1-600	50 ..	99½-102½
Direct United States Cable Co.	20 ..	13¼-14
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	99½-101½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	98½-100½ xd
Eastern Extension, Australasia and China, 1-300,000	10 ..	13-13¼
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	100-102
Eastern Telegraph Co., Ordinary Stock	100 ..	131-136
—— 3½ per cent. Preference Stock	100 ..	84-87
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102 xd
Great Northern Telegraph Co. (of Copenhagen)	10 ..	29-31
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100 ..	98½-101½
Indo-European Telegraph Co.	25 ..	53-56
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1 ..	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	29/32-1 1/32 xd
—— 5 per cent. Preference, 1-86,492	1	13/16-15/16 xd
National Telephone, Preferred	100 ..	107½-108½
—— Deferred Stock	100 ..	108-111
—— 6 per cent. Cum. First Pref.	10 ..	10¾-12½
—— 6 per cent. Cum. Second Pref.	10 ..	10½-12½
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	98-100
—— 4 per cent. Deb. Stock, Red.	100 ..	101½-103½
Oriental Telephone and Electric Company	1 ..	1⅜-1⅝
—— 6 per cent. Cum. Pref.	1 ..	1⅜-1⅝
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6-6¼
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅜-5¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1¼-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	98½-101½
West India and Panama Telegraph Co., Ordinary	10 ..	9/16-11/16
—— 6 per cent. Cum. 1st Preference	10 ..	8¼-8⅜
—— 6 per cent. Cum. 2nd Preference	10 ..	8¼-9
—— 5 per cent. Debs., Red., 1-800	100 ..	101-104
Western Telegraph Co., 1-207,950	10 ..	13¼-13⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	100-102

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week. Ending	1908.	1907.	Increase or decrease. Week.	Current year.	Miles of track open. 1908.	1907.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pass'nger	Car mile.	£	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	May 6	1,340	1,384	- 44	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 9	232	222	+ 10	—	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 9	3,040	2,390	+ 650	+13,849	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 10	1,116	1,035	+ 81	+ 304	23·53	23·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 2	6,248	5,942	+ 306	—	56½	56½	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	April 29	950	961	- 11	+ 58	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	May 7	531	511	+ 20	+ 804	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·785
Bolton Corporation	,, 10	2,318	2,245	+ 73	+ 995	42	42	March 31	111,294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 6	1,566	1,654	- 88	- 395	29¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 2	4,478	4 426	+ 52	- 812	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 10	775	911	— 135	+ 76	17·191	17·191	,, 31	50,652	10,759,310	1,798,505	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 8	4,910	4,943	— 33	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 9	1,201	1,257	— 56	—	19¾	19¾	,, 31	62,699	11,967,488	1,205,830	1·31	12·48	5,825	8·21
Burton Corporation	,, 10	266	283	- 17	—	9½	8½	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	May 9	174	178	— 4	+ 39	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 9	5,899	5,924	+ 75	- 3,801	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,357	5·22a
Charing X, Euston, & Hamp. Ry.	,, 9	3,240	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 10	3,000	2 694	+ 306	+ 6,747	9	6¼	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 6	181	195	— 14	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 7	486	449	+ 37	- 444	15½	15½	Dec. 31	25,032	5,966,364	891,998	—	6·74	—	4·78
Croydon Corporation	,, 8	1,395	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,602,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 8	241	257	- 16	+ 24	7 23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	,, 2	185	192	- 7	— 165	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	,, 8	123	107	+ 16	+ 74h	6¾	6¾	—	—		—	—	—	—	—
Dublin U.T.	,, 8	5,353	6,000	- 637	+ 190	54¼	48¾	—	—		—	—	—	—	—
Dundee City Tramways	April 8	1,144	1 195	- 51	—	22	22	May 15	57,672	15 554,905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	May 9	799	924	- 125	- 301	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 9	17,463	18,402	- 939	+14,523h	177½	169	May 31	887,381	224,063,098	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 6	272	241	+ 31	+ 15	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 9	5,565	4,050	+1,515	+10,256	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	April 14	1,413	1,253	+ 130	—	52·574	37	,, 31	77,996	18,899,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	May 2	1,506	1,443	+ 58	+ 68	35½	35	,, 31	81,196	15,252,150	1,804,745	1·22	10·79	2,770	5·94
Hull Corporation	,, 9	2,402	2,403	- 1	- 122	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 2	410	449	- 39	—	10½	10½	,, 31	26,499	6,586,754	645,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 6	141	137	+ 4	- 11	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 6	249	256	- 7	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1,73	4 95
Lancashire United Tramways	,, 6	1,247	1 2 6	+ 21	+ 1,048	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 2	6,243	6 293	- 50	+ 400	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5·58
Leicester Corporation	,, 9	2,164	2,393	+ 234	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 2	10,872	10,801	+ 71	- 1,703	104	104	Dec. 31	563,793	122,094,528	12,115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 10	1,399	1,475	- 76	- 385h	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	April 25	32 110	28,550	+3,560	+ 11,720	98	98	March 31	1378,014	314,227,090	30,130.297	1·05	10 98	—	8·56
Lowestoft Corporation	May 9	160	156	+ 4	+ 139	3½	—	Sept. 30	11,009	2,622,922	343,190	1·03	7·9	2,156	6 39
Maidstone Corporation	,, 7	186	106	+ 80	—	3½	2	March 31	5,913	1.186,566	157,050	1·14	8 6	2 956	6·2
Manchester Corporation	,, 9	14,469	14 629	- 160	+ 5,359	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 9	8,970	7 759	+1,211	+18,476	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 10	15,457	15 353	+ 104	+ 2,635	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 9	126	150	- 14	- 134	2¾	2¾	March 31	7,309	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 9	3,805	4,120	- 315	—	59⅛	57½	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 9	628	653	- 5	+ 16	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10 01	1,525	6·87
Oldham Corporation	,, 3	1,894	1,871	+ 23	- 321	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·259
Portsmouth Corporation	,, 2	1,849	1,778	+ 71	—	28½	28½	,, 31	98,911	20,668,825	2,199,823	1·15	10 79	—	—
Reading Corporation	—	—	—	—	—	13½	13½	,, 31	32,661	8,130,179	918,825	·96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6·03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10·45	2,691	7·38
Salford Corporation	,, 4	4,560	4,494	+ 66	- 656	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	
Sheffield Corporation	,, 3	5,336	5,454	- 58	- 21	66¼	65¾	March 25	276,907	73,966,299	6,804,656	·898	9 767	4,174	
Southampton Corporation	,, 6	1,079	932	+ 147	+ 202	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 6	342	325	+ 17	- 25	9	9	,, 31	20,076	4,431,728	390,538	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 10	1,126	1,358	- 232	- 1,658	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 7	305	140	+ 166	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 9	828	778	+ 50	+ 63	12 68	12·43	‡ ,, 31	42,810	8,312,592	890,906	1·23	11·53	3,376	—
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,965.296	429,785	—	10 724	1,989	6·95
West Ham Corporation	April 30	1,924	2,178	- 254	— 1,152	14·7	14 7	,, 31	122,881	35,502,856	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	May 6	895	839	+ 56	+ 49	20	20	,, 31	43,823	9,276,023	966,133	—	10 886	2,159	6·096

* 1905-6 figures. ‡ 1907-8 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures

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THE

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UNIFORMITY OF PLANT.

The mode of procedure enforced by law on all municipal bodies when purchasing plant or materials is briefly as follows: A specification or statement of materials required is first prepared by the municipal officer responsible for the undertaking in question. Tenders are then asked, and the fact that the plant is required is advertised in the public Press. The object of this procedure as laid down by Parliament is that there should be no orders placed without public competition, which should protect the ratepayers against municipal corruption. This object is accomplished as a rule, and the exceptions only prove that men cannot be made honest by Act of Parliament. There is one fault, however, arising out of this procedure, which is emphasised in the report on the Halifax tramways appearing elsewhere in this issue. While the general conditions issued with the specification for tramway plant state that the purchasers do not bind themselves to accept the lowest or any tender, it is usual for the lowest tender to be accepted, and it requires a strong engineer to carry through a recommendation to the contrary. It is quite likely that the materials offered by the lowest tender are practically as good as those the corporation have in use when the inquiry for extensions was issued. It is not easy for the engineer to put a cash value on the advantage of having all the controllers on a tramway, for instance, of the same type, and hence every new contract is likely to be placed with a different firm, and the type of controller varied. In the report above referred to by Major Cardew and Mr. H. Graham Harris the following sentences occur: "As regards controllers, we would emphasise the recommendations we felt necessary to give to you by letter immediately after our inspection, and would say that all controllers should be absolutely similar in their modes of working, although they may differ in their details; in other words, similar movements of the controller or other handle in similar directions should have similar effects. As a matter of fact you have in use now controllers of five different patterns. The motions are similar in most of them as regards the application of power for propulsion, but as regards braking—and this, after all, embraces the emergency question and the question of the safety of the public—these controllers differ very materially." The drivers of the tramcars in Halifax have, as the report shows, extremely severe grades to drive over, and the difficulty of safely negotiating these grades had been increased by this want of uniformity in the controllers. A driver cannot always be sent out on the same car, and the variation in the braking equipment referred to entails a risk which is sure to lead, as it has done, to serious accidents. In such a case the slight extra cost of giving all the orders for controllers to one firm is more than warranted by the increased safety obtained and the decreased cost of upkeep. In another field we have seen this recognised. Thus the London County Council engineers when building the first half of the generating station at Greenwich ordered and directed all the switchgear for the complete station. This entailed a capital expenditure on material which has laid idle for two or three years, but it avoided the great risk of having a diversity of high-voltage control apparatus on the one switch platform. It is the committees rather than the engineers which require educating in this matter, and we would urge upon them the advisability of placing repeat orders at the schedule rates of old contracts rather than allow a new contractor to come in by slightly undercutting the known prices of the firm who executed the first contract. To use a homely

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simile which may fix itself in the mind of councillors, all good wine is good, and frequently adds pleasure to a municipal function, but an indiscriminate mixture of good wines does not tend to the maintenance of mental equilibrium. So a tramway driver who has to use five different types of controllers indiscriminately, cannot be so reliable in an emergency as if he had not first to remember what particular car he is on.

BLACKPOOL TRAMWAYS.

Comparisons, we know, are odious—the safest, however, are the comparisons of an undertaking with itself, otherwise the differing conditions are difficult to estimate. Even with the same undertaking the conditions vary slightly from year to year, so that allowances have to be made. The industry has to thank municipal authorities for the very full and detailed accounts they publish of undertakings controlled by them. If such figures were not available, scarcely any real information would be in existence—at any rate so far as the general public are concerned. Here we have a scheme with a total borrowing power of £424,490, of which £282,631 (neglecting shillings and pence) has been obtained and spent in constructing and equipping about 17½ miles of single line. (Only just over 1½ miles is really single, the remainder is double.) Between three and four miles of line is leased, so the total worked equals 21 miles 1 furlong 9·67 chains of single line. Blackpool, as is well known, is an uproarious holiday resort, catering for the lighter vein of the multitude, and the immense value of the tramway system is seen during the visits of the tripper, especially during the August sunshine, when the average revenue reaches over £3,000 per week. In the first place, however, we wish to direct attention to the capital account of the undertaking and its gradual extinction. The assumption in these discussions may be of two kinds: either that tramways will at a not very distant future be superseded by a more flexible system, or that they will survive through a long period before such supersession. Blackpool has a gross capital expenditure of £282,631. Business was commenced in 1893 with an income of £2,361, which in 1908 became £53,740. This, however, is the point. Except in the opening year a net profit has been made every year, and this has been disposed of in various ways—to assist the rates, to a reserve fund, to reconstruction, or to a permanent-way renewal fund. This net profit, of course, is in excess of interest charges and sinking fund. The broad result of the working comes to this: the payment of working expenses, the percentage of which to total revenue was 60·32, the provision of £63,653 as a sinking fund, of £7,788 as a reserve, of £6,801 as a permanent-way renewal fund, and to rates £33,997. Now we are always inclined to look upon the amount aid to rates in the light of a reserve, and cannot see why ratepayers who have had the use of £34,000 should object to the, if necessary, borrowing at any time of emergency of a similar sum upon the security of the rates. Practically since 1893 Blackpool's undertaking has provided over 40 per cent. of its capital expenditure as a hard cash reserve. Altogether, the results of the working of this undertaking seem very satisfactory, and the greatest possible credit should be given to the tramway manager and the committee for their unceasing effort to supply a suitable service. This service carried during the year 9,079,274 passengers, with a car mileage of 943,268 miles, using 1·36 units per car mile, with a total usage of 1,287,152 units. Few better results, considering all conditions, can be found.

CONCERNING EXHIBITIONS.

The opening of the great Franco-British Exhibition at Shepherd's Bush last week found the exhibition in a most incomplete state. There were, nevertheless, sufficient evidences available to indicate how vast and comprehensive it will be when full of exhibits. Our interest lies mainly in the engineering and machinery section, which on the opening day was in a very backward state. But we understand that much progress has since been made in the erection and equipment of the necessary buildings. As we mentioned in a previous issue, the electrical industry is not to be without its special display, and, thanks to the enterprise of the London supply companies, a fairly representative list of exhibits will be got together. The electrical section at the Shepherd's Bush Exhibition cannot fail to prove interesting and instructive, while as a means of educating the public in the uses of electricity it is bound to prove effective and to indirectly repay the supply companies and manufacturers for their outlay and labour. At the same time, it can hardly be claimed that the display will rank with equal importance in its bearing upon the industry as will the electrical exhibition to be held in Manchester in October, and which, we are glad to know, is receiving such strong support from the industry. These two exhibitions show that British manufacturers are not adverse to patronising exhibitions when they are well and influentially organised, and are likely to recoup exhibitors for their trouble and expense. There has been, and even is, an opinion that exhibitions are nowadays promoted and kept open less with a view to the furtherance of trade interests than with the object of attracting pleasure-seeking visitors and achieving financial success from the receipt of gate money, and the value of exhibiting as a means of obtaining direct orders for goods is materially diminished. But we think that the Franco-British Exhibition, and certainly the Manchester Exhibition, will tend to correct that opinion.

WIMBLEDON ELECTRICITY UNDERTAKING.*

BY H. TOMLINSON-LEE, A.M.I.E.E.

The Urban District Council of Wimbledon obtained from the Board of Trade in 1897 a provisional order for an electricity supply scheme in their district, and the supply for private and public lighting was inaugurated on July 17, 1899. In 1903 a further order, named the Wimbledon electric lighting extension order, was obtained, authorising the inclusion of the adjoining parish of Merton in the area of supply. The total extent of the combined areas is 4,985 acres, and the estimated population is 60,000. The consulting engineer for the original scheme, Mr. A. H. Preece, A.M.I.C.E., read a paper thereon before you in 1898. The author, therefore, does not propose to refer to the works as originally constituted, but to confine himself to a description of them as they at present exist.

System.—The high-pressure alternating-current, single-phase system of generation is employed. The high-pressure, or primary, voltage is 2,000 to 2,500 volts, the periodicity being 50 complete cycles per second. Transformer sub-stations for reducing this primary pressure to the low-pressure, or secondary, voltage of 220 and 240 volts for distribution, are built in different parts of the supply area. The author will refer more fully to the distributing system in another part of this paper.

Buildings. — The buildings consist of an engine-room of two bays, a boiler-house of two bays, offices, staff-house, stores, workshop, circulating-pump house, the refuse-destructor house, and tipping platform. With the exception of the original engine-room and boiler-house, now the

* Paper read at the Home Counties Meeting of the Incorporated Association of Municipal and County Engineers at Wimbledon on May 2.

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refuse-destructor house, which now form a very small part of the works, the whole of the buildings have been designed by Mr. C. H. Cooper, M.I.C.E., the borough surveyor, and erected under his superintendence. There are two chimneys, one 175ft. high from the ground level, with an internal diameter of 11ft., built on the Custodis principle, and the other 96ft. high from the ground level, with an internal diameter of 6ft. The offices are commodious and conveniently arranged, and the rooms over them are used for the accommodation of the members of the technical staff.

Engine-Room.—In the engine-room there are seven steam-driven alternators, particulars of which are given in the following table:

No.	KW.	I.H.P.	R.P.M.	Type of alternator.	Type of engine.	Exciter.
1	120	150	365	Crompton-Brunton, with revolving armatures	Willans three-crank compound	Direct coupled
2	120	150	365	Ditto	Ditto	Ditto
3	120	150	365	Ditto	Ditto	Ditto
4	350	550	333	Ditto	Ditto	Ditto
5	350	550	333	Ditto	Ditto	Ditto
6	625	900	300	British Thomson-Houston, with revolving field magnets	Browett-Lindley three-crank compound	Ditto
7	1,000	1,200	1,500	Ditto	Curtis vertical turbine	Separate motor-driven

The whole of the reciprocating engines—Nos. 1 to 6—exhaust into a surface condenser, situated in a pit at the end of the engine-room, having a cooling surface of 3,400 square feet, and capable of dealing with 35,000lb. of exhaust steam per hour. An oil separator and a grease extractor are installed in connection with this condenser. The condensed steam is discharged into the adjacent hot-well by steam-driven twin air-pumps and a monotype air-pump. The turbo-alternator has its own condensing plant, consisting of a Worthington surface condenser, having a cooling surface of 3,000 square feet, with a three-throw motor-driven air-pump, which discharges the condensed steam into the before-mentioned hot-well. There are two hand-operated overhead travelling cranes in the engine-room. That over the reciprocating sets has a lifting capacity of five tons, and that over the turbo-alternator has a lifting capacity of 15 tons. The main high-tension switchboard, mounted on a gallery at one end of the engine-room, is of a cellular type. There are seven generator panels, an interconnector panel, and 10 feeder panels, with the usual indicating and measuring instruments. The exciting switchgear is mounted in front of the generator panels. In connection with this main switchboard there are two sub fuseboards — fixed on the wall facing the 120-kw. sets—controlling the street-lighting circuits and the power circuits for the works and sewage pumping station.

Circulating-Pump House. — The circulating-pump house is situated at the rear of the workshop. It contains at present two centrifugal circulating pumps, each coupled direct to a 45-b.h.p. single-phase motor, the switchgear for which is mounted on a gallery above the pumps. The circulating water for the whole of the condensing plant is obtained from the River Wandle. It flows by gravity from the river to a well immediately underneath the circulating pumps. These pumps are capable of delivering 2,000 gallons of water per minute to the condensers, through approximately 140 yards of 22in. delivery pipe; the maximum pump suction is 9ft. 9in., and the total static head about 28ft. The circulating water, after passing through the condensers, returns to the river by gravity. A two-ton overhead travelling crane, operated by hand, traverses the circulating-pump house.

Boiler-House.—The boiler-house contains eight water-tube boilers having a total heating surface of 24,077 square feet. Three of these boilers—Nos. 1, 2, and 3—are hand-fired with Welsh coal, the remainder being fitted with Bennis patent mechanical stokers and compressed-air furnaces. These stokers are operated by motors through overhead shafting and belting. The coal used is Midland small nuts, having a calorific value of about 13,000 B.Th.U. There are two Green's economisers—one of 128 tubes connected with Nos. 4, 5, and 6 boilers, and one of 320 tubes connected with Nos. 7 and 8 boilers—three Weir feed pumps, and two Worthington feed pumps. Attached to the flues are two combustion recorders for recording the percentage of carbon dioxide (CO_2) in the flue gases. Since their installation the author has been able to detect and remedy various irregularities, with the result that the coal is now burned more economically. Coal is brought into the works direct over a siding from the main line of the L. and S.W. Railway. The trucks are hauled over a weighbridge and up on to a turntable at the workshop end of the overhead railway, which runs the whole length of the boiler-house between the two lines of boilers. The coal is deposited on the floor under the railway, and fed into the stoker hoppers by hand. The gases from Nos. 1, 2, and 3 boilers are carried off by the small chimney, and those from the other boilers are carried off by the main chimney.

Water-Softening Plant.—Adjoining the main chimney is a water-softening and storage plant. The softener is capable of softening continuously 4,000 gallons of water per hour, the process being as follows: The water to be softened is pumped from the circulating-pump house well by a Worthington turbine pump direct-coupled to a single-phase motor to the softening tank, where it is mixed with the soda softening reagent and clear lime-water. From this tank the water passes to a precipitation chamber, then through a wood-wool filter, and finally, before being discharged into the storage tank, it passes through a quartz sand filter, which removes all finely suspended matter. The whole of the softening and filtering system is contained in the tower alongside the storage tank. The initial hardness of the water is about 24deg., which is reduced by the treatment to about 8deg. at a cost of approximately 4d. per 1,000 gallons. The storage tank has a capacity of 30,000 gallons.

Workshop.—The workshop adjoins the boiler-house, and is immediately under the coal-hauling platform. The author has installed an equipment of machine tools electrically driven through overhead shafting. The whole of the mechanical repairs are carried out in this workshop.

Stores.—The stores are situated under the tipping platform and adjacent to the refuse destructors. They are very complete, a good stock of spare parts for the various machines in the works being kept.

Refuse Destructors.—The refuse destructors are of the Beaman and Deas top-feed type. They consist of four cells connected to two water-tube boilers having 3,580 square feet of heating surface. The maximum capacity of these destructors is 21,000 loads of house refuse and 2,700 loads of sludge cake per annum. Forced draught is obtained by means of a centrifugal fan driven by a small steam-engine. It was originally intended that the steam raised in the boilers attached to these destructors should be used for driving the engines in the electricity works, but after about two months' running this was found to be impracticable, and the cells were shut down, the boilers being hand-fired with Welsh coal. In 1902, in consequence of the removal of the original coal-fired boilers from the destructor house, the author was enabled to effect some much-needed improvements in the destructor cells, and they were again set to work on June 1 of that year. The steam raised was used for driving the engines of the sewage-pumping station, and at present it is employed for heating the isolation hospital and driving the machines installed there.

Distributing System.—The distributing system is very extensive. High-pressure mains run from the works to the main sub-stations, and from these main sub-stations to the minor sub-stations. The whole of these high-pressure feeders are interconnected. The current is transformed in the sub-stations to a pressure of 220 volts for private and 440 volts for public supply. The high-pressure mains are concentric, paper insulated, and lead covered. They are drawn into stoneware conduits, each cable being isolated.

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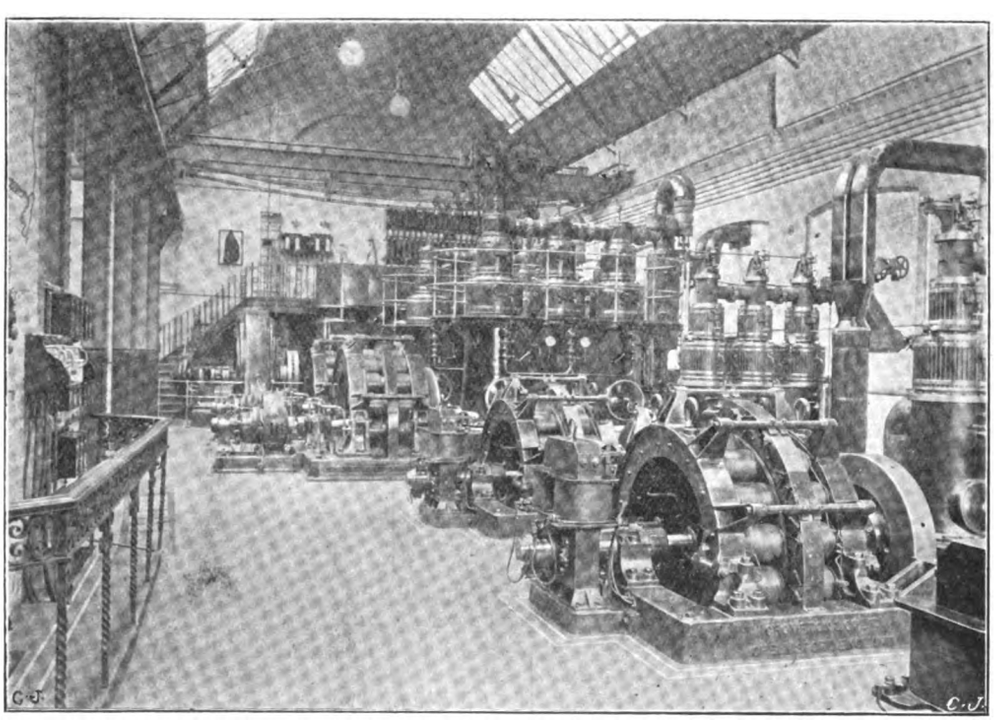
The private lighting low-pressure cables are concentric, paper insulated, lead sheathed, and armoured, and they are laid direct in the ground. The public lighting low-pressure cables are three core, vulcanised indiarubber, lead sheathed, and armoured, and they are laid direct in the ground.

Electricity Works and Sewage Pumping Station, Wimbledon.

A pressure of 440 volts is maintained between the outer conductors. The house service cables are twin, paper insulated, lead sheathed, and armoured, and the public lamp service cables are twin vulcanised indiarubber, lead sheathed, and armoured. The total mileage of mains laid to date is as follows : high-pressure mains for private and public supply, 45·3 miles ; low-tension private distributing mains, 78 miles ; low-tension public lighting mains, 48 miles ; low-tension private and public lighting service cables, 27·6 miles—total, 108·9 miles. There are 28 sub-stations, both under and above ground, and six transformer pits, with a total capacity of transformers installed of 2,455 kw., the average capacity of each sub-station being 83 kw., and of each pit 21 kw. The present capacity of the largest sub-station is 225 kw. The author has redesigned and enlarged practically the whole of the sub-stations. They are now up to date, and comply with the regulations of the Home Office and the Board of Trade. In order that the engineer-in-charge at the works may be cognisant at any time with the private lighting low-tension pressure in the various parts of the supply area, 15 of the principal sub-stations have recently been connected with the works by means of a system of pilot wires. These wires are brought to a central point in the engine-room, and there connected with 15 voltmeters, one for each sub-station. These voltmeters are fitted with recording charts, which are renewed every 24 hours, and indicating scales.



Engine Room, Electricity Works, Wimbledon

Public Lighting.—The public lighting system is entirely separate from the private lighting system, the mains being

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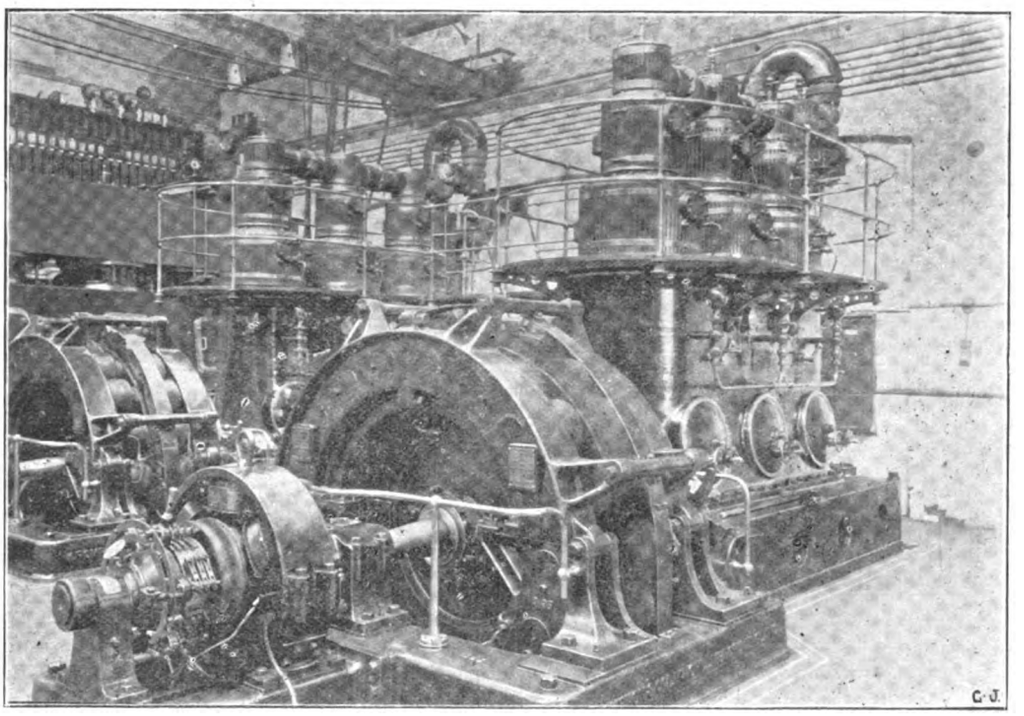
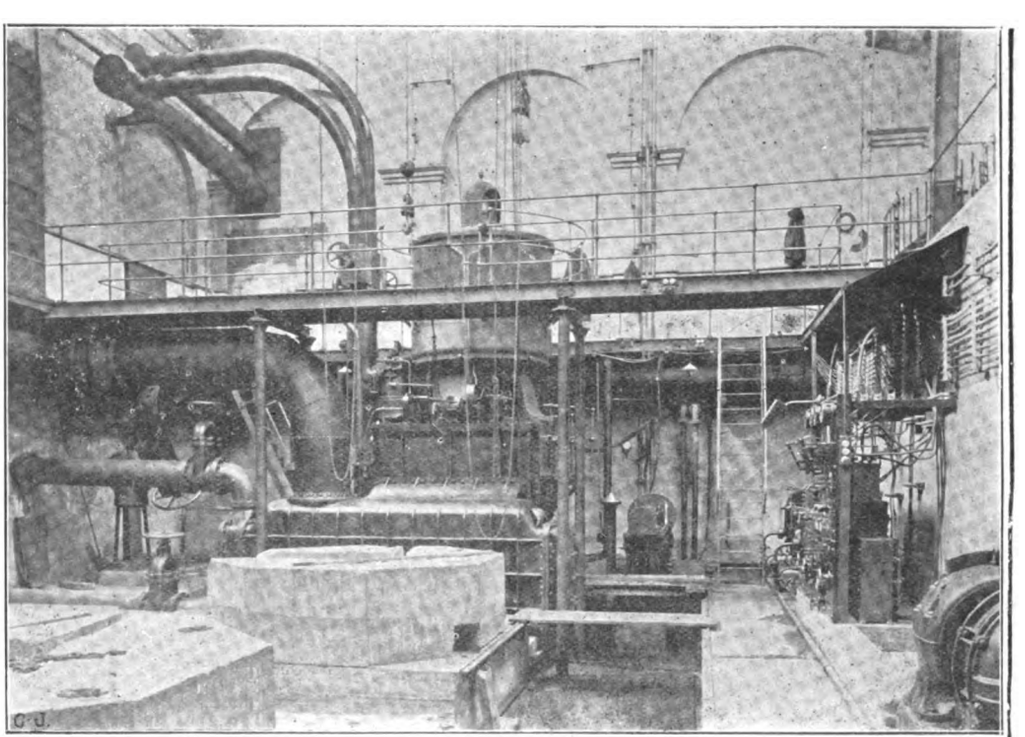
"dead" during the day. The whole of the lamps are controlled from the works, being switched on simultaneously in the following manner: The public lighting feeder is switched in on the main switchboard, a separate alternator being then run up on it; when up to the proper speed and pressure, this alternator is paralleled with the other machines running on the private lighting load. When the public lighting is switched off, this operation is reversed, the alternator being separated from the private-lighting machines, and then gradually shut down. All the main roads and important cross-road junctions in Wimbledon are lighted by 98 flame arc lamps, each giving approximately 2,700 c.p., and consuming 500 watts per hour. The side roads are lighted by incandescent electric lamps, there being 1,036 posts, with two 16-c.p. lamps in each lantern. Forty-three hot-wire Foster arc lamps giving approximately 1,200 c.p., and consuming 600 watts each, have been erected on the Ashen-grove estate, a part of Wimbledon which is being rapidly developed. Each lamp is protected by its own fuses. Experiments with metallic-filament lamps for side street-lighting have been carried out. The results obtained with the Osram lamp have been very satisfactory, and it is probable that the whole of the side streets may eventually be lighted by them. The charge for street-lighting is 2¼d. per unit, which includes attendance and cleaning. The total charge for the past year was £5,994. 15s., or approximately £5. 11s. 10d. per post.



Engines, Electricity Works, Wimbledon.



Extensions, Electricity Works, Wimbledon.

Commercial Statistics.—The annual accounts of the undertaking afford striking proof of its phenomenal success, and the author trusts the analysis of the yearly returns as shown in Table A will prove interesting. The net profit earned by the undertaking to March 31, 1907, has been apportioned in the following manner:

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TABLE A.

Year.	Capacity of works in kw.	Capital expended.	Total revenue.	Total expenditure.	Profit or loss.	Units generated.	Units sold. — Private.	Units sold. — Public.	Average price obtained per unit sold.	Total cost per unit sold.	Number of consumers.	Private 8-c.p. lamps connected.	Public lamps. — Arc.	Public lamps. — Incandescent.	Max. load in kw.
		£	£	£	£										
1900*	360	41,004	2,671	3,711	1,040 –	181,401	100,613	53,629	4·05	5·69	253	13,965	—	554	198
1901	360	57,703	9,508	9,374	134 +	724,028	229,117	415,304	3·48	3·30	459	24,051	—	903	367
1902	1,060	85,963	13,239	11,881	1,358 +	889,027	360,269	446,011	3·86	3·22	705	33,504	—	1,025	510
1903	1,060	100,201	15,472	13,444	2,028 +	1,157,084	500,846	511,152	3·57	2 98	978	50,170	4	1,087	603
1904	1,060	115,746	18,640	15,700	2,940 +	1,283,060	653,305	539,673	3·65	2 98	1,254	64,158	6	1,104	772
1905	1,685	136,099	20,619	17,776	2,843 +	1,499,958	801,459	507,769	3·65	3·25	1,625	78,194	42	1,059	1,012
1906	1,685	152,538	22,084	21,745	†338 +	1,801,075	933,880	617,670	3·34	3·14	2,011	91,971	43	1,077	1,050
1907	2,685	169,682	24,230	20,776	3,453 +	2,084,434	1,152,695	611,208	3·26	2·81	2,551	119,291	62	1,081	1,311
1908	2,685	180,514 (Est.)	29,236 (Est.)	25,630 (Est.)	3,606 + (Est.)	2,819,317	1,732,560 (Est.)	639,440	2·96 (Est.)	2·59 (Est.)	3,087	137,200	141	1,036	1,548

* Eight months. † After deduction of accrued interest to end of financial year amounting to £1,351. 9s. 7d.

Applied to the relief of local rates	£4,350	7	5
Placed to the credit of a reserve fund	6,621	18	1
Transferred to a suspense account to await allocation...	2,123	10	2
Total	£13,095	15	8

System of Charging.—The present charge for electricity supplied to all consumers for lighting purposes (including that supplied to religious and charitable institutions, public buildings, etc.) is:

	Per B.T.U.
(*a*) For all units consumed up to but not exceeding 400 units per quarter	4½d.
(*b*) For all units consumed in excess of 400 units but not exceeding 800 units per quarter	4d.
(*c*) For all units consumed in excess of 800 units per quarter	3½d.
The present charge for electricity supplied for power (up to 2 h.p.) and for cooking, heating, or other special purposes when installed on a separate meter is	2d.
The present charge for electricity supplied for power (2 h.p. and upwards) when installed on a separate meter is	1½d.

In any case where small motors, cooking apparatus, heaters, etc., are installed requiring less than 220 watts, energy will be supplied only at lighting rates. The charge for hire of a meter is 1s. per quarter, except in the case of a consumer whose account for energy supplied during any quarter amounts to 5s. or upwards per meter, when no charge is made.

Extensions.—The following extensions will be carried out during the present year: The generating machinery will be increased by the addition of a 1,000-kw. turbo-alternator with condensing plant. A main high-tension, remote-control switchboard, having nine machine panels, an interconnector panel, 16 feeder panels, and exciting gear; two water-tube boilers with chain-grate mechanical stokers, Weir feed pump, and an economiser of 320 tubes, will also be erected. The total cost of these extensions is estimated at £17,600, and they will be carried out in accordance with the specifications of the author, and under his superintendence. A new and modern refuse destructor is also to be erected on a site adjoining the railway siding, but distinct from the electricity works. The plant will be of the back-feed type, and will be capable of destroying 84 tons of refuse and 28 tons of sludge cake per day of 24 hours. It will be erected in accordance with a scheme prepared by the borough surveyor, Mr. C. H. Cooper, and the author, and the estimated cost, including a chimney 180ft. high by 8ft. internal diameter, will be £9,750.

Curtis Turbine.—In view of the increasing interest in turbo-generating plant, the author hopes the following brief description of the Curtis vertical turbine at the works will not be out of place. The turbine is of the three-stage type. The first stage contains three sets of revolving buckets, the second and third stages two sets each. In each stage the bucket rings are bolted in a single cast-steel disc. There is one shaft, which serves for both the turbine and the alternator. Between each stage is a diaphragm, and on them are fixed gunmetal packing sleeves, grooved on the inside; also where the shaft passes through the first stage, a packing consisting of three carbon rings, each made up in three segments and held together and against the shaft by a garter spring, is inserted. No packing is required at the bottom, or low-pressure, end of the shaft, as the step-bearing water is discharged into the steam space. No by-pass valves are provided in any of the stages. With steam at a pressure of 150lb. per square inch, superheated to about 125deg. F. and exhausting to a vacuum of 1lb. absolute pressure, the pressure in the various stages is approximately as follows:

First stage.....	35lb. per square inch above atmosphere.
Second stage ...	vacuum 20in.
Third stage.....	vacuum 28in.

The step bearing consists of plain cast-iron blocks, the upper one being fixed on the end of the shaft. The lower block is supported on four gunmetal screws, geared together and operated from the outside by a pair of chain wheels and a chain. The water pressure in the step bearing is about 225lb. per square inch at full load. Four to five gallons of water per minute are required to lubricate this bearing, while the guide bearings require about three gallons of oil per minute. This oil is returned to a cooling tank, and is used over and over again. The average total clearance between the stationary and moving parts of the turbine is about 0·13in. The turbine is fitted with hydraulic controlling valve gear. It consists of a hollow piston valve working inside a liner, around the circumference of which passages are cored communicating with the various sections of the first-stage nozzles. These passages have openings into the interior of the liner, and the piston valve, which is actuated by a hydraulic ram, in moving up or down, uncovers or covers these openings in succession, thus regulating the number of first-stage nozzles in action. The ram is operated by water at the foot-step bearing pressure, and is controlled by two small pilot valves operated by the governor. An emergency valve is placed on the top of the liner. It is of the mushroom type, so arranged as to be able to immediately cut off steam from the turbine. It is normally held open by steam pressure on the underside of a small piston on the valve spindle, the upper side of which is connected to the exhaust. In this position it compresses a strong spring, which closes the valve when equality of pressure is obtained on both sides of the piston, by the admission of steam to the upper side of this piston through a small pilot valve. This emergency valve is alway fully open when the turbine is up to full speed and the controlling piston is at its lower or no-load position. To prevent a sudden demand of water for the foot-step bearing operating gear robbing the step blocks of lubricant, a spring-loaded ram accumulator is provided. It is connected to and supplied by the foot-step bearing supply pump.

THE "MERSEY" DYNAMO WORKS, STOCKPORT.

Lancashire mills and mines have during the past few years provided a very steady demand for electrical machinery, and manufacturers within the County Palatine have been to the fore in meeting it. We were recently afforded an opportunity by Messrs. McClure and Whitfield of inspecting their "Mersey" Dynamo Works at Adswood. These works, although only covering a few acres of ground,

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are of modern design, excellently equipped, and account for a very large annual output

large volume of this class of work. In course of erection are three 120-kw. slow-speed generators for supplying

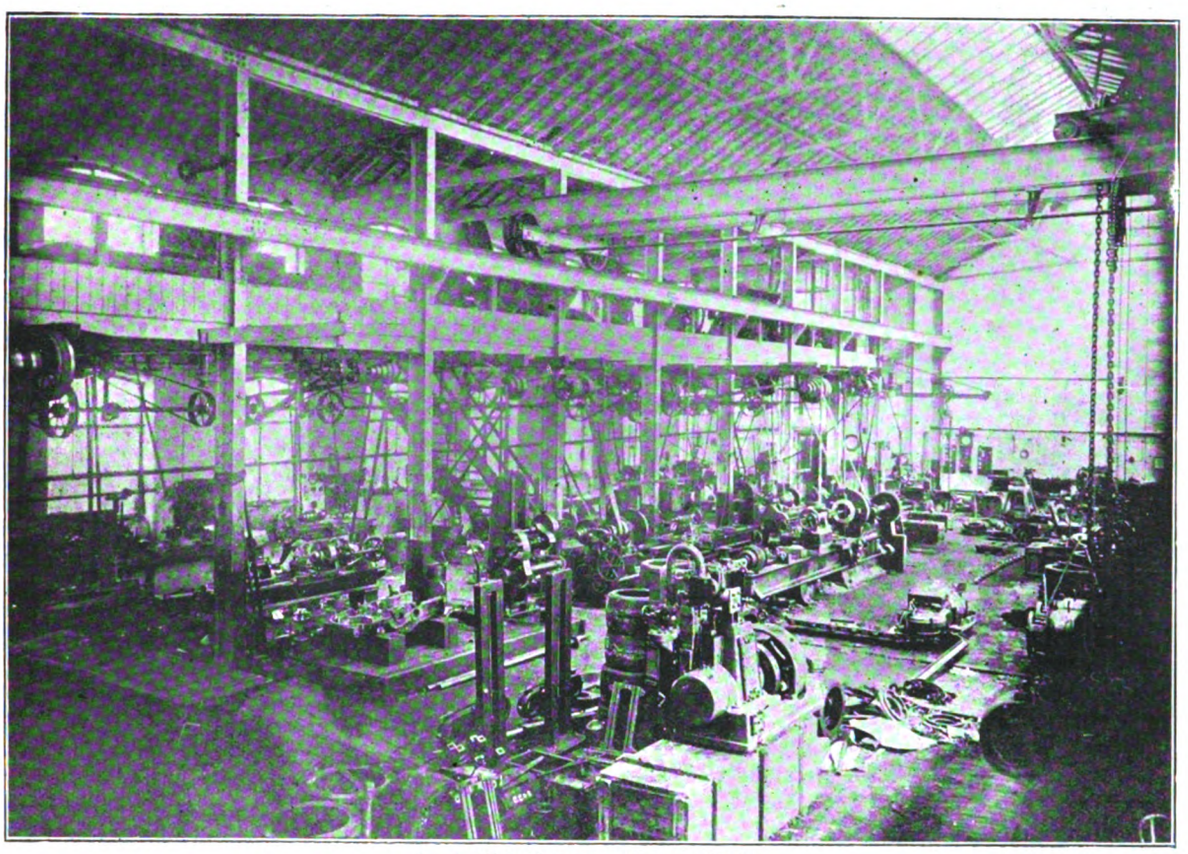

FIG. 1.—Main Shop, Mersey Dynamo Works.

Among the various applications of electric power to industrial purposes, which are constantly increasing on account of the adaptability of electric motors to the most

current to 60 electric motors which are also going through their various stages of construction, and will ultimately be destined to drive doubling machinery. The motors, we

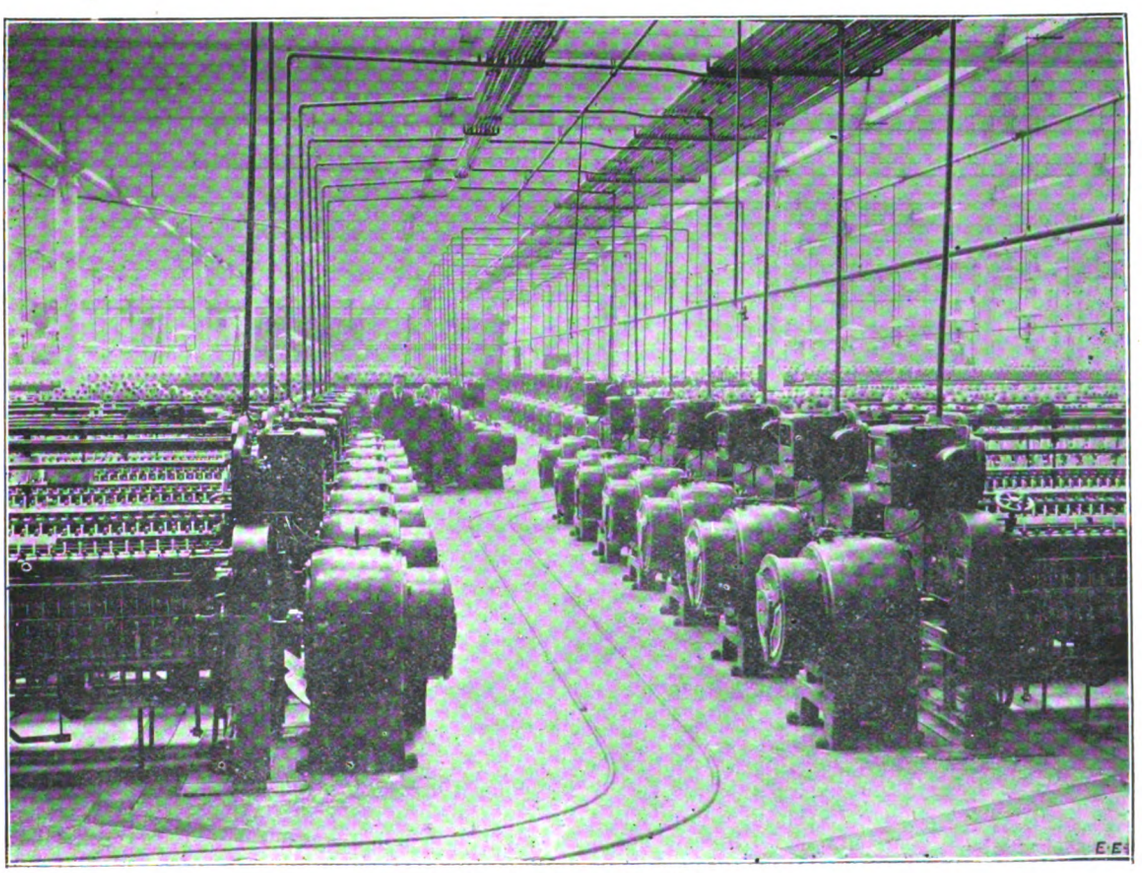

FIG. 2. Motors driving "Doubling" Frames.

varied conditions, the individual drive of ring spinning and doubling frames is particularly interesting, and an inspection of their main shop (Fig. 1) brings before our notice a

notice, are up to date and have been specially designed for the purpose for which they are required. In looking into details of construction we find that these machines are

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fitted with ball bearings, and that special attention has been paid to commutation to ensure sparkless running, which is very essential for mill work. Figs. 2 and 3 show a number of motors recently made and installed in a Lancashire cotton mill by Messrs. McClure and Whitfield.

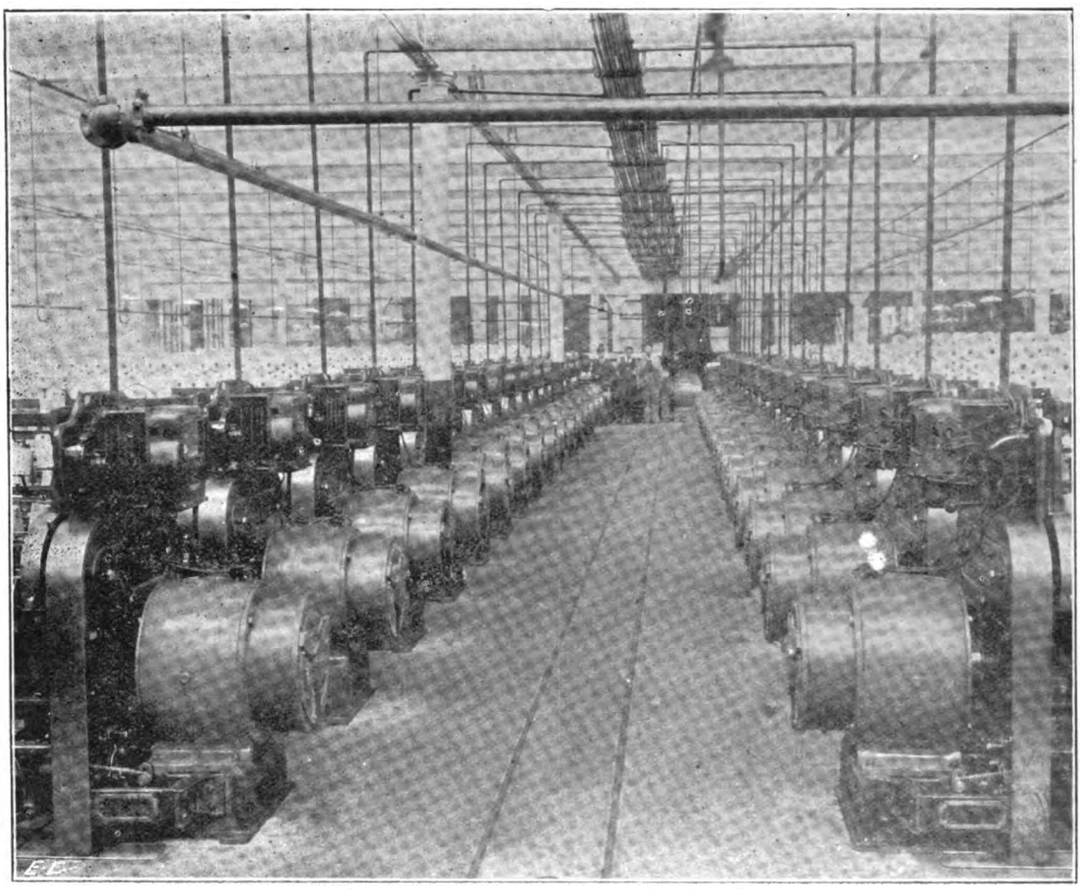

FIG. 3.—Another view of Motors driving "Doubling" Frames.

factory and private house lighting. Two 50-kw. generators are to be driven by Alley and Maclellan high-speed engines, whilst another of 80 kw. output is coupled to an Allen engine, and our illustration (Fig. 4) shows this combination just received from the test bed. Fig. 5 illustrates a standard belt-driven generator for outputs of 60 kw. and upwards. We must not omit to mention their standard heavy-type motors for use in collieries, shipyards, iron-works, etc., as illustrated in Fig. 6

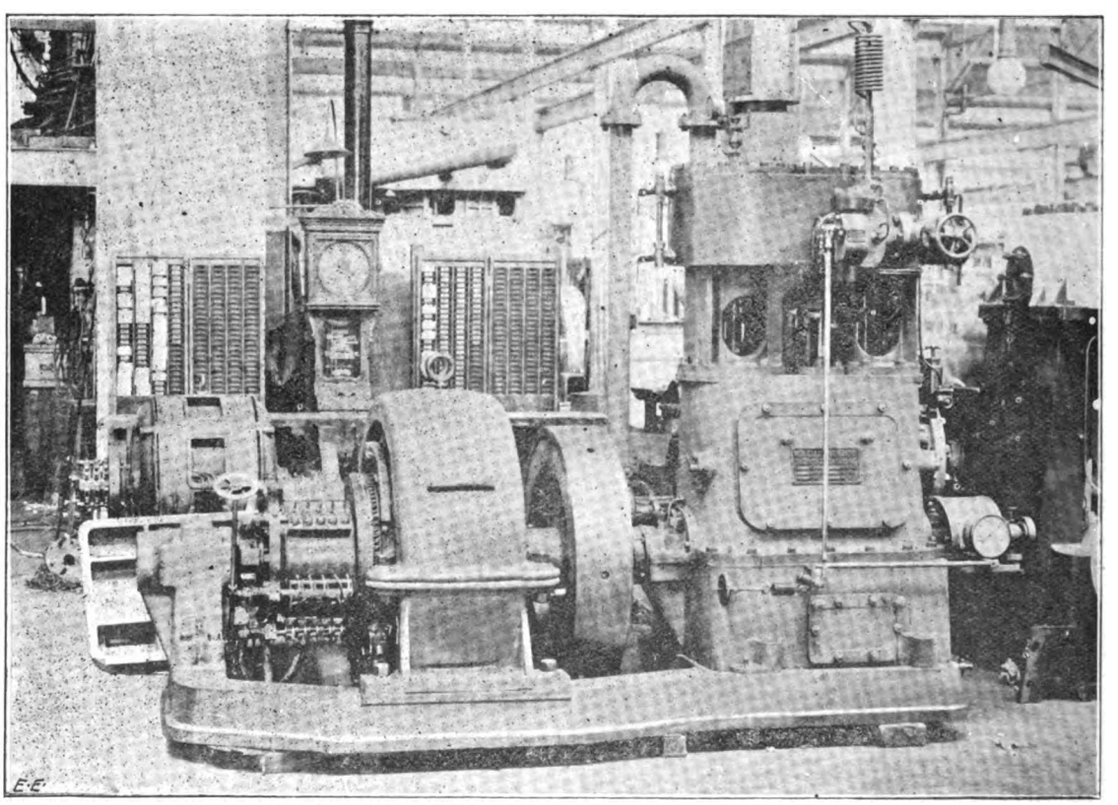

FIG. 4.—A "Mersey" 80-kw. Generator direct coupled to "Allen" Engine.

Several finished motors from the test bed arranged for direct coupling, and fitted with ventilated end covers, are ready for dispatch, and present a very sound and neat appearance. The rest of the plant in hand is mostly for

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A further inspection of their works reveal a number of machines used for coal cutting. The firm have made a speciality of manufactures for underground work, and the

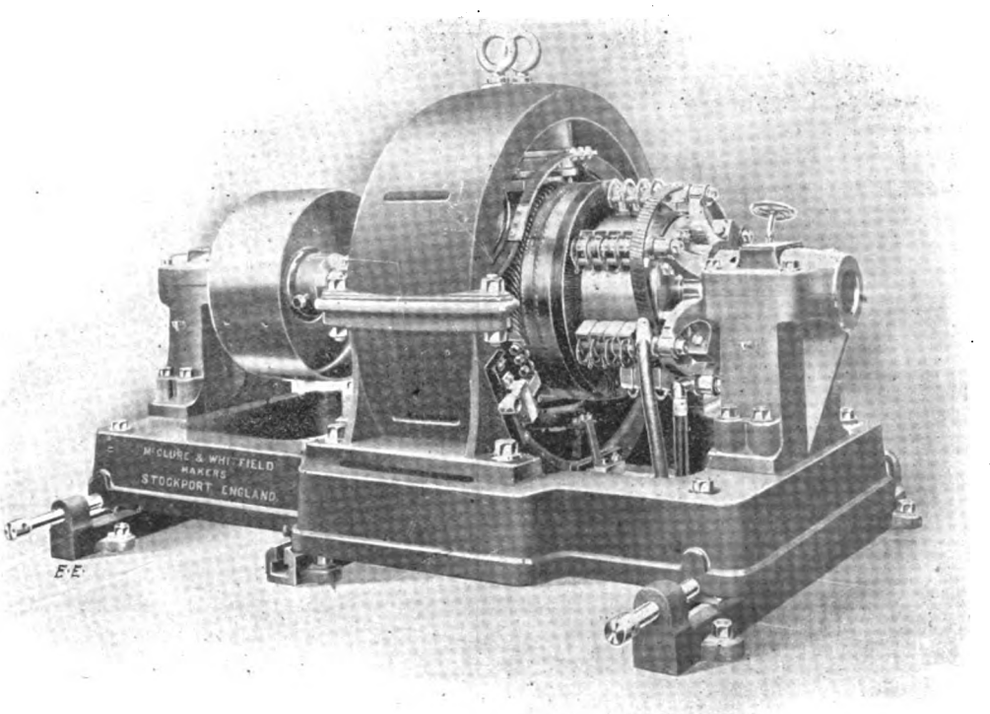


FIG. 5.—Standard Type Belt-Driven Generator for outputs varying from 60 kw. upwards.

machines they make are the outcome of long and intimate acquaintance with the practical difficulties which have to be faced in mining work.

Whilst being actual manufacturers, Messrs. McClure and Whitfield pay great attention to repair work, and in this department we find a very busy staff of workmen who are

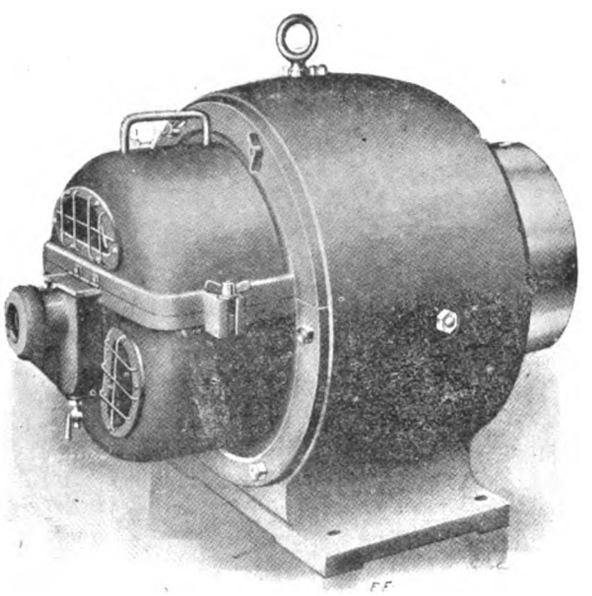


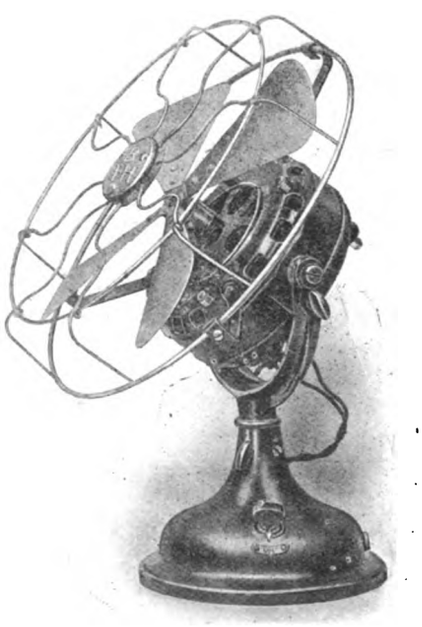
FIG. 6.—Standard Colliery Type Motor.

experienced in this class of work, and every facility for immediate execution and dispatch of this class of work

ELECTRIC FANS.

Certain fundamental principles determine the general design of a fan motor, but the application of these principles offers a wide field for inventive genius and manufacturing skill. This fact must be patent to anyone who has noticed the design of the various types of fan motors now on the market, some of which were described in an article which appeared in these columns last week. In the present article we propose to deal with another batch of fan motors which has been brought to our notice.

The well-known B.T.H. fan motor adheres to principles that previous fan-motor models and larger electrical



Alternating-Current Fan, Swivel and Trunnion Frame (B.T.H. Co.).

machinery of the British Thomson-Houston Company, Limited, have shown to be correct. Their continuous-current fan motors have elliptical bodies. The bearings are carefully proportioned and are lubricated from oil-cups of a special design, oil being fed to the bearings by a wick pressed against the shaft by a light spring. A shield surrounds the outer bearing and projects over the inner end of the fan hub, and two grooves in the hub prevent the oil from reaching the fan. The commutator is also protected by a light shield which may be removed to permit examination of the brush-

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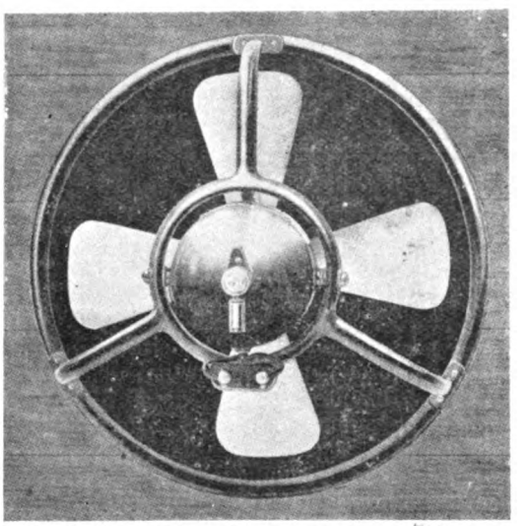
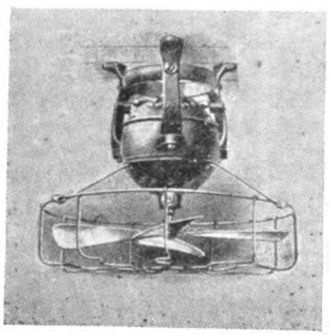
holders and commutator. We illustrate an alternating-current fan motor. As the design for the B.T.H. alternating-current fan motor requires no moving contacts, the construction is extremely simple. A cast-iron frame, an armature of laminated soft iron with bare copper conductors, field coils on a laminated iron field frame, and a regulating device make up the practically indestructible alternating-current fan motor. That illustrated is convertible from desk to wall bracket by the use of an angular adapter. A positive notched clamp secures the motor to the trunnion, and set screws are provided for clamping the



Continuous-Current Exhaust Fan (British Thomson-Houston Co.).

motor in any position. Considering its convenience as well as its many advantages, the cheapest method of ventilating is by means of electrically-driven fans. The great flexibility of the electric motor in running at different speeds, its noiselessness, small compact size, and ability to operate with the minimum of attention, recommend it particularly for this class of work. To meet an ever-increasing demand, the British Thomson-Houston Company have introduced a line of small and compact exhaust fans, which are being largely used for ventilating purposes in private residences and apartments, as well as in public and business buildings. They are made in two sizes, with 12in. and 16in. fans, for both continuous and alternating current.

The Sun Electrical Company, Limited, 118 and 120, Charing Cross-road, London, W.C., are this year intro-



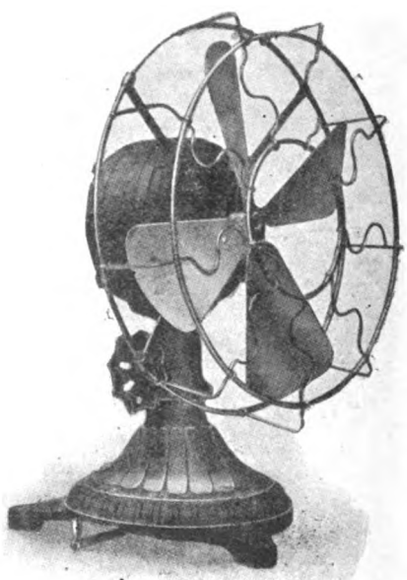
"Cabin" Fan (Sun Electrical Co.).

ducing one or two patterns of fan motors which have not hitherto been described, and we regret that we could not see them in time for a description in this issue. They are experiencing a very large demand for their box-blade type power fans both for continuous and alternating current, which are made in sizes from 12in. to 60in. Apart from this, their supplies for the present season do not differ very much in design from previous years' supplies. This is not surprising considering what a large measure of success the Sun Electrical Company, Limited, have obtained with these patterns, which certainly renders it unnecessary to introduce any alterations other than a few minor improvements. Of course, fans are supplied for all purposes. An interesting little device is the cabin or low ceiling fan. These fans have been specially designed for ships' cabins or other positions where little headroom is available. They consist of desk fan motors fitted with tripods for attaching to ceiling.

The electric punkah fan shows a very distinct departure from the ordinary type of fan, the motor being entirely hidden from view by the handsome Oriental repoussé bowl. The punkah fan can also be supplied without this, and fitted with down rod and ceiling plate if required. By the use of a 12in. blade only, quite as far-reaching an efficiency is obtained as that of a 60in. ordinary wing blade. Such a type of fan is illustrated to show the deflecting blades.

The Punkah Electric Fan (Sun Electrical Co.).

Messrs. Veritys, Limited, are large makers of various types of fans (which are made throughout by them), including the propeller blade ventilating fans, ceiling fans for India and for ship work, cabin fans, train fans, also motor-driven blowers, of which latter they have just completed 400 for the British Admiralty. In addition, they make the "Typhoon" table fans. The "Typhoon" alternating-current fan motor is a self-starting alternating-current induction motor with stationary field and short-circuited armature. The magnetic circuit of the stator consists of laminated high-permeability steel stampings insulated from each other. These carry four former-wound and well-



"Typhoon" Table Fan (Veritys Limited).

insulated coils. A slotted type of armature, built up of high-permeability steel sheets, is employed. The spindle is made of hard steel accurately turned on the bearing portion. Grease lubricators are fitted to the bearings, thus enabling the fan to run for long periods without any attention. The blades and guards are of polished brass lacquered, and the pedestal and body are enamelled black unless ordered otherwise. These fans are similar to those which they supply to the Admiralty. It will be noticed

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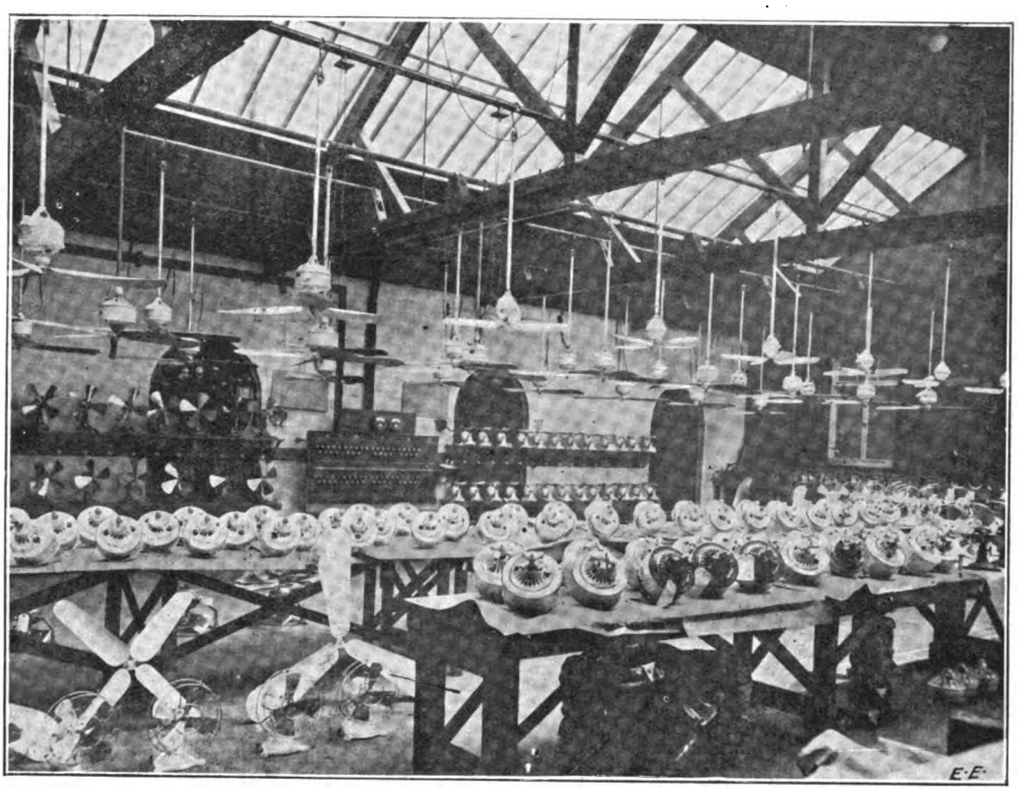
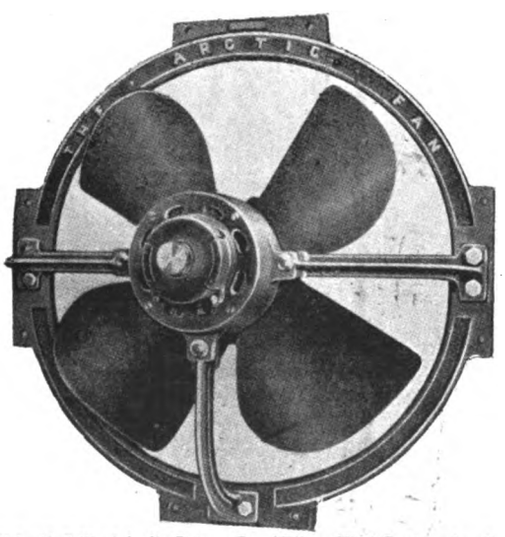
that each fan can be used as a desk, wall, or ceiling fan at the will of the user.

The "Arctic" propeller fans, manufactured by the Wilson-Wolf Engineering Company, Limited, Thornton-road, Bradford, have been partly redesigned for the 1908 season, and contain many new improvements. The fans are now made, in addition to electric drive, for belt driving. The new



View of Veritys Fan Test-Room with a number of Ceiling and other Fans.

propeller type of blade, evolved after many tests and experiments, has a very high efficiency, and exceeds the old-fashioned box type of blade in air-moving capacity by 30 to 70 per cent., according to size. The shape of the fan suggests the ship's propeller, and its peculiar depth, combined with the particular shape and curve, results in the high efficiency and capacity. There is still a prejudice, however, in favour of the box type of blade in certain



"Arctic" Electrically-Driven Fan (Wilson-Wolf Engineering Co).

quarters, and it can be fitted to this type if desired. The motors in the belt-driven fans are bolted to the frames of the fans by three T arms, which combine great rigidity and strength with the minimum resistance to the passage of air. The peculiar construction of the fan blades, and the method of fixing to the motors, ensure great steadiness of running, freedom from vibration, and silence. It will be found that the "swish" of air characteristic of ventilating fans is entirely absent in fans of this design. The motors are exceedingly compact, the frames being of cast iron of circular pattern. In the 12in. and 15in. sizes the motors are totally enclosed, and the sizes 18in. and upwards are usually made enclosed ventilated, and fitted with hinged doors over the commutators. They are series wound in all sizes, two polar up to size 24in., with the poles cast solid with the frame, and four-polar above that size, fitted with cast-steel poles of high permeability. All sizes have former-wound armatures, and all windings undergo treatment by a special process, making them absolutely impervious to moisture. Burnt-out armature and field coils are practically unknown. The commutators are made of the best hard-drawn copper, assembled under hydraulic pressure with best white India mica, and mounted on the socket between shaped micanite rings. The brushes are of carbon, feeding radially, and are easily accessible on raising the hinged covers.

A special feature of the fans is the combined thrust and journal ball bearing, fitted at the commutator end, which takes the thrust in either direction, in addition to the journal weight. This bearing runs in grease, and is enclosed in a brass cap, which screws into the nose of the end shield, and contains the grease. The other bearing runs in an ordinary gunmetal bush, and is fitted with a "Stauffer" lubricator. This arrangement does away entirely with the necessity for fitting an arm on the opposite side of the fan when required to feed the air in the opposite direction, or when the fan is fixed in a ceiling with a motor above the blade. It also enables the fans to run for lengthy periods without attention.

U.S.A. GOVERNMENT WIRELESS CONTROL.

The reports of the U.S.A. War and Navy Departments and the Department of Commerce and Labour on the international wireless telegraph convention signed at Berlin, Nov. 3, 1906 were sent to the Senate by President Roosevelt on April 25. All three departments recognise the necessity for some rules governing the exchange of aerial messages and applaud the convention. The need is urgent, for the reason that there are said to be in the United States 97 wireless shore stations. Of these 40 are operated by the navy, 16 by the army, and 41 by private concerns. A Bill is now under consideration by Congress providing for rigid Governmental control of wireless communication and fixing penalties for private persons who interfere with Government messages or indulge in "fake" messages.

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RECENT PROGRESS IN TUNGSTEN METALLIC FILAMENT LAMPS.*

BY H. HIRST, MEMBER.

During the past few years a great deal of attention has been paid both by chemists and electrical engineers to the construction of metallic-filament lamps for incandescent electric lighting. Ever since the advent of the Nernst lamp with its oxide filament, chemists, scientists, and lamp-makers have felt instinctively that the supremacy of the carbon-filament lamp was seriously challenged. The efforts made have been attended with more or less success, yet it may be news to a large number of electrical engineers of the younger generation that the metallic-filament lamp is one of the oldest forms of electric lighting. In fact, incandescent electric lighting commenced with metallic-filament lamps, platinum being the incandescent body. Such lamps were made long before the Edison or the Swan carbon filaments were invented. Several inventors worked on these lines, and Edison especially endeavoured to perfect a lamp in which a thin platinum wire raised to white heat by the current formed the illuminating body. These lamps were, however, never a commercial success, because the melting point of platinum is only slightly higher than that temperature to which it has to be raised for the economical production of light. In consequence the life of the filaments was short, and the slightest increase in the voltage, which was extremely difficult to prevent in those days, was sufficient to melt the filament. Attempts were made to overcome this defect by automatic arrangements to cut out the lamps should the voltage rise to a point likely to melt the filament. Even in 1880 we find Edison (U.S. Patent No. 227,229, 1880) trying to further improve the platinum lamp. Maxim (U.S. Patent No. 247,380) in 1881 describes and claims a thermo-regulator designed to prevent the overheating and consequent melting of the platinum filament. In the same year Maxim (German Patent No. 13,383, 1881) described a process of producing carbon bodies for illuminating purposes which were flashed in carbonaceous vapours with a view of improving them.

It was in 1881 that the carbon-filament lamp came to the front and stopped the researches and experiments in connection with the perfection of the then existing metallic-filament lamps. It was only after a lapse of nine years that the next American patent dealing with a new metallic-filament lamp made its appearance—this was the Poland Patent No. 432,710, of 1890, for the iridium lamp. There were two predominant reasons for the immediate success of carbon as an incandescent lamp filament: (1) It could not be melted, and in this respect had an enormous advantage over any of the then known metals. Platinum had at that time the highest melting point of any of the then available metals which could be made into a thin wire, but this temperature is much lower than that which a carbon filament will stand for a prolonged period in a vacuum. (2) Carbon has also a very high specific resistance as compared with any of the metals then available. The question of the distribution of current was at that time of great importance, and it was even then recognised to be a difficult problem to distribute large currents at a low pressure over a considerable area.

Due to its high specific resistance carbon was found to be a most suitable material from which to produce illuminating bodies to be incandesced by a small current at a high voltage. When first introduced the carbon-filament lamps were made for circuits of 50 to 60 volts, but improvements in manufacture soon increased the standard to 110 volts. The bulk of the pioneering work in central-station supply was carried out at this voltage, but it was found that as the distribution networks were extended over large areas the great cost of attaining constant voltage was hampering the spread of electric lighting. The mains absorbed such a large proportion of the total capital outlay of a supply system that it was found necessary to raise the pressure of distribution in order to keep down the cost of electrical energy to a reasonable figure. The three and five wire continuous-current systems invented by the late Dr. John Hopkinson, and the high-pressure alternate current with step-down transformers, helped to extend the period during which 110-volt lamps could be used. In spite of these means of reducing the cost of the distributing networks and feeders, the engineers of the electric supply companies and of the municipal authorities encouraged the incandescent lamp makers to develop higher voltage lamps. As a result the 200-250-volt lamps made their appearance in the early nineties, and by the middle of that decade were adopted commercially. Although these lamps were not as efficient as those for the lower voltages, they saved so much in the cost of distribution that the supply companies were able to reduce the cost of electrical energy to those consumers using them. These lamps have since been so far improved in efficiency as to meet all requirements, and they were officially recognised by the Board of Trade Regulations issued in 1901, which enabled the supply undertakers to enforce their use on all consumers.

* Paper read before the Institution of Electrical Engineers.

Some Recent Inventions and Developments in the Metallic-Filament Lamp.

When the carbon incandescent lamps were first introduced they had to compete with the flat-flame gas burners, and a glance through the earlier estimates of the comparative costs of electric and gas lighting shows that these gas burners were then considered as the standard illuminant. With the high price of electricity it was the very great convenience, beauty, and safety of the carbon lamp which enabled electric lighting to make the progress it did. As this price of electricity was lowered with extended use, the carbon lamp had to face a much stronger competitor. The incandescent gas mantle invented by Auer von Welsbach suddenly reduced the cost of gas lighting to one-third of what it had been before. Electric lighting has survived this blow and made progress, but this progress during the last 10 years has been severely handicapped by the cheapness of incandescent gas lighting. It is worthy of note that a considerable number of gas engineers considered that Welsbach mantles would ruin their undertaking because they reduced the consumption of gas for a given amount of light by one-third. Sufficient time has now elapsed to show how absurd their prophecies were. It is of far greater interest to electrical engineers to know that Auer von Welsbach by his invention of the osmium lamp has removed the handicap which he placed on the electrical industry. Thus, what he has taken away with one hand his inventive genius has enabled him to return with the other. The existence of incandescent gas lighting has not only had a damaging but also a stimulating influence on the development of electric lighting. The quiet peculiar radiation of the incandescent gas mantle, which, as is well known, consists of thorium oxide containing 1 per cent. of cerium oxide, has been the subject of numerous researches which have furthered the purely theoretical knowledge of radiation. Very careful experiments, especially the now famous investigations of Lummer, have shown that bodies exist which at the same temperature radiate as light a larger percentage of the supplied energy than the so-called "black bodies." The Welsbach mantle owes its high efficiency to this property.

The success of these oxides of the rare earths in gas lighting led to their application to electric lighting, as has been done in the Nernst lamp. The first English patent for this lamp was applied for by Nernst on Aug. 23, 1897 (British Patent No. 19,427, 1897), and in one of the claims it is stated that: "A body of magnesia, zirconia, or suitable rare oxide is heated to incandescence by a Bunsen gas flame or otherwise, and is then kept incandescent by the passage of electric current through it." It is interesting to note that Nernst was endeavouring to dispense with the vacuum, which, of course, would have been an eminent advantage. The chief drawbacks of this lamp are that it requires separate means to heat up the glower in order to render it conductive, and also a series ballast resistance. This lowers its economy, and without this resistance the glower cannot be safely used. There have not been any other important adaptations of the use of oxides for incandescent electric lighting, and it is to the metallic filament that we must turn for those inventions which are enabling electric lighting to compete with the Welsbach gas mantle.

The first commercial metallic-filament lamp was the

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osmium lamp, invented by Auer von Welsbach in 1898, and put on the market in the following years. Its regular commercial supply commenced in 1902. In this lamp the filament is made of metallic osmium, which has a considerably lower specific resistance than carbon. Due to this increased conductivity doubts were expressed as to whether osmium lamps could be manufactured for the usual voltages. The osmium lamp consumed per candle-power 1½ watts. Useful life over 1,000 hours. Decrease of candle-power during that period scarcely any. They were hence much superior to carbon lamps taking per candle-power 3½ watts, and after a life of 800 hours decreasing in candle-power 20 per cent. At first the osmium lamps could only be produced for 37 volts, which necessitated the connection of three lamps in series on a 110-volt circuit. The lamps were very fragile, and had to be burned in a perpendicular position. Their cost was about ten times that of a carbon lamp, due largely to the limited quantities of osmium available. This did not prevent millions of these lamps being manufactured, but it was evident that it would be impossible to produce them in the quantities required to supply all Europe, which would need between 30 and 40 million lamps per year. During the following three years the osmium lamp was further improved and made available up to 77 volts, enabling two in series to be used for 110 volts, and three in series for 220 volts.

In January, 1905, shortly after a paper read by Drs. von Bolton and Feuerlein (*Elektrotechnische Zeitschrift*, Jan. 26, 1905), the tantalum lamp appeared on the market. It possessed the great advantage that it could be burnt in any position and on a 110-volt circuit. Its economy was slightly less than that of the osmium lamp, and the useful life of the filament was considerably shorter. It was found that this life, when the tantalum lamp was used on alternating-current circuits, was so low that the makers did not recommend their lamps for these circuits. It must, however, be said that in spite of this disadvantage the tantalum lamp would have been looked upon as the lamp of the future had there not been a serious competitor to it even before it was a commercial article. Many inventors had been working independently on the improvement of the electric incandescent lamp, using metals with high melting points, such as osmium, chromium, molybdenum, tungsten, etc., and it is interesting to note the various suggestions as to methods of manufacture which appear in the patent specifications. Thus, Lodyguine (U.S. Patent No. 575,002) proposed to coat a suitable core of platinum, silver, or carbon with these metals, but he could not obtain incandescent bodies consisting of the pure metals of high fusing points, as evidently he did not know how to eliminate the interior core of platinum, silver, or carbon on which the filament was built up. The superiority of tungsten over other metals such as osmium, molybdenum, chromium, zirconium, thorium, tantalum, vanadium, niobium, etc., for the construction of incandescent filaments has now been ascertained by research, but was not proved at the time when Lodyguine made his investigations.

In 1904 Siemens and Halske (British Patent No. 20,277, 1904) endeavoured to extend their drawing process, which had been successful with tantalum, to tungsten, thorium, etc. The brittleness of tungsten and its want of ductility rendered the process inapplicable, and apparently Siemens and Halske have not up to the present time succeeded in producing lamps with drawn tungsten wire. It was also in 1903 that Drs. Just and Hanaman (British Patent No. 23,899, 1904) applied for a patent for incandescent bodies consisting of pure tungsten. This is the first English patent describing the manufacture of pure tungsten filaments—all previous inventors had failed to produce metallic bodies from this element which were free from oxides, carbon, or carbides. The second claim of their patent reads: "Process for the manufacture of incandescent bodies in accordance with claim 1, characterised by the fact that tungsten or molybdenum or compounds of these metals are mixed with organic binding media, formed and carbonised, whereupon the carbon is chemically eliminated, substantially as described." Quite independently of these inventors, the Deutsche Gasglühlicht Aktiengesellschaft (the Auer Company) applied for a patent (British Patent No. 19,379, 1905) which covers a process for the manufacture of pure tungsten filaments. In 1906 and 1907 a large number of British patents were granted both to the Deutsche Gasglühlicht Aktiengesellschaft and to Drs. Just and Hanaman, which describe further improvements in the manufacture of tungsten filaments. The two patents above mentioned cover what is known as the "paste" process of producing tungsten filaments—another method called the "coating" process was protected by Drs. Just and Hanaman in their British Patent No. 11,949 of 1905. These fundamental patents appear to protect the processes according to which tungsten filaments can be manufactured commercially at the present time.

Before passing on to the details of manufacture I desire to mention the patents of some other inventors. Amongst these are: Heany (American Patent No. 839,585), who proposes to use an alloy of tungsten with titanium. Kuzel (British Patent No. 28,154 of 1904) suggests the manufacture of glowing bodies from colloidal metals. British Thomson-Houston Company (British Patent No. 18,749 of 1906 and subsequent patents) describes the manufacture of filaments of tungsten with the help of volatile metals or alloys, chiefly amalgams, which could be drawn into wire. It will be interesting to watch the progress of this suggestion Zerning (British Patent No. 2,554 of 1906) claims the use of hydrogen and nitrogen compounds of tungsten as the materials from which to construct tungsten filaments. As far as I know, the hydrogenous compounds of tungsten have never been described by a chemist, and from the information I have been able to obtain the statement of Sir Henry Roscoe still stands. In his famous work, "Elements of Chemistry," he refers to the treatment by Berzelius of tungsten trioxide in a current of hydrogen. I understand that the result of the experiments of this famous scientist, which were confirmed by his French contemporary, Moissan, was the production of nothing but pure tungsten powder without any trace of hydrogenous compound being formed. As Zerning's experiments were directed towards the same object, it would denote a wonderful achievement if he should have produced a result which is not described in any scientific work and which the above eminent authorities found to be impossible. The nitrogenous compounds are well known, and it is proved that they cannot exist at the high temperature at which the filaments have to be burned. The patent description is not very clear, but indicates that Zerning intends to make use of the "paste" process, thus producing filaments containing probably carbon or carbide.

After a careful consideration of all the patents on the subject, I believe I am right in maintaining that of the multitude of processes that have been applied for and tried since the first application of the Deutsche Gasglühlicht Aktiengesellschaft and the Just and Hanaman patents, these two alone have during the last two years produced to the world commercial and useful lamps. By this I mean lamps of such characteristics as regards current consumption, life, and light as to inaugurate a new epoch in the electric lighting industry. It has been ascertained that all metallic filaments burning at a consumption of one watt per candle have been made with tungsten filaments. If ever so small percentages of other substances are added to the tungsten, the economy and useful life of lamps with such filaments suffer immediately. "Osram" is the name under which the Auer Company introduced the first commercial tungsten metal-filament lamp. The Osram lamp is manufactured by the "paste" process, the principle of which consists in preparing from solid substances, such as the metals themselves, in the most finely divided form, a paste with binding or stiffening agents such as the gums, dextrine, and other similar bodies. Such a mass has the consistency of putty, and is then squirted through a very fine orifice in a diamond, with a pressure of several tons per square inch. The result of the squirting operation is that one obtains a somewhat moist thread, which, however, has enough coherence to be formed into filaments that do not break while being dried. The filaments are first heated under exclusion of air and then possess sufficient strength to be held in metal clamps. They are then sub-

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jected to the passage of an electric current which raises them to a high temperature, causing the filaments to sinter. The process of sintering is carried out in gases which chemically attack all the constituents of the binding agent, without the metal being affected, so that eventually a filament of pure metal remains. This filament is dense and homogeneous, but being obtained by a sintering process, it is different in structure from the still denser metal which would be obtained from a melted mass.

Auer von Welsbach (British Specification 1,535 of 1898, and German Patent 138,135) describes a method for the manufacture of an electrical illuminating body of osmium by sintering the most finely divided metal at such a high temperature that platinum would evaporate, which temperature destroys the binding material which had been used in the manufacture of the threads. The filament so obtained withstands a very high temperature, but it is still of a more or less spongy or porous constitution; very metallic, but nearly solid. The difference of the filament of the Osram lamp, which is pure tungsten metal, from the filaments of the osmium lamp, shows itself by the following characteristics. Owing to the higher melting point of tungsten, an Osram filament will stand a temperature at least 100deg. C. higher than the osmium filament. Their specific resistance and resistance coefficients differ, and there is considerable difference in their radiation properties. The colour of the Osram filament is a steel to a silver grey, whilst the osmium filament has a bluish-grey appearance.

When preparing Osram filaments for lamps of 120 volts, 22 c.p. to 27 c.p., burning at an efficiency of about 1·1 watts per candle-power, taking 0·2 to 0·25 amperes, the diameter of the filaments is 0·03mm. The jet from which this filament is squirted is, of course, much larger. As an example, the diameter of the jet at point of issue from the diamond is about 0·055mm. The thread, after being squirted, shrinks to when dried 0 050mm. After it has been heated to a red heat under exclusion of air it becomes a very porous filament, with a diameter of 0·045mm. When this is sintered by the passage of an electric current, which raises it to the brightest white heat, its length is reduced, and it finally shrinks down to a diameter of 0 030mm. The shrinkage is caused by the removal of the carbon and other material forming the organic binding medium, which originally amounted to 84 per cent. of the volume of the paste. It follows that during the whole process 84 per cent. of the original volume must disappear, and the shrinkage corresponds to a linear contraction of 55 per cent. It is easy to alter the amount of shrinkage by selecting suitable proportions of the binding medium or by adding volatile substances which disappear on heating.

During this heating process the filament is fastened in clamps and placed in globes or other arrangements containing certain gases. The heating is effected by the electric current to a gradually increasing amount, and while the thread decreases in length and diameter it at the same time allows the passage of increased currents. This is due to the sintering of the particles and also to the filament being freed from carbon, which even in minute quantities increases its resistance. The process is controlled by the operator, who has a voltmeter and ammeter to guide him. The current increases rapidly at first, but reaches a constant value within a few minutes. This is common to all sintering processes, and the same phenomena are observed with osmium, iridium, or molybdenum filaments. The filament so obtained is elastic but brittle—that is, the Osram thread, 0·03mm. diameter, can be bent into a loop of about 1cm. diameter without breaking. After this bending it returns to its original form. Each filament is fastened on to its leading-in wires without the application of any paste. This is carried out in the following way. The end of the leading-in wire is melted down to a small globule by means of an electric arc. This globule holds the filament securely, and the resistance from the passage of the current from the leading-in wire to the filament is negligible The evacuation of the lamp is carried out in the same way as with carbon-filament lamps. Any process, mechanical or chemical, is suitable, but it is found that any traces of the gases occluded in the tungsten filament escape much more slowly than in the case of the carbon filament. The result is that the evacuation process requires a longer time with the Osram than with the carbon filament-lamp.

The other method of constructing tungsten filaments was developed by Drs. Just and Hanaman simultaneously with, but quite independently of, the Deutsche Gasglühlicht Aktiengesellschaft. Their lamp was introduced commercially under the name "Just-Wolfram." They use what is known as the "coating process" as described in the British Patents 11,949 of 1905 and 3,684 of 1906. This interesting process is carried out as follows: Ordinary carbon filaments of very small diameter, 0·02mm. to 0·06mm., are raised to a bright red heat by means of an electric current in an atmosphere of volatile tungsten compounds in the presence of hydrogen. The compounds most used are the chlorides and oxychlorides of tungsten. The heat of the filament causes the hydrogen to reduce the volatile metallic compounds, depositing the metal in homogeneous condition on the carbon filament. A later patent discloses a process whereby three or more filaments are coated in series at one operation. After the filaments have been coated in this way, their transformation into pure tungsten filaments is carried out as follows: The filaments are submitted to the action of an electric current in an atmosphere of highly rarefied inert gas, such as, for example, hydrogen at a pressure of about 20mm., until they show the clearest white incandescence. This process causes the carbon to combine with the tungsten surrounding it, forming a carbide. This change is so complete that in the resulting filament the cross-section is tubular, and no carbon can be distinguished under a microscope at the point of fracture. The filaments so obtained containing carbon (mostly a carbide) present a glittering white metallic appearance. In the next process they are raised to a high temperature through the passage of an electric current while they are surrounded by a mixture of hydrogen and a little steam. This causes the carbon to be oxidised by the same reactions which go on in the water-gas process. The carbon may, however, be eliminated by any other method which gives a resulting filament entirely free from carbon. Further improvements of this process, first described in the British Patent 11,949 of 1905, have been disclosed in the British Patent 3,684 of 1906.

Drs. Just and Hanaman have also obtained patents (British Patent 9,349 of 1906) protecting the process of mounting their tungsten filaments to the leading-in wires. This is effected by means of a paste consisting of finely divided tungsten metal mixed with coal tar or gum. These paste mounts are dried and finally made red hot by any suitable means before the filament is heated in the bulb. The supports used in these lamps are made of suitable metal. Exhausting is done in a manner similar to that employed for carbon lamps. The filaments made by this process have a light-grey silvery appearance and a little smoother surface than those made by other methods—in fact, they most nearly approach the appearance of a drawn wire. Though this process is entirely different from the "paste" process, the final result in each case is a pure, sintered filament of tungsten metal. The sole difference is that the filament made by the Just and Hanaman process is tubular. As regards economy, the tungsten or Osram lamps produced by either of the above-described processes have identically the same characteristics. It has been proved that these lamps will burn for from 1,000 to 2,000 hours with a consumption of about one watt per candle-power without any appreciable falling off in the candle-power. Of all the metals which have been experimented with up to now, only pure tungsten has such a life. In economy, the result is also better than has been obtained with other filaments—thus, the osmium filament takes 1·5 watts and the tantalum 1·7 watts for direct current and somewhat more for alternating.

Output and Efficiency.

In the following comparisons between the Osram and carbon lamps I have adopted the Hefner candle-power in every case, as this has so far been the standard mostly used when metallic-filament lamps have been discussed. At the present it is found next to impossible to try to standardise metallic-filament lamps per candle-power. It would make the lamp commercially impracticable. The metallic-filament

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lamps resemble in characteristics more the incandescent gas mantle than carbon-filament lamps, and there is, therefore, nothing unreasonable in demanding a similar treatment for them as is accorded to the incandescent gas mantle. The normal efficiency of both Osram and Just and Hanaman lamps of all voltages is about one watt per candle-power. At such efficiencies they burn 1,000 hours without a perceptible decrease of candle-power. The following figures give a comparison between the energy taken and power radiated from the surfaces of Osram and carbon filaments: The filament of a 25-c.p. Osram lamp, consuming per mean horizontal candle-power 1·1 watts, has a total surface of about 50 square millimetres, which equals per candle-power 2 square millimetres, or per watt of supplied energy 1·8 square millimetres. A good surfaced carbon filament consumes per mean horizontal candle-power 3·5 watts = per candle-power 5·5 square millimetres, or per watt of supplied energy 1·57 square millimetres. It results, therefore, that 1 square millimetre surface of Osram filament gives 0·5 c.p, and consumes 0·55 watt. One square millimetre surface of carbon filament gives 0·182 c.p., and consumes 0·63 watt.

Radiation.

It will be seen from the above figures that the Osram filament radiates only 87 per cent. of the energy radiated by an equal surface of the carbon filament, but gives 275 per cent. of the light given by the carbon filament. If the kind of radiation were the same in both cases, the carbon filament ought to get hotter than the Osram filament by about 60deg. C., because of the higher total radiation per unit of surface. On the other hand, considering the greater light emanating from the Osram filament, it ought to exceed the carbon filament by about 200deg. C. These contradictory conclusions show clearly how different is the radiating power of the Osram filament as compared with the carbon filament. The latter behaves much more like the "black body" of the radiation theory. From approximate calculations, the temperature of an Osram filament burning at 1·1 watts per candle-power is about 250deg. C. higher than that of a carbon filament burning at 3·5 watts per candle-power. If a carbon filament were to be overrun to such an extent as to consume only 1·1 watts per candle-power, its temperature would then have to be raised by 360deg. C. The favourable radiating properties of the Osram filament, therefore, mean that its temperature is 100deg. lower than that of a carbon filament of the same efficiency. If it were not so possessed of this radiating property it would have to be burnt at an efficiency of 1·5 to 1·6 watts per candle-power, in order that it might have the same life it actually possesses at 1·1 watts per candle-power.

A further favourable property possessed by all tungsten filaments is their high positive temperature coefficient of electrical resistance. If one takes the resistance of carbon, tantalum, osmium, and tungsten filaments at ordinary temperatures, the resistances at those temperatures which, in a vacuum, correspond to 1·5 watts per candle, will be as follows:

For a carbon filament	0·55 of the original.
For a tantalum filament	5·70 times.
For an osmium filament	8·50 times.
For a tungsten filament	11·00 times the original.

At temperatures of about 2,200deg. C. absolute, each increase of temperature of 10deg. increases the resistance of a tungsten filament about 0·45 per cent. If the pressure is raised from 100 to 104·5 volts, the current rises from 1 to 1·027 amperes. For a carbon filament the amount of the increase would be from 1 to 1·05 amperes. The total energy supplied, therefore, rises in the former case about 7·3 per cent., and in the latter about 9·7 per cent. Near the normal conditions the light of a carbon-filament lamp rises and falls with the 6·3 power, that of a tungsten-filament lamp with the 3·6 power, of the voltage. The latter differences are too great to be explained by the increase of energy caused by the change of pressure. The small changes in the light of the Osram lamp, as compared with a carbon lamp for the same change of voltage, can only be completely explained by the supposition that with a change of energy the radiated light is altered in a different way with the two lamps. A simple calculation shows that near the normal efficiency the light of a carbon lamp changes with the third power of the energy, whilst such change for an Osram lamp progresses with 2·3 power of the energy. These proportions have a very important practical consequence, which is clearly shown by the accompanying curve (Fig. 1) and Table I.

Table I.

	Osram.	Carbon.
Increase of light due to 10 per cent. increase in voltage	36 per cent. ...	84 per cent.
Decrease of light due to 6 per cent. decrease of voltage.....	21 ,, ...	34 ,,

It will be seen that the Osram lamp is much less affected by changes in voltages. Thus, if the pressure is decreased by 6 per cent. from the normal, the light from a carbon-filament lamp is reduced so much that it is a considerable drawback, whilst the reduction of light from the Osram lamp is not considerable.

High-Voltage Lamps.

High-voltage metallic filaments of the Osram type have recently been put upon the market manufactured both by the D.G.A. and the Just-Hanaman processes. A number

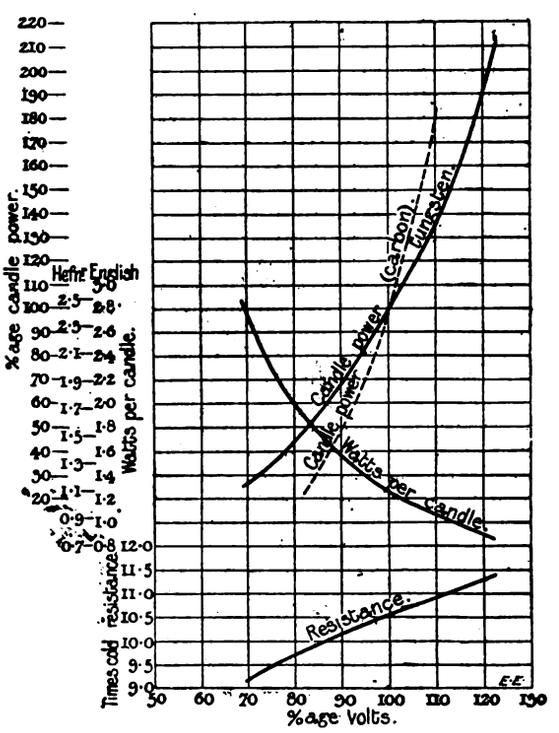

Fig. 1.

of these have been tested in commercial use and under special conditions to ascertain their life. From the results obtained the average life of a 1-watt 1-c.p. lamp seems to be between 800 and 1,000 hours. During this period there is no appreciable drop in candle-power, and the lamps have shown themselves to be equally good as the low-voltage Osram or Just lamps. These high-voltage lamps, made for from 200 to 250 volts, require double the number of filaments used in the low-voltage lamps. It is evident, therefore, that they cannot be produced for small candle-power. Up to the present 40 c.p. to 50 c.p. is about the lowest unit that has been obtained in a commercial lamp, and some extraordinary development or discovery will have to be made before that candle-power can be largely reduced.

The Use of 110-Volt Lamps on 220-Volt Circuits.

In so far as the lamp is different from the carbon lamp, it will, therefore, always be necessary to rely on series running whenever low units of light are required on high-voltage circuits. Thus, for public lighting (especially for the lighting of large spaces), the convenience of one lamp will be apparent, and people will stretch a point to use 50 c.p. for such purposes whenever they can; but for the use of private houses and confined spaces it will always be necessary to revert to lamps burning in series. To meet this demand, elaborate arrangements have been made at the

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Osram Works for testing lamps that will run in series. They are tested to one-hundredth of an ampere, and sorted out in from five to seven series numbers according to the type of lamp and carefully marked, and the reference numbers (ranging from, say, 28 to 38, which are marked on the caps of all lamps singled out for series burning) practically mean the consumption of current is 0·028, 0·029, 0·030, 0·031, etc., of an ampere. This running of Osram lamps in series can be avoided to a very large extent in those areas where the supply is given on the alternate-current system. In such cases, where the wiring of the premises to be lighted is carried out on the sub-circuit principle (as recommended in the wiring rules of this Institution), it is an easy matter to group up the circuit into two halves, and to connect these halves in series. If it could be ensured that there would be always an equal number of lights burning in each of the groups of circuits connected in series in this way, nothing further need be done. As this is not possible in most cases, an auto-transformer has to be added, and connected up as shown in Fig. 2. These tungsten-filament lamps burn equally well

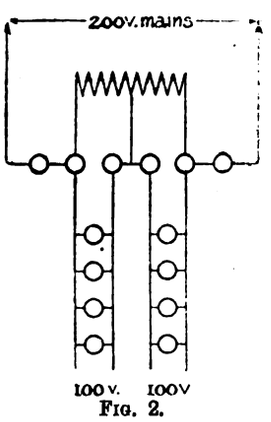

FIG. 2.

on either continuous or alternating current, and are quite independent of both frequency and wave-form.

(To be continued.)

IGNITION CELL CHARGING PLANT

BY FOURD ELY.

It can hardly be too emphatically pointed out to users of motorcar ignition and kindred accumulators that skilled recharging is a dominant factor in the life of such cells. With this end in view the Dumfries Electricity Works, at the instance of the local motor company, have lately fitted up a set of apparatus, a description of which may interest some of your readers. This installation consists of a ½-h.p. double-wound motor-generator, the primary circuit of which is connected to the 230-volt continuous-current mains of the Dumfries Electricity Works through an automatic switch and series speed regulator; the secondary winding providing the electricity for charging at the reduced pressure of 3-30 volts.

So much for the motor-generator, then, which is already in such common use as to require no further description. The great feature of the plant under review is the provision for storing electricity during the operation of charging customers' ignition cells. There is thus provided a second source of energy, making it convenient to continue charging all through the night by discharge from the storage battery, under perfect control, without attention and without anxiety. To make this arrangement possible the charging current from the generator is led first through an ordinary starting switch fitted with double automatic cut-outs to prevent overload or the running back of the cells, should the primary circuit be inadvertently broken, and the motor brought to rest. The main circuit of this switch is in the secondary circuit, the no-volt release being connected across the primary terminals of motor-generator.

The current then passes to a switchboard having five circuits in parallel, in each of which provision is made for connecting an ignition cell of any of the usual sizes by means of flexible conductors plugged into concentric sockets, thus making sure of correct polarity. A dead-beat moving-coil ammeter with a scale divided into tenths of an ampere is mounted on this board, so that by means of two-way switches the current in any or all of the five circuits can be seen at a glance. In each of these five circuits are two low resistances—viz., of 0·3 and 0·15 respectively—which may be switched in or out as the condition of individual cells demands. The exact voltage of any cell can be read on charge while the current is flowing (which is, of course, the only reliable method), as from each plug separate voltmeter wires are taken to a double-pole seven-way voltmeter switch. A standard moving-coil voltmeter is permanently connected across this switch, and has an evenly-divided scale calibrated in fifths of a volt ranging from 0-12 volts.

From the switchboard the current passes to a double-pole two-way charge and discharge switch, which, in the present case, would be in the charge position. This position puts the switchboard in series with the storage battery. The current now flows from the charge switch through a multiple-contact adjustable resistance of 3-15 ohms, 12-6 amperes, to a special socket connection into which a 24-ampere flexible cord can be plugged connecting the storage battery. This battery is of the Tudor Accumulator

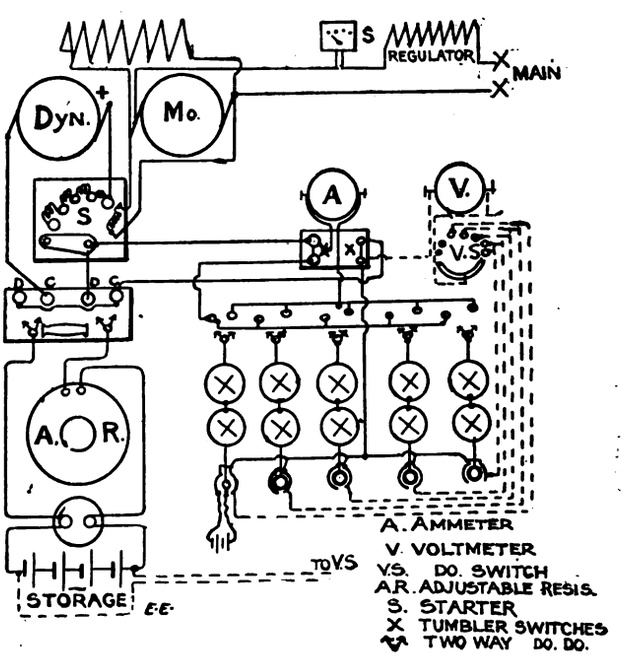

Diagram of Charging Gear. Charge—Ignition Cells in Series with Storage Battery. Discharge—Storage Battery in Parallel with Ignition Cells.

Company's latest pattern in glass boxes, mounted on oil insulators and pitch-pine stands, and consists of four cells of 160 ampere-hours capacity. From the storage socket the current returns through the opposite pole of the charge and discharge switch direct to the generator, thus completing the series charging circuit. Supposing the storage battery to be fully charged, this socket may be short-circuited by removing the battery plug and lead and substituting a special short-circuiting plug. These plugs are large size ordinary two-pin plugs, but to preserve polarity the pins are of different diameter.

Now when it is required to take current for cells to be left on all night, the charge and discharge switch is thrown in to the discharge position, which has the effect of putting the storage battery in parallel with the switchboard and its five circuits, and isolates them entirely from the generating plant. The adjustable resistance is now set to the total current required in those of the five circuits in use, the relative currents being adjusted by cutting in or out the small resistances in each of the switchboard circuits in use. Thus it is possible to charge cells of various capacities at rates proper to each, at one and the same time, surely an improvement on the method one usually sees—viz., a string of various sizes in series, the charging current governed by the smallest cell, which, as often as not, is being grievously over-run to try and get the larger cells done in time; the result being (as the motorist finds to his cost) that the

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former is permanently damaged, and the latter never really full.

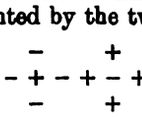
THE ELECTROLYTIC THEORY OF THE CORROSION OF IRON.*

BY ALLERTON S. CUSHMAN.

(*Concluded from page 702.*)

In the pink zones, as would naturally be expected, the iron remains quite bright as long as the pink colour persists. In the blue zones the iron passes into solution and continually oxidises, with a resulting formation of rust. Even the purest iron develops the nodes in the ferroxyl indicator, but impure and badly segregated metal develops the colours with greater rapidity and with bolder outlines. This result would, of course, be expected, as in pure iron the formation of poles would be conditioned by a much more delicate equilibrium than in impure iron, where changes in concentration of the dissolved impurities would stimulate the electrolytic effects.

In the writer's opinion these effects which are produced in the ferroxyl indicator constitute a visible demonstration of electrolytic action taking place on the surface of iron, and causing rapid corrosion at the positive nodes. We have, however, still another ocular demonstration of the truth of this theory. If a section of rolled metal, such as sheet or plate, is immersed in water, if the electrolytic theory is correct, rusting must take place with the establishment of positive and negative spots or areas. At the positive points iron will pass into solution and be rapidly oxidised to the loose colloidal form of ferric hydroxide which is characteristic of rust formed under these conditions. It is a well-known fact that colloidal ferric hydroxide will move or migrate to the negative pole if subjected to electrolysis. We may, therefore, consider the possibility of two separate effects that may be produced—viz., when a positive centre is surrounded by a negative area, and *vice versâ*. These two conditions may be graphically represented by the two circles A and B:



Now, as rusting proceeds we should expect in the case of A that the ferric hydroxide would be piled up in a cone at the centre. That this is precisely what is taking place whenever a sheet of metal rusts under water, a low-power microscope very clearly shows. The photomicrographs, in which the craters and cones are clearly shown, have been published in the bulletin referred to above. If you are willing to accept the electrolytic theory of corrosion, you will very naturally inquire in what respect it points the way to an improvement in the conditions as they exist at the present time. It follows from what has been said that the more carefully lack of homogeneity and bad segregation are guarded against during the processes of manufacture, the less likely is the metal to suffer from rapid corrosion. If the iron contains metallic impurities dissolved in it—such as manganese, which differ electrochemically from iron—trouble is sure to ensue if there is a lack of homogeneity in the distribution of the impurity. In the old days, when iron was made more slowly and received more careful working than is possible in the present day, serious corrosion of iron was not the important problem it has since become.

The writer has in his possession a hand-forged nail which is still in good condition, which was driven in the old Masonic hall at Richmond, Virginia, in 1807, and for a long portion of this time it has been freely exposed to the weather. There is a widespread opinion, which the writer shares, that the old re-wrought or puddled iron of 30 years ago is more resistant to corrosion than most of the modern steels.

But the interesting point is that modern steels vary so widely from each other. If we have a metal in which the electrical potential for any reason varies from point to point on the surface, we have the precise conditions which are necessary in order to establish the local nodes of electrolytic action on the surface which lead to rapid corrosion. It is apparent, therefore, that if we are to allow the presence in structural steel of comparatively high percentages of metallic impurities, such as manganese, we must attempt to obtain an extremely homogeneous distribution of such impurities. It is for this reason principally, in the opinion of the writer, that the more quickly and more carelessly the metal is manufactured and rolled, the more quickly it disintegrates under corrosive influences. As has been pointed out before, there are two methods of meeting the problem: first, to keep the percentage of metallic impurities as low as possible, and, secondly, to guard against segregation and imperfect chemical homogeneity in the metal. In experiments we have made looking to the manufacture of a corrugated steel culvert for use in road building, it has been found by the author that corrugated metal, running as low as 0·04 manganese, has been more resistant to the corrosive test employed than the ordinary steel of the day, which usually carries about 0·5 per cent. manganese. Material of this kind has not been available for a sufficient length of time to determine whether under service conditions this low manganese metal will be longer lived, but it can safely be stated that the indications are all in its favour.

Considerable attention has been given to the peculiar passive condition that can be induced on the surface of iron by contact with solutions of certain oxidising agents. Without going into the details of this phenomenon, which have been already published, I will refer briefly to the peculiar action of chromic acid and its salts. Polished specimens of steel may be kept indefinitely without suffering corrosion when immersed in a dilute solution of potassium bichromate. On first thought it would seem a paradox that a strong oxidising agent should have the effect of preventing the oxidation of iron, and yet this is the case.

According to the theory of the writer, the oxidising agent polarises the surface of the iron to the condition of an oxygen electrode, so that it is immune from the attack of the hydrogen ions; thus the whole electrolytic process is checked or inhibited. A curious feature of this action is that it is to a certain degree persistent after the metal has been removed from contact with the oxidising solution, washed, and wiped. This phase of the phenomenon requires further study, but at the present time it does not appear probable that the induced passive condition can be maintained on the surface to an extent that would make it of practical value for treating structural steel. With regard to the preservation of boilers tubes, and for certain special purposes, it is still a question whether a practical application of these principles will be found.

In conclusion, it may be said that there is reason to hope that the time is not far distant when specifications may be drawn for material that is going into service under conditions which make it particularly subject to corrosive influences. The possible added cost of such specially resistant metal will be small in comparison with the benefits which will be derived from its use in the long run.

* Paper read before the American Electrochemical Society.

LONDON POWER BILLS.

The Select Committee of the House of Lords presided over by Lord Cromer is still considering the first of the London Electric Power Bills—*i.e.*, the London and District Electric Power Bill. The greater portion of the time since the appearance of our last issue was taken up with the examination and cross-examination of Mr. Robert Hammond, one of the engineers. On Wednesday financial evidence was given by Sir Hugh Bell, one of the promoters. In examination by Mr. J. D. Fitzgerald, K.C, Sir Hugh Bell said that in embarking on an undertaking of so speculative a character as that of supplying electricity to London on a wholesale scale, it was essential that the undertakers should have extensive powers to enable them to safely recover the capital invested, and it was from this point of view that the purchase clause had been

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drafted. Their object was to knit together the consumers of London and supply them with electricity at a cheap rate, and to do this the undertakers must be able to raise their capital on reasonable terms. To do this they wanted to be able to show subscribers that they would get their capital back. He had gone carefully into the figures connected with the scheme, and was satisfied that it was a sound and workable one, and one for which they would be able to raise the money if passed substantially in its present form. He undertook to be responsible to find £250,000, and he was authorised by Lord Fitzwilliam to say that he was prepared to take a substantial interest. Asked by Lord Welby as to the manner in which the capital would be raised, he said if they went into the market to raise large sums of money they would have to pay for it. At a time like the American crisis it would have been impossible to raise any money, but given ordinary conditions of the money market he believed the money they required could be raised on fair and reasonable terms. Mr. Coward, K.C., on behalf of the London County Council, pressed witness to say what price he had in his mind as to what he could raise the capital at. Witness said it was quite impossible for him to answer such a question. Questioned further, witness said they preferred their own purchase clause to the one which was inserted in the Administrative Company's Bill.

Mr. Owen Smith, another promoter, said that the other promoters were Mr. Vincent York, Mr. Guinness, Mr. George Young, and Mr. R. Miller. It was not anticipated that they would make any direct issue to the public, but they would get the money they required through financial houses.

FRANCO-BRITISH EXHIBITION.

We understand that good progress is being made with the arrangements in connection with the electrical section at the Franco-British Exhibition at Shepherd's Bush which is being organised by the officials of the London electricity supply companies. It is gratifying to note that the companies are receiving municipal support in their endeavour to make their section a success. The first local authority owning an electricity undertaking to throw in its lot with the companies is the St. Pancras Borough Council, whose Electricity and Public Lighting Committee are recommending that a sum not exceeding £25 be contributed by the Borough Council towards the expenses incurred in providing an electrical exhibit at the Franco-British Exhibition.

LONDON UNITED TRAMWAYS BILL.

On Wednesday, Mr. D. A. Thomas's Committee of the House of Commons passed the preamble of the London United Tramways Bill, which provides for the electrification of a short tramway and the construction of a tramway over Kew Bridge.

Mr. BALFOUR BROWNE, K.C., for the promoters, said the only opposition was from the County Councils of Surrey and Middlesex, who refused consent.

Sir CLIFTON ROBINSON stated that in the whole of the company's district £1,000,000 of capital had been exacted from them by local authorities, so that instead of giving a return to their shareholders of 5 per cent., as they should have done if the wayleaves and exactions had been eliminated, they had paid only 1 per cent.

The committee passed the preamble of the Bill, but ordered a clause to be inserted providing for wayleaves of £500 each per year being paid to the County Councils of Surrey and Middlesex.

LONDON COUNTY COUNCIL TRAMWAYS.

At Tuesday's meeting of the London County Council Mr. W. W. Thompson (chairman of the Highways Committee) stated that his committee would not be able to report next week on the "G. B." system of electric tramway traction in the Whitechapel-road, which was still in an experimental stage and had not yet been passed by the Board of Trade. He was asked by a member of the Council what the effect would be on a horse coming into contact with a "live" stud. He replied that the animal would suffer from the staggers, but without fatal result. The accident, however, showed that there was a danger until this difficulty was overcome. There had also been a great escape of gas in the Mile End-road, and until that was overcome it would be impossible to run the cars, but it was the fault of the gas company, for the soil was impregnated with gas.

The report of the Highways Committee submitted to the same meeting contained estimates involving large capital expenditure on tramways. The committee asked for £45,330 for the track work and electrical equipment in connection with the reconstruction for electric traction of the existing tramways from Loughborough Junction to Norwood. The total estimated cost of the whole of the work was £77,540. For the supply of 175 bogie-truck double-deck electric cars fitted with roof covers and draught screens the committee asked for £179,450, an average of £1,025 a car, as compared with £1,084 each for the last 300 cars purchased. For the purchase of rails required for the construction or reconstruction of further portions of the tramways a capital estimate of £70,000 was submitted. On the purchase and electrical equipment of the portion of the undertaking of the Lea Bridge, Leyton, and Walthamstow Tramways Company in London it was proposed to expend £14,400, and for the construction on the underground system of electrical traction of the authorised tramways from Dulwich Library, *vid* Lordship-lane and London-road, to Forest Hill a sum of £32,620 is allotted.

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

Annual Congress.

It has now been definitely settled, says the *Official Circular* of the association in its May issue, that this year's congress shall be held on two consecutive days, instead of on one day only as previously announced. It was felt that the convenience of members would be better served by not compressing too much business into one day, but by devoting the mornings only to papers and lectures; this will give members a better opportunity of visiting the many attractions of the exhibition during the afternoons. The dates fixed for the congress are July 9 and 10. Members will be received in the congress hall of the exhibition by the chairman of the association and by the members of the reception committee at 10.30 a.m. on Thursday, July 9. At 11 a.m. Sir Clifton Robinson, one of the vice-presidents, will open the proceedings with a lecture on the "Tramways of the World." At 12 noon, Mr. A. H. Gibbings, member of the association, will read a paper on "Tramway Rail Joints."

On Friday, July 10, Mr. A. L. C. Fell, vice-chairman of the association, will take the chair at 11 a.m. and will open the proceedings. Prof. C. A. Carus-Wilson will deliver a lecture on "Rail Corrugation." Members will be given an opportunity of discussion at a later meeting to be held at 35, Parliament-street, Westminster, on Friday, July 24, at 4 p.m. At 7.30 p.m., (July 10) the banqueting hall at the Franco-British Exhibition will be reserved, and dinner will be served to members and their friends (including ladies). Members are requested to communicate with the secretary (at 35, Parliament-street) as early as possible.

PERSONAL.

Mr. E. A. Nash, of the St. James's and Pall Mall Electric Light Co., has been presented with a handsome brass standard electric lamp on the occasion of his marriage.

We are informed that Mr. H. Faraday Proctor, city electrical engineer of Bristol, has removed from Redland-road, and in future his private address will be 3, Downs-park West, Bristol.

We regret to announce the death of Mr. Francis Hughes Webb, A.I.E.E., formerly secretary of the Institution of Electrical Engineers, who passed away on the 17th inst. in his eighty-fourth year.

The *London Gazette* announces that the partnership between Messrs. B. G. Jones and G. H. Ingham, carrying on business as electrical engineers at 33, Commercial-street, Newport, has been dissolved by mutual consent.

The Derby Town Council have increased the salary of Mr. W. C. Pinn, works superintendent, electricity department, from £185 to £200 per annum, and that of the chief clerk (Mr. H. Munns) from £2. 10s. per week to £140 per annum, with a further increase to £150 at the expiration of 12 months.

Epsom.—The Rural District Council have received from the Board of Trade the print of the provisional order granted by them to the Woking Electric Supply Co. in respect of the extension of their area of supply as finally approved.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

INSTITUTION AND SOCIETY NOTES.

Institution of Electrical Engineers.

At a meeting of the Institution of Electrical Engineers held on the 14th inst. the following were elected:

Associate Members.—W. N. Cochrane, York Cottage, Bowdon, Cheshire: P. Cordiner, P.O. Box 115, Roodepoort, Transvaal; P. L. Davis, 57, Botanic-road, Liverpool; H. W. Edwards, Corporation Electricity Works, Burslem; H. A. Fleet, 7, Plevna-terrace, Savile Town, near Dewsbury; J. A. Fraser, 7, School-road, Moseley, Birmingham; E. H. Rhodes, P.O. Box 29, Para, Brazil; W. V. Waite, 14, Dudley-terrace, Leith.

Students.—H. R. Climie, B.Sc., care of Messrs. Mavor and Coulson, Limited, 47, Broad-street, Mile End, Glasgow; I. K. Kaul, 35, Falkner-street, Liverpool; W. T. Magrath, Doriscourt, Hall Green, Birmingham; W. Pate, B.Sc., Blacktoun House, Carron, Falkirk.

PROPOSED "INSTITUTE OF METALS."

We have received a circular, signed by Mr. William H. Johnson (Messrs. Richard Johnson, Clapham, and Morris, Limited, Manchester), announcing that a meeting will be held on Wednesday, June 10, at 2.30 p.m., at the Institution of Mechanical Engineers, with reference to the formation of the proposed new "Institute of Metals," which was decided upon at a meeting held in Manchester on March 11.

FORTHCOMING EVENTS.

FRIDAY, MAY 22.

Physical Society.—At 5 p.m., in the physics laboratory of the Royal College of Science, Imperial Institute-road, South Kensington, "On the Spectrum Top," by Mr. G. P. Sexton; "On the Coefficient of Diffusion," by Mr. B. W. Clack; "On the Production of Small Alternating Currents of Variable Frequency suitable for Telephonic and other Measurements," by Mr. B. S. Cohen.

SATURDAY, MAY 23.

Junior Institution of Engineers.—Visit to Avonmouth Dock works and electricity works, Bristol.

TUESDAY, MAY 26.

Faraday Society.—At 8 p.m., at the Institution of Electrical Engineers, 92, Victoria-street, "Some Aspects of the Work of Lord Kelvin," by Sir Oliver Lodge (presidential address).

OBITUARY.

We regret to learn of the death on Sunday last of Mr. Francis Hughes Webb, who for over 20 years acted as secretary of the Institution of Electrical Engineers. Mr. Webb was born in London in 1824, and thus was in his eighty-fourth year. When he resigned this position in 1898 he did not withdraw his interest in the work of the Institution, and it has been a pleasure to see him so often attending the meetings and the annual conversaziones. We are pleased to think that our old friend for 10 years enjoyed the well-merited repose he sought when giving up the arduous duties as secretary to the Institution. For the benefit of those who had not the privilege of knowing Mr. Webb so intimately as we did, we reprint the following from our issue of Jan. 7, 1898: "Every man who mingles in the real work of the world always feels regret when one of the honest workers leaves a sphere of labour he has adorned so long, and the regret is intensified to those who have been the immediate colleagues and fellow-workers. Thus, every member of the Institution of Electrical Engineers will regret the resignation of Mr. F. H. Webb, although they will sympathise with his desire for a little rest and leisure. It is about 20 years ago that Mr. Webb was appointed secretary of the then Society of Telegraph Engineers, and it may be well to glance at the progress of the Institution during that period. In the first place the number of members has about trebled, as might be expected, the year 1878 being on the brink, so to speak, of the new electrical era. Paris was gay in 1878, but so far as electricians are concerned their innings can hardly be held to have started till the Paris Exhibition of 1881. The English Institution had meetings in Paris in 1881 and again in 1889, in both of which the secretary was necessarily an active participant. As regards the Vienna Exhibition of 1883, Mr. Webb was one of the secretaries to the commission. He also took an active part in the meeting at Edinburgh in 1883, and at the Healthreies in 1884 When, then, we consider the increasing number of members during these early years of his secretaryship, and the arduous labours attached to the management of these various meetings, and find also that the library was opened in 1881, while the throes of incorporation were concluded in 1883, it must be acknowledged that the secretary was fully occupied But this was not all. The society had during these years under consideration fire rules, issued first in 1883, again in 1888, and again in 1897. The eighties were indeed busy years, for annual premiums were instituted in 1882, students' meetings commenced in 1887. The work in connection with all these matters needed energy and tact, which the results show were not lacking. The good work of progress did not stop, however, at the end of the eighties, for we find the Salomons scholarship founded in 1891, a building fund begun in 1894, and students' visits to works inaugurated in 1896, to say nothing of consultations that would naturally arise between the Board of Trade and the Institution over electrical matters during this period. Perhaps the point that appeals most to business men is the change in the financial position of the society. When Mr. Webb took office the finances were not healthy, the balance was on the wrong side, while now he leaves the financial position healthy, with large balances on the right side. These are a few of the facts concerning the work of the Institution during the secretaryship of the gentleman who has resigned the office he has so long and so honourably filled."

ELECTRIC EXTENSIONS AT BLYTH.

The seaport of Blyth, on the North-Eastern Coast, is rapidly attaining an important position as the outlet for the vast quantities of Northumberland steam coal which annually are exported to the Continent, inasmuch as it is one of the main converging points for the goods traffic of the railway system in the northern and eastern sections of the county, in which are located the large majority of

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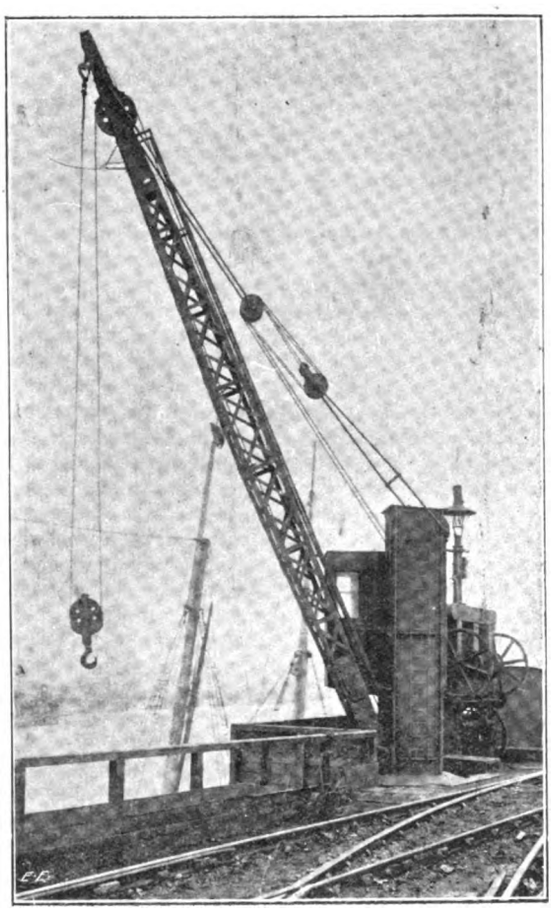
the coal mines. The North-Eastern Railway Company pursues a vigorous policy with regard to the development of this trade, and very much of the traffic proceeds to the jetty at North Blyth, where coaling proceeds almost uninterruptedly.

In connection with recent extensions, Messrs. Cowans, Sheldon, and Co., Limited, of Carlisle, have just erected a very fine example of fixed electric wharf crane intended primarily for coaling purposes, but which can be used also for general quayside work, it being a duplicate of one previously erected at the same docks by this firm. It is fitted with lifting, slewing, and derricking motions, and is capable of lifting the full load of 8½ tons at a maximum radius of 32ft. The various motions are worked at the following speeds: lifting, 8½ tons at 22ft. per minute; slewing, 8½ tons at 200ft. per minute; derricking, 8½ tons at 30ft. per minute.

The lifting and derricking barrels are driven by the same motor, and are geared in such a manner that the load remains at a practically uniform level when the radius is being varied. For the slewing motion an independent



motor is provided. In order to take the dead weight of the crane, a ring of turned steel conical rollers is fitted at the bottom of the mast, while the horizontal thrust is taken by a large roller path fixed to the framework of the jetty. In order to reduce the space necessary on the jetty platform to a minimum, the motors and gearing are all fixed on a steel frame at the foot of the mast. The jetty and mast are strongly constructed of steel plates and angles, and particular care has been taken in providing substantial machine castings to quarry the various shafts, pulleys, and other gear.

The electric equipment, which was supplied by Messrs. Siemens Bros. Dynamo Works, Limited, consists of a 20-b.h.p. motor for lifting and derricking, and one of 8 b.h.p. for slewing. The installation was supplied complete with controllers, resistances, switchboard, and all connections by this firm. In order to enable the current to be conveyed to the crane at any position, large ring collectors are fitted round the mast below the stage level, and the illustration shows the general appearance of the crane in position. Direct current at 460 volts is used for the supply.

THE MANUFACTURE OF ELECTRICAL CONDENSERS.*

BY G. F. MANSBRIDGE, MEMBER.

Although electrical condensers are among the oldest devices in the art of applied electricity, it is only within the last few years that the demand for them has assumed any degree of commercial importance. Until about 1898 pratically the whole of the supplies were for telegraph work, but since then the situation has been entirely changed by the great development of the telephone service of the world, and particularly of the common-battery system, in which condensers play a modest but important *rôle*. The magnitude of the present demand may be gauged from the fact that the aggregate output of condensers in Europe and America during 1907 is estimated at the once inconceivable capacity of five farads. With manufacture established on this scale economy in production is imperative, and the skilled hand of the 'nineties who laboriously assembled or "built" his one or two microfarads per day has given place to the machine hand who, with less physical distress, readily turns out one hundred times that quantity per diem. As a result the manufacturing costs have been so greatly reduced that condensers equal in quality to those produced 10 years ago can now be purchased at approximately one-tenth the price. This reduction in cost has brought about a yet further increase in the demand, since it now pays to employ condensers for many services from which they were previously shut out by their high cost. Consequent, no doubt, upon the newness of the industry, very little seems to have been published in the way of precise physical, electrical, or manufacturing data, and the present paper is an attempt to deal with some of the technical points which seem to be of the most importance in the manufacture and use of condensers.

Throughout the paper the subject has been looked at chiefly from the point of view of the practician; the numerical data quoted must, therefore, be considered not as figures obtained in a laboratory, but as representing the carefully digested results of workshop tests made in the ordinary course on large batches of condensers. These tests, though made with reasonable care, may not be of the high order of accuracy obtainable with tests of isolated specimens taken under laboratory conditions, but it is thought that their accuracy is sufficiently close for all ordinary purposes, and that they will be of practical value as representing the average of a very large number of results obtained under commercial conditions. The author has, moreover, no respect for five-figure results worked out on two-figure galvanometer deflections. Many of the data are gleaned from the records of the Post Office factory at Mount-pleasant, Clerkenwell, E.C., and for permission to publish these the author has to acknowledge his indebtedness to Mr. J. W. Willmot, I.S.O., the controller of the factories' department of the Post Office.

For convenience of description, the various types of condensers are considered separately. They fall naturally into four chief classes—namely: (1) mica; (2) glass; (3) paper or other fibrous material impregnated with wax, resin, oil, etc.; (4) electrolytic cells.

1. *Mica Condensers.*—On account of the very high cost of mica sheet suitable for the work, condensers of this form are but little used. Mica condensers, when well made, retain their capacity and insulation better than those made of paper, and they have also a higher dielectric strength for the same thickness, but the cost per microfarad is approximately ten times greater than that of paper condensers. Fortunately, the inductive capacity of mica is high (about twice that of paraffined paper), or the labour cost would be excessive, since the size of the sheets is limited to about 4in. by 3in., the cost of larger sheets of uniform thickness being prohibitive. A good working thickness is 0·0015in. to 0·002in., and if the material is carefully selected there is no necessity, for ordinary purposes, to use more than one sheet between consecutive foils. For purposes where mechanical strength in the condenser plate itself is of special advantage mica is very

* Paper read before the Institution of Electrical Engineers.

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satisfactory, and for standards it is unrivalled. In standards the chief desiderata are: (1) constant capacity with efflux of time; (2) constant capacity with varying temperature; (3) high insulation and low absorption.

To obtain (1) it is necessary that the mica and tinfoil sheets be perfectly flat and free from inequalities, so that they will build up under pressure into a solid mass without flexure or mechanical strain; it is also necessary that in assembling the sheets all air-bubbles be excluded. To obtain (2) advantage is taken of the fact discovered by Dr. Alexander Muirhead (U.K. Patent 15,337), 1891, A. Muirhead), that the mica sheets have a positive temperature coefficient if coated with shellac, and a negative temperature coefficient if coated with paraffin. By building a condenser in two sections—one treated with shellac and one with paraffin wax, the variation of capacity within ordinary limits of temperature can thus be brought practically to vanishing point. To obtain (3) it is necessary to use only selected sheets of the finest clear "ruby" mica, which must be uniform in thickness throughout the sheet, and free from cracks, veins, or flaws; spotted or "speckled" mica is useless for the purpose.* The shellac employed should be the finest button lac dissolved in absolute alcohol and carefully strained until perfectly free from suspended matter. The building-up or assembling of the sheets of foil and mica may conveniently be done on a "hot plate," the greatest care being taken to exclude air-bubbles, grit, or excess of paraffin or shellac. The desiccation should be slow but thorough, and the temperature should not exceed 212deg. F. The finished condenser should be carefully and not excessively pressed, and should be allowed to cool under pressure in the ordinary way.

2. *Glass Condensers.*—A few years ago the Leyden jar would not have called for comment in a "practical" paper, but the requirements of wireless telegraphy and X-ray work have latterly increased the importance of apparatus of this character, and there is now quite an appreciable trade in glass jars for this specific purpose. As is well known to wireless workers, Leyden jars, like other condensers, are prone to fail in use if at any point there is imperfect contact between the conductor and the dielectric, and to avoid this difficulty the best plan is to silverplate the glass. This may be done by precipitating metallic silver on to the glass in the form of a bright continuous film by the well-known method employed for silvering galvanometer mirrors, etc. The solution generally used is nitrate of silver which has been treated with ammonia until the precipitate first formed has been completely re-dissolved. The surface of the glass must be cleaned with the most scrupulous care before plating is attempted, or an imperfect coating will result. The silver coating should then be mechanically strengthened by a protecting layer of varnish, or it may be over-plated with copper. An important development of this silver-plated Leyden jar is to be found in the Moscicki high-tension condenser recently placed on the market. A brief description of this condenser has already been made public, but it is thought that the apparatus is of sufficient interest to warrant detailed reference, and by the courtesy of Messrs. Isenthal and Co., of Mortimer-street, London, the author is able to exhibit a condenser of this form in a manner which will permit of the construction being readily seen. In the author's opinion this condenser represents the most satisfactory and practical high-tension condenser for commercial work which has been introduced up to the present.

The failures of previous high-tension condensers were due to imperfect adaptation of the material to the requirements and to the inherent weakness or instability of the dielectric, and, as is well known, the working life of such condensers was invariably short. In the Moscicki condenser great technical skill has been shown in adapting the material so as best to meet the onerous conditions. An imperishable and highly stable material—glass—is used for the dielectric, a most intimate and complete contact is made between the conductor and the dielectric by chemical deposition of silver, excessive strains are avoided at the point of high dielectric stress—the edges—by suitably thickening the dielectric at this point, and the effects of local heating are minimised by water cooling. The failures of high tension condensers of other types have no doubt engendered a certain feeling of distrust in the minds of many station engineers, and it may be that this suspicion will take some time to eradicate. In view, however, of the large number of stations working with a power factor ranging about 0·75, and of the advantages to be gained by improving this power factor, the author would suggest that the question of installing a battery of modern glass condensers at such stations is worthy of more than passing consideration.

3. *Condensers with Paper or other Fibrous Dielectrics.*—Although this form of condenser has been employed for many years, there have been but few important changes in the process of manufacture until lately. The standard practice up to the last decade was to use separate sheets of tissue paper and separate sheets of thin metallic foil, and the method employed was to dry the paper by heat, then to transfer it to a bath of hot paraffin wax, and after due soaking to build up the condenser on a "hot plate," the paper being taken sheet by sheet from the bath of hot wax. At least two sheets of paper were used between consecutive foils, the alternate foils being bunched into two books in the well-known way. The paper used was of fine quality, giving only a minute percentage of ash on incineration, being free from grit, holes, specks, etc., and being neutral in chemical reaction. A good working thickness was 0·001in. The metal foil was usually of tin, the thickness being about 0 0003in. Obviously this method of building condenser plates was slow, tedious, and expensive, and it had the further disadvantage that as the workmen who handled the material were exposed to a high temperature, the risk of contamination of the wax by emanations from the body was great; indeed, the difficulty was such a serious one that the manufacture of satisfactory condensers in very hot weather was practically impossible, and in London it often became necessary, on this account, to cease manufacture during the summer months. Even in cooler weather it was necessary to select workmen who were not prone to perspire freely, as only such men could be depended upon to produce condensers with satisfactory and permanent insulation. In consequence of this difficulty the author found it of advantage to build up the condenser plates "dry" in a separate room and to desiccate and impregnate the condensers as a subsequent operation. By this arrangement practically all the handling was done under more favourable conditions in a cool shop, and the electrical results obtained were more satisfactory than under the old system, and at the same time the cost of manufacture was considerably reduced. The slow process of assembling the sheets one by one and of handling about 250 separate pieces to make up a one-microfarad plate had, however, still to be reckoned with, and the percentage of failures through short-circuit or low insulation was considerable, so that the labour cost remained an important factor.

The next step was in the direction of bringing down this high labour cost by reducing the number of pieces to be handled. The method adopted was to wind up into the form of a roll long strips of metal foil, two strips of paper being interposed between each foil—that is, six strips in all. This method, which was introduced to the Post Office by Sir John Gavey in 1899, had, however, difficulties of its own. Pure tinfoil of the requisite thinness could not at that time be obtained in strips longer than a few feet, and the alternatives were: (1) to feed between the rolls of paper a series of strips of pure tinfoil some 4ft. long, each strip overlapping its predecessor by an inch or two so as to maintain continuity; or (2) to use an alloy of lead and tin which could be obtained in continuous lengths. The former was an awkward and unmechanical arrangement, and the latter had the disadvantage of producing a heavy and bulky condenser. Both methods also involved a considerable proportion—rarely less than 10 or 15 per cent.—of short-circuits in the finished plates brought about by grit in the foil or by defects in the paper. In endeavouring to overcome these difficulties, the author hit upon the idea of using metallised or "foiled" paper of the same character as that sometimes employed for wrapping up packages of tea, etc. Experi-

* An interesting memorandum on mica has recently been published by the United States Department of the Interior.

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ments showed that commercial "tin-foiled paper" as then made was not sufficiently reliable as an electrical conductor for the purpose; indeed, many samples, although having apparently an excellent metallic surface, were found to be almost as devoid of conductivity as paper itself. Microscopic examination revealed that this want of conductivity was chiefly due to the tin being distributed, not as a continuous film over the surface of the paper, but in small isolated patches, the breaks between the contiguous patches being due to small fibres of the paper standing above the average level. Further, it was found that even in those samples which gave fair conductivity in the plain sheet very little creasing of the paper sufficed to destroy the continuity. The matter was, however, considered sufficiently promising to warrant careful investigation, and the difficulties in the way of producing a thoroughly reliable conducting surface on such paper were found to be surmountable (U.K. Patent 19,451, 1900, G. F. Mansbridge) For assistance in carrying this part of the work to a successful issue, the author desires to express his indebtedness to Messrs. Olive and Partington, Limited, of Upper Thames-street, London, who gave the matter considerable technical attention at their works, and who were the first to produce foiled paper for electrical purposes on a commercial scale.

(To be continued.)

HALIFAX TRAMWAYS.

Report of Major Cardew, R.E., and Mr. H. Graham Harris.

The following is the full report which was referred to in our last issue. The report is dated May, 1908, and addressed to the town clerk of Halifax:

We have the honour to report that, as instructed by your letter of Dec. 4 last, we opened our inquiry on the working and management of the undertaking with regard to the safety of the travelling public on Feb. 6, 1908, at the Town Hall, Halifax. At this inquiry were present your sub-committee, the recently appointed general manager, and the rolling-stock engineer of your tramways, Messrs. Spencer, senior and junior (the late general manager and rolling-stock engineer), the borough engineer, and the town clerk. The views of the chairman and members of the sub-committee as to the scope and extent of our inquiry were ascertained, and evidence was given by the two present and the two former tramway officials and by the borough engineer as to the contributory causes of the recent fatal accident, the design and condition of rolling-stock and equipment, condition and maintenance of permanent way, regulations for drivers and conductors of tramcars, and particulars of those routes on which, owing to long and steep gradients, curves, and liability to greasy deposit on the rails, special precautions are necessary. After this sitting and discussion we proceeded to the car-sheds, where we made a minute inspection of the various patterns of brake, sanding gear, and controllers in use at the present time, and also examined the equipment generally, and inspected the repair shop and the condition of all apparatus under repair. On Feb. 7 we inspected all the routes on which steep grades occur, and carried out tests on the electric "run-back" brake and on the three patterns of "slipper" brake now in use. We will first describe briefly your tramway undertaking generally, and will express our opinion in detail on those points needing our comments.

General Description of Undertaking.—The tramway system of Halifax is an electrical overhead trolley system, working with the usual direct current at 500 volts. The total length of tramway route is 37 miles, and this represents 52½ miles of single track, a great proportion being on steep gradients, in some parts as steep as 1 in 9. On these gradients there are many curves, some of short radius, many in the centre or busy part of the town, with streets crossing the line at right angles, and much heavy traffic. The gauge of the track is 3ft. 6in., and the rails weighed originally 97lb. per yard. Generally speaking, it may be said that your tramway routes are bordering upon the limit of possible safe working by electric cars fitted with ordinary flanged wheels running on grooved rails, for not only are the gradients steep, but the hills are long and with many curves, and the exudations from the soil and deposits from the air and from other traffic frequently produce a greasy surface on the rails. Safety can only be secured, even with every possible mechanical safeguard and with the most careful regulations, by constant and unremitting attention to the maintenance of the efficiency of every working part of the cars and stock, including also that of the human element of "drivers" and "conductors." The number of passengers carried in 12 months has averaged about 19 millions for the last two years, with a car mileage of about 1,650,000, which gives a number of passengers per car mile in excess of the average for similar undertakings. The average journeys per head of population served is given in your last report as 106, which is also, we believe, rather above the average. Notwithstanding these favourable features, however, your accounts show a loss on last year's working. Such a system of tramways as yours must necessarily be somewhat more expensive in working cost and maintenance than if it were laid on the level, but in your case the expense appears excessive. The car miles run per car per diem are decidedly low, especially if based on the total cars in stock, which reduces the figure to 46. We would also direct attention to the diagram published in the last report showing consumption of energy per car mile, the persistent rise of the curve for 1906-7 as compared with 1905-6 being very striking. Also to the increase in the number of accidents given in the report. In these and other respects, referred to later, it appears your tramway undertaking in the past has not been maintained to the "level of perfection" which, having regard to the physical difficulties inherent to its construction and working, is essential to economy and to safety. The best construction, equipment, supervision, and manipulation are no whit too good for your requirements, and this standard of excellence, once reached, should be carefully maintained. In some respects your undertaking is, in our opinion, up to this standard; in others, with which we will deal in detail, it requires amendment. To render this report (in which we shall have of necessity to carefully consider minute details of construction and working) as brief and intelligible as possible, we relegate to an appendix the discussion and consideration of the various points which require comment from us and simply include herein the recommendations which, in our judgment, should be adopted in order to secure the safety of the public and to render the working of your undertaking as satisfactory as, having regard to all the conditions and circumstances, it is possible to make it. Taking the various items discussed and dealt with in full detail in the appendix hereto in the order in which they are set out in it, we suggest the following:

1. *Permanent Way.*—The permanent way has been well laid originally, and is generally in good condition. Having regard to the great stress brought upon it, we recommend that in all cases when relaying is undertaken the joints should be properly anchored, and that granite setts should be exclusively used in the paving of all steep grades exceeding 1 in 20 and of curves of short radius. On several routes we noticed that the joints are out of truth, causing a knock as the wheels pass over them. These routes should be relaid as soon as can conveniently be arranged. With regard to the cleansing of the surface of the rails, we do not think that the existing arrangement of "sprinklers" at the tops of hills satisfactorily answers the purpose, as it appeared that for considerable lengths the water merely flowed along the groove as a channel without washing the tread of the rails. In any case this method must be very wasteful of water. We recommend that for the present all steep grades should be swept by hand while the water is running, which will ensure a thorough cleansing of the tread. The profusion of water is prejudicial to the paving, especially in winter. We would point out that a tank car with sweeper would be of considerable service.

2. *Cars.*—These are fairly suitable in size and design—a rather longer wheel base with less overhang would conduce to safety on the steep grades. We have no doubt also that single-deck cars would give greater security and ease of control on these grades. The increased height of the centre of gravity with double-decked cars is distinctly prejudicial to the efficiency of the brakes, especially on steep inclines and on your narrow gauge. It might be considered, when new cars have to be obtained, whether single-deck cars with open sides should not be purchased for use as workmen's cars. In any case, we would strongly urge that no cars with covered upper decks (of which pattern you now possess two) should be allowed to serve the routes with steep grades.

3. *Trucks.*—These are mainly of two patterns, "Peckham" and "Brush." The former is, we consider, rather light in construction for the stresses to which these trucks are now subjected, owing to the steep gradients, the high speed of running, the great weight of the motors, and the use of track brakes. These trucks, moreover, have seen much service. We recommend that they should all be thoroughly overhauled and strengthened where found necessary. One some of the "Brush" trucks we found that the axle-box springs had been removed. We agree with your present general manager that this removal was a mistake, and that it is likely to cause broken axles and undue vibration and hammering on the tracks.

4. *Wheels.*—We recommend the use of steel-tyred wheels rather than chilled cast wheels as giving better effect in braking, and enabling "flats" to be more easily removed; these wheels also last longer.

5. *Gearing.*—The gears shown to us appeared too narrow to

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be relied upon, considering the great power of the motors which may be suddenly applied in an emergency, or by a careless driver at other times. All gears should certainly be machine cut, and with split wheels.

6. *Motors.*—We prefer the 49B Westinghouse motor for steep grades on account of its giving better effect and taking less current, but we agree in the use of the higher-speed motors if it is found that the difference in the speed between the 49B and the other motors seriously affects the earning capacity of the cars.

7. *Controllers.*—As regards these, we would emphasise the recommendations we felt necessary to give to you by letter immediately after our inspection, and would say that all controllers should be absolutely similar in their modes of working, although they may differ in their details; in other words, similar movements of the controller or other handle in similar directions should have similar effects. As a matter of fact, you have in use now controllers of five different patterns. The motions are similar in most of them as regards the application of power for propulsion, but as regards "braking"—and this, after all, embraces the "emergency" question and the question of the safety of the public—these controllers differ very materially.

8. *Brakes.*—The provision of ample brake power is of the utmost importance to your tramway system, having regard to the exceptionally steep gradients with which you have to deal, and, further, to the high speeds at which you run. We recommend that every car should be fitted with an efficient "emergency" brake, and it is also necessary that there should be an adjustable brake for continuous use for controlling speed down steep inclines. It is obviously desirable that both these functions should be performed by one apparatus. In our judgment the latest form of "Spencer" track brake fulfils more satisfactorily than any other which you have in use the necessary conditions as to this, but it requires to be handled promptly and effectively, and by a skilled driver. A satisfactory magnetic track brake is equally suitable and much more rapid and powerful in its application than any hand brake can possibly be. A new form of "skid" brake has recently been devised, which, from published tests, appears to be very suitable for use as an emergency brake. It is still somewhat in the experimental stage, and we merely call your attention to it as a promising improvement.

9. *Sanding Device.*—We recommend the replacing of the sanding device by such a device as will deliver the ordinary quantity of sand, necessary for ordinary working, under ordinary circumstances, and will also deliver, when worked by the driver from either end of the car, a much larger "emergency" quantity of sand in front of the wheels, no matter whether the car be running forward or backward.

10. *Upkeep.*—We would most strongly impress upon the committee the necessity for more careful attention to the upkeep and cleaning of the motors and all accessories than appears to have been exercised in the past. Numerous motors under repair were shown us in which there was evidence of damage caused by the motor having been allowed to run too long without attention. These remarks also apply to rheostats, cut-offs, wiring, and electrical and mechanical equipment generally.

11. *Printed Regulations for use by Drivers and Conductors in Working.*—We have considered these, and the matter was dealt with at the meeting with the tramway officials past and present, and as the result we make certain suggestions, which will be found in the appendix. These deal only with certain points which are within our province, but we recommend that the whole of the regulations be rearranged and reconsidered, and that amended copies be printed and issued.

Should there be any further information which we can afford we shall be only too pleased to answer any questions, or to deal with any further matter, or to attend a meeting in Halifax should the committee or yourself desire it.

(Signed) { P. CARDEW.
H. GRAHAM HARRIS.

WIRELESS APPARATUS EXEMPT FROM SUEZ CANAL TOLLS.

The United States Ambassador in Paris sends the following translation of a letter from the president of the Suez Canal Company announcing certain modifications in the regulations concerning the navigation of the canal: "At its meeting of March 2, 1908, the administrative council of the Suez Canal Company decided in future to include the spaces intended to hold the apparatus of wireless telegraphy and the electric projector of the vessels among the spaces deducted from the gross tonnage as being useful for the manœuvre of the vessel, and under reserve of the observation of the maximum total of 5 per cent. of the gross tonnage."

LEGAL INTELLIGENCE.

SKIDDING MOTOR 'BUSES AND ELECTRIC LIGHT STANDARDS.

In the Court of Appeal last week, before the President of the Probate, Divorce, and Admiralty Division (Sir Gorell Barnes), Lord Justice Fletcher Moulton, and Lord Justice Farwell, an application was heard by the plaintiffs in the case of the City of London Electric Lighting Co. *v.* the Vanguard Motorbus Co. for judgment or a new trial in an action tried before Mr. Justice Ridley and a special jury. The plaintiffs sued the Vanguard Motorbus Co. to recover the sum of £75. 13s. 10d., the cost of repairing an electric lighting standard and lamp, which were damaged by the skidding of motor omnibuses belonging to the defendants, owing to the alleged negligent driving of the defendants' servants. In the alternative they claimed that the defendants were liable to pay the sum in question on the ground that they had committed a nuisance by placing on the highway motor omnibuses which they knew to be dangerous and uncontrollable. The defendants denied liability.

Mr. Justice Ridley held that there was no evidence to go to the jury on the question of negligence with regard to one of the dates. He left questions to the jury as to whether there was any negligence on the first occasion, and as to whether the omnibuses of the defendants were a nuisance at law—that was to say, whether they were reasonably safe vehicles to be used upon the road in question in such circumstances as usually occurred. The jury found a verdict for the plaintiffs on the ground that there was negligence on the part of the defendants' driver on the occasion of the accident on June 15. They also found that there was negligence in the use of the vehicle on the second occasion, but that the vehicles were not legal nuisances. The learned judge gave judgment for the plaintiffs for £43. 3s. 4d., being the amount of the damage attributable to the first accident. The plaintiffs applied for judgment or a new trial. They contended that they were entitled to succeed on their claim for negligence in respect of the second accident, and also on their claim for nuisance.

The Court ordered a new trial of the whole action, on the grounds that it was not clear what the jury meant by their verdict and that there had been an unsatisfactory trial.

BOURNE AND HOLLINGSWORTH v. ST. MARYLEBONE BOROUGH COUNCIL.

In the Court of Appeal last week an application by the defendants was made for judgment or a new trial in an action tried before Mr. Justice Ridley and a special jury, and brought by the plaintiffs, Bourne and Hollingsworth, who carry on business at 116 to 122, Oxford-street, in the county of London, to recover damages for breach of contract, committed by the mayor and Council of St. Marylebone. The statement of claim alleged that by a contract, partly verbal and partly in writing, made in June, 1905, between the plaintiffs and the defendants the latter agreed to supply the plaintiffs the electric light required by them for their new premises at Berners-street, Oxford-street, and the plaintiffs in consideration therefore agreed to pay to the defendants their charges for the same; that it was an express term of the contract that the supply of the electric light should be at the rate of 240 volts, and that such supply should be given to the plaintiffs' premises by the first week in September, 1905, and that the plaintiffs were to fix in the premises electric fittings capable of receiving a supply at the rate of 240 volts; that the plaintiffs duly fitted their premises with the necessary fittings, but that the defendants did not in fact supply the electric light until Oct. 3, 1905; that by a further contract made on Sept. 19, 1905, it was agreed that if the plaintiffs would adapt the system at their premises by cutting out one of the arc lamps on each circuit so as to be able to receive a temporary supply of electric light at the rate of 200 volts. the defendants would, within two days from Sept. 22, furnish a supply at the rate of 200 volts, and that the defendants broke that contract, and the plaintiffs claimed damages. The defendants, in their statement of defence, denied the making of the contracts and that the persons who made them had any authority from the defendants to enter into them, and they further pleaded (1) that the contracts (if made) were not under the seal of the defendant Corporation, and were, therefore, not binding upon them; (2) that the alleged contracts were not within the power or capacity of the defendant Corporation, and were, therefore, void; and (3) that by Section 26 of the St. Marylebone Electric Lighting Order, 1901, the only liability, if any, imposed upon them for the alleged breaches of contract was a penalty not exceeding 40s. per day, recoverable only in a court of summary jurisdiction.

In the court below the learned judge, after hearing argument on the questions of law raised in the case, gave judgment for the plaintiffs, being of opinion (1) that the contracts were binding on the defendants, although they were not made under seal; (2) that they were not *ultra vires* of the defendants; and (3) that, as the action was founded on a breach of contract and not on a breach of a statutory obligation, the defendants were liable in damages and not to the statutory penalty. The defendants applied for judgment or a new trial, and contended that there was no evidence of any contract either in June or in September, and that, if there was evidence of such a contract, there was no evidence of any authority in Mr. Wright or Mr. Wilkinson, the engineers, to make such a contract. For the plaintiffs it was contended that upon the evidence and correspondence there was evidence upon which the jury could find that there was a contract either in June or in September, and that Mr. Wright and Mr. Wilkinson had implied authority to make the respective contracts.

The Court allowed the appeal, and Sir GORELL BARNES said, with

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regard to the first alleged contract, the letter of June 15 from Mr. Wright was not capable of being construed as a contract. It only amounted to a statement of the engineer that, in his opinion, there would be no difficulty about complying with the plaintiffs' request. It was a hopeful expectation, but no binding contract. With regard to the second alleged contract, he felt some doubt whether there was any contract at all, and there was no evidence that Wilkinson had any authority to make such a contract as that alleged. It was a very special contract. Nor was there any holding out by the defendants of Wilkinson as having such authority. Therefore, even if there was evidence to support the finding that the contract was made, there was no evidence of authority or of holding out. Judgment must accordingly be entered for the defendants.

The other Lord Justices delivered judgment to the same effect.

COMPANIES' MEETINGS AND REPORTS.

DIESEL ENGINE.

The eighth ordinary general meeting of the Diesel Engine Co. was held last week, Mr. C. C. Ellis (chairman of the Company) presiding.

In moving the adoption of the report, the CHAIRMAN reported that the progress of the previous year had continued, and that it could be confidently asserted that the business was on a firm basis. The purposes for which their engine was used were of such a varied nature that, even if an engine were invented which, perhaps, might suit one of those purposes better than their own, there would still be a very large field which would keep them quite well employed. The past had been the best year the Company had had. Last year's dividend was 5 per cent., and this year it was proposed to make it 10 per cent. Last year they carried £3,000 to reserve, this year they were carrying £7,000, which made £10,000 in all. Last year they had a carry forward of £3,488, and this year the figure was £7,203. Last year the cash in hand was £10,661, and this year it was £26 360. The net profit last year was £11,212, this year it was £20,721. The orders in hand on March 31 last year, which were carried over, were 9,442 b.h.p. This year the figure was 12,799 b.h.p., and since March 31 they had added about 900 b.h.p., making about 13,800 b.h.p. of orders in hand, the profits on which will come into the current year. The balance transferred from the trading account of the profit and loss account last year was £7,465 better than for the previous year, and this year they had added to that balance £9,810, being to that extent better than last year. Consequently in the two years they had made an increase in their profits of nearly £17,000. Orders had been received from very varied sources. They had received orders from the War Office, the Japanese Navy, the Indian Government, a large newspaper association, one of the largest electric light supply companies in London, Indian cotton mills in Bombay, and recently had completed a contract for the Indian Government for the largest irrigation scheme in the world that was to be driven by internal-combustion engines. Their licensees, Messrs. Mirrlees, Watson, and Co., asked permission during the year to erect new works in Manchester for the manufacture of Diesel engines. The directors had given them this permission, and as they thought it was desirable that they should have a share in this concern, they applied for £1,000 worth of their shares, but only £800 were allotted to them. They were at present negotiating with one of their other manufacturers, and the negotiations were proceeding very satisfactorily, for a new type of engine which may for some purposes be more suitable than the existing engine. They had arranged with the *Daily Mail* that an engine they had supplied to them should be utilised at their exhibit at the Franco-British Exhibition. This engine was to supply power for their printing press.

Mr. H. DE F. COX seconded the motion, which was unanimously carried.

A sum of £300 was voted for distribution among the staff.

LISBON ELECTRIC TRAMWAYS.

The annual general meeting of the Lisbon Electric Tramways Co. was held last week, the chairman, Sir Charles Euan-Smith, presiding.

In moving the adoption of the report, the CHAIRMAN remarked that during the past year the operations of the tramways had practically maintained the figures of the previous year in spite of several disadvantageous circumstances. Portugal had suffered from abnormal weather and a poor harvest, besides which the exchange, owing to political and other causes, had considerably declined. They had lost a certain amount of traffic in comparison with similar months in the previous year, but on the whole their system had maintained its service successfully and with very little derangement during the worst period of the unrest. The outlook, however, had improved, but it would not be right on his part to ask them to assume that the political horizon was absolutely clear. The shareholders would, therefore, thoroughly endorse the conservative and prudent policy of the Board in husbanding the Company's resources and maintaining a strong financial position. There had never been any difficulties between the Company and the Lisbon Municipality, and they had full confidence of a continuance of the equitable treatment they had always hitherto received at their hands.

Mr. L. BREITMEYER seconded the motion, which was unanimously adopted.

BUENOS AYRES TRAMWAYS.

An extraordinary general meeting of the members of the Buenos Ayres Grand National Tramways Co. was held on the 15th inst. at Winchester House, Old Broad-street, E.C., Sir Irving Courtenay presiding, to consider resolutions authorising the creation of £200,000 additional 5 per cent. conversion debenture stock, and such further amount as might be necessary to provide for the redemption of £150,000 5½ per cent. preference debentures, providing for the variation of the trust deeds so as to make the 6 per cent. debentures redeemable at £105 per cent. in the event of voluntary liquidation for the purpose of reconstruction or amalgamation, and authorising the directors to vary the agreements with the Buenos Ayres New Tramway Co. and other companies relating to the distribution of the receipts of the joint working of the tramway systems.

On the motion of the CHAIRMAN, seconded by Mr. C. M. ROSE, the resolutions were unanimously adopted.

MARCONI'S WIRELESS TELEGRAPH.

An extraordinary general meeting of Marconi's Wireless Telegraph Co. was held on Monday to consider the confirmation of a resolution adopted at a meeting on April 30, providing for the increase of the capital by the creation of 250,000 7 per cent. cumulative participating preference shares of £1 each. Major S. Flood Page presided.

The CHAIRMAN formally moved the adoption of the resolution, which was seconded by MR. MARCONI.

Various questions were put, the CHAIRMAN in his replies stating that the four stations alluded to at the previous meeting would be completed by the end of the year.

The resolution was unanimously adopted.

AUCKLAND ELECTRIC TRAMWAYS.

The tenth ordinary general meeting of shareholders of the Auckland Electric Tramways Co. was held on Wednesday, Mr. C. G. Tegetmeier (chairman of the Company) presiding.

The CHAIRMAN, in moving the adoption of the report, said the issued share capital stood at £350,000, the amount having been increased early in the year by the issue of £50,000 in 6 per cent. preference shares. The depreciation account stood in the previous year's balance-sheet at £41,134. They had added to the account out of last year's profits the sum of £10,000, and had charged the account with £18,726, being the cost of various renewals and reinstatements which were carried out during the year. Turning to the other side of the balance-sheet, "old tramways now reconstructed" stood at the same figure as before, £12,684, and real estate in Auckland showed practically no change at £19,495. In regarding their increase in capital expenditure, it had to be remembered that when the Company was formed it was not, and could not have been, anticipated that the traffic would develop to such a remarkable extent as it had. To carry, as they did last year, passengers equal in number to 300 times the whole of the population of the district, and on several special occasions, with a population of 75,000, to carry over 110,000 in one day, was, he thought, quite exceptional in the record of tramway undertakings. The estimates upon which the undertaking was based, which at the time were considered in some quarters unduly sanguine, had been largely exceeded, and the question of the provision of a larger margin of power and plant over actual and probable future requirements was specially under the consideration of their general manager, Mr. Walklate, and his assistant engineer, Mr. Wilkes, when they took up their duties in Auckland in May of last year. As to profit and loss account, their total traffic receipts amounted to £137,718, an increase of £7,382 over the previous year, and equal to an average of approximately £7,200 per route mile. They carried nearly 22½ millions of passengers, an increase of over 1,300,000 upon the number carried in 1906. The route mileage worked out the same, but they ran an increased car mileage of 156,000 miles, or an increase in the service of more than 8 per cent. over the previous year. On the other side of the account their expenses showed a material increase under each of the three principal heads into which they were divided. Power and running was £5,668 more. Of the total of £45,745, wages accounted for £35,157, an increase of £3,200, and their fuel bill was £1,600 more than in the preceding year, owing to their having used more coal and to their having had to pay a higher price for it. Repairs and maintenance showed an increase of £3,435, due principally to exceptional expenditure on the electrical equipment of the cars and to more money having been spent in the maintenance of the permanent way. After payment of £14,255 for debenture interest and providing £3,567, being the amount payable to the Auckland City Council for rental and percentage of profits, and after setting aside £10,000 to meet depreciation, they had a surplus on the year's working of £29,722, making, with the amount brought forward, an available balance of £32,823. The payment of the preference dividend to the end of the year would require £2,658, and they proposed to place £10,000 to the general reserve fund, and to pay a dividend on the ordinary shares at the rate of 6 per cent. per annum, which would absorb £18,000, and leave £2,165 to be carried forward. As stated in the report, it was only to a slight extent that the large capital expenditure they incurred during the year contributed to the year's revenue, although the year's profits were charged with the cost of the new capital which was raised to provide the money. Taking this into consideration, and in view of the somewhat exceptional increase in their expenses, the directors considered it prudent policy to pay the reduced dividend of 6 per cent., and to strengthen the Company's financial position by placing the substantial sum of £10,000 to the reserve fund. For the current year the results up to the present showed considerable improvement on last year. For the period up to April 24, on an increased car mileage of 40,700, they had carried nearly a million more passengers and taken £5,749 more in traffic receipts. The chairman then referred to a suggestion submitted to the Board by the Mayor of Auckland that they should enter into negotiations for the sale of the Company's undertaking to a local

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Tramways Board, who would obtain legislative authority to acquire and work the concern on behalf of and for the benefit of the various local bodies interested. He said that after full consideration, and with the concurrence of the principal shareholders, they had informed the mayor that if it was the desire of the citizens of Auckland that the tramways should be owned and worked by or on behalf of the various local bodies interested, the directors would be prepared to negotiate for the disposal of the rights and property of the Company on an equitable basis, having regard to the terms and tenure of the concession and to the present and prospective profit-earning capacity of the undertaking.

Mr. R. P. SIMPSON seconded the adoption of the report, which was agreed to.

PERTH ELECTRIC TRAMWAYS.

The report of the Perth Electric Tramways (Western Australia) for the year ended Dec. 31, 1907, states that the gross receipts for the year amounted to £75,041, as compared with £78,542 for the previous year, while the net profit amounted to £31,177, against £35,260. The traffics for the year 1906 were favourably affected by an exhibition which was held at Perth. After payment of interest and sinking fund on the first and second debenture issues and trustees' fees for the year, the balance at credit of profit and loss account is £13,656, which is carried to profit allocation account. To this is added the balance brought forward from last year—namely, £789—making £14,445, from which has to be deducted £6,000, dividend paid on preference shares for the year, leaving a balance of £8,445. Out of this a sum of £1,500 has been expended on capital account in respect of new car barn, new machine shop, etc., and will be carried to reserve account of undivided profits as in former years. It is proposed to apportion the total sum of £8,445 as follows: reserve account, expended in extensions, etc., £1,500; cash reserve fund, £1,000; dividend on ordinary shares at 5 per cent., £5,000; carry forward, £845. Including the above-mentioned sum of £1,500, a total of £23,625 has been expended out of profits on capital account. The sum of £4,276 shown in the balance-sheet as cash in the hands of the trustees, has since been utilised in the redemption of £4,130 of first mortgage debenture stock, reducing the debenture debt accordingly. The directors deeply regret the death of their colleague, Mr. R. C. Ogilvie, A.M.I.C.E., whose technical knowledge has been of great service to the Company. The vacancy, on the suggestion of some of the most influential debenture holders and shareholders, will be filled by the election of Mr. Richard Popkiss, M.I.C.E., whose engineering experience eminently fits him to fill the vacancy.

NEW COMPANIES REGISTERED.

Greystones Electric Light and Power Co., Limited.—Registered May 8 in Dublin. Capital, £3,500 in £1 shares. Objects: to carry on the business of electrical engineers, electricians, practical engineers, contractors, etc. Registered office: 5, Leinster-street, Dublin.

Riple Copper Mines, Limited.—Registered May 8 by Faithfull and Owen, 58, Lombard-street, E.C. Capital, £175,000 in £1 shares. Objects: to adopt an agreement with A. Barclay Meidell; to acquire any mines, mining rights, and land in Norway or elsewhere, and to carry on the business of miners and millers, prospectors, explorers, calciners, refiners, dressers, amalgamators, and preparers for market of and dealers in ores, metals, and mineral substances, etc. No initial public issue. Registered office: Finsbury House, Blomfield-street, E.C.

Liens Registered.

New Electric Rifle and Target Co., Limited (London).—A memorandum of satisfaction to the extent of £1,500 of a debenture dated June 13, 1906, securing £2,000, has been filed. Previous partial satisfaction registered, £500.

Bude Electric Supply Co., Limited.—Issue on May 4 of £1,800 5 per cent. mortgage debentures, part of series created April 14, 1908, to secure £2,500. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

Delhi Electric Tramways and Lighting Co., Limited.—Issue on April 29 of £3,100 debentures, part of series created Jan. 3, 1908, to secure £50,000, charged on the benefit of the Delhi Municipality Electric Licence of 1905 and the Delhi (Municipality) Electric Tramway Order, 1906, certain land in Circular-road, Delhi, between Lahore and Cabool Gates, containing 6,234 square yards, together with the erections thereon, tramway line, generating station and plant, and the company's undertaking and other assets, present and future, except uncalled capital. Trustees: R. C. Pearman, 21, Old-buildings, Lincoln's-inn, W.C., and J. Greig, 18, Belsize Park-gardens, N.W. Total amount previously issued of same series, £26,300.

Nairobi Electric Power and Lighting Co., Limited (London). A mortgage or charge, contained in a scrip certificate, dated April 23, 1906, to secure £250, has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital, but excluding £1,500 deposited in the joint names of the Crown Agents for the Colonies and the National Bank of India, uncalled capital on 16,000 shares to be hereafter numbered, and the contract dated July 26, 1906, between the Crown Agents and C. Hertzel, save as the company shall hereafter, with the previous consent of H.M. Commissioner of the East Africa Protectorate or the said Crown Agents on his behalf, subject the same to such charge. Holder: Lieutenant R. C. Bayldon, Nairobi, British East Africa Protectorate. The above is an equitable charge to operate pending the issue of the debentures.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Weymouth.—The Town Council have decided to purchase a turbo-generator at a cost of £3,707.

Worksop.—The Urban District Council have decided to purchase an economiser for the electricity works at a cost of £325.

Bray.—The Town Council are seeking sanction to the borrowing of £4,792 for the installation of a suction gas plant and engine.

Sheffield.—The City Council have decided to install the electric light from the town hall to Blonk-street at an estimated cost of £107.

Stoke-on-Trent.—The Board of Guardians have decided to have the batteries at the electricity works provided with separators at an estimated outlay of £20.

Stepney.—The Electricity Committee are recommending the lighting of Commercial road, Brook-street, and Old Gravel-lane to the Council at an estimated outlay of £540.

Berwick.—The Council have decided to adopt a scheme for lighting the town with electric flame arc lamps in the main streets and gas lamps in the side streets at an outlay of £745 per annum.

Change of Title.—The title of the London Electrical Fittings Co., of 15, Newman-street, Oxford street, W., has been changed, and the business is carried on under the name of Galsworthy, Limited.

Liquidation.—According to the *London Gazette* the Britannia Electric Lamp Works (1905) has been wound up voluntarily, and Mr. J. Berryhill Cross, 65, Linzee-road, Hornsey, appointed liquidator.

Overton.—The Rural District Council have decided to allow the Postmaster-General to erect an overhead telegraph service on the Hall Green-road, between Redbrook post office and the back drive of Iscoyd Park.

Hove.—The Corporation Electricity Committee are considering the advisability of laying a main for electric lighting in Boundary-road, between New Church-road and Seaford-road, at an estimated cost of £210.

Notice of Dividend.—The *London Gazette* announces that a first and final dividend of 2s 0½d. in the £ has been declared in the estate of Mr. W. A. Roderick, electrical engineer, 12, Penmaen-street, Swansea.

Swansea.—The Swansea Harbour Trustees have decided to erect two electricity power stations at the new King's Dock, and the matter has been referred to a sub-committee. The total cost will be from £25,000 to £30,000.

Bedford.—The Electricity Committee are recommending the laying of an additional length of cable in Ampthill-road at an estimated cost of £250; also that an engine at the works be reconstructed and fitted with a new exciter at an estimated cost of £938.

Lowestoft.—The Electric Lighting Committee's report shows that there are connected to the mains 899 consumers, representing 44,516 8-c.p. lamps. During the past month 11 new consumers, representing 30 8-c.p. lamps, were connected, including one motor.

Fulham.—The Electricity Committee are recommending the Council to lay additional mains to Stephendale Works at an estimated cost of £350; also to extend the cables to Kenyon-street at a cost of £31, and to erect five lamps in the street at an outlay of £15.

Farnham.—An application has been made to the Board of Trade by the Farnham and District Electric Supply Co. for consent to the placing of electric lines above ground throughout the urban district of Farnham (except in Castle-street) for the purpose of the supply of electrical energy.

Tunbridge Wells.—At the Corporation meeting last week there was a renewal of the controversy as to whether the Watch Committee or the Electricity Committee should have the control of the street lighting, and in the end the control was restored to the Electricity Committee.

Heolycyw.—The electors of Coychurch Higher, which place, consequent on developments at Brynwith and Raglan Collieries, has now a population of about 900, have decided to erect a public hall, and the Raglan Co. will supply the building, when ready, with electric light from their generating station.

Grimsby.—At Monday's meeting of the Council's Electric Lighting Committee the engineer reported that, after providing for all working expenses, repayment of loans and bank charges, a profit of £2,442 had been made. The committee allotted the profits to form the nucleus of a depreciation account.

Seaford.—The Urban District Council are asking the gas company to reduce the present charges for street-lighting. No less a sum than £3. 8s. 6d. per lamp per annum is demanded, and strong complaints were made at the last Council meeting as to the wretched light given by the gas lamps for which the above payment is made.

Heswall.—The Electric Lighting Provisional Orders (No. 1) Bill, which seeks to confirm, among others, the provisional orders for the electric lighting of Heswall and Calday Manor Estate, came before the Examiner of Standing Orders Proofs at the House of Commons on Monday last. The examiner allowed the Bill to proceed.

Alteration of Partnership.—Mr. M. Mansell, of 12, Soho-street, W., has purchased the interest of Mr. J. Elliott, his late partner, and asks us to state that he is now solely responsible for all debts incurred to date and for all future debts which may be incurred by him under the title of Elliott and Mansell, electrical engineers and contractors.

Windsor.—Keen competition in tendering for lighting the main streets has taken place between the gas and electric supply companies, The gas company made a bold bid to oust the present illuminant, and

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offered to supply the Council with 23,640 c.p. for £1,193. 13s. 6d. The electricity supply company offered 80,000 c.p. for £1,852 per annum, which has been accepted by the Council.

Yarmouth.—The Finance Committee are recommending the Council to make application to the Local Government Board for sanction to loans to the amount of £2,000 for electricity mains. Lamps are to be erected and lighted by electricity at Beckett's-buildings, South Market-road, Edinburgh-place (next Sailors' Home); Saloon-street, Runham Vauxhall; and Cliff-hill, Gorleston.

Bexhill.—At the last meeting of the Council the news that the electric light works had had a splendid year was received with applause. The gross profit was £4,451. 9s. 3d., leaving a net profit of £1,017. 15s. 9d. The debit balance of £693 has been cleared off and the undertaking now has a balance to the good of £190. This, said the chairman of the committee, reflected the highest credit on the electrical engineer.

York.—The City Council have made application to the Local Government Board for sanction to the borrowing of the following sums, which are estimated will be required during the next two years or so for the undermentioned purposes in connection with the supply of electricity: for main services, £900; for main extensions, £5,000; for meters, £500; for motors, £800—making a total of £7,200. The Local Government Board will hold an inquiry on June 2.

Oldham.—At the last meeting of the Electricity Committee the engineer reported that the station costs for the preceding fortnight amounted to £546. 2s., as compared with £438. 5s. 2d. for the corresponding period last year. The increase he attributed principally to the rise in the price of coal. The number of arc lamps fixed at the previous meeting was 357, incandescent 24,708—an increase of 2 and 28 respectively. The total number of arc lamps is 359 and 24,736 incandescent.

Whitehaven.—At the last meeting of the Town Council the accounts of the electricity undertaking for the past year were submitted, showing that the receipts realised £4,963, an increase of £188 on the estimate, all the items showing increases. The expenditure was £6 239, £56 less than the estimate. The difference is £1,267, but £54 is added to receipts as an increased value of stores in hand. This reduces the deficit to £1,223 as carried to general district account. Last year's deficit was £1,031.

Foleshill.—At the last meeting of the Council the surveyor presented a draft agreement in connection with lighting the hospital with the Newdigate Colliery Co. for the supply of power, the Council undertaking to accept not less than 2,400 units at 4d. per unit per annum. The minimum payment to the company each year was to be £40, and the contract to be binding for 10 years. At the end of this period six months' notice to terminate the arrangement could be given by either side. The Council accepted the agreement.

Shrewsbury.—It was reported at the last meeting of the Council that the consumption of electric current showed an increase of 10·4 per cent. compared with the corresponding quarter last year. The revenue account for the year ending March 31 gave the following figures: General receipts, £7,470. 1s. 3d.; value of stock in hand, £649. 14s. 3d.; sundry debtors for current up to March 31, £2,338 19s 6d.—total, £10,458. 15s. After paying off interest on loans, sinking fund transfer, reserve fund transfer, etc., there was a credit balance of £345. 0s. 7d.

Denny.—The Council have considered with the engineer the conditions of contract and specification and schedule for construction of overhead electric lines from the proposed sub-station behind the public hall to Bridgend and the head of Glasgow-road, and of switchboard to be erected at the sub-station, and have agreed that the engineer should prepare and submit an adjusted specification. The power company have not yet sent a plan of transformer house; when this is done the engineer will meet the convener, and adjust plan and specification for the erection of the sub-station.

Mansfield.—The engineer reports 29,579 units passing through station meters during April, an increase of 767 on the year; traction units generated, 45,665—increase, 6,851. The question of dealing with the men in the employ of the Corporation who are in the Territorial forces has been referred to the General Purposes Committee, and the town clerk is to obtain a list of all the men affected in the various departments. The draft agreement for the supply of electricity to the tramway company has been approved by the Electricity Committee, who are recommending the Town Council to affix the seal of the Corporation.

Newport.—At the Town Council meeting a letter was received from the gas company in reply to a communication from the Corporation requesting the company to discontinue the lighting of the gas lamps in Fields Park-road, Fields-road, Oakfield-road, Westfield-road, and Clytha Park-road, as the Corporation had decided to light these streets in future by 27 electric Osram lamps. The company's letter urged that gas was better and more economical, and invited the Corporation to take part in a trial between the rival lights before independent lighting experts. The Corporation, having had an experience of both illuminants, decided to proceed with their scheme to light the streets with electricity.

King's Lynn.—At the last meeting of the Electricity Committee the engineer reported that since the previous meeting an application had been made for 28 lamps of 8 c.p. or equivalent, making a total of 621 private connections and 29,498 lamps. The following statement was submitted: units generated March, 1908, 53,619, against 49,227 units for March, 1907; total units sold to private consumers (light and power), 30,933, against 26 362; units sold at lighting rates, 16,110, against 13,191; units sold at power rates, 14,823, against 13,171; cost of fuel, stores, repairs, and wages at station, £160. 3s. 4d., against £141. 17s. 8d.; cost per unit generated, 0·7169d., against 0·6917d.

Sowerby Bridge.—The House of Lords Examiner on Unopposed Bills had before him on the 18th inst. for proof of compliance with the Standing Orders a Bill to confirm an electric lighting provisional order relating to Sowerby Bridge. The Bill amends the order of 1900. The principal provisions relate to supply in bulk, amendments as to compulsory works, and power to transfer. At any time within one year after the commencement of the order the undertakers may, with the consent of the Board of Trade, transfer or lease any part of the undertaking to the Electrical Distribution of Yorkshire. The Standing Orders having been found duly complied with, the examiner reported the Bill for second reading.

Isle of Ely.—The Southern Roads District Committee have resolved, and their decision has been confirmed by the County Council, that consent be given to the placing and maintenance of an overground telegraphic line along the Whittlesey-March main road, from a point near the Whittlesey Union Workhouse to the Council's boundary on the east side of the Three Horse Shoes level crossing, on the condition that the poles be placed in such positions as shall be approved by the county surveyor, and that the Postmaster-General make good any damage that may be done in the placing or maintenance of the line, and agree to alter the position of the poles within 14 days after being requested to do so by a written notice from the county surveyor.

Staffordshire.—At the last meeting of the County Council the Main Roads and Bridges Committee recommended that the application of H.M. Postmaster-General for permission to erect an overground telegraphic line along the Kingsley-Froghall road, between the Department's existing line at St. Werburgh's Church, Kingsley, be acceded to, subject to the positions of the poles being agreed to by and the roads and footpaths restored to the satisfaction of the chief surveyor. The committee reported that satisfactory arrangements had been come to with the National Telephone Co. on the subject of telephonic communication in the county buildings, under which greater facilities will be provided and a smaller cost entailed than that now being paid.

Twickenham.—A letter was read at the last District Council meeting from Mr. F. E. Gripper, general manager of Edmundson's Electricity Corporation, stating that the amount shown on the Twickenham Co's balance-sheet of Dec. 31, 1906, against mains was £49,136. 5s. 4d. These mains were all laid within the district of Twickenham. Of the amount £3,849. 1s. 2d. represented the cost of the trunk mains laid in the Twickenham district, which were not in any way used for supplying that district, but were high-pressure trunk mains, conveying electric energy to outside districts. In the case of the Twickenham Council purchasing the undertaking they would take over the mains to the value of £45,287. 4s. 2d. These figures had been carefully gone into by the Board of Trade auditor, and approved.

Stock Exchange.—The Stock Exchange Committee have appointed May 28 a special settling day in the Charing Cross, West End, and City Electricity Supply Co.'s provisional certificates, fully and partly (50 per cent.) paid, for £301,630 4½ per cent. debenture stock, and have ordered the undermentioned securities to be quoted in the official list: Calcutta Tramways Co.'s further issue of 3,176 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 42,129 to 45,304; Charing Cross, West End, and City Electricity Supply Co.'s £111,700 4½ per cent. debenture stock, and provisional certificates, 50 per cent. paid, for £301,630 4½ per cent. debenture stock; and Mexico Tramways Co.'s 300,000dol. additional first mortgage 50-year 5 per cent. gold bonds, Nos. 12,001 to 12,500 for 500dol. and 31,501 to 32,000 for 100dol. each.

Luton.—At the last meeting of the Electric Light and Power Committee the chairman and the electrical engineer were appointed delegates to the municipal electrical conference at Nottingham. The engineer reported that since March 20 last 136,090 units had been generated, an equivalent of 252 8-c.p. lamps, and four motors of 30½ h.p. connected, making a total of 482 consumers, with 26,402 lamps and 227 motors of 1,403½ h.p.; that the units generated showed an increase of 76 per cent. over the number generated during the corresponding period of last year; and that at the present time applications were in for over 1,450 additional lamps and 280 h.p. in motors. The electrical engineer also reported he had received an application for electric current in Ashburnham-road, compliance with which would necessitate the extention of the main at a cost of approximately £116. It was resolved that the question be considered.

Ayr.—At the last meeting of the Town Council a minute of meeting from the Lighting Committee showed that letters had been received from the clerk of Ayr District Committee and the town clerk of Prestwick naming certain conditions on which these public bodies would agree to the extension of the lighting area to Alloway and Prestwick respectively. The condition of the District Committee was that the Ayr Town Council should place electric lights on every second standard of the tramway from the end of Rozelle Woods to Burns Monument, and one of the conditions of Prestwick Town Council was that the Ayr Town Council should light the main street of Prestwick till the last car left. The committee had unanimously agreed to recommend the Council not to proceed further with the proposed extension in view of the unreasonable conditions. The meeting unanimously resolved to accept the recommendations.

Walsall.—On the 15th inst. Mr. W. O. E. Meade-King, M.I.C.E., held an inquiry at the Council House as to a proposal by the Council to borrow £4,000 for the development of the electrical undertaking. The town clerk, Mr. J. R. Cooper, represented the Council, and explained that £2,600 of the desired loan would be for the provision of a condensing plant. At present 12,873,000 gallons of water were used, which at the price of 9d. per 1,000 gallons cost £483, but with the condensing plant the cost was estimated at only £121. The present consumption of coal was 9,160 tons, costing £3,600, and it was hoped to reduce this to £2,880. After allowing for repairs and maintenance, interest, and repayment of capital, it was estimated that

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£500 a year would be saved by the provision of this new plant. Of the remainder of the loan, £1,000 was required for mains and services and £400 for meters, which were needed owing to the rapid expansion of the undertaking. The plans and estimates were submitted by Mr. Barnard, the electrical engineer, and subsequently the inspector visited the works.

Glasgow Electrical Engineers.—The annual meeting of the Glasgow Local Section of the Institution of Electrical Engineers was held on the 12th inst. at 207, Bath-street. Prof. Baily presiding. The report stated that the membership had increased steadily and satisfactorily, the figures being 49 members, 116 associate members, 44 associates, and 85 students—a total of 294. The committee is now constituted as follows: chairman, Mr. W. W. Lackie; past-chairmen, Mr. John M. M. Munro and Prof. Francis G. Baily; vice-chairman, Mr. Sam. Mavor; chairman of students' section, Prof. Magnus Maclean; hon. secretary and treasurer, Mr. James E. Sayers; members, Mr. Chas. Day, Mr. Frank Newington, Mr. J. S. Nicholson, Mr. J. K. Stothert, Mr. Wm. M'Whirter, Mr. Joseph Taylor, Mr. Robert Robertson, Mr. E. George Tidd, and Mr. J. Robertson. The report was adopted. A paper by Messrs. H. W. Handcock and A. H. Dykes on "Electric Supply Prospects and Charges as affected by Metallic-Filament Lamps and Electric Heating" was read by Mr. A. H. Dykes.

Birmingham Electric Club.—An interesting paper upon "Electrical Porcelain" was read to the Birmingham Electric Club on Saturday evening by Mr. H. W. Brady. He stated that the critical event in the history of the art of pottery in Europe was the introduction of Chinese methods for making true porcelain. The term for this substance was derived from the Italian "porcelana," originally a diminutive of "porca" (Latin), meaning a pig, which was applied to the white-surfaced Venus shell on account of its resemblance to a pig's back. Particulars were given of the origin of the clays and other ingredients that go to the making of a first class porcelain insulating material capable of withstanding high electrical pressure. The superiority of English over German insulators was pointed out, and particulars were given of high-tension tests applied to the former up to 900,000 volts. The lecturer also dwelt upon the difficulty of producing porcelain in complicated shapes of exact size owing to the shrinkage under firing at a sufficiently high temperature to secure vitrification, not only of the surface but throughout the substance. The paper, which was listened to with much interest, was illustrated by lantern slides and by specimens of high-tension insulators and the materials used to produce them, which were lent by Messrs. Bullers, Limited.

Alloa.—At the last Council meeting the convener of the Electricity Committee submitted his report on the electricity supply to the town. The report contained interesting statistics and details as to the undertaking. The general results showed that for the first five years the loss to the burgh in the electricity department amounted to £2,576, or an annual loss of £515. The reason was that the turnover in the trading account was not nearly sufficient for the amount of capital expenditure, and the difference between the buying and the selling price was so small that there was no real chance of making a profit with the turnover as at present. In 1907 the amount paid to the British Electric Plant Co., Alloa, for current was £1,081, and this was retailed to consumers at £1,159, showing a gross profit of £78. Deducting sinking fund and mortgage interest, the loss for the year was £573. The Electricity Committee had approached the British Electric Plant Co. with the view of terminating the present agreement, but the terms asked by the company were prohibitive, so that the committee were not in a position to place any proposal or recommendation before the Council. He thought, however, that, both in the interest of the Council and the users of the current, the Council should insist on the terms of the agreement between the Council and the British Electric Plant Co. being carried out. The report gave rise to a lengthy and animated discussion, and in the end the whole question of electricity supply was remitted to the sub-committee to further consider and report to a future meeting of the Council.

TRACTION.

Ashton.—The Corporation Tramways Committee have decided to increase the wages of their inspectors from 33s. to 35s. per week.

Croydon.—The County Council have decided to replace the feeder cable from the Swan to the power station at an estimated outlay of £1,077.

Madras Electric Tramways (1904).—The receipts for the fortnight ending May 15 amounted to Rs.19,376, being an increase of 10·2 per cent. over the corresponding period of 1907.

Keighley.—The neighbourhood of Crosshills, Steeton, Eastburn, and Sutton has been petitioned by the Keighley Corporation for the purpose of considering the desirability of extending the tramways to Crosshills.

Glasgow.—Passengers carried last week numbered 4,426,503, a decrease from the corresponding week last year of 124,669, and the receipts amounted to £17,680. 11s., a decrease of £482 10s. 5d. Receipts for 50 weeks, £868,713. 16s. 1d.; increase, £14,040. 10s. 5d.

Buenos Ayres and Belgrano Electric Tramways Co.—The receipts for the week ending May 13, 1908, converted to gold were £4,044; corresponding period last year £3,985—increase, £59. Aggregate from Jan. 1, 1908, £72,208; aggregate from Jan. 1, 1907, £71,477—increase, £731.

Ayrshire.—At a meeting of the Northern District Committee of Ayrshire County Council a letter was read from the agents for the promoters of the Largs and Wemyss Bay tramway scheme, intimating that it had been decided to hold the matter over owing to the opposition of the County Council.

Stalybridge, Hyde, Mossley, and Dukinfield Tramways.—The traffic receipts for the week ended May 9, 1908, amounted to £713. 1s. 4d., against a total for the corresponding week of last year of £810. 19s. 4½d.

Birmingham.—The profits of the Birmingham tramways for the past year amount to £121,000, which is about double the previous year. The disposable balance is £72,000, out of which it is proposed to place £37,000 to the reserve fund and contribute the remaining £35,000 to the relief of rates, which is £23,000 more than last year.

Edinburgh.—The Tramway Committee of the Edinburgh Town Council have had under consideration the slow progress which is being made with the cabling operations in Broughton-street. The town clerk has been instructed to write the tramway company pressing for the work being expedited and finished as early as possible.

Ripley.—A notice has been received by the Urban District Council from the Nottinghamshire and Derbyshire Tramways Co. of their intention to apply to Parliament for power to carry out an arrangement with the Nottingham Corporation for taking over certain tramways, and for an extension of time in which to purchase the same.

Lowestoft.—At the last meeting of the Town Council the Tramways Committee reported that the total receipts from Oct 1 to date were £4,571. 3s 1d., against £4,471. 13s. 6d. in the corresponding period of last year. The engineer reported that he required a small track grinder for use on the points, and was authorised to obtain one at a cost of £11. 6s.

Leith.—At a meeting of the Tramway Committee of the Edinburgh Town Council it was stated that all the clauses about which there had been dispute between Edinburgh and Leith in regard to the tramway extensions proposed by Leith had now been adjusted, and it was expected that the Bill would come before Parliament either on Friday of this week or on Monday.

Blackburn.—The traffic returns for the Blackburn Corporation tramways for the week ending May 6 show that during that period 201,539 passengers were carried, the receipts amounting to £1,048. 16s. 2½d., a decrease of 3,195 passengers and £14. 2s. 2½d. on the corresponding period last year. For the 42 days' running in the year the receipts were £6,961. 14s. 6d., an increase of £47. 2s. 9d. over the previous year, and of £619. 9s. 2½d. over 1906

Belfast.—The Corporation electric tramways have not proved the success which had been hoped, the accounts for the year ended March 31 showing a heavy loss. In consequence of this the general manager was instructed to reduce the services and make all other possible economies. Notices of dismissal have been served on upwards of 40 motormen and conductors. The tramways were taken over and electrified by the Belfast Corporation three years ago.

Derby.—The receipts of the Corporation tramways during the month ended April 25 last amounted to £4,235. 7s., being an increase of £316. 9s. 9d. as compared with the corresponding period of last year. The committee have decided to engage Messrs. Nash and Sons to test materials to be used in the extension of the Burton-road route. The Council are recommended to appoint Mr. E. Banner as clerk of the works for the extension of the Burton-road route at a salary of £3. 10s. a week. The Council are also recommended to grant the sum of £85 for the purchase of a track grinder.

Leeds.—The Corporation Tramways Committee have discussed the question of removing from the centre of Boar-lane the poles which support the overhead tramway cables. If this could be accomplished it would be possible to widen the road space available for traffic other than the tramcars by 18in. between the rails and the kerb on either side of the thoroughfare, besides improving somewhat the appearance of the street. As the lines in Boar-lane are to be relaid in the course of a month or two, the committee have decided to recommend the Council to remove the poles when the relaying takes place. In that case the cables would be supported from side poles or from suitable points on the buildings at either side.

Bothwell.—The Bothwell Parish Council at their monthly meeting unanimously agreed to petition the County Council to request the Glasgow Corporation to proceed with an extension of their tramway system to Bellshill. The route proposed is from Broomhouse, *viâ* Aitkenhead, Tannochside, and Bothwell Park, the distance from the city being over seven miles. The road is regarded as suitable for the purpose, and in the event of the extension being proceeded with Bellshill and Mossend will ultimately be in the enviable position of having the use of two systems, as the Lanarkshire Tramway Co. have given an undertaking to commence the laying of a new track within 12 months, and complete the work within three years.

Heyside.—Shortly before 10 o'clock on Sunday evening, what might have resulted in a very serious tram smash occurred near the Lancashire Hotel, Heyside. An Oldham Corporation electric car was being driven to Shaw, when it failed to take the points at this particular spot. The result was that the car left the rails, and although the driver at once applied the brakes the car went over the kerbstone, across the footpath, and crashed into a house. The impact was very great, and a portion of the front of the house was dislodged! The flags on the footpath were badly broken. Luckily no one was injured, although the passengers suffered from fright. It took some considerable time to replace the car. This is not the first time that a car has missed the points at this spot.

Walsall.—The following are the particulars respecting the working of the tramways during the four weeks of April and the corresponding weeks in last year—viz.: Four weeks ending April 27, 1907—number of passengers, 366,024; receipts, £1,937. 19s. 11d.; car miles run, 43,087; receipts per car mile run, 10·79d. Four weeks ending April 25, 1908—number of passengers, 398,983; receipts, £2,237. 18s. 2d.; car miles run, 50,286; receipts per car mile run, 10·68d. Wages paid, including repair of permanent way—four weeks ending April 25, 1907, £571. 10s. 8½d.; four weeks ending April 23, 1908,

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£632. 8s. 2d. The manager has been instructed to have one of the new cars fitted up with an electro-mechanical track brake at a cost of £33, with a view to testing its efficiency.

Clydebank.—At the last meeting of the Council a letter from the manager of the Glasgow Corporation tramways with reference to the county tramways was considered. The letter explained that the Dumbartonshire Tramway Co. desired to make a connection between their tramway system and that of the Corporation at the bridge over Duntocher Burn, and they asked the consent of the Council. It was stated that on the bridge the line of rails would only be 18in. clear of the footpath on the north side of the road, and it was recommended that no such connection should be made until the bridge is widened to such an extent as would permit the tramways to pass over it with an ordinary degree of safety to the public. It was agreed to defer further consideration until another communication was received from the company.

Drighlington.—At the last meeting of the Urban District Council the clerk read a letter from Mr. Sydney Morse, London, *re* Spen Valley and Morley Light Railways (Extension) Order, 1902, stating that he had been in communication with Mr. Oppert as to dealing with the unconstructed portion of these railways, and he was glad to say that Mr. Oppert was prepared to give careful consideration to the suggestion made by Mr. Askwith and to discuss the terms with the local authorities. In these circumstances it seemed to him that it would facilitate matters greatly if a cesser of powers were granted to the promoters, thus leaving a clear field to Mr. Oppert and the councils In reply to a question as to when the construction of the tramway would begin, the clerk said he had received no further communication.

Southampton.—Alderman Dunsford, chairman of the Tramways Committee of the Southampton Corporation, has just informed the Council that the position of the undertaking this year is as follows: on their depreciation fund they carried forward something like £8,000; in regard to their third-party insurance fund they had a nest egg of £2,000; their sinking fund was over £40,000, and that, together with the £23 000 they had already given to the ratepayers, made, he thought, a very handsome return from their tramway undertakings. The committee thought it was impossible to have at Southampton such an accident as at Bournemouth, but with all their care accidents might happen, and they, therefore, were going to build up their reserve fund to £20,000 (£10,000 of which they had at present), and when they had that amount accumulated they would be as generous to the ratepayers as possible.

Portslade.—A serious tramcar accident occurred near the bottom of Fishersgate-hill, Portslade, about 7.15 on the evening of the 17th inst., as the result of which several passengers sustained painful injuries. The tram, which was driven by John Clark, was descending the incline, travelling in the direction of Hove, at the time, and the mishap occurred at a place where there is a loop line, a few yards from the Britannia Flourmills. It is presumed that there was, perhaps, some obstruction at the points. However that may be, the tram left the line, and after going on two side wheels for a brief period, turned bodily over on its side. The driver escaped unhurt, and most of the passengers on the top also escaped injury of any consequence, although one man, named Hemsley, sustained injury to his ribs and was conveyed to his home at Shoreham. The car turned over very steadily, and it was due to the fact that the persons on the outside were able to cling to the seats and rails that they got off so lightly as they did.

Southend —At the Burnham Public Hall on Wednesday week, before Colonel G. F. O. Boughey, R.E., C.S.I., and Mr. H. A. Stewart, an inquiry was held into the application of the Southend and Colchester Light Railway Co. for extension of time to construct certain railways and additional powers. In 1904 the company obtained an order to construct light railways from Prittlewell by way of Creeksea, Burnham, Southminster, Bradwell, and West Mersea to Colchester. They were allowed until Sept. 31, 1909, to carry out the works, and the present application is to obtain an extension of time until September, 1912, permission to construct an additional light railway between Creeksea and Burnham, and also compulsory running powers over a part of the Southend tramways system between Southend and Prittlewell, so as to join up the company's line at the top of North-street, Prittlewell. The company also applied for compulsory powers to alter the gauge of the Southend light railway to suit theirs. After hearing evidence for and against the inquiry was adjourned.

Weston-super-Mare.—At the monthly meeting of the Council the Works Committee reported that they had further considered an application from the Weston-super-Mare and District Electric Tramways Co. for permission to construct a proposed alteration to Birnbeck Pier terminus in accordance with plans therewith transmitted for approval under Section 17 of the Weston-super-Mare Tramways Order, 1900, and now produced. It was unanimously resolved to recommend to the Council to decline to consent to the application and that the plans be disapproved. The clerk also read a notice he had received from the Weston-super-Mare and District Electric Supply Co. of their intention to apply to the Board of Trade to prolong the time limit for the completion of the tramways until June 6, 1909, and intimating that objections should be made on or before May 27, 1908. It was resolved that the clerk be instructed to object on behalf of the Council to the application so far as it applies to any extension of the tramway from its present termination in Birnbeck-road in direction of the posts defining the entrance to the private approach road to the pier.

West Ham.—The tramways manager reported to the Tramway Committee at the last meeting that 77 per cent. of the motormen eligible and 70 per cent of the conductors, or, in other words, 74·3 per cent. of the men eligible, had earned bonuses. The payments for the quarter were £108. 0s. 2d. Eighty-nine motormen and 34 conductors also received an additional £1 per head for having received four quarterly bonuses during the year. He asked permission of the committee to obtain for each of these a badge or bar, to be worn during the year. The award in connection with the bonus scheme of 5s. each to the conductors who are above the average of their group in the collection of fares during the March quarter was made on the 10th inst., 85 conductors benefiting to the extent of £21. 5s. Of these 85, 39 were included also in the list under the other bonus scheme and 46 were not. It will thus be seen that the total bonus payments for the March quarter amounted to £252. 5s. 2d., and that 248 motormen and conductors benefited to the average extent of £1. 0s. 4d. each. The manager was directed to get a badge or bar for those who had earned the four bonuses.

Cardiganshire.—At a meeting of the County Council at Lampeter, Mr. J. C. Harford, Falcondale, Lampeter, brought forward once more a resolution in favour of light railways. According to the Finance Committee, it appeared that Mr. Cooke, of Bristol, solicitor for the promoters of the Lampeter, Aberayron, and New Quay light railway, had met that body and stated on behalf of the promoters that it was proposed to proceed with the construction of the first portion of the railway—viz., that between Lampeter and Aberayron. The Treasury had arranged to make for that purpose a loan of £20,000 at 3½ per cent., to be repaid by instalments extending over a period of 25 years, the first instalment of the repayment to be postponed for two years from the commencement of the work of construction. Several tenders had been received, all cash contracts, but the promoters were inclined to accept the tender of £67,208, the whole cost of the railway being £81,000. It was stated that the cost of the remainder of the line—viz., from Aberayron to New Quay—would be larger in proportion to that of the portion now proposed to be made. The promoters had applied to the Council to advance £15,000—viz., £11,250 to be secured by debentures and £3,750 to be taken in ordinary shares—and they were applying to the Lampeter Town Council and the District Councils of Lampeter Rural, Aberayron Urban, and Aberayron Rural for an advance of £5,000 to be similarly secured.

Battersea.—At the last meeting of the Borough Council the Highways and Dusting Committee reported that they had considered the letter from the London County Council with reference to the proposed electrification of tramways from East-hill, Wandsworth, to Nine Elms lane, in which they point out a difficulty that has arisen as regards the necessary widenings in the borough of Lambeth. With the concurrence of the Finance Committee, it had been suggested to the London County Council that the needs of the boroughs of Battersea and Wandsworth might be met by alternative routes until such time as the Lambeth Borough Council may come to an agreement with the County Council—viz, by Falcon-road and by Queen's-road. The Falcon-road tramways are already converted, and it has been decided to electrify the tramways in Queen's-road, and, if the tramways in East-hill, St. John's-hill, and Lavender-hill are converted, electric cars will be able to run to town from East-hill *via* either Falcon-road or Queen's-road. The projection of such a course might facilitate negotiations between the County Council and Lambeth. Only single-deck cars could be used on the Queen's-road route, owing to the limited headway under two of the railway bridges. With reference to this matter, the Finance Committee reported that they concurred with the proposal made to the London County Council to proceed with the electrification of the route from East-hill as far as Queen's-road. This was agreed to.

Newcastle.—At the last meeting of the Corporation Tramways Committee it was decided to open the Market-street extension as soon as the Board of Trade's sanction was received, which is expected towards towards the latter end of next week. It is proposed that the cars now running from Scotswood Bridge and the toll-house will journey along New Market-street. The engineer and general manager of the tramway department presented a return for the period ending March 31 last showing the income and expenditure of the cars during that time. This shows that the trams have earned £19,477. 12s. 4d. profit, which with £1,551. 9s. 8d. to be utilised in paying the annual instalment in connection with the old horse trams, makes a total net profit of £21,029. 2s. The traffic expenses during the 12 months amount to £58,583. 4s. 1d., and include £39,302. 5s. 9d. for wages of motormen and conductors. The expenses for the previous year amounted to £56,001. 1s. 5d. On general expenses £17,609. 2s. 7d. was spent, as compared with £16,535. 18s. 2d. General repairs and maintenance absorbed £22,570. 6s. 1d., as against £20,481. 7s. 4d. The total working expenses amounted to £116,852. 6s. 4d. In the previous year the amount was £107,318. 19s. 9d. During the year £34,094. 13s. 6d. was spent in interest on loans and £34,878. 5s. 1d. was placed in the sinking fund. The total traffic receipts worked out at £205,322. 6s. 5d. This represents a net average of 11·17d. per car mile. Last year the receipts were £205,261. 16s. 6d. and per car mile 11·56d. During the year £5,370. 17s. 6d. was received for lighting purposes, as compared with £4,132. 5s. 3d. During the year the cars ran 4,411,745 miles, as against 4,263,174. It was decided that there should be a special meeting of the committee to consider the returns before they are sent on to the City Council.

APPOINTMENTS VACANT.

Draughtsman, Ferranti, Ltd., Hollinwood. See advertisement.

Traveller for the Midlands to represent manufacturers of electric lighting accessories and switchgear. Applications to J. H. Tucker and Co., King's-road, Hay Mills, Birmingham. See advertisement.

Professor of Mechanical Engineering, Poona College of Science. Salary, Rs 500 per month, rising by annual increments of Rs.50 to Rs.1,000, with a pension. Applications to the Secretary, Public Department, India Office, London, S.W., by June 15.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

Woolwich.—Tenders are invited for the supply of coal for the electricity works for one year.

Orsova.—The Municipality require tenders for public electric lighting for 50 years. Tenders by June 1.

Tarragona.—Tenders are invited for the erection of an electricity generating station. Tenders by May 31.

Melbourne.—The City Council invite tenders for the supply and delivery of one 500-kw. motor-generator. Tenders by July 3.

Queensland.—The Postmaster-General invites tenders for battery glassware, etc., battery material and chemicals. Tenders by June 1.

Stockport.—Tenders are invited by the Tramways Committee for automatic point controllers. Particulars from the Borough Electrical Engineer.

Toulon.—Tenders are invited for electrically lighting coal depôts. Particulars from the Director of Hydraulic Works, Toulon. Tenders by May 30.

Gravesend.—The Town Council invite tenders for the erection of an electrical sub-station at Rosherville. Tenders to the Town Clerk by May 29.

Hanley.—The Corporation invite tenders for the supply of arc lamps and lamp columns. Particulars from Mr. C. Yeaman, borough electrical engineer.

South Australia.—The Postmaster-General invites tenders for telephone material, telephone instruments, and telephone switchboards. Tenders by June 3.

Dartford.—The Urban District Council invite tenders for surface-condensing plant. Particulars from the Clerk to the Council. Tenders by June 3.

West Ham.—The Guardians invite tenders for the supply of engineer's oils for a period commencing June 1 and ending Oct. 3. Tenders by May 28.

Leith.—Tenders are invited for the annual supply of coal to the electricity station. Particulars from the Burgh Electrical Engineer. Tenders by May 25.

Sofia.—Tenders are invited for the installation of electricity in mines. Particulars from the Director of Mines and Minerals. Tenders by June 19.

Liege.—Tenders are invited for the installation of an electric lighting system. Particulars from the Secretaire Communal at Amay. Tenders by June 25.

Derby.—The Electricity Committee invite tenders for the supply of bitumen cable. Particulars from the borough electrical engineer, Mr. T. P. Wilmshurst.

Herne Bay.—The Urban District Council invite tenders for the annual supply of petroleum, lubricating, and other oils. Tenders to the Town Clerk by June 3.

Tamworth.—Tenders are invited by the directors of the Kingsbury Collieries, Limited, Tamworth, for an electric haulage plant. Particulars from the Secretary.

Stanislau.—The Municipality invite tenders for the establishment of an electric tramway system, also for the erection of a generating station. Tenders by Aug. 31.

Dartford.—Tenders are invited for the annual supply of stores to the electricity department, including meters, service cables, etc. Tenders to the Clerk by June 9.

Brussels.—Tenders are invited for the supply of underground conduit electric cable by the Société Nationale des Chemins de Fer Vicinaux. Tenders by May 27.

Greenwich.—Tenders are invited for the supply of coal to their various establishments from June 27, 1908, to June 26, 1909, for the Guardians. Tenders by May 28.

Croydon.—Tenders are invited for the supply of sulphuric acid for one year, for the Croydon Gas Co. Tenders to Mr. W. Topley, secretary, Katherine-street, Croydon, by June 9.

Adelaide.—Tenders are invited by the Municipal Tramways Trust, Adelaide, for the supply, delivery, and laying of underground electric cables. Tenders to the Chairman by June 23.

Dudley.—The Electricity Committee invite tenders for the annual supply of oils. Particulars from Mr. C. E. Savage, resident electrical engineer. Tenders to the Town Clerk by May 25.

Shrewsbury.—Tenders are invited for the annual supply of coal for the electricity works. Particulars from Mr. C. M. Johnston, engineer and manager. Tenders to the Town Clerk by June 5.

Paisley.—The Paisley Corporation Electricity Department invite tenders for coal and oil. Schedules may be obtained from Mr. C. F. Parkinson, engineer and manager. Tenders by May 25.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Madrid.—The Post and Telegraphs Department invite tenders for the exploitation of telephones in Spain. Particulars from the Direccion-General de Correos y Telegrafos. Tenders by June 1.

Kilmarnock.—The Electricity Committee invite tenders for a Lancashire boiler for the electricity works. Particulars from Mr. A. H. Burbridge, burgh electrical engineer. Tenders by May 25.

Leeds.—The Tramways Committee invite tenders for the reconstruction of a portion of tramway track in Leeds; also for the construction of a portion of track. Specifications from the General Manager.

Plymouth.—The Corporation Electricity Department require tenders for the supply of about 7,500 tons of coal. Particulars from Mr. E. G. Okell, borough electrical engineer, to whom tenders must be sent by June 3.

Salford.—Tenders are invited by the Electricity Committee for the supply and erection of cooling towers, pumps, etc., at the electricity station, Pendeton. Particulars from the Borough Electrical Engineer. Tenders by May 25.

Worthing.—The Corporation invite tenders for the supply and erection of condensing plant, air and circulating pumps and piping. Particulars from the Resident Electrical Engineer. Tenders to the Town Clerk by May 25.

London, E.C.—The South Indian Railway Co. invite tenders for the annual supply of stores. Specifications and forms of tender may be obtained at the Company's Offices, 91, York-street, Westminster, S.W. Tenders by May 26.

Penrhiwceiber (Glam.).—The Penrikyber Navigation Colliery Co. invite tenders for the annual supply of stores from July 1, 1908, including miners' lamps and lamp glasses, electric lamps and fittings. Tenders to the Secretary by June 4.

Walsall.—The Electric Lighting Committee invite tenders for the supply and erection of condensing plant, including surface condenser, air pumps, cooling tower, and water purifier. Tenders to the Town Clerk by May 29. See advertisement.

Grimsby.—Tenders are invited for the lighting of such of the public streets of the borough as are not lighted by electricity from the Corporation electricity works for one year, for the Grimsby Urban Sanitary Authority. Tenders by June 6.

Sale of Plant.—Tenders are invited for the purchase of heating and generating plant at the Nottingham post office. Particulars from the Controller of Stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by May 25. See advertisement.

London, N.—The Great Northern Railway Co. invite tenders for the supply of various stores for 12 months from July next. Particulars from Mr. Weeks, stores superintendent, Doncaster. Tenders to Mr. Burrows, secretary, King's Cross Station, London, N., by May 25.

Victoria.—Tenders are invited for the following for the Postmaster-General's Department: 2,600 jacks, in strips of 20; 1 mile 61-wire switchboard cable; 50 3-conductor cords, 7ft. long, for "B" boards; 96 3-part plugs, and 66 listening and ringing keys. Tenders by June 9.

Handsworth (Staffs).—Tenders are invited by the Urban District Council for the supply of low-tension distributor cables, lead-covered, paper-insulated. Specification, etc., on application at the Generating Station, Soho road, Handsworth. Tenders to Mr. H. Ward, clerk, by May 25.

Rawtenstall.—The Corporation invite tenders for the supply, delivery, and erection of two track boosters (Contract 3) and of low-tension direct-current and high-tension alternating-current switchboards (Contract 11). Tenders to the Town Clerk by May 29. See advertisement.

Johannesburg.—Tenders are invited for a refuse destructor plant. Specification, etc., may be obtained from Messrs. E. W. Carling and Co., St. Dunstan's-buildings, St. Dunstan's-hill, London, E.C. Tenders to the Town Clerk, Municipal Offices, Plein Park, Johannesburg, by June 10.

Great Yarmouth.—The Tramways Committee invite tenders for the following stores for 12 months ending June 16, 1909: oils and grease, iron, bolts and nuts, brake blocks, unbroken coke, brushes and cleaning materials, electrical accessories, and miscellaneous stores. Tenders by June 2.

Southend.—The Corporation invite tenders for the laying along Southchurch Beach-road of about 1,500 yards of single tramway track with loops (rails and setts will be provided by the Corporation). Particulars from the Borough Engineer. Tenders to Mr. W. Snow, town clerk, by May 28

Oswestry.—Tenders are invited for the supply of stores for 12 months ending June 30, 1909, for the Cambrian Railways Co. Specifications and forms of tender may be obtained at the Stores Office, Cambrian Works, Oswestry. Tenders to Mr. S. Williamson, secretary, Oswestry, by June 6.

London, S.E.—The London County Council invite tenders for the manufacture and supply of two electrically-driven centrifugal pumps, etc., to be erected at the Council's electricity generating station at East Greenwich. Tenders to the Clerk of the Council, County Hall, Spring-gardens, S.W., by May 26.

Ilford.—The Urban District Council invite tenders for the supply and erection of surface-condensing plant, and cooling tower, steam, and feed pipes, boiler feed pump, and extensions and alterations to main switchboard. Particulars from the Electrical Engineer. Tenders to the Town Clerk by June 10. See advertisement.

Stalybridge.—Tenders are invited for the supply and delivery of stores for the Generating Station and Tramways Committee of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board. Specification and form of tender may be obtained from Mr. Robert Blackmore, chief engineer. Tenders by May 30.

Clyde Navigation.—The Trustees of the Clyde Navigation invite tenders for the annual supply of stores, including electrical goods oils, indiarubber, asbestos and packing, etc. Particulars from the Superintendent of Stores. Tenders to Mr. T. Mackenzie, general manager and secretary, 16, Robertson-street, Glasgow, by June 6.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

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Newcastle-on-Tyne. — The Tyne Improvement Commissioners invite tenders for the supply of various stores for six months commencing June 30, including incandescent lamps and arc lamp carbons, indiarubber, etc. Particulars from the secretary, Mr. J. McDonald Manson. Tenders to the Chairman of the River Works Committee by June 1.

Adelaide.—Tenders are invited by the Municipal Tramways Trust for the supply, delivery, and erection of rotary converters, transformers, boosters, switchboards, and equipment for converter stations Nos. 1 and 2. Particulars from Mr. W. G. Goodman, the electrical engineer, 8, King William-street, Adelaide, S A. Tenders to the Chairman by July 14.

Southend-on-Sea.—The Corporation invite tenders for the supply and delivery of traction poles, brackets, overhead line material, and bonds for rails required in connection with the construction of about 1,600 yards of single-line track with passing places or loops. Particulars from Mr. R. Birkett, borough electrical engineer, Southend-on-Sea. Tenders to Mr. W. H. Snow, town clerk, by May 28.

Rio de Janeiro.—Tenders are invited for the supply of new lighting apparatus and accessories for the lighthouse on Raza Island. Tenders will be opened on June 2 in the Ministry of Marine (Secçao de Pharóes) at Rio de Janeiro. No deposit is required. Further particulars may be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

Manchester.—The Tramways Committee invite tenders for the supply and fixing of steel roof trusses, girders, stancheons, cast-iron columns, and other metal work for an electric car depôt at Princess-road, Manchester. Particulars from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester, on deposit of £3. 3s., which will be returned on receipt of a *bona fide* tender. Tenders by May 26.

Edinburgh.—Tenders are invited for the supply of a 16-20-h.p. four-cylinder motor chassis, fitted with four-speed (forward and reverse) gear case, chain-driven or live axle, high-tension and magneto ignitions, with accumulator, head, side, and tail lamps, horn, chest, tools, two spare accumulators, mileage recorder, and wind screen complete, with Palmer (non-skid) tyres on driving wheel, for the Corporation. Tenders to the Town Clerk by May 27.

RESULTS OF TENDERS.

Yarmouth.—The tender of Christy and Co. has been accepted for the supply of caps for the tramway employés.

Edinburgh.—The Bastian Meter Co. have secured the contract for the supply of 2½-ampere meters to the city of Edinburgh for the ensuing year.

Kingston-on-Thames.—The Board of Guardians have accepted the tender of Drake and Gorham, at £53. 10s., for a milking booster and battery motor.

Portsmouth.—The tender of Ashton and Holt, Ryde, has been accepted by the Guardians for the electric wiring at the infirmary and extension blocks, for £145.

Foleshill.—The Guardians have accepted the tender of the Electric Trades' Supply Co., Birmingham, at £268, for installing the electric light in the isolation hospital.

Stoke Newington.—The Electric Lighting Committee recommend the acceptance of the tender of Ferranti, Limited, for the supply of meters during the ensuing two years.

Newcastle.—Subject to the consent of the City Council, the Tramways Committee have accepted the tender of the Tudor Accumulator Co., at £3,594, for storage batteries at the Manors power station.

Aberdeen.—The Electricity Committee have accepted the tender of the Brush Electrical Engineering Co., at £2,485. 15s., for the supply of extra high tension plant for Dee Village and Cults stations.

Derby.—The Town Council have accepted the tender of Johnson and Phillips, at £84. 6s. 8d., for the supply of bitumen cable, and that of the British Insulated and Helsby Cables for the supply of high-tension cable.

Bermondsey.—The Electricity Committee recommend the acceptance of the tender of G. J. Cockerell and Co. for the supply of coal at 23s. per ton for 12 months, and that of Myers, Rose, and Co. for a 12 months' supply of coal at 14s. per ton.

Newcastle-under-Lyme.—The Corporation have accepted the tender of Baggaley and Wood, Newcastle-under-Lyme, for the supply and laying of 1,010 yards of three-wire mains, for the sum of £579. 10s. The cable will be supplied by Callender and Co.

Weymouth.—The Town Council have accepted the following tenders for the extension of plant at the electricity works: Brush Electrical Engineering Co., turbo-generator, condensing plant, and pipework, £3,707; Whipp and Bourne, switchboard panel, £125. 17s. 6d.

West Ham.—The offer of the Vulcan Electric Co. to alter the electric fittings at the Napier-road schools, so as to provide for the switching on of separate lights in the halls of each department for £3. 6s., is recommended for acceptance by the Electricity Committee.

Walsall.—The Town Council have accepted the tender of the British Thomson-Houston Co., at £918, for supplying the electrical equipment for four new cars; and that of the United Electric Car Co. for supplying four trucks of the Preston compensating type at £65 each.

Derby.—On the recommendation of the Tramways Committee, it has been decided to accept the tender of G. Robson and Co., at £85, for a track grinder; and that of E. Allen and Co., at £16. 10s., for constructing a new crossing at the junction of London-road and Midland-road.

Lowestoft.—On the recommendation of the Electric Lighting Committee, the following tenders were accepted by the Corporation: Electrical Co., 800 lampholders, 2s. 7d. per dozen; Pope's Electric Lamp Co., 1,000 5-c.p. and 8-c.p. lamps, 6s. 3d. per dozen; Siemens Bros., 2,000 yards of cable for Sparrow's Nest lighting, £12. 13s. 3d.

St. Marylebone.—The Electricity Committee recommend for acceptance the following for the annual supply of stores: Pryke and Palmer, F. Bird and Co., Naylor Bros., General Electric Co., Pooley and Austin, Edison and Swan, Baxter and Caunter, Lundberg and Sons, W. McGeoch and Co., Glenboig Union Fireclay, West Bros., Le Carbone, engine-room stores; St. Helens Cable Co., British Insulated and Helsby Cables, Henley's Telegraph Works, cables.

Woolwich.—The Borough Council have received the following tenders for the supply of 750 yards three-core cable and 170 yards four-core cable:

Western Electric Co. (accepted)	£285	0	0
Callender's Cable Co.	289	17	7
Johnson and Phillips	290	6	0
W. T. Glover and Co.	293	0	0
British Insulated and Helsby Cables	294	13	0
Siemens Bros. and Co.	295	2	6
W. T. Henley's Telegraph Works	298	2	6
St. Helen's Cable and Rubber Co.	305	0	0

Uxbridge.—The Uxbridge Joint Hospital Board have received the following tenders for the electric light installation for the hospital extension:

Wells, Rayner, and Co. (accepted)	£89	13	0
C. Pullan	93	10	0
Park Bros.	96	10	0
E. R Smith	103	0	0
Windsor Electrical Co.	106	0	0
Taylor and Co.	109	10	0
P. W. Baker	110	4	0
Tilley Bros.	145	0	0
Canon and Son	193	5	0

Govan.—The Corporation have accepted the following tenders for the annual supply of cables, etc., to the electricity department: British Insulated and Helsby Cables, Prescot, lead covered and armoured and leadless cables; J. A. Rudd and Co., Glasgow, rubber-covered cables; Verity's, Limited, Glasgow, cable accessories; Craig Sharp, Limited, Glasgow, bitumen, etc.; Chamberlain and Hookham, Birmingham, meters; Keighley Engineering Co., Keighley, fuse boxes; Crompton and Co., London, arc lamp carbons; J. Kennedy and Sons, Glasgow, coal; British Insulated and Helsby Cables, joint-boxes; General Electric Co., Lancashire Dynamo Co., Manchester, and Electric Construction Co., Wolverhampton, motors (divided); Bray, Markham, and Reiss, Walthamstow, and Brook, Hirst, and Co., Chester, motor starters (divided); E. P. Allam and Co., London, double-pole switches.

London, E.—The Poplar Borough Council have accepted the following tenders: C. A. Parsons and Co. for the supply and erection of a Parsons steam-turbine of 1,250 kw. capacity, 1,500 r.p.m., coupled to a Bruce Peebles alternator, giving an output of 1,330 kw., with a power factor of unity at a pressure of 6,000 to 6,500 volts, for the sum of £5,907. 10s. without motor; the British Westinghouse Co. for provision of switchgear, etc., at the generating station and the south sub-station, for the sum of £337. 10s.; Johnson and Phillips for provision of switchgear, etc., at the new sub-station, for the sum of £593. 15s.; Bruce Peebles and Co. for provision and erection of two 500-kw. motor converters at the new sub-station, and one 250-kw. converter at the northern sub-station, for the sum of £3,699. 10s.; the Western Electric Co. for cable for High-street (Wade's-place feeder) and cable for extra high-tension feeder, at a cost of £1,059 and £847 4s. respectively.

London, N.W.—The St. Pancras Electricity and Public Lighting Committee have received the following tenders for the supply of 530,000 arc lamp carbons during ensuing year:

Geipel and Lange	£752	10	0
Sloan Electrical Co.*	821	9	7
Johnson and Phillips	869	17	6
H. Tuchman	894	0	0
Pestalozzi and Co.	905	5	0
G. Braulik	907	10	0
Crompton and Co.	912	11	8
General Electric Co.	929	10	0
E.M.F. Manufacturing Co.	955	7	6
H. G. Mayer and Co.	1,109	18	9
Siemens Bros. and Co.	1,449	12	6

* Recommended for acceptance.

London.—The London County Council have received the following tenders for the manufacture, supply, and delivery of car bodies, trucks, and electrical equipments required for the 175 electric cars needed for the tramway during the year 1908-9:

Car bodies.

Hurst, Nelson, and Co., Motherwell*	£72,450	0	0
United Electric Car Co., Preston	79,275	0	0
Metropolitan Amalgamated Railway Carriage and Wagon Co., Birmingham	80,500	0	0
Cravens, Limited, Darnall, near Sheffield	82,687	10	0
Gloucester Railway Carriage and Wagon Co., Gloucester	83,825	0	0
Brush Electrical Engineering Co., Loughborough	84,525	0	0
G. C. Milnes, Voss, and Co., Birkenhead	96,250	0	0

Electrical equipment and assembly of cars.

British Westinghouse Electric and Manufacturing Co., London and Manchester*	55,387	10	0
Ditto, alternative tender (not to specification)	54,950	0	0
Dick, Kerr, and Co., London	59,062	10	0
Siemens Bros. Dynamo Works, London	63,000	0	0
British Thomson-Houston Co., Rugby	64,750	0	0

* Recommended for acceptance.

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OPENINGS FOR CONTRACTORS.

ACCRINGTON—Church, parish St. James's (£12,000), Ecclesiastical Commissioners.

ALDERSHOT—County secondary school, Hants Education Authority.

ALNWICK—Three houses, Officials at Newbrough Colliery.

ALTON—Enlargement of elementary school, Education Committee.

ARLESFORD - Enlargement, fire-engine house, Parish Council.

ASHBURTON—Elementary school, Education Authority.

ASHBY-DE-LA-ZOUCH—Alterations, Ashby grammar school (£1,700), Leicester County Council.

ASHFIELDS—Wesleyan Sunday school, Trustees.

ASHTON—Elementary school, Wrigley Head, Education Committee; elementary school, Manchester-road, Education Committee.

ASHTON-ON-RIBBLE—Church, St. Michael and All Angels, Egerton-road (£5,800).

ASPATRIA—Shops, stores, and house at Fletchertown, Aspatria Industrial Co-operative Society.

BARNET—Two houses, Byng-road, Mr. C. T. Anstee; two houses, Margaret-road, Mr. A. E. Prentice.

BARNET—School, Education Committee of Herts County Council.

BATTERSEA, S.W.—Shop, St. John's-hill, Mr. R. H. Weymouth.

BECCLES—Secondary school, East Suffolk Education Committee.

BECKENHAM—Art school, Urban District Council.

BEDFORD—Additions, house, Embankment, Mr. G. Mayes; four houses, Tennyson-road, Messrs. Jacobs and Burton; house, Melbourne-street, Mr. T. Linfield; conveniences, Pyghtle Works, Mr. J. P. White; house, Castle-road, Mr. S. Constant; two houses, Kingsley-road, Mr. W. B. Braybrook; additions, premises, St. Loyes-street Mr. J. F. Robinson; additions, cooler-room, Horne-lane Brewery, Mr. C. Wells; additions, works, Southville-road, Messrs. W. H. Robertson and Co.

BELFAST—Hall in connection with All Souls' Church, Mr. W. J. Gilliland.

BEN RHYDDING—Wesleyan church, Trustees.

BEXHILL—Isolation hospital (£1,600), Council.

BILLINGHURST—Improvements, C.E. School, Board of Education.

BIRKENSHAW—House, Station-lane. Mr. E. H. Parkinson, architect.

BIRMINGHAM—Public baths (£21,995), Aston Church-road, Nechells, City Council.

BIRSTALL—Roman Catholic church (£2,000), Presbytery.

BISHOP AUCKLAND—Seven houses, Oak-terrace, Mr. R. Lewis.

BISHOPWEARMOUTH—Parish church, Chester-road, Mr. H. E. Hinkley.

BLACKO—Enlargement of Council school, Education Committee.

BLACKPOOL—Library, Town Council.

BOASLEY CROSS—New school and mistress's house, Devon County Education Committee.

BONNYBRIDGE—Art school, Falkirk Parish School Board.

BOOTLE—Additional sheds at refuse destructor (£586), Brookhill-road, Town Council.

BOSTON—House, Carlton-road, Mr. A. Harrison.

BOTESDALE—Business premises. Mr. G. W. Leighton, architect.

BOURNEMOUTH—School (£3,000), County Council.

BRAMPTON—Mission-room, St. Thomas's Church (£250).

BRICKET WOOD—Bungalow, Mr. R. B. Spanswick.

BROMPTON—Church dedicated to St. Luke. Messrs. Cutts, architects.

BURGESS HILL—Additions, London-road Council School (£1,293), East Sussex Education Committee.

BURGHEAD—Additions, Hopeman School (£1,000), School Board.

BURY—Extensions, workhouse (£12,410), Board of Guardians.

BUSHEY—Council offices, etc., Urban District Council.

CAMBERWELL, S.E.—Additions to premises, Bassano-street, Mr. A. E. Mullins.

CAMBORNE—United Methodist church. Mr. S. Hill, architect

CAMBORNE — Eleven houses, Penponds, Mr. Williams; two houses, Enys-road, Mr. Opie; additions, house, Trevenson-street, Mr. Hosking.

CAMBRIDGE—Cambridge and County School and school of arts and crafts (£15,000), County Council.

CAMBRIDGE—Secondary school, Town Council.

CAMBRIDGE—School of agriculture (£13,000), Local Syndicate.

CANNING TOWN—Salvation Army mission hall, Mr. O. Archer; schools and classrooms, St. Gabriel's Church, Mr. J. B. Moore-Smith.

CANTERBURY—Equipment of store depôt (£1,000), City Council.

CARDIFF—Bottling stores, Awyto Bavarian Brewery, Mr. E. G. C. Down.

CARDIFF—Additions to school, Canton, School Managers.

CARLISLE—Turkish baths (£2,500), Town Council.

CHELTENHAM—Alterations, Eye, Ear, and Throat Free Hospital, Governors.

CHESTERFIELD—County police court-house, Town Council.

CHILTON—Infants' school, Durham County Council.

CHICHESTER—Secondary school, West Sussex Education Committee.

CHORLTON-CUM-HARDY—Additional buildings at refuse destructor works (£1,740), Manchester Town Council.

CLACKMANNAN—Extension, county buildings, County Council.

CLACTON—Public conveniences (£1,600), Urban District Council.

CLAPTON, N.E.—Partial rebuilding of Christ Church, Vicar and Trustees; Salvation Army Citadel, Terrant-road.

CLIFTON—Wesleyan church, Trustees.

COLD KIRBY—Chapel, Trustees.

CORNFORTH—Elementary school (£5,550), Spennymoor Education Committee.

COUPAR ANGUS—Houses, Causewayend, Mr. J. Turnbull; cottages, Causewayend, Mr. W. Ferguson.

COVENTRY — Enlargement Radford School (£10,400), Education Committee.

CREATON—Sanatorium. Mr. F. Dorman, architect.

CROWBOROUGH—Enlargement, Council school (£993), East Sussex Education Committee.

CROYDON—Telephones, lighting, etc., three ward blocks, Mental Hospital, Hospital Committee.

CROYDON—Elementary school, Tavistock-grove (£14,350), Education Committee.

CULLEN—Two houses, Victoria-street, Messrs. A. and W. Findlay.

CWMBACH—Twenty-eight workmen's dwellings, Aberdare Urban District Council.

CYMMER—Three fire stations, Glyncorrwg Urban District Council.

DALKEY—Thirty-six cottages, Urban District Council.

DARLEY DALE—Alterations and extension, Red House. Dr. W. C. Sharpe.

DARTON—Brewery, Mr. George Hall.

DISLEY—Alterations to premises, Disley Co-operative Society.

DORKING—Thirteen cottages rear of Red Lion Hotel. Plans passed.

DUFFTOWN—Additions to property, Mr. Symon; alterations to property, Fife-street, for Commercial Bank; alterations at the Town Hall, Town Council.

DUNDEE—New Peter's electrical engineering laboratory, Union Mount, Council of University College.

DURHAM—Alterations at Chilton, Ferryhill, and Page Bank Council Schools, Durham County Council; branch stores, Durham Co-operative Society.

EARBY—New church. Messrs. Bromet and Thorman, architects.

EASTBOURNE—Workhouse, Hinds Estate (£36,000).

EAST MOLESEY—Renovation, Manor-road Wesleyan Church, Trustees.

EDINBURGH—Alterations to Assembly Hall (£2,500), Trustees of the Free Church of Scotland.

EGREMONT—Alterations to Wesleyan chapel. Mr. J. S. Stout, architect.

ELLAND—Electricity extensions (£3,000), District Council.

ETON—Improvements, workhouse (£600), Guardians.

EXETER—Reconstruction and enlargement of Hele School (£3,500), City Council.

EXETER—Extension electricity mains (£8,100), Council.

FEATHERSTONE—Public baths (£3,500), Urban District Council.

FENTON—Elementary school, Heron Cross, Education Committee.

FISHGUARD—Twenty houses, Trustees of the Vergam Building Club.

FLETTON — Elementary school (£3,000), Huntingdon Education Committee.

FORDEN—Extensions, Bicton Asylum, Guardians.

FOREST GATE—Alterations and additions to premises, Romford-road, Mr. F. G. Faunch.

FRESHWATER BAY—Mission church. Mr. J. Jones, architect.

FRIMLEY—Cottage hospital, Hospital Committee.

FULHAM, S.W.—Two shops, Fulham-road, Messrs. Marks and Bland

FULHAM, S.W.—Wood and iron building, Harwood-road, Messrs. Humphreys, Limited.

FULWOOD—Enlargement Sunday school, Trustees.

GATESHEAD—Parish hall (£1,500), Durham School Committee.

GLENTIES—Housing scheme (£7,937), Rural District Council.

GLOUCESTER — Infirmary, Buddings Field (£5,250), and enlarging workhouse, Guardians.

GODREAMAN—Twenty-two workmen's dwellings, Aberdare Urban District Council.

GOODMAYES—School (£18,345), Ilford Urban District Council.

GORSEINON—New church to accommodate 600 persons, Building Committee.

GORLESTON—Cloakrooms and conveniences, Wellington Gardens (£1,500), and public lavatories, Salisbury road, Town Council.

GRAIANFRYN—School, Education Committee.

GRANGE—Alterations, Victoria Hall, Urban District Council.

GRAVESEND—Theatre, Princes-street, Local Syndicate.

GREAT YARMOUTH—Bakery, Industrial Co-operative Society.

GREENWICH—Five houses, Lower Park-road, Captain Warburton.

GUERNSEY—New school, Education Committee.

HADDINGTON—Church hall (£1,500). Plans passed by Council.

HALIFAX—New feeders for electric lighting purposes (£2,048), Town Council.

HALIFAX—Outbuilding, Huddersfield Golf Club.

HAMMERSMITH, S.W.—Additions, Godolphin and Latymer Girls' School, Messrs. Greenaway and Newbery.

HARROGATE—Extension, electricity mains (£115), Town Council.

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HANDSWORTH—Low-tension distributor cables, etc., Urban District Council.

HARPENDEN—Two cottages, Willoughby-road, Mr. J. Mooring; house, Moreton-avenue, Mr. Pinnington; two houses, Ox-lane, Mr. G. Coburn.

HARROW—Two house, Devonshire-road, Mr. J. Smith; shops, Clarendon-road, Kymberley-road, and Springfield-road; nine houses, Devonshire-road, Mr. W. H. Watts; eleven houses, Oxford-road, Mr. J. Churchman; five houses, Drury-road, Mr. J. Beckwith; additions, Havelock Arms, Station-road, Messrs. Benskin and Co; manse, Lower-road, Mr. J. Jeffrey; iron school, College-road, Baptist Church Trustees

HATFIELD—Motor-house, The Horseshoes, Mr. T. Powell.

HAYES—Additions, post office, Hayes End, W. Labrum, Esq.

HEATH COMMON—Additions, hospital, Hospital Committee; additions, 88, Station-road, Mr. D. Evans; additions, workshop, Messrs. T. Horny and Sons; additions, 20, Stepney-place, Mr. W. Hopkins; workshop, New road, Mr. D. John.

HEATH TOWN—Seven cottages, Old Fallings Park Estate. Plans passed by District Council.

HEMSWORTH—Elementary school, South Elmsall, Education Committee.

HEMSWORTH CROSS HILL—Additions to schoolhouse, Education Committee.

HESWALL—Elementary school, Cheshire County Council.

HETTON—Twelve houses, Lilywhite-terrace, Messrs. R. Lawson and Sons; five houses, Percy-street, Mr. J. Logan.

HORNSEY—120 dwellings, Highgate, Improved Industrial Dwellings Co.

HUDDERSFIELD—Four houses, Leeds-road, Mr. J. Hall.

HUTHWAITE—Vicarage, Executive Council of Notts Church Extension Society.

HYTHE—Depôt (£950), Colchester Town Council.

ILFORD—Workmen's dwellings (£5,000), Urban District Council.

INVERURIE—Extension, townhouse, Town Council.

INVERKEILOR—Additions, public school, Mr. J. Sim.

KING'S LYNN—Alterations, shop, High-street, Mr. W. C. Scott; house, Sir Lewis-street, Mr. R. C. Powell; house, Lansdowne-street, Mr. A. F. Foreman.

KINGSTON-ON-THAMES—Enlargement, workhouse, Board of Guardians.

KIRKWALL—Extensions to post office, H.M. Commissioners of Works.

KIRRIEMUIR—Workshop, etc., Webster's Seminary.

LEEK—Additions to Memorial Cottage Hospital.

LESLIE—Addition, The Auld House Tavern, Mr. Morgan.

LETCHWORTH—Council school, Garden City (£8,975), County Council.

LINTHORPE—Secondary school, Education Committee.

LINTHWAITE—Two houses, Western-road, Messrs. J. Wimpenny and Co.

LIVERPOOL—Alteration, etc., at Mill-road Infirmary.

LLANELLY—Synagogue, Victoria Ward. Plans approved by Urban District Council.

LONDON—New wing, Tate Gallery.

LONDON, E.—Repairs at workhouse, Poplar Board of Guardians.

LONDON, N.W.—Extensions to library, Finchley-road, Hampstead Borough Council.

LONDON, W.—Rebuilding mansion, Grosvenor-road, W., Messrs. Higgs and Hill.

LONDON COLNEY—Additions, cottages, Messrs. Burr and Co.

LOUGHBOROUGH—Church, St. Peter's parish, Ecclesiastical Commissioners.

LOUGHBOROUGH—Extensions to electricity department, Town Council.

LOWESTOFT—House, Beccles-road, G.E.R. Co.; alterations, Jewson's Sawmills, Belvedere-road, W. Podd, Esq.; house, St. Leonard's-road A. Haws, Esq.; four houses, Kirkby Park-road, Messrs. Woolnough Bros.

LOW VALLEY—Elementary school (£9.500), West Riding Education Committee.

LUTON—Elementary school, Beech-hill, Town Council.

LYDD—New offices at Council school, Kent Education Committee.

LYMINGTON—Elementary school (£1,200), Hants County Education Committee.

MADRON—House, Boskenwyn, Mr. F. G. Tupper.

MAESTEG—Public hall and institute. Mr. W. Beddoe Rees, architect.

MAGOR—Parish hall, Christchurch. Plans passed by District Council.

MANCHESTER—Baths, etc. (£38,500), Town Council.

MANSFIELD—Strong-room in town hall (£200), Town Council.

MANSFIELD WOODHOUSE—Drill hall, Forest Town, Bo'sover Colliery Co.

MARKET HARBOROUGH—Five houses in Kibworth Beauchamp. Plans passed by Rural District Council.

MIDDLEWICH—Wesleyan chapel, Trustees.

MIDDLEWICH—Restoring tower of parish church (£700), Churchwardens.

MOIRA—Housing scheme (£12,217), Rural District Council.

MONEYDIG—Orange hall, Londonderry County Council.

NANTWICH—Steam disinfecting chamber (£200), Guardians.

NELSON—Public baths, Town Council.

NELSON—Two houses, Carr-road, Mr. D. Walton; house, storeroom, etc., Grove-street, Mr. J. Elliott; two houses, Hibson-road, Messrs. T. and J. Edmondson; 22 houses, Halifax-road, Messrs. F. and J. Edmondson.

NEWARK—Joint isolation hospital (£6,000), Urban District Council.

NEWBURY—Cottage, Midgham Park, Mr. A. F. Clarke; bungalow, Cold Ash, Mr. Deacon.

NEWMARKET—House, Mrs. E. Adam; house, Stein-square, Mrs. P. Flynn; hall, Ladywell, U.F. Church.

NEWPORT—Shower baths (£2,000), Town Council.

NEWQUAY—Hotel, Pentire Headland.

NORTHALLERTON—Extension, school at Brompton (£400), North Riding County Council.

NORTHFLEET—Electricity sub-station, Electricity Committee.

NOTTINGHAM—Rebuilding Albert Hall (£32,000), Mr. A. E. Lambert.

OMAGH—Housing scheme (£35,101), Rural District Council.

OTLEY—Technical school (£3,525), Council Education Committee.

OUGHTERARD—Workmen's dwellings (£7,108), Rural District Council.

PADDINGTON, W.—Alterations, workhouse, Harrow-road, Guardians.

PAISLEY—Electrical engine-house, for Messrs. J. M'Lardie and Sons, Meikleriggs.

PALMERS GREEN—Church hall (£3,000), Rev. E. A. B. Sanders.

PECKHAM—Warehouse, Queen's-road, Mr. H. J. Collis.

PENYGRAIG—Two villas at Pimmer. Mr. R. S. Griffiths, architect.

PENZANCE—Pavilion (£2,500), Town Council.

PLAISTOW—Store, etc., Barking-road, Messrs. Clemens Bros.; additions to premises, Mr. R. S. Newman.

PONTYPRIDD—Higher elementary school, Mill-street (£10,000), Education Committee.

PORTDINORWIC—Four houses, Beach-road, Mr. W. E. Jones.

PORT-GLASGOW—Public school, High Holm (£18,000), Education Authority.

PORTSLADE—Fire station, Urban District Council.

PWLLYPANT—Twelve houses. Mr. J. H. Phillips, architect.

RAWTENSTALL—Boosters at the electricity works, Town Council.

RAYNES PARK—Alterations to property, Messrs. Whitehead Bros.

READING—Goods shed, Great Western Railway Co.

ROSEWARNE—Additions, house, Mr. F. Bassett.

ROTHERHITHE, E.—Building, Mr. J. J. Freeland.

ROTHESAY—Pavilion (£5,000), Town Council.

ROYDHOUSE—Two houses, Mr. E. Baxter.

RUGELEY—R.C. elementary school. Mr. H. T. Sandy, architect.

ST. ALBANS—Two houses, Clarence-road, Mr. J. Elwood; dairy, Colney-street, Colonel Cartwright; three houses, Cambridge-road, G. E. Archer, Esq.; engine-room, Beaumont Works, Messrs. Nicholson and Co.; house, London-road, Mr. W. Hylard.

SALFORD—Baths at Seedley (£20,000), Town Council.

SALFORD—Extensions, secondary school, Board of Education.

SANDSEND—Additions to and enlarging the chapel of St. Mary, Mr. E. H. Smales.

SANDQUAY—Six cottages, Mr. T. Wilton; house, Mr. R. T. Pillar; cottage, South Embankment, Mr. Widdicombe.

SANDYFORD—Wesleyan chapel, Trustees.

SCARBOROUGH—Public hall, North Marine-road, Corporation.

SCUNTHORPE—Fire station and depôt, public convenience, Cole-street (£3,000), Urban District Council.

SEAFORD—Enlargement, Council school (£3,237), East Sussex Education Committee.

SHILDON—Electric power at wagon building and repairing shops, North-Eastern Railway Co.

SHIPSTON-ON-STOUR—Improvements to St. Edmund's Church, Churchwardens.

SHREWSBURY—Two secondary schools, Salop County Council.

SIDDAL—Church (£7,130). Messrs. Walsh and Nicholas, architects.

SIDLESHAM—Extension, Council school (£600), West Sussex Education Authority.

SILVERTOWN—Seventeen houses, Mr. T. P. Blower.

SKIPTON—Free library (£4,000), Libraries Committee.

SLOUGH—Additions, Bayliss House, Mr. E. Wood; house, Uxbridge-road, Mr. T. Perkin; two houses, Arthur-road, Mr. E. E. Glanfield.

SMITHRIDING—Five houses, Mr. C. H. Whiteley.

SOUTHAMPTON—Extensions at King Edward VI. Grammar School, Education Authorities.

SOUTH SHORE—Extension of United Methodist Church (£1,000), Trustees.

SOUTHWARK, S.E.—Building, south side of Southwark-street, Mr. W. H. Rogers.

SPENNYMOOR—Higher elementary school (£8,000), Education Committee.

STAFFORD—Enlargement of the North-street infants' school, Staffs Education Committee.

STAVERTON—Five cottages, Golden Valley, Mr. W. Drew.

STEPNEY, E.—Warehouse, Artillery-lane, Mr. W. A. Lewis.

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STOCKTON BROOK—School-chapel, Governors.
STOCKTON-ON-TEES—Additions at the education offices, Education Committee.
STOKE-ON-TRENT—Mission hall (£10,000), Trustees.
STRATFORD—Four workshops, etc., Mr. R. Wayman.
SUNDERLAND—Hospital for children at High Barnes, Hospital Committee.
SWANAGE—House, Cecil-road, Mr. H. J. Smith; additions, Linden Hall, Mr. O. R. Bean; five villas, Linden-road, Mr. G. Pond.
TARBERT—New United Free Church, Trustees.
TOOTING—Free public library, Library Committee.
TORQUAY—Alterations, electricity generating station (£6,000), Council.
TORQUAY—Alterations and additions, Grand Hotel, Messrs. Watson and Watson.
ULCEBY—Wesleyan chapel, Trustees.
WAKEFIELD—Music hall, Westgate-terrace, Messrs. Sherwood and Co.; additions, house, Wentworth-terrace, Mr. G. Newell; additions, house, Park Lodge-lane, Mr. A. Peace; seven houses, houses, Cambridge-street, Mr. J. Slack; public conveniences; six houses, College Grove-road, Devisees of late Mr. T. Armitage.
WANDSWORTH, S.W.—Additions, High School for Girls, Streatham High-road, Mr. S. R. J. Smith; buildings, Gatton-road, Mr. J. B. Gripper; motor garage, etc., Clive House, Clarence-lane, Messrs. Blow and Billerney.
WEALDSTONE—Five houses, Newton-road, Mr. S. G. Pailthorpe; two houses, Locket-road, Mr. E. W. Fisher.
WELLINGBOROUGH — Temporary classroom, Grammar School Governors.
WHALLEY — Restoration, old parish church, Ecclesiastical Commissioners.
WHICKHAM—Council school to accommodate 600 scholars, Durham County Council
WHITECHAPEL, E.—Additions, premises, Chamber-street, Mr. C. Thompson.
WHITECHAPEL, E.—Building, King-street, Messrs. Barlow and Roberts.
WHITEHAVEN—Elementary school, Town Council.
WHITSTABLE ON-SEA—House, Church-road, Mr. W. London; house, Saddleton-road, Mr. F. G. Gann; house, Joy-lane, Mr. G. Coulter; house, Canterbury-road, Mr. Rowland.
WIMBLEDON—Shops and flats, High-street, Messrs. Thompson and Pomeroy; church, Vicar of Wimbledon; alterations and additions, premises, Camp-road and West-side—Mr. R. A. Hinds, architect.
WIMBLEDON—Five houses, Ashen-grove, Mr. C. Barwell.
WINDSOR—Secondary school, Education Committee of Berks County Council.
WINKHILL—Wesleyan chapel, Trustees.
WIRKSWORTH—Additions tape mill, Steeple Grange.
WITHINGTON—Public baths, Burton-road, Manchester Town Council.
WOKINGHAM—Additions, houses, Langborough-road, Mr. R Hann; house, Station-road, Mr. D. Grove.
WOLVERHAMPTON—Houses, Garden Suburb, Old Fallings Estate.
WOMBWELL—Three houses, High-street, Mr. G. Hattersley; 10 houses, Main-street, Messrs. F. B. Ward and Sons; house and shop, Blythe-street, Mr. T. Downend; workshop, Bromhill, Messrs. Spencer and Co.
WOOLFARDISWORTHY—Enlargement of school, Devon County Education Committee.
WORCESTER—Elementary school, City Council.
WORSBOROUGH BRIDGE—Three houses. Mr. A. Whitaker, architect.
YARMOUTH—Alterations, workhouse, Guardians.

PROVISIONAL PATENTS, 1908.

MAY 8.

10009. Improvements in and connected with electric ignition devices for internal-combustion engines. Moses Henry Cameron and Frederick Woodruffe Cooke, 4, Corporation-street, Manchester. (Complete specification.)

10019. Improved apparatus for producing electrical impulse charges for use in wireless telegraphy. Simon Eisenstein, 7, Southampton-buildings, London. (Complete specification.)

10023. Improvements relating to condensers of the Leyden jar type. Simon Eisenstein, 7, Southampton-buildings, London. (Complete specification.)

10037. Improvements in or relating to accumulators or secondary batteries. Alfred Julius Boult, 111, Hatton-garden, London. (Schlesische Akkumulatoren-Werke A.-G., Austria.) (Complete specification.)

MAY 9.

10078. Improvements in or relating to electrical storage batteries. Alfred Wood Somers and Richard Joseph Crowley, Sunbridge-chambers, Bradford, Yorks.

10088. Improved filament for electric glow lamps. John Walton Ward and Richard Henry Stevens, 11, Southampton-buildings, London.

10109. Improvements in or relating to emergency brake systems for electric railways and tramways. William Herbert Turner, 8, Quality-court, Chancery-lane, London.

10118. Improvements in and relating to electrical railways, tramways, and the like. Casimar von Gizinsky, William McClure, and Ernst Wiesner, 18, Southampton-buildings, London. (Complete specification.)

10121. Improvements in and relating to dynamo-electric machines of the commutator type. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Sept. 30, 1907, being date of application in Germany.) (Complete specification.)

10128. Improvements in electric portable lamps. Joseph Bein, 205A, Pentonville-road, London.

MAY 11.

10156. Apparatus for preventing collision between ships by means of electric waves. George Erdmann, 60, Doughty-street, London. (Complete specification.)

10157. Improvements in and connected with electrical controlling devices. William Herbert Turner and Rowland Edward Dixon, 31, Swinegate, Leeds.

10168. Improvements in or relating to trolley heads for electrically-propelled vehicles. Herbert Simpson, 111, Hatton-garden, London. (Arthur Matthew Simpson and George William Adamson, India.)

10171. Improved means for reducing the reflex action at the points of connection of electrical conductors or circuits differing in the values of their electrical properties. Siemens Bros. and Co., Limited, Queen Anne's-chambers, Broadway, Westminster. (Application for patent of addition to No. 9273/06.) (Complete specification.)

10172. Improvements in the construction of telephone jacks. Siemens Bros. and Co., Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

10184. Improvements in combined electric connecting plugs, sockets, and switches. William Wooyger Buckton, 23, City-road, London. (Complete specification.)

10211. Improvements in insulators for telegraph wires and the like. George Pollock and William Elias Werd, Fife House, Kingston-on-Thames. (Date applied for under Section 91 of the Act, May 9, 1907, being date of application in United States.) (Complete specification.)

MAY 12.

10244. Improvement in the electro-deposition of metallic alloys. William Arthur Thoms and Harold Charles Mossop, 52, Queen Victoria-street, London.

10269. New or improved arc lamp. Frantisek Ruzicka, 115, Cannon-street, London. (Complete specification.)

10317. Improvements in insulating supports for high-tension conductors. Ralph Davenport Mershon, 322, High Holborn, London. (Date applied for under Section 91 of the Act, May 21, 1907, being date of application in United States.) (Complete specification.)

10339. New or improved electrode for arc lamps. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

10341. Improvements in and relating to incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elecktricitäts-Ges., Germany.)

MAY 13.

10343. Improvements in systems of electrical wave transmissions. Isidor Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

10351. Improvements in or connected with magnetic or rheostatic brakes. Mark Cummins, 518, Stretford-road, Manchester.

10358. Improved type of electrical controller more particularly applicable for controlling or "dimming" electric lights in theatres, music halls, and the like. Norman Russell Booth, 7, Harrison-road, Halifax.

10378. Improvements in electric furnaces. Erik Cornelius, 33, Chancery-lane, London.

10394. Improvements in mechanism for electrically operating railway and like signals. Siemens Bros. and Co., Limited, and Luiz de Moreas Gomes Ferreira, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

10406. Improvements in the control of electric circuits. Charles Cornfield Garrard and Ferranti, Limited, 18, Southampton-buildings, London.

10431. Improvements in or connected with electric voltameters. Henry Stafford Hatfield, 18, Palmeira-square, Hove, Brighton.

MAY 14.

10478. Mechanism for operating electric ignition on gas-engines. William Coates and Hubert Harry Patrick, trading as Coates and Patrick, 15, Great Hampton-street, Birmingham.

10489. Improved electric lampholder. Thomas Joseph Digby, 32, Shaftsbury-avenue, London. (Complete specification.)

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10507. Improvements in flexible electrical conductors exposed to mechanical tension. Theodor Peterson and Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, London.

10520. New electrolyte for electric batteries. The New Ignition Syndicate, Limited, and Wallace James Lambert Sandy, Britannia Works, Canal Bridge, Old Kent-road, London.

10521. Improvements in or relating to electrically-heated tools. Alfred Julius Boult, 111, Hatton-garden London. (O. A. Miller Treeing Machine Company, United States.)

10536. Improvements in and relating to electrical switchgear. Henry William Clothier and A. Reyrolle and Co., Limited, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on May 28.)

1907.

2986. Electrical apparatus for transmitting and receiving signals. Dawson and Buckham.

4988. Rotary transformers permitting the transformation of alternating current into continuous current and vice versa. Heyland and Korda. (Date applied for under International Convention, June 20, 1906.)

5301. Electric furnace. Igevesky.

10065. Manufacture of waterproof paving slabs, building blocks, roof coverings, electric insulators, and the like. Coward.

10119. Apparatus for controlling electric cooking and heating apparatus and the like, and indicating when they are in use. Newbury and British Prometheus Company.

10169. Electric fire-alarms and thermo-indicators. McNeil.

10171. Controlling devices for electrically-operated winding engines. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, May 2, 1906.)

10513. Arc lamps and electrodes for use therein. Beck. (Date applied for under International Convention, May 5, 1906.)

10515. Methods of and apparatus for braking electrically-propelled vehicles. Condict. (Date applied for under International Convention, May 9, 1906.)

10641. Leakage detectors for surface-contact electric traction systems. Mitchell.

10662. Arc lamp. Winther-Hansen and Bouchsein.

10665. Switches, fuses, and the like. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

10666. Electric switches. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

10687 Electrical block signalling system for railways. Brown.

10943. Means for connecting up electric cables. Brown.

10969. Repulsion electric motors. Felton und Guilleaume-Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, May 14, 1906.)

11066. Dynamos for train lighting. Leitner.

11086. Telephone receivers. Sullivan.

12462. Sockets for electrical purposes. Lawley-Pinching and Walton.

13543. Control of the supply of electrical energy to consumers. Highfield.

15451. Manufacture of refractory electrical conductors suitable for electric lamps, furnaces, and the like. British Thomson-Houston Company. (General Electric Company.)

18261. Laminated core structures, particularly applicable to dynamo-electric machines. British Thomson-Houston Company. (General Electric Company.)

21299. System of directed wireless telegraphy. Bellini and Tosi.

23586. Galvanic element and method of manufacturing the same. Weman. (Date applied for under International Convention, Oct. 27, 1906.)

25313. Alternating-current commutating electric machines. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, Nov. 15, 1906.)

27177. Electric insulators. Barclay. (Date applied for under International Convention, July 22, 1907.)

28634. Electric locomotives or motor vehicles. Lamme and Storer. (Date applied for under International Convention, Jan. 5, 1907.)

1908.

35. Electrical pattern for the manufacture of jacquard cards. Weissenborn.

699. Radio-telegraphy. Amalgamated Radio-Telegraph Company. (Date applied for under International Convention, Jan. 14, 1907.)

3700. Electric arc illuminating apparatus more particularly for use in photography. Schmidt. (Application for patent of addition to No. 9574/07.)

3770. Electrically-controlled pneumatic dispatch tubes, cash railways, and the like. Bluemel, Bluemel, Bluemel, and Shill.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
—— Ord., 1,125,000	1 ..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1 ..	11/16-13/16
—— Ordinary, Nos. 1 125,000	1 ..	3/16-5/16
British Aluminium Co., Ordinary, 2 001-40,000	5 ..	3¼-3⅜
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4-4¼
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	4⅞-5¼
—— 4 per cent. Funding Certificates, 1-20,000	5 ..	3⅜-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	102-106
—— 5½ per cent Loch Leven Deb. (Reg.). Red., 1-3,000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6¼-6⅝
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5⅝-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	93 98
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275,001-475,000	3 ..	7/16-11/16
—— 4 per cent. Mortgage Debenture Stock	100 ..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	0-¼
—— Non. Cum., 6 per cent., Pref.	2 ..	3/16-7/16
—— 4½ per cent 1st Debenture Stock	100 ..	70-75
—— 4½ per cent. 2nd Debenture Stock	100 ..	55-60
Callender's Cable, Debentures	100 ..	106½-108½
—— Ordinary	5 ..	10-11
—— 5 per cent. Pref.	5 ..	5¼-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	¼-⅜
Crompton and Co.	3 ..	1 9/16-1 13/16
—— 5 per cent Debentures	100 ..	92-95
Dick, Kerr and Co., Ordinary, 1,250 000	1 ..	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99 261	3 ..	⅝-¾
—— "A" Shares, 01-017,139	5 ..	1¼-2⅛
—— 5 per cent. Debentures	100 ..	85-87
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112,100	2 ..	¼-½
—— 7 per cent. Cumulative Pref.	2 ..	1½-1⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	75-80
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅞-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	87-90
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11½
—— 4½ per cent. Preference	5 ..	4¼-5⅜
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16½
—— 4 per cent. Debentures	100 ..	98-100
National Electric Construction Co., 1-170,000	1 ..	⅜-½
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	29-31
—— 4 per cent. Bonds	100 ..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	7¼-8¼

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅝-5¼
Bournemouth and Poole, Ordinary	10 ..	10½-11
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	9¼-10⅜
—— 6 per cent. Cum Second Pref., 15,001-22,500	10 ..	10½-11
—— 4½ per cent. Debenture Stock, Red.	100 ..	102-105
Bromley (Kent) Electric Light and Power Co.	5 ..	4¼-5
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	94-97
Brompton and Kensington, Ordinary	5 ..	6⅜-7⅜
—— 7 per cent. Preference	5 ..	6⅜-7⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5 ..	6-7
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13½
Canadian General Electric Co., Common Shares	$100 ..	89-93
—— 7 per cent. Cum. Pref. Stock	$100 ..	105½-108½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	99-102
Charing Cross, West End, and City Electric Supply, Ord., 1-60,000	5 ..	3¼-3⅜
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	4¼-4⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	3¼-4¼
—— ditto (1903) 40,001-80,000	5 ..	4¼-4⅜
Chelsea Electricity Supply	5 ..	3¼-3⅜
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	7⅜ 8½
—— 6 per cent. Cumulative Pref.	10 ..	10¾-11½
—— 5 per cent. Debenture Stock	100 ..	107-110
—— 4½ per cent. 2nd Deb. Stk., Red.	100 ..	99-99
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,630	£0 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Sds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2½-3
—— 5 per cent Preference, 1-50,000	5 ..	3¾-4¼
County of London Elec. Supply, Ordinary	10 ..	7⅜-8¼
—— 6 per cent. Cum Pref.	10 ..	10⅜-11½
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅛-¼
—— 6 per cent. Cum Pref.	5 ..	½-1
—— 4½ per cent. First Mort. Deb.	100 ..	65-75
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	78-81 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2¼-2⅜
—— 5 per cent. Debenture Stock, Rd.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	90-95
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4⅜-5¼
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5 ..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	6¼-6⅜
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	95-98
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	90-95
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	⅜-½ xd
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5 ..	7-8
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100 ..	95-99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5	1-1¼
—— 6 per cent. Pref.	5	4⅞-4¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	80-85
Metropolitan Ordinary, 100,001-300,000	5	4⅜-4⅞
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4⅜-4⅞
—— 3½ per cent. Mortgage Debenture, Red.	100	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000	—	76½-79½ p.c.
Mexican Light and Power Co., Capital Stock	$100	56-57
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	84-86
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	5½-6
—— do., 57,010-75,000	5	5½-6
—— do., 75,001-87,500 (issued at £22 prem., 16s. paid	5	5⅛-5⅜
—— 5 per cent., Pref., 1-57,009	5	5⅛-5⅜
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5	5⅛-5⅜ xd
Notting Hill Electric Lighting	10	11½-12¼
—— 4 per cent. First Mort. Deb. Nos. 1-500 (Reg.)	100	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5¼-6⅜
—— 4 per cent. Debenture Stock	100	94-98
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1	13/16-15/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	¼-1
—— 5 per cent. Debenture Stock, Red.	100	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	4⅝ 5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5	4⅜-5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96-98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¼-⅜
—— 4 per cent. Debenture Stock	100	70-74
South London, Ordinary	4	2⅜-2½
South Metropolitan Electric Light and Power, Ord.	1	⅜-⅝
—— 7 per cent Cum Pref.	1	1 1/16-1 5/16
—— 4½ per cent. 1st Mort. Deb.	100	99-102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7¼-8¼
—— 7 per cent. Pref.	5	6¼-7
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1-2
—— 5 per cent. Cumulative Preference, 50 001-80,000	5	1⅝-2¼
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	87-90
Westminster, Ordinary	5	7¼-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅜-5¼

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5	6 3/16-6 7/16
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	7⅛-8¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	137-142
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	104-107
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent. Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	⅜-⅝
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	11/16-13/16
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100	93-96
Blackpool and Fleetwood Tramroad	10	13⅜-17⅝
Bombay Elec. Supply and Trams. Co., 6 per cent. Cum. Pref.	10	10-10½
—— 4½ per cent. Deb. Stock, Red.	100	93-96
Brisbane Tramway Invest., Ord., 1-75,000	5	3¼-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4 11/16-4 15/16
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	98-102
British Columbia Electric Railway Co., Ord Def.	100	132-135
—— Ord. Pref.	100	111-115
—— 5 per cent. Cum. Perpetual Pref. Stock	100	108-112
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	99-102
—— 4½ per cent. Vancouver Power Deb.	100	101-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	1¼-1⅜
—— 6 per cent. Cm. Pf., 30,0001-60 000	10	3⅜-4¼
—— 5 per cent. Perpetual Debenture Stock	100	88-92
—— 4½ per cent. 2nd Deb. Stock	100	64-68
Bueno Ayres and Belgrano Trams	5	4 11/16-4¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅝-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅝ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	96-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	98-102
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	92-96
Calcutta Tramways, Ord., Nos. 1-137,610	5	6-7 xd
—— 5 per cent. Cum. Pref., Nos. 1-30,000	5	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	103-106
Cape Electric Tramways, Nos. 1-480,000	1	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4¼-4⅜ xd
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100	97-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5⅜-5⅝
—— 4 per cent. Deb. Stock, Red. 1885	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	88-91 xd
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	94-97
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	80-85
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	¼-1⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	87-91
—— 6 per cent. "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296,500 2nd Mort. Deb. Stock	—	—
—— £83,350 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1¼
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	90-95

Name.	Amount paid.	Last price.
	£	£
London United Trys. (1901), 5 per cent. Cum. Pref.	10	6¾-7¾
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	80-85
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-9,635	$1,000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5	4¼ 5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	11/16-13/16
—— ½ per cent. Deb. Stock, Red.	100	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	87⅞-88⅜ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	¼-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅞-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1	¼-⅜
—— per cent. Cum Pref., 300,001-545 000	1	½-¾
—— per cent. Debenture Stock	100	95-96
Provincial Tramways Co., Ordinary, 1-24,912	10	4⅜-5¼
—— per cent. Cum. Pref., 1-10 000	10	9¼-10¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5	5¼-5¾
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	128-134
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-12,000	$500	98-100 p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-1
—— 4 per cent. Deb Stock, Red. 1940	100	76-80
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5	3¼ 3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100	79 82
—— 4 per cent. Pref.	100	87-89
—— " " deferred	100	56-59
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100	100-103
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent Debenture Stock	100	99-102
—— 5 per cent. Pref. Stock '91	100	113-116
—— " " " '96	100	112-115
—— " " " '01	100	110-113
—— " " " '03	100	106-109
Liverpool Overhead, 5 per cent. Pref	10	10-10¼
—— Ordinary, 1-50,000	10	3¾-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent Profit-sharing Secured Notes	—	38-42
—— Deposit Receipts	—	38-42

Telegraphs and Telephones.—

Name.	Amount paid.	Last price
	£	£
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	83-86
Anglo-American Telegraph Co., Ordinary	100	57-60
—— 6 per cent. Preferred Ordinary	100	100-103
—— Deferred Ordinary	100	16¼-16¾
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	98½-101½
Chili Telephone Co., 1-44,000	5	7-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	86-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	7¼-8¼ xd
—— 10 per cent. Preference, 1-6,000	10	15¾-16¾ xd
Direct Spanish Telegraph Co., Ordinary	5	3¼-3½
—— 10 per cent. Cum. Preference	5	8-9
—— 4½ per cent. Debs., 1-600	50	99½-102½
Direct United States Cable Co.	20	13½-14
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	98½-101½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	98½-100½ xd
Eastern Extension, Australasia and China, 1-300,000	10	12¾-13½
—— 4 per cent. Mort. Deb. Stock, Perp.	100	100-102
Eastern Telegraph Co., Ordinary Stock	100	129-134
—— 3½ per cent. Preference Stock	100	83-86
—— 4 per cent. Mortgage Debenture Stock	100	100-102 xd
Great Northern Telegraph Co. (of Copenhagen)	10	29-31
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100	100-102
Indo-European Telegraph Co.	25	55-56
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	29/32-1 1/32 xd
—— 5 per cent. Preference, 1-86,492	1	13/16-15/16 xd
National Telephone, Preferred	100	108-110
—— Deferred Stock	100	109½-111½
—— 6 per cent. Cum. First Pref.	10	10¾-12⅛
—— 6 per cent Cum. Second Pref.	10	10¼-12⅛
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	98½-100½
—— 4 per cent. Deb. Stock, Red.	100	101½-103½
Oriental Telephone and Electric Company	1	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1	1¼-1½
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	98-101
United River Plate Tels. Co., Ordinary, 1-100,000	5	6¼-6⅜
—— 5 per cent. Cum. Pref., 1-40,000	5	4¾-5⅜
—— 4½ per cent. Debenture Stock, Red.	100	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10½
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	99-102
West India and Panama Telegraph Co., Ordinary	10	9/16-11/16
—— 6 per cent. Cum. 1st Preference	10	8¼-8⅜
—— 6 per cent. Cum. 2nd Preference	10	8¼-9
—— 5 per cent. Debs., Red., 1-800	100	101-104
Western Telegraph Co., 1-207,930	10	13½-13⅝
—— 4 per cent. Debenture Stock, Red.	100	100-102

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Mile of track. Pas-s'nger	Car mile.	Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	May 13	1,342	1,303	+ 39	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·54
Ayr Corporation	,, 16	233	235	- 2	+ 77	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 16	3 120	2,360	+ 760	+14,609	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 17	1,052	1,023	+ 29	+ 519	23·53	23·53	March 31	55,408	11,686,691	1,324,745	—	—	—	6·1
Birmingham Corporation	,, 9	6,255	6,190	+ 66	—	56½	56½	,, 31	18,557	5,352,088	215,345	·87	16·2	9,288	—
Blackburn Corporation	,, 13	1,169	1,087	+ 82	+ 128	25·80	25·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 14	549	5'2	+ 17	+ 813	17½	17½	—	—	—	—	—	—	—	
Blackpool-Fleetwood Trams	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	*7·79b
Bolton Corporation	,, 17	2,354	2,147	+ 207	+ 1,202	42	42	March 31	111,294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 13	1,426	1,533	- 107	- 503	29¼	24¾	,, 31	83,663	13,503,610	1,765,088	1·48	11·37	2,860	7·28
Bradford Corporation	,, 9	4,487	4 669	- 182	+ 1,970	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 17	775	878	- 103	—	17·191	17·191	,, 31	50,552	10,759,310	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 15	4,739	5.152	- 353	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 18	1,243	1 2o7	- 14	—	19¾	19¾	,, 31	62,699	11,967,448	1,205,830	1·31	12·48	5,825	8·21
Burton Corporation	,, 17	267	283	- 16	—	9¼	8¼	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	May 16	165	182	- 17	+ 23	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 16	6,630	5.828	+ 802	- 2,990	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,357	5·222a
Charing X, Euston, & Hamp. Ry.	,, 16	3,760	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and south London Railway	,, 17	2,954	3 156	- 192	+ 6,565	9	6¼	A June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 6	181	195	- 14	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 14	443	459	- 16	- 461	15½	15½	Dec. 31	25,032	5,966,364	891,998	—	6·74	—	4 78
Croydon Corporation	,, 15	1,496	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 15	297	298	- 1	- 26	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	,, 9	179	229	- 50	- 214	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,695	—
Dublin and Lucan Electric Ry.	,, 15	120	110	+ 10	+ 84h	6¾	6¾	—	—		—	—	—	—	—
Dublin U.T.	,, 15	5,154	5,609	- 445	- 345	54½	48¾	—	—		—	—	—	—	—
Dundee City Tramways	April 8	1,144	1 195	- 51	—	22	22	May 15	57,672	15,554,905	1,162,792	·878	11·9	4,352	7·3
East Ham Corporation	May 16	834	931	- 97	- 437	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 16	17,680	18,163	- 483	+14,040h	177½	169	May 31	887,381	224,063,028	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 13	254	260	- 6	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	,, 16	5 565	4,080	+1,485	+31,741	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	April 14	1,413	1,2.3	+ 130	—	52·574	37	,, 31	77,996	18,899,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	May 2	1,506	1,443	+ 58	+ 68	35½	35	,, 31	81,186	15,252,150	1,804,745	1·22	10·79	2,770	5·94
Hull Corporation	,, 16	2,418	2,409	+ 9	- 113	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 2	410	449	- 39	—	10½	10½	,, 31	26,499	6,586,754	645,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 13	153	151	+ 2	- 8	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 6	249	256	- 7	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7·55	1,73	4 95
Lancashire United Tramways	,, 13	1,342	1 2.0	+ 122	+ 1,176	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 9	6 226	6.560	- 334	+ 111	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5 58
Leicester Corporation	,, 16	2,323	2,365	- 41	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 9	10,714	11,014	- 300	- 2,003	104	104	Dec. 31	563,793	122,094,528	12,115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 17	1,423	1,509	- 86	- 471h	9·25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 2	32,807	29,745	+3,062	+ 14,782	98	98	March 31	1378,014	314,227,090	30,130.297	1·05	10 98	—	8·56
Lowestoft Corporation	,, 16	157	161	- 4	+ 135	3½	—	Sept. 30	11,079	2,622,922	343,190	1·03	7·9	2,156	6·39
Maidstone Corporation	,, 14	189	120	+ 69	—	3½	2	March 31	5,913	1,186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 16	16,177	14.956	+ 221	+ 5,459	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 16	9,005	7.966	+1,039	+19 515	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 17	15,407	15 1 4	+ 303	+ 2,938	23½	23½	June 30	637,794	87,639,334	—	1·39	—	—	—
Nelson Corporation	,, 16	1 9	141	- 2	- 136	2¾	2¾	March 31	7,309	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 16	3,685	4 051	- 368	- 2,873	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 18	6 7	631	- 13	+ 3	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10·01	1,525	6·87
Oldham Corporation	,, 3	1,834	1,871	+ 23	- 321	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·2o9
Portsmouth Corporation	, 9	1,880	1 865	+ 15	—	28½	28½	,, 31	98,911	20,668,825	2,199,883	1·15	10 79	—	—
Reading Corporation	—	—	—	—	—	13½	13½	,, 31	32,661	8,130,179	918,825	·96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6·03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10·45	2,691	7·38
Salford Corporation	,, 11	4 639	4,582	+ 57	- 539	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	
Sheffield Corporation	,, 17	5.680	5,452	+ 228	+ 255	65½	65¾	March 25	276,907	73,966,299	6,804,656	·898	9 767	4,174	
Southampton Corporation	,, 6	1,079	932	+ 147	+ 202	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 13	347	346	+ 1	+ 26	9	9	,, 31	20,076	4,431,728	390,538	1·07	12 33	3,155	6 75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 17	1,151	1,364	- 213	- 1,872	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9·94	1,968	7·79
Torquay Tramways	,, 14	268	174	+ 94	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 16	842	7:0	+ 52	+ 115	12 68	12·43	‡ ,, 31	42,810	8,312,592	890,906	1·23	11·53	3,376	—
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965,286	429,785	—	10·724	1,989	6·95
West Ham Corporation	,, 14	2,187	2,514	- 327	- 1,641	14·7	14·7	,, 31	122,881	35,602,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 13	785	841	- 56	—	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·085

* 1905- figures. ‡ 1907-8 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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THE
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LINCOLN ELECTRICITY AND TRAMWAY DEPARTMENT.

In our larger cities the success of municipal electricity supply and of electric tramways is assured by the magnitude of the undertakings, and even indifferent management cannot do more than retard progress. This can be proved by examples, which, however, we think would be rather invidious. Our readers will know of towns where through slackness on the part of the engineers the cost of electricity has been maintained at a figure which has stifled the growth of the supply system. In these towns the annual balance-sheets have been satisfactory from the ratepayers' standpoint, in that the undertakings have not involved any charge on the rates. The manufacturers in these towns have, on the other hand, been handicapped by not having electric power at sufficiently low cost to warrant its use. In the case of the smaller towns, amongst which we class the city of Lincoln, indifferent management and want of business push on the part of the engineer is found out much more rapidly, and it takes a better man to make these smaller undertakings successful. Mr. Stanley Clegg, the city electrical and tramway engineer of Lincoln, has this week sent us his report and accounts for the year ending March, 1908. The report is excellent reading, and might well be taken as a model by the young station engineer. It shows a progressive decrease in cost, and also of the price charged per unit. This has enabled the output for electric lighting to be increased in spite of the economy of current obtained with metallic-filament lamps. Again, the electricity supplied for power purposes increased by no less than 143,342 units over the previous year's output, which clearly shows that decrease in price means a large increase in returns. The largest consumers for power are Messrs. Clayton and Shuttleworth, who during the past year took 702,120 units. The price they paid averaged 1·024d., and we note from a clause in the report that this price was 16 per cent. higher than it would have been had the cost of coal not risen. The report shows also that while Mr. Clegg has been keen in the commercial management of the undertaking, he has also made during the year improvement on the engineering side. Amongst these was the installation of some electrically-driven centrifugal pumps. These during six months saved no less than 22,000 units over the older pumps, and pumped more water. This saving in the works consumption is valued by the engineer at £70, which is an excellent return for six months on an expenditure of £460. Last, but by no means least, we come to the tramway department. The cars for the year in question have been worked at the low figure of 6·10d. per car mile. It must be remembered that the tramway route at Lincoln is short, and the cars run few as compared with most municipal tramways One would naturally expect, therefore, that the smallest municipal tramway running would have the highest cost. Instead of this, the cost per car mile at Lincoln is 6·1d. as against an average figure of 6·31d. for seventy other municipal tramways. These tramways use the overhead system, while at Lincoln they have the G.B. surface-contact system. We reproduce Mr. Stanley Clegg's report on the tramways in full elsewhere in this issue, so that our readers may see what his experience has been with this system. The cost during the year for maintaining the automatic contacts in the street has been only £54. This figure amply justifies the decision of the London County Council engineers in adopting the G.B. system in preference to others for certain of the London routes. In conclusion, we would congratulate both Mr. Clegg on the report before

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us and the Corporation of Lincoln on having selected such an able engineer to run their electric supply and tramway undertakings.

METALLIC-FILAMENT LAMPS.

To state that the metallic-filament lamp has now, to use a popular expression, come to stay, is to state a truth that can hardly be challenged. It matters not that, when first introduced into this country, its advent was regarded with a certain amount of scepticism, not to say suspicion. But the most striking comment upon our lukewarm attitude towards it in the early days is to be found in our general appreciation of it at present. Mr. Hirst's paper before the Institution of Electrical Engineers purported to trace recent progress in tungsten metallic-filament lamps. If some might object that Mr. Hirst showed too great a partiality towards one particular form of tungsten lamp—viz., the Osram — none surely will gainsay that Mr. Hirst's interesting account did not tend to add to our knowledge of the subject. Mr. Hirst described the process of forming the filaments of the Osram lamps. This process has never before been described. The tungsten in the form of a fine powder is made into a paste with gum and dextrine. This paste, which has the consistency of putty, is then squirted through a very fine hole in a diamond under a pressure of several tons per square inch. The damp thread thus obtained is dried by heating to a white heat by an electric current. Mr. Hirst dealt with the question of breakage and blackening. Neither of these difficulties it seems may be encountered by the exercise of a reasonable amount of care and knowledge, which it is presumed that many of those who handle the lamps possess. With the elimination of these difficulties, and the promised introduction of lamps of high voltages and low candle-powers, with increased efficiencies and lower costs, we may safely predict a revolution in the electricity supply business in this country. The question as to the effect upon the supply companies has already been fully discussed, particularly in the able paper of Messrs. Handcock and Dykes. We can only add that it cannot but be to the interests of those companies to encourage the use of lamps which yield such a higher ratio of light per watt than the carbon-filament lamps, and thus tend to win over an enormous number of additional consumers, the revenue from whom will more than balance the loss of revenue on account of the economic consumption of those lamps.

LODGE ON KELVIN.

The Faraday Society is not too well supported, but it is doing excellent work. When it was known that Sir Oliver Lodge had been elected president, it was expected that his presidential address would prove satisfying to the most exacting. Lodge always fulfils expectations—and that is more than can be said about most prominent men. The subject chosen by him for his address was "Some Aspects of the Work of Lord Kelvin." Perhaps no other man living is better qualified to speak of Kelvin's work—indeed, there are few men who understand its greatness. The time has not come to fully realise the length and breadth of the genius who at a ripe old age so lately passed away. As Sir Oliver Lodge said, Kelvin began his original work very early in life and continued it to the end. Several times in the course of his address the year 1848 was mentioned as the date of published investigations which within a few years revealed some of the most interesting and far-reaching of Nature's laws. Sir Oliver emphasised the view that the apotheosis of Kelvin's mental activity, of his genius, and of his wonderful insight into Nature's secrets was during the fifties of last century. To understand what Kelvin did means that you must thoroughly understand the position of scientific knowledge at the time. Few—very few—are familiar with the state of scientific knowledge in the early years of the second quarter of last century, fewer still of the state in the first quarter, yet to attain that position is not difficult, for the printing press began to be freely used. The technical books and periodicals of the time are also few, but it is a little sad to know that even of the little either in theory or practice that was known then, large parts have of late been rediscovered and credited to people whose claims to originality would not bear inspection. We would go farther than Lodge. In our opinion Kelvin was even greater than Newton, and his genius and discoveries revolutionised the scientific and practical world, and opened up an era of progress that is so vast as not to be understanded of the multitude. Joule and Kelvin (then Thomson) experimented, proved, and told us practically all we know about the conservation of energy. But, like Lodge, we incline to the view that the Victorian era will ever be known in history as the era of scientific giants, and in years to come the tales of the mythologists will abound with folk-lore of a scientific character founded upon the doings of the heroes of that age. It is so easy for a schoolboy now to pooh-pooh a wild-cat theory that doubts or runs counter to the law of conservation of energy, but it was not so easy before the middle of last century. Sir Oliver revelled in dilating upon the wonderful achievements of Kelvin in this connection and in the domain of thermo-dynamics, wherein in those early days he reigned quite supreme. Time was to the hearers a bugbear during the delivery of this address, in that it did not permit more than a passing mention of some of the greatest works of Kelvin, and with an exponent of Lodge's calibre the loss of a single word of exposition was felt. The president of the Faraday Society has given us one more eulogy of the greatest British scientist who ever lived, and who will fill the same place in scientific history as Shakespeare does in literature.

ELECTRIC DRIVING IN COTTON-SPINNING FACTORIES.

BY WILLIAM HANNA, A.M.I.E.E.

Electrical engineers in looking round for the expansion of their British home trade cannot afford to overlook the immense possibilities offered in the various textile industries. Many firms are now attacking the problem of electrically operating textile mills, and some few who have for many years been doing valuable pioneer work are now reaping the benefits of their earlier experiments. Of all textile trades, perhaps cotton spinning in this country is the most important. Certainly none has reached such a remarkably high state of perfection and organisation. The latest returns show that in Lancashire the total number of spindles now running is about 56 millions. The power taken to drive these is roughly calculated well over a million horse-power—*i.e.*, a figure well in excess of the aggregate output of the whole of the electricity central stations in the British Isles. More spindles are being erected every year. In 1906-7 about 100 new factories, averaging 80,000 to 90,000 spindles each, were put in work, and many others are projected. If, therefore, it can be proved to cotton spinners that electric driving is advantageous, there will follow a great boom in the electrical engineering trades. Electric driving has not been taken up very greatly; the progress of electrifying cotton-spinning mills has only been slow. At present about 1½ million spindles are either being operated or about to be operated with electricity. The general outlook is,

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however, very hopeful. A sufficient number of good results have been obtained to prove beyond all doubt that the many advantages claimed for in this system of factory driving are all that can be desired.

It must be remembered that the very high running efficiency of a modern cotton-spinning factory considered as a whole, and the very good understanding which exists between the cotton spinners and the mechanical engineers who cater for the textile business, are very real features in the competition for mill equipments. The mechanical engineers were first in the field, and their intimate knowledge of the conditions obtaining in the industry make them keen and zealous rivals. Their long years of experience have made them thoroughly conversant with all the requirements of cotton spinning, and in this respect they have no little advantage over the electrical engineers. In the face of these circumstances it behoves electrical engineers to take very judicious care in approaching any schemes for driving spinning mills. Only those firms who have had experience in this class of work and who have overcome the many difficulties can hope to attain success. Certainly textile manufacturers can only expect to get good results by seeking the aid of those firms who have made a special study of the many peculiar and varied aspects of the question. A good idea of the pros and cons of electric driving *versus* mechanical can be got from Mr. H. W. Wilson's papers read before the Manchester Section of the Institution of Electrical Engineers (see *Journal* I.E.E., vol. 34, p. 757, and vol. 40, p. 159). It is not proposed to enter into a discussion of this part of the subject here, but rather to consider the nature of the various loads met with in cotton-spinning mills and the class of the machinery used.

The general lay-out and construction of modern factories vary very little in each case. The mills practically all follow the same plan, but with regard to the selection and proportion of the various productive machines and other details hardly two are alike. Each mill is engaged in manufacturing its own specialities, as a rule keeping to one class of cotton, and spinning one or two counts of yarn. On this account each case should be considered separately. No hard-and-fast rules can be laid down to cover every scheme of factory driving. The most important machines used in preparing and spinning cotton are given in Table I. In each factory just sufficient preparing machines are installed to keep the spinning and finishing machinery in full work. The production is practically continuous in all its stages, and consequently every machine is kept on or about full load. Obviously the load factor of the whole mill is uniformly high.

TABLE No. I.—Cotton Preparing and Spinning Machinery.

Machine.	Horse-power. Approximate.	R.P.M.	Description of load.
Hopper bale opener.	2-3	300	
Waste opener...	—	650	
Hopper feeder..	1½-2"	600	Steady if feed is regular.
Exhaust opener	8-10	850-1,000 950-1,400	
Crighton opener (double).	7-8	450-900 950-1,400	
Single scutcher.	3½-5½	950-1,400	Steady.
Carding engine.	¾-1	140-200	
Sliver-lap machine.	1	250-320	Steady during running; frequent stoppages.
Heilman comber	½	240-324	
Ribbon-lap machine.	1	250	
Drawing frame	14 deliveries*	180-300	Steady during run, 8-27 % loss of time due to stoppages.
Slubbing frame	40-50 spindles*	240-450	Ditto 29-22 % ditto
Intermediate ...	55-60 spindles*	390-450	Ditto 16-8 % ditto.
Roving frame...	65-70 spindles*	390-450	Ditto 17-5 % ditto.
Roving frame (fine).	65-70 spindles*	400-480	Ditto 12½-4½% ditto
Ring frame.....	140-70 spindles*	600-1,000	Ditto 5-10 % ditto.
Mules	100-175 spindles*	—	Very variable load, 4-7½ % ditto.
Doubling frame	40-70 spindles*	600-1,000	Steady during run, 5-10 % ditto.
Winding.....	300 spindles*	140-180	—
Beaming.....	Six machines*	40	—
Sizing	1½-3"	—	—

* Per 1 h.p.

As previously pointed out, the selection and proportion of the various machines depend upon the class of work done. For example, a mill containing 80,000 spindles and spinning 30's/40's warp yarns and 40's/50's weft yarns would contain machines as shown in Table II. Finer counts would require a larger proportion of spinning machinery, whilst coarser yarns need more preparing machines. Bale openers, exhaust openers, thread extractors, scutchers, and other blowing-room machinery run at fairly high speeds.

TABLE II.—List of Machines in a Cotton Mill Spinning American Cotton Counts 30's to 40's warp and 40's to 50's weft.

Cotton machinery.	Driven by
2 waste openers 1 roving waste opener 2 hopper bale breakers with lattice feeders	One 12-n.h.p. motor.
4 hopper feeders 4 horizontal openers with double scutchers 12 single scutchers	Two motors, 40 n.h.p. each.
84 carding engines 3 drawing frames, each six heads of seven deliveries	Two motors, 65 n.h.p. and 50 n.h.p.
8 slubbing frames, each 100 spindles 19 intermediate frames, each 146 spindles 45 rovers, 184 spindles	Two motors, 90 n.h.p. and 75 n.h.p.
63 ring frames, total spindles = 34,864 32 mules, total spindles = 41,216	Several motors, total H.P. = 850, in 200-h.p. and 150-h.p. units.
5 winders, 2,000 spindles 10 beaming machines	One motor, 15 h.p.
Total spindles, 80,000	Aggregate H.P., 1,250.

In every case the load is continuous, as they are seldom started and stopped during the day's run. They can readily be adapted for individual driving. A separate motor for each carding engine would not be economically successful. The load on these machines never exceeds 1 h.p. each, and the pulley speed is never more than 200 r.p.m. The number of cards installed in a modern mill is great enough to admit of the arrangement of several groups, each group being driven with a motor of efficient capacity and speed. Combers, sliver-lap, and ribbon-lap machines are only used where very fine counts of yarn are spun. Group driving is advocated for this part of the factory. Draw frames as well as slubbing, intermediate and roving frames have rather frequent stoppages for doffing and piecing broken ends. The loads are steady, and usually would be high enough to admit of the use of separate motors. Reduction gearing would be required except in the case of fine roving frames, as the running speeds are rather low. It is, therefore, more economical to adopt grouping. Fine rovers running at a pulley speed of about 500 r.p.m. have occasionally been operated with separate motors with success. The loads on the speed frames depend upon the number of spindles on each frame, and varies with the speed of the spindles. Thus, a slubbing frame with 96 spindles at 600 r.p.m. takes 2 h.p., an intermediate frame with 150 spindles at 750 r.p.m takes 2½ h.p., and a roving frame with 200 spindles at 1,080 r.p.m. takes 3 h.p.

There are two distinct types of spinning machines in use at the present time: (1) the self-acting mule and (2) the ring frame. The mule is not a continuous-running machine. Its leading peculiarity is that, whilst the headstock or driving gear is stationary, the frame carrying the spindles is fixed on a carriage which has a backward and forward motion to and from the headstock. The length of the travel or stretch is usually about 64in., and the number of stretches per minute is from two to five, according to circumstances. At the beginning of each of the stretches the power taken is three to four times the normal load. This, of course, makes the adoption of individual driving entirely out of the question. Grouping is the only satisfactory method of driving mules. Sufficient machines should be grouped so that the load peaks of each machine are balanced and fluctuations damped down. About six machines would be the minimum number to group, and as each mule, containing, say, 1,200 spindles, would require 10 h.p. to 12 h.p., motor units of over 100 h.p. would be installed in the mule-room. Even with groups of this size large variations of load are apt to occur. It is, therefore, necessary that the motors installed should be capable of withstanding large overloads.

Ring frames take up the fibre at the same stage as the mule, and perform exactly the same functions. Their

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importance lies in the fact that the initial cost and running charges are lower than those of the mule. Female and unskilled labour can be employed to operate them. Up to the present time only coarse and medium counts of yarn can be spun on ring frames. Any improvement affecting their running properties and increasing their usefulness is eagerly sought after. With electric driving the range of the machine has certainly been extended. Very gratifying results have been obtained from electrically-operated ring frames. Their steady demand for power, rather infrequent stoppages, and high running speeds make them an ideal load for induction motors. The power taken by an ordinary size of frame, containing, say, 400 spindles, would be 5 h.p. A separate motor of about 7·5 h.p. would be required to drive each frame if individual driving were adopted. In some cases larger motors, of some 10 h p. to 12 h.p., have been used to drive two machines, the motor being fixed between the frames, arranged end to end and direct-coupled to the shaft of each. Ring doubling frames have the same characteristics as the spinning frames, and their driving arrangements are similar. Other finishing machines are seldom driven separately, as either they are too often started and stopped or the power required is too small to make individual motors economical.

In mechanically-driven mills the various line shafts extend the whole length of the factory, and terminate in the rope race. They are driven by rope pulleys, which take their power from the engine flywheel by means of cotton ropes. The cotton-rope drive itself is very efficient, and under good conditions, where well-designed pulleys are used, there is practically no slippage. The speed variation at the rope pulley end of the line shafts can be reduced to a minimum, but owing to the torsion in them and the slip of the belts on the machine pulleys, fluctuations of speeds on the machine shaft may be very high. Merely to replace the rope pulleys by a large power electric motor, as has been done in some recent cases of mill driving, is certainly a retrogression as far as internal economics goes. The whole crux of the question lies in the judicious grouping of machines. Whenever possible, long line shafting should be eliminated and the size of the groups made as small as is economical. Each scheme has its own peculiarities which require special consideration.

The actual efficiency of the internal power transmission is not, however, the sole aim of the spinning engineer. Steadiness of running is quite as, if not more, important. The fragile nature of the material necessitates very careful treatment. Slight irregularities of speed lessen the quality of the yarn, and sudden fluctuations cause breakages of the threads, and consequently stoppages of the machines. The safe running speeds of the machines are limited by the frequency of the breakages. With steady running fewer "ends" come down, and for the same percentage of breakages higher speeds can be run than with uneven irregular driving.

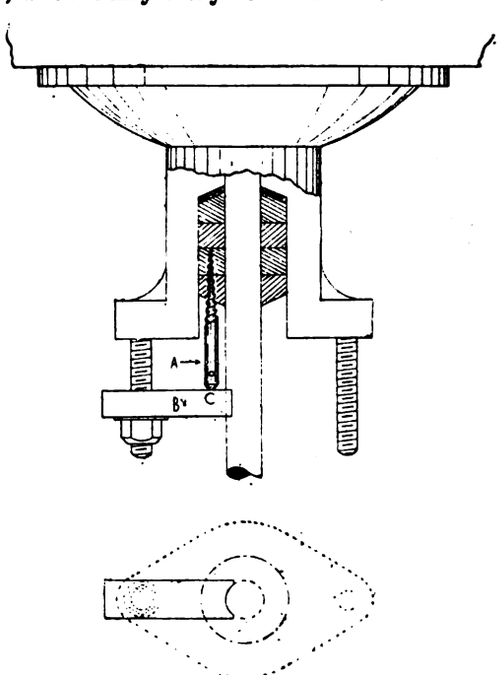
Cotton-spinning machinery is very adaptable for a load for polyphase motors. Without doubt better all-round results have been obtained with this type of motor than with any other. The effect of driving mills with induction motors taking power from turbo-generators is very noticeable in the improved quality of yarn spun. In factories taking power from central stations containing both turbo-machinery and reciprocating engine sets, the operatives can tell by the behaviour of their machines which type of generator is running.

The question of power generation is a very wide one. Whether millowners should generate their own power or purchase it from outside suppliers will depend upon price of supplier's power, type of plant in central station, nature of current available, and various other considerations. In some parts of the cotton district, supply authorities are catering for the industry, but their number is very small indeed. In the most important cotton-manufacturing towns the municipal supply systems are useless as far as cotton-mill driving is concerned. Where suitable power can be obtained, electrically-driven mills are being erected. Several factories have, of course, been equipped with private generating plants, but there is a growing favour for externally-driven mills. As electrical operation of cotton mills is gradually superseding the older driving systems, much more attention will have to be paid to the demands of the manufacturers by the hitherto lax municipal supply authorities. The centre of the industry will certainly move in the future towards those districts where suitable power is available. One very important municipality is now seriously considering the question. The necessity of the substitution of their large direct-current supply station for an up-to-date alternating-current system has been brought home to them. Other towns will eventually have to convert their systems. All this will mean that in Lancashire the demand for electrical machinery will be great. The electrical manufacturing business will receive a great impetus, and the electro-textile engineering industry will become as important a branch of electrical engineering as electric lighting and electric traction.

A DEVICE FOR WITHDRAWING REFRACTORY PACKING.

BY S. LEES.

The wrinkle described herewith will be found useful for withdrawing refractory soft packing, especially on small-sized quick-revolution engines of the inverted-vertical type, where the rod stuffing boxes are almost invariably ungetatable. Of course, if the engine can be spared out of service for a sufficient length of time, or if there is no objection to working on it while the parts are hot, a good plan is to block the flywheel—*i.e.*, fix the barring lever in one of the barring holes, and pack up tight to prevent the engine from turning—and turn on steam gently, meanwhile slacking off the gland gradually until the packing is loosened, when it may easily be withdrawn.



The accompanying illustration is really self-explanatory, but, perhaps, a brief note or two may be appreciated. The screw, A, is made from a "coach screw" having a sharp, full thread, the head end of which is turned or filed to a centre point. A couple of holes are drilled at right angles to each other through the shank to take a "tommy bar." The guide piece, B, is made from a stiff length of iron just centred to take end of screw at C. To use, the screw is given a turn or two until it has got a good hold of the packing to be withdrawn, the guide being followed meanwhile. A little gentle coercion by means of the "tommy bar" after slacking off the guide does the trick. The device shown in sketch is fitted to a two-stud stuffing box, but it can easily be adapted to suit boxes of different design. Appliances (mostly corkscrew devices) are usually supplied for the purpose as described in the foregoing, but oftener than not they are quite useless for the job, especially if the packing has been nipped up hard for any length of time.

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THE ADAMS MANUFACTURING COMPANY'S WORKS, BEDFORD.

Igranic Starters and Rheostats.

The starting switches and speed-regulating rheostats made by the Adams Manufacturing Company will be known in some form or other to most electrical engineers

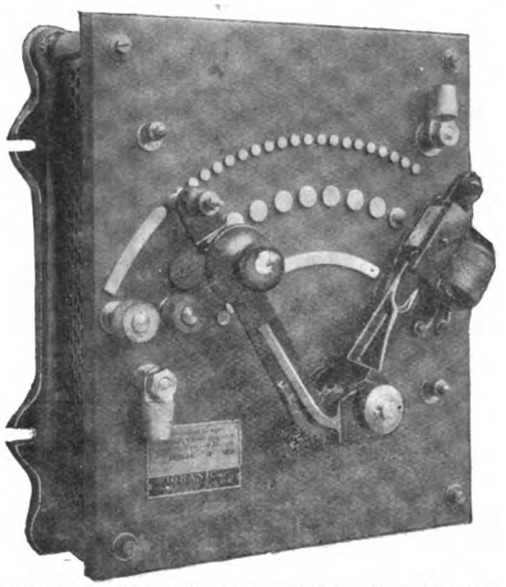

FIG. 1.—The Igranic Combined Motor Starter and Speed Regulator.

in this country. Comparatively few, however, have had the opportunity of inspecting the works at Bedford in which the Igranic starters are made. We found, when these works were thrown open to us last week, that the manufacturing processes were most interesting, but we were particularly impressed with the organisation of the firm which enables prompt delivery to be given. Those who have used largely the starting switches and speed-regulating rheostats of the company may have the impression that their manufacture in quantity is a simple matter, but this is not the case. It is true that the firm can and have standardised the bulk of the numerous parts required in their very varied products. The assembly of these parts can also be put through in quantities for the standard starting switches and motor controllers. This applies especially to the switchgear, but the special shunt regulating resistances have to be arranged to suit the particular motors which have to be controlled. As an example, the firm have a compound starting and speed-regulating rheostat (Fig. 1) equipped with the no-volt (and, if it is required, the overload) release, which also enables the speed of the motor to be regulated by inserting resistances in the field circuit. This is done by the lever on which the handle is mounted moving back over the outer row of contacts. The device is excellent, in that it ensures the full field on the motor when starting up. These rheostats are made for three standard voltages and in 14 sizes for each voltage. This alone gives 42 variations in the general design and arrangement of the front part of the rheostat. For each standard voltage they are made for two maximum values of the shunt current, and, again, they can be made to reduce this shunt current by predetermined amounts, varying from 50 per cent. up to 90 per cent. Thus in this one list there are no less than 512 possible variations which may be selected by the purchaser when giving an order. It will be obvious to any engineer who has had experience in manufacturing that unless some perfect system of promptly instructing the works what to do is adopted, these variations will lead to endless mistakes and delay. With the Adams Manufacturing Company at Bedford the average time between the receipt of an order and the dispatch of the apparatus required is slightly under five days, which is the best proof of the efficacy of Mr. Curtis's organising ability.

Before referring again to the system adopted, we would give a brief description of the works themselves. In these works the company make motorcars as well as electrical switchgear, and a good deal of the automatic machine tools are used at times for making parts for either product. Fig. 2 shows one view of the machine shop, but does not give an adequate idea of the numerous automatic machines for turning out the small parts used in the Igranic rheostats. All these small parts are manufactured on stock orders, and then are passed into that section of the stores devoted to parts (Fig. 3). From this they are issued to the workmen who assemble these parts. For this purpose trays are used with numerous compartments, into which the storekeepers place that number of each part which is required to make up the batch of starting switches. Fig. 4 shows the department in which the fronts are assembled, and these when complete are again passed into the store. Certain lines of standard rheostats are then completely finished by adding the resistances and their cases, which are seen in course of completion in Fig. 5.

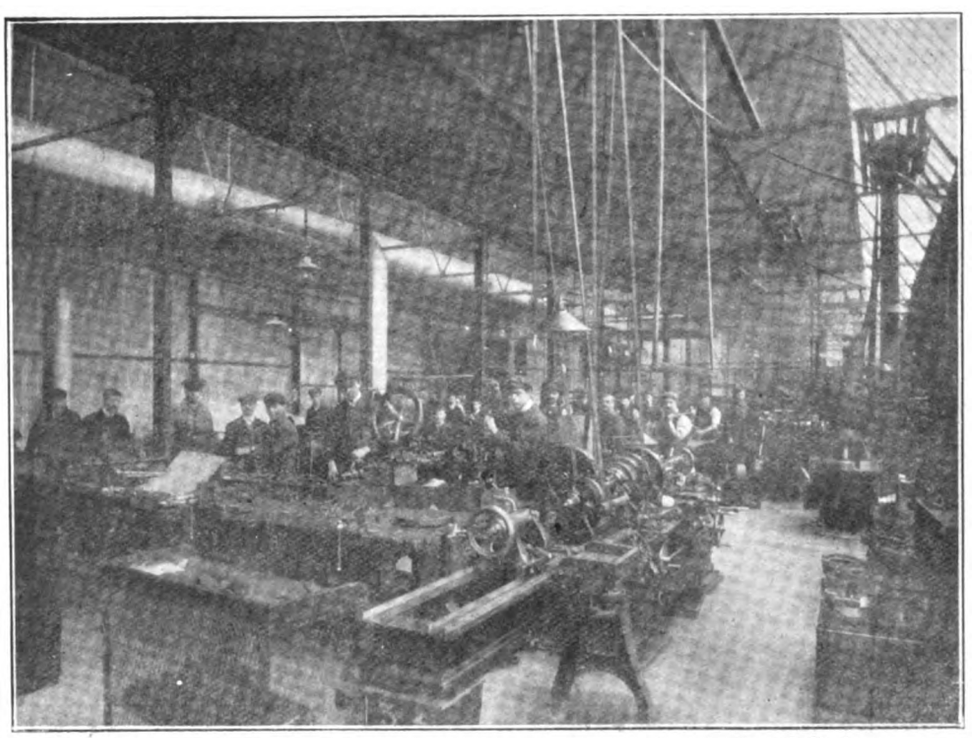

FIG. 2.—View of one end of the Machine Shop of the Adams Manufacturing Co. at Bedford.

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Quite a large proportion, however, of the fronts are retained in store and completed with special resistances to complete particular orders. For example, the cases enclosing the resistances can be varied considerably, and Fig. 6 shows that portion of the work in which cast-iron cases are

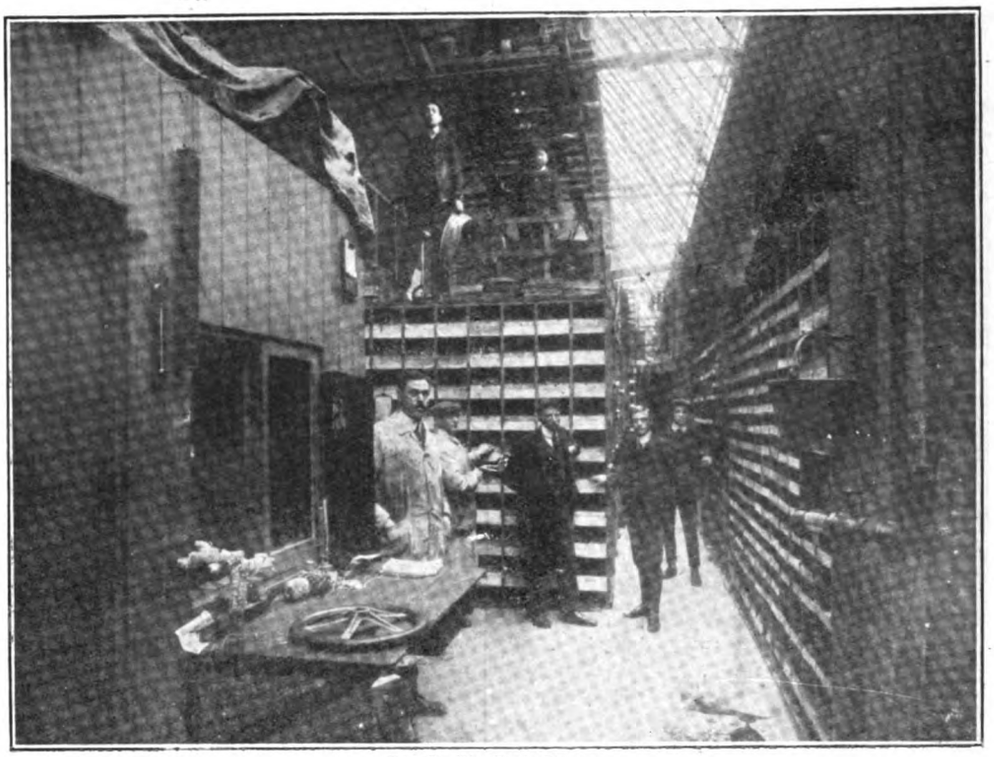

FIG. 3.—The Parts Stores.

used for the purpose. Dealing with the resistances alone we find again that certain parts, such as the fireproof tubes round which the wire is wound, can be put through in large quantities, but the winding of these with wire suitable for particular work is often done after the order is received. In spite of this, the system adopted is such that

idea of the procedure. The incoming orders each morning are divided out according to their urgency, and also according to whether they are for standard apparatus The clerk dealing with incoming orders fills up a card for each, and he can deal with the majority unless some highly technical point is disclosed in the order. If so, it is referred to a designer, but even then the majority of the cards giving particulars of the urgent orders reach the shop before 10 a.m. Another card giving similar information is issued to the test-room, where each rheostat is carefully inspected and the resistance of each step

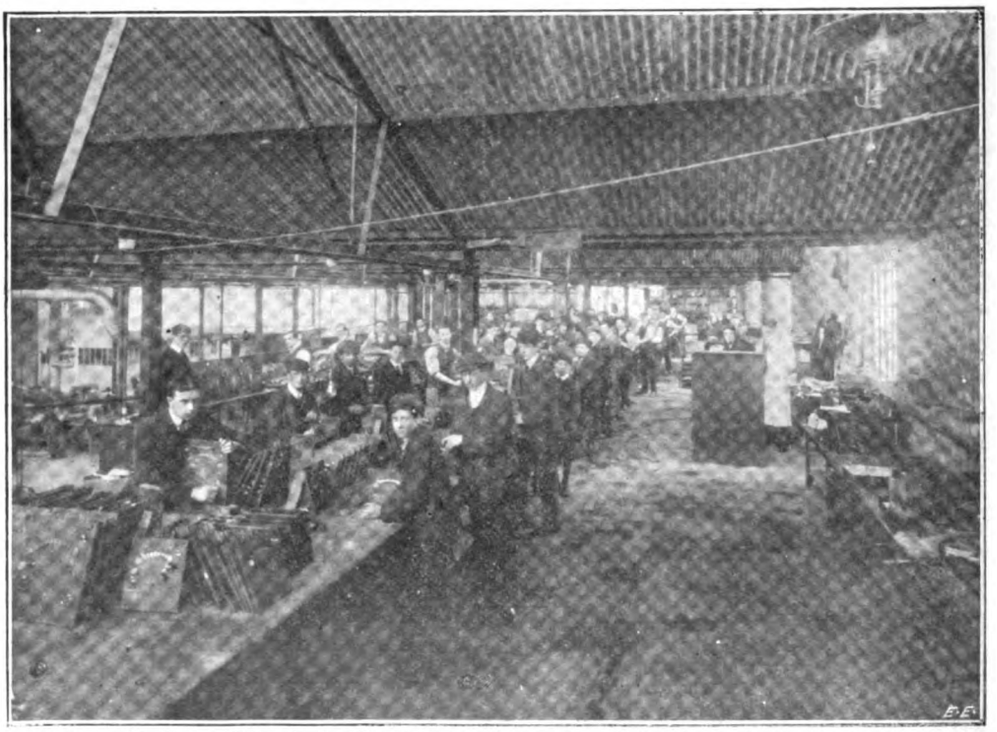

FIG. 4.—The Gallery in the Adams Manufacturing Co.'s Works where the Fronts are assembled

urgent orders requiring special resistances behind standard starting switchgear are put through the same day that the order is received.

While we do not pretend to be able to describe in the space we have available the full particulars of the card system adopted, the following brief outline will give some

measured. These instruction cards and the test-room report on the apparatus are passed forward when all is completed, and serve as a permanent record of exactly what has been supplied. The less urgent orders are afterwards dealt with, and the works manager, Mr. Curtis, has in his office an excellent system which

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shows at a glance what deliveries have been promised for each order in hand. Numbered cards for each order are placed in vertical racks under the day by which the goods have to be dispatched, and these are not removed until delivery has taken place. Any notes as to causes of delay are made on these cards, so that he can see quickly any special reason for the non-fulfilment of the expected completion. This rack also serves as a guide for promises for delivery, as the possible output for a day is known. The whole scheme reflects great credit on Mr. Curtis, and from our talks with the members of the staff we found that each man was able to quickly carry through his own portion of the work entailed. In the shops themselves there was no indecision as to what the cards for each order instructed, and these cards going through with the work served as a check on each stage towards completion.

After having seen through the works and having avoided the temptation to investigate the motorcar department as well, we discussed with Mr. J. T. Mould some of the latest developments in the Igranic specialities. We have referred to the compound starting and speed-regulating rheostats above, of which there are two moving levers. In this rheostat the riding lever, which also forms the shunt regulator lever, is fitted with a handle. When operated this lever pushes before it the starting lever, cutting out series resistance from the armature circuit, and when same has reached the end of its travel it is held by the no-voltage release magnet. During the time the starter lever is passing over its contacts the field regulator resistance is short-circuited, so that the motor starts up with full field. When the starter lever has reached the full on contacts this short circuit is removed, and the movement of the riding lever to the left inserts resistance gradually into the field-circuit, thus increasing the speed of the motor. On the no-voltage release acting, a hub spring automatically returns the starter lever to the "off" position, carrying with it the shunt regulator lever. This type of controller is made to give speed increases above normal as high as

FIG. 5.—Adding the Resistances to the Starters.

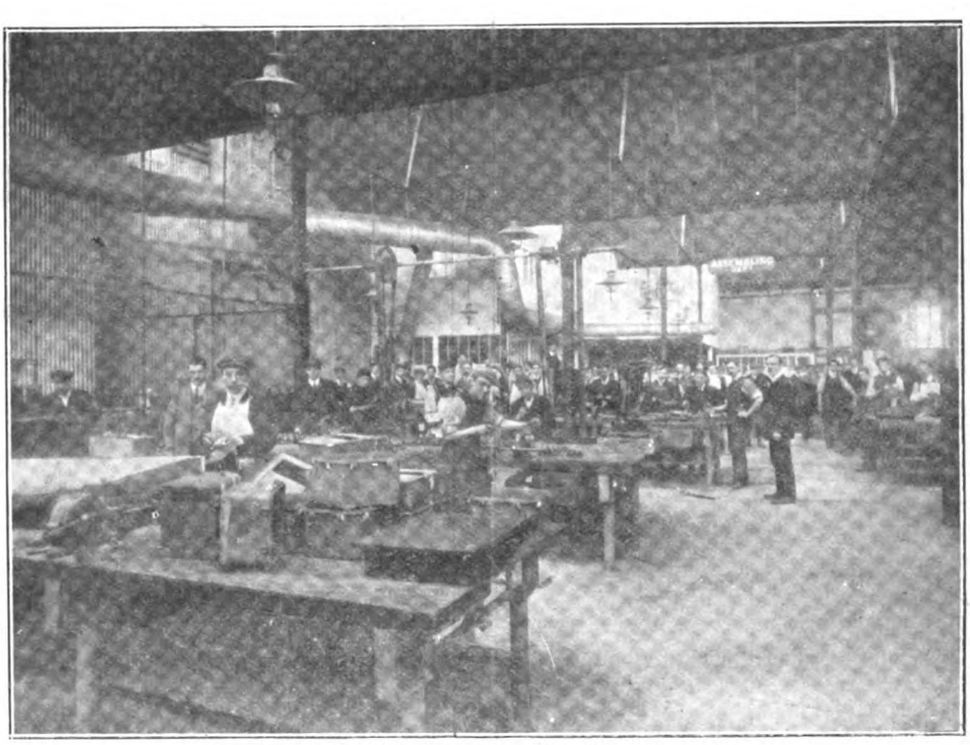

FIG. 6.—View of the Ground Floor Assembling Department.

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400 per cent. with specially wound motors. There is another type of two-lever rheostat in which the no-voltage

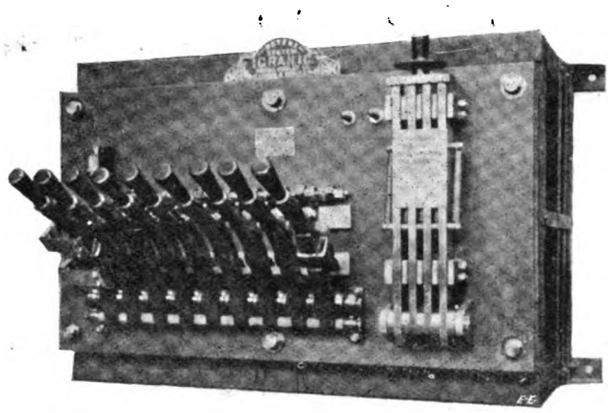
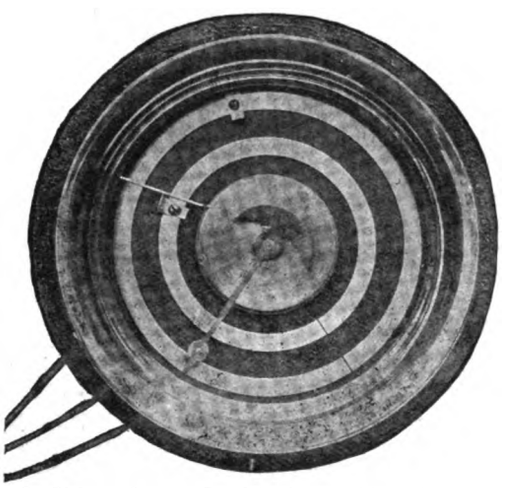


Fig. 7.—Multiple Switch Starting Rheostat with No-Volt and Overload Release.

coil is carried on the first handle, and pulls the main or starter lever by magnetic attraction over the



G. 8.—Dial type Pressure Regulator for use with Air Compressors.

contacts. On the front an overload release is fitted which operates by short-circuiting the no-volt release coil. This automatically prevents the too rapid starting

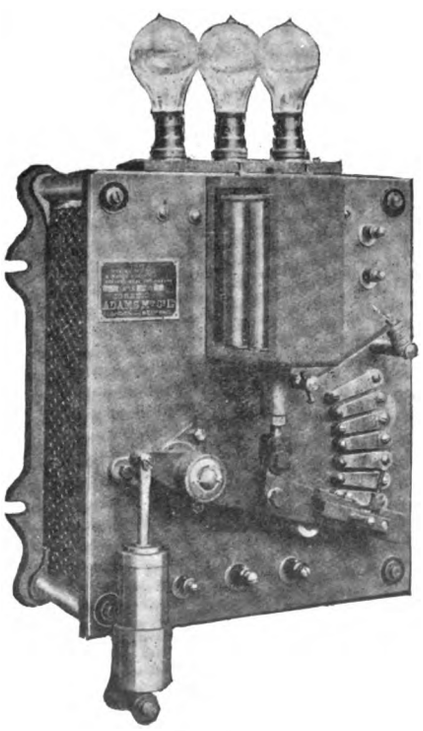


Fig. 9.

of the motor, and is much used on those corporation circuits on which a definite starting current for each size of the motor must not be exceeded.

Fig. 7 shows a new type of multipole switch starting rheostat with interlocking levers which is used for large motors and heavy starting currents. The feature of this construction is that there are no sliding contacts at which injurious sparking can occur. The individual levers are

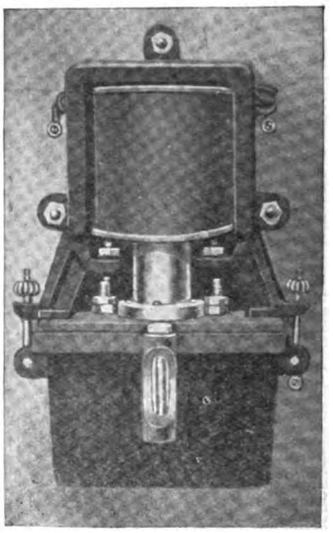


Fig. 10.—Electrically-Operated Solenoid Switch (Oil Immersed).

closed one after another and so interlocked that they can only be operated in the proper sequence. The circuit is always broken by the circuit breaker at the end, which is provided with carbon surfaces to take the arc at breaking. When this is tripped the whole of the levers open automatically. This apparatus is stocked to control

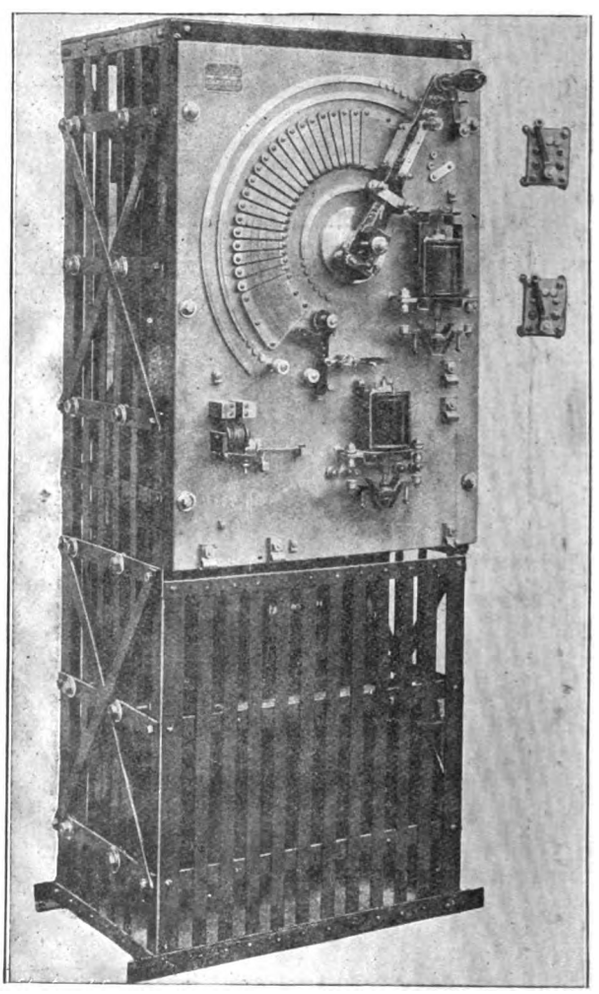


Fig. 11.—Igranic Printing Press Controller.

motors up to 150 h.p. for three standard voltages, and is standardised and made up to 1,500 h.p. Fig. 8 shows the dial-type pressure regulator used by the Adams Manufacturing Company for the control of electrically-driven air-compressors, etc. The pressure regulator acts much in the same way as the pressure gauge, and

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consists of a metallic U tube with the usual pointer. The fixed contacts against which this pointer makes connection can be moved to any pressure desired. The device then is employed in connection with any of the automatic solenoid

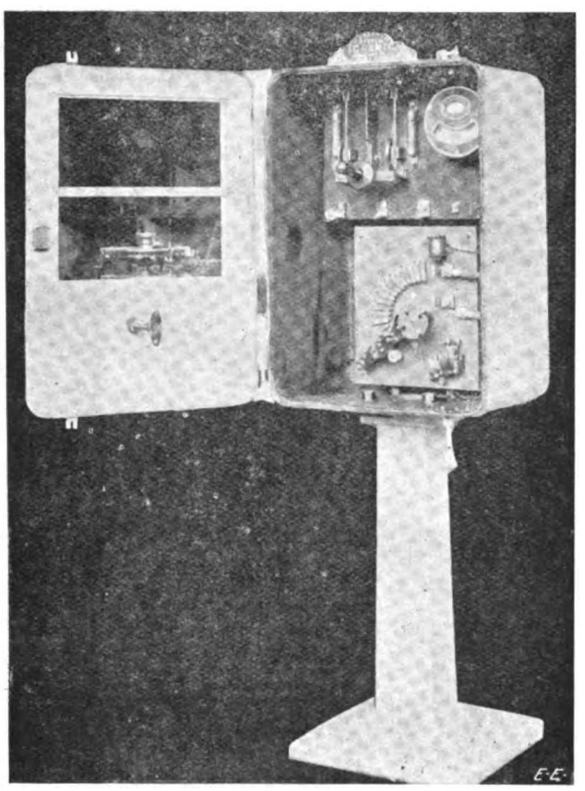

FIG. 12.—Switch Pillar containing Main Switches and Fuses, Meter, and "Igranic" Motor Starter.

self starting rheostats manufactured by the firm. Fig. 9 shows one of these for direct current, and Fig. 10 is an automatic self-starting switch for alternating currents. These switches are of the oil-immersed type, and can be used equally well

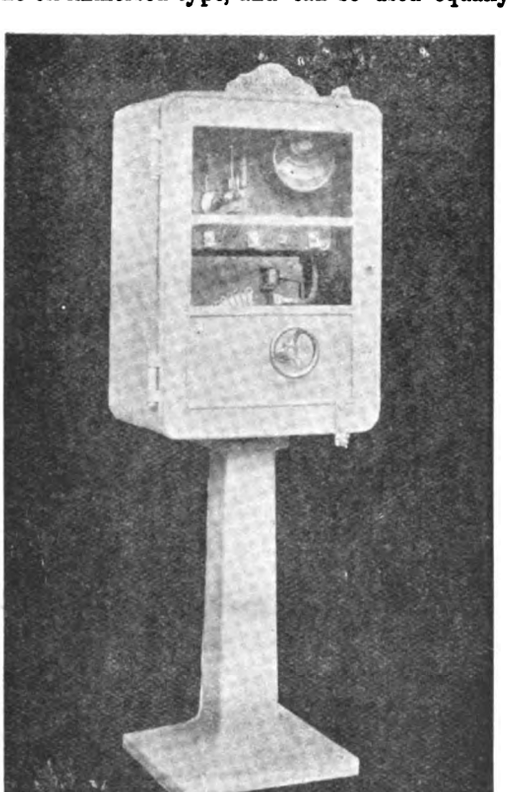

FIG. 13.—The Switch Pillar with the Door Closed.

in connection with the stopping and starting of pump motors.

We have not in the above description referred to the standard starting switches of the Adams Manufacturing Company, as these are well known, but should there be any of our readers who have not tried these British-made rheostats, we would advise them to do so before placing orders for inferior apparatus made abroad. Again, should they have any special problem in motor starting or control before them, they would do well to see if the above firm have not some standard apparatus which can be used before finding what not to do by experience. For example, Fig. 11 shows a controller for a rotary printing machine, by which many special conditions are fulfilled. With this the speed control ranges from the lowest speed required when making ready up to the highest speed the printing machine will stand. This range will stand without any strain on the motor or controller, or upon the intelligence of the operator, and by the use of one handle only. Figs. 12 and 13 show a switch pillar which has found favour with many corporation and factory engineers.

We have to thank Mr. Rigby, the secretary of the company, and Mr. Curtis and Mr. Mould for the great rouble they took in showing us every part of the Bedford Works. An Adams car also speeded our departure, and by its smooth running and gear changing left in our minds the regret that the works were not miles away from the railway station.

CREOSOTE AS A WOOD PRESERVATIVE.

Creosote is, of course, a valuable agent to preserve wood against decay. The Forest Service of the United States is publishing information about it. A recent pamphlet is "The Analysis and Grading of Creosotes," by Arthur L. Dean and Ernest Bateman. The following is an extract from this publication: "A pure coal-tar creosote will protect properly treated timber for a great many years. What protection will be afforded by the distillates from other kinds of tar is as yet an open question, but the increased production of these tars and the growing practice of distilling them make it imperative that definite information regarding their preservative value should be acquired. At present, despite the apparent approximation to the composition of coal-tar creosotes by the creosotes from oil or water-gas tars, the known preservative value of the pure coal-tar creosotes makes them of greater market value. We must, therefore, regard the creosotes obtained by the distillation of properly made coal tars as the highest grades for preservation. It is, of course, well known that by varying the conditions under which coal is decomposed tars are obtained which differ in composition. With distillations at low temperatures the production of aromatic compounds is reduced, and the resulting tar contains compounds analogous to those present in crude petroleum; hence the single specification that a creosote shall be distilled from pure coal tar does not necessarily assure a high-grade oil. In addition to being a pure distillate from coal tar, the creosote must also possess a composition which gives it properties falling within narrow limits."

LONDON COUNTY COUNCIL TRAMWAYS ESTIMATES.

The report of the Finance Committee of the London County Council, presented at the usual weekly meeting of the Council on Tuesday last, contained the following estimated expenditure to be incurred by the Council on capital and revenue accounts to be incurred by the Council in connection with the tramways during the period from June 1, 1908, to June 30, 1908.

The amount voted in respect of annual capital account was £80,000, the amount voted on this account prior to the further amount being £80,000.

The following table shows the estimated total expenditure on revenue account:

Electric traction.	Amounts already voted on account.	Further amounts to be voted.
Traffic expenses	£72,000	£38,000
Advertisement expenses	700	400
Repairs	31,260	16,240
General expenses	15,600	11,400
Power expenses	25,300	14,700
Horse traction	60,050	29,370
	£204,910	£110,110

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ELECTRIC FANS.

The British Westinghouse Electric and Manufacturing Company, Limited, Trafford Park, Manchester, are introducing a varied selection of electrically-driven fans, designed in accordance with the principles which have given such efficient results in their application to the other classes of electrical machinery manufactured by them, and

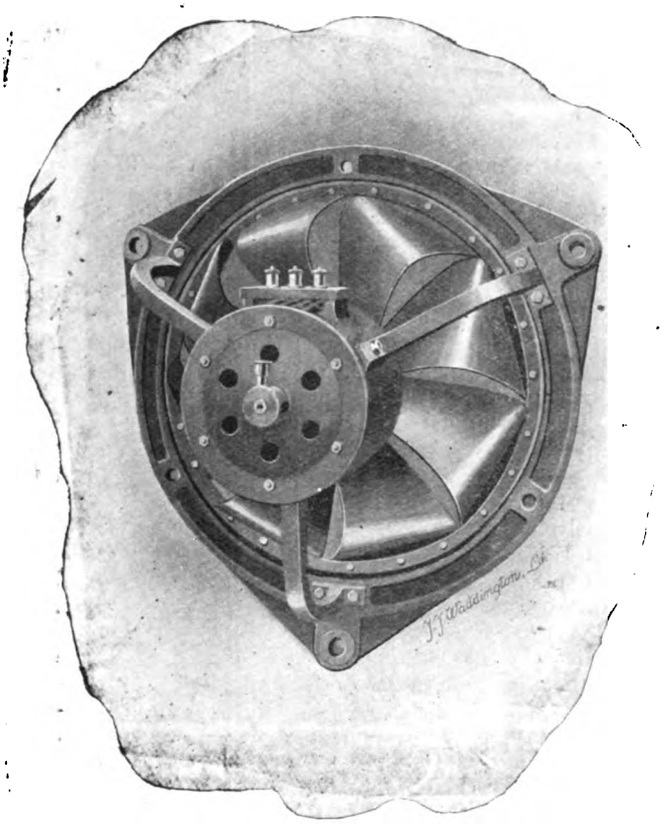

FIG. 1.—"Ariel" Exhaust Fan (Westinghouse Co.).

presenting an appearance which combines neatness with effectiveness. The illustrations which we are able to present here afford some idea of the range covered by the design of the electric fans constructed at Trafford Park.

The first fan to attract attention is the "Ariel" box-blade exhaust and ventilating fan for alternating-current circuits, which is shown in Fig. 1. These fans are made in eight sizes, from 12in. to 48in. in diameter, with capacities of 1,300 to 14,500 cubic feet of free air per minute. The motors are suitable for all periodicities up

FIG. 2.—"Ariel" Desk Fan.

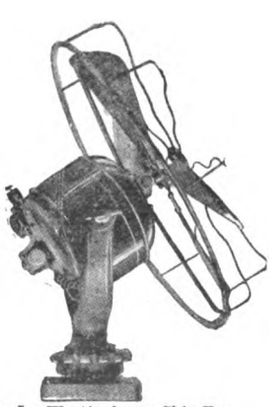

FIG. 3.—Westinghouse Ship Fan.

to 60, while the 30in. fan can be used on circuits up to 83 periods, and the 24in. up to 100 periods.

Another type of fan is shown in Fig. 2. This represents an "Ariel" desk fan with swivel and trunnion base for alternating-current circuits. The motors are of the self-starting induction type, and are designed to run on 400-100 period circuits at 105-110 or 210-230 volts. The fans have nickel-plated guards and blades, while the motor is finished on black enamel with gold lines.

Fig. 3 depicts a patent ship fan with special supporting base for direct-current circuits. This fan was specially designed for use in ships, trains, and similar positions,

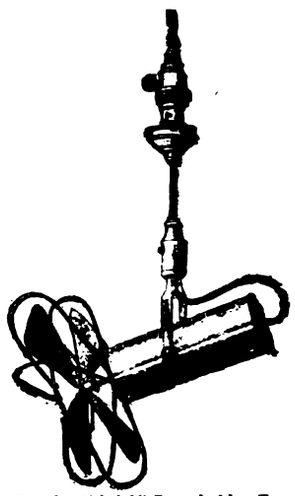

FIG. 4.—"Ariel" Lampholder Fan.

and is specially insulated to withstand the action of sea-water and hot climates. An important feature is a patented base for supporting the fan from the ceiling of the cabin or car, and by means of which it can be readily removed when not in use. The construction is a very substantial

FIG. 5.—"Ariel" Cabin Fan.

one in every respect. The blades and guards are of polished brass and lacquered, the motor and base being finished in black enamel. It is manufactured in three sizes—9½in., 12in., and 16in. diameter.

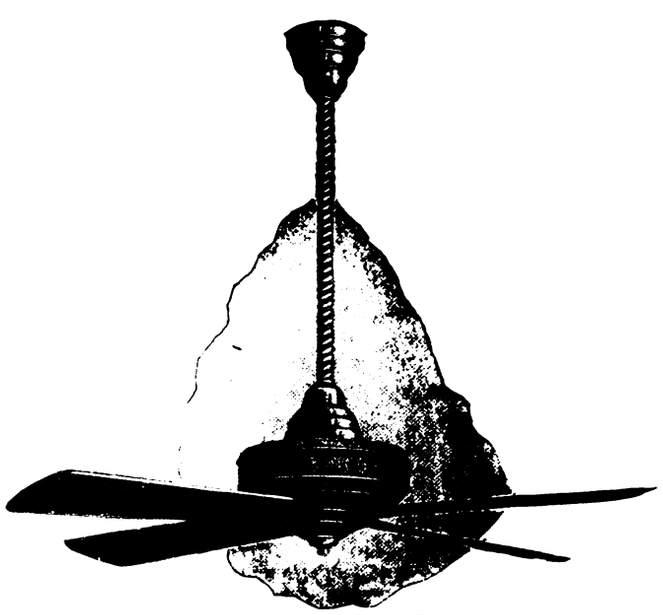

FIG. 6.—Westinghouse Ceiling Fan.

A novel type of fan is that depicted in Fig. 4. This is a lampholder fan with a new swivel and trunnion arrangement. This fan is arranged for running on alternating-current circuits of 100 or 200 volts up to 60 periods, and on 100, 200, and 240 volt direct-current circuits. It can be supplied with a suitable stand for converting it to a

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TABLE II.—LIFE TEST RESULTS.

No. of test.	Type and cost per lamp.	Tested by	Starting		Efficiency in W./C.P.	No. of lamps.	Duration of tests.	Average useful life.	Mean efficiency	Average C.P.-hours.	Cost per 1,000 C.P.-hours.		
			Watts.	C.P.							Renewals	Energy at 4d. per unit.	Total.
	Low voltage.						Hours.	Hours.	W./C.P.		d.	d.	d.
I.	Osram—48d.	Faraday House.	35·7	36·3	0·99	12	2,000	1 520	1·12	48,700	0·98	4·48	5·46
II.	Osram—48d.	Westminster Testing Laboratory.	35·8	29·7	1·22	12	1,500	1,360	1·29	36,600	1·31	5·16	6·47
II.A*	Osram—48d.					12	3,350	2.850	1·42	70,800	0·67	5·68	6·35
III.	Osram—48d.	T. R., Charlottenburg.	34·7	1·0	1·12	?	1,000	1,000	1·11	31,100	1·54	4·44	5·98
IV.	Osram—48d.	Robertson E. L., Limited.	35·0	27·7	1·26	6	1,800	1,720	1·36	45,600	1·06	5·4	6·50
V.	Wolfram—48d.	Robertson E. L., Limited.	38·0	30·7	1·24	2	1,000	1,000	1·27	28,900	1·66	5·08	6·74
VI.	Tantalum—33d.	Westminster T.L.	39·1	22·0	1·78	6	1,000	700	1·84	15,000	2·19	7·36	9·55
VII.	Carbon—12d.	—	59·0	18·7	3·15	10	1,000	1,000	3·25	18,000	0·67	13 00	13·67
	High voltage.												
VIII.	Wolfram—90d.	Robertson E. L., Limited.	63·4	53·7	1·18	10	880	720	1·12	42,500	2·12	4·48	6·60
IX.	Carbon—12d.	—	68·0	18·9	3·6	10	1,000	1,000	3·95	18,200	0·66	15·80	16·46

NOTE.—For the purpose of comparison all the above results have been expressed in terms of the "Hefner" unit of candle-power. * This is a continuation of Test II. to 3,350 hours to show that it pays to burn Osram lamps to the limit of life.

desk fan, or with a trunnion and swivel to enable the air current to be turned in any desired direction.

Fig. 5 shows an "Ariel" cabin fan. The "Ariel" cabin fans for direct-current circuits have been designed for use on board ship and in railway carriages where there is little space available. The motors are series wound, and are made for running on any circuits between 65 and 110 volts. The blades are of aluminium, and all other parts are finished in black enamel with gold lines. The speed of the motor can be varied slightly by altering the angle of the blades.

A Westinghouse ceiling fan is shown in Fig. 6. This fan is arranged for running on alternating-current circuits at 40-60 periods, at 100-110 or 200-220 volts. They are supplied with four wooden blades with a sweep of 57in., set at angles calculated to give the greatest possible movement of air with the least consumption of energy, the rotating element being mounted on ball bearings with automatic lubrication. The motors are strong, reliable, efficient, and practically noiseless.

RECENT PROGRESS IN TUNGSTEN METALLIC FILAMENT LAMPS.*

BY H. HIRST, MEMBER.

(Continued from page 736.)

THE EFFECT OF METALLIC-FILAMENT LAMPS ON SUPPLY SYSTEMS.

Fears have been expressed by some electrical engineers that the introduction of these Osram lamps will seriously affect the finances of supply undertakings. As I pointed out in the introduction of this paper, exactly the same fears were expressed by gas engineers when Welsbach mantles were introduced, which enabled the gas required to produce a given quantity of light to be reduced to one-third of that previously used. These fears proved groundless, and the demand for gas increased instead of decreased. I feel confident that the same result will follow the commercial use of the metallic-filament lamp. It seems likely that the introduction of these lamps will mean an increase of 100 per cent. in the unit adopted for electric light. Sixteen-c.p. carbon lamps will be replaced by 25 to 35 watt tungsten lamps, and those places in which a low illumination is desired will still be supplied with carbon-filament lamps of 2½, 5, and, perhaps, 8 c.p. As it is not practicable at present to make Osram lamps for 110-volt circuits of a lower candle-power than 25, it is likely that in small rooms greater illumination will have to be used. Where larger spaces have to be lighted, it is easily possible to obtain the present illumination by using fewer lamps, but I think that, with the cheaper light, the general tendency will be towards higher illumination.

Generally speaking, I do not think that the metallic-filament lamp will decrease the current consumption of existing consumers to the extent expected, but will, instead, lead to a large increase in the amount of illumination. At the same time, the high efficiency of the lamp, compared with all other forms of lighting, will turn the scale in the favour of the use of electric light rather than other illuminants. Station engineers will find that the increased load from new consumers will more than make up for the decreased consumption of existing ones. This conclusion has already been proved to be correct by Mr. C. P. Sparks, Mr. A. H. Seabrook, and others. As has been the case with so many new inventions, so the tungsten lamp on its introduction had to run the gauntlet of many reproaches on the part of the more conservative elements in our profession. I think it well to allude as fully as possible to what have been termed the disadvantages of the lamp. Amongst these is the burning in vertical position, which up to now has been insisted upon by the manufacturers. This problem is already solved in different ways, and lamps can now be supplied to burn in any position.

The price of these lamps is for the moment a trifle higher, but before many months, I believe, they will be supplied at the same price as the others. The price itself is naturally held up as a disadvantage, especially when a consumer is displacing old lamps for new ones. The outlay then appears serious, but Table II. shows that the saving in current for given illumination rapidly wipes off this expenditure. Much has been made of the brittleness of the metallic filament and of the percentage of breakage in certain instances. I have no experience of what the makers of tantalum lamps have found in this respect, but from the moment it was understood how to pack the Osram lamp the breakage in bulk has been a negligible quantity. It now only affects the supply of the lamps in small parcels of one half-dozen to one dozen. This problem is now being dealt with, with every prospect of an early success.

Another point about which there has been considerable outcry is the blackening of individual bulbs which occasionally occurs. It is at present thought that this blackening is due to some extent to the great sensitiveness of the filament to small changes in vacuum. Other theories exist as to the cause of this, but what for the moment mainly interests the users is that if a lamp is going to blacken it usually happens at a very early period of its life, when the makers are prepared to deal with the matter generously. It is quite different in this respect to a carbon lamp, in which a blackened bulb means, as a rule, that the lamp has been kept on circuit for an indefinite period, far exceeding its useful life.

Having dealt with these points, I would call attention to the other data on Table II. and to the following curves (Figs. 3, 4, 5, and 6), showing some characteristic tests of Osram, tungsten, and tantalum lamps made by various independent testing authorities.

The samples of Osram lamps were selected at efficiencies corresponding to the limits of sorting—that is, 1·0 to 1·25 watts per candle-power—so that they represent the lowest and highest efficiency at present on the market. Test I. on Table II. and Fig. 3 is a good example of an Osram lamp. This was made by Faraday House on an ordinary commercial lighting circuit, alternating current, with a

* Paper read before the Institution of Electrical Engineers.

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variation of voltage of about 3 per cent each way. Twelve lamps were tested, and nine gave a life of 2,000 hours, with a 20 per cent. drop in candle-power. The first failure took place at 900 hours, the other two failures following between 1,200 and 1,400 hours. The cost of lighting with such lamps comes out at the very low figure, including renewals, of 5½d. per 1,000 candle-power hours. Tests II. and II.A on Fig. 3 are other examples of Osram lamps burnt at a slightly lower efficiency, and after

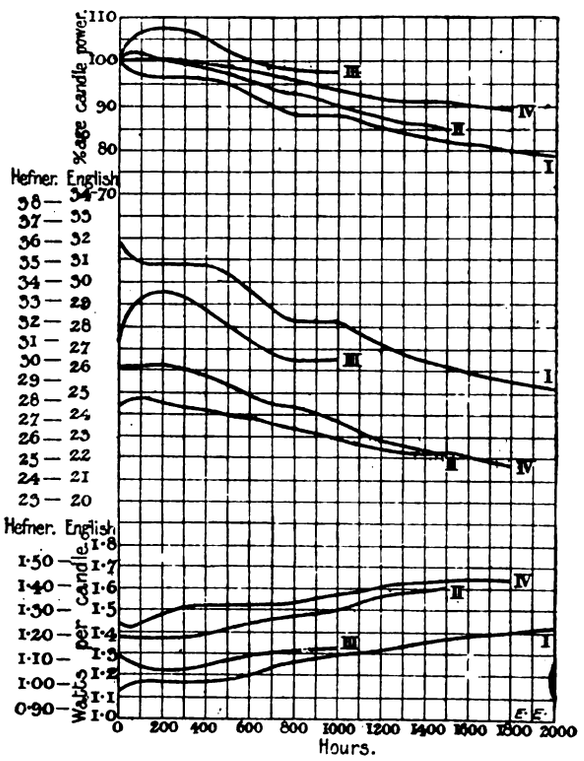

FIG. 3.—"Osram" Average Life Test Curves, etc

1,500 hours' use the drop in candle-power only amounted to 11 per cent. This test was continued to 3,350 hours, when nine lamps were still good. Their average candle-power was then 70 per cent. of the initial candle-power. It is interesting to note from this test that it pays to run these lamps to a point when the candle-power has dropped 30 per cent., as will be seen from the table. The test No. V. on Fig. 4 of tungsten lamps made by the Just-Hanaman process shows that these lamps are quite as good as the Osram. The test was only carried to 1,000 hours, but it is

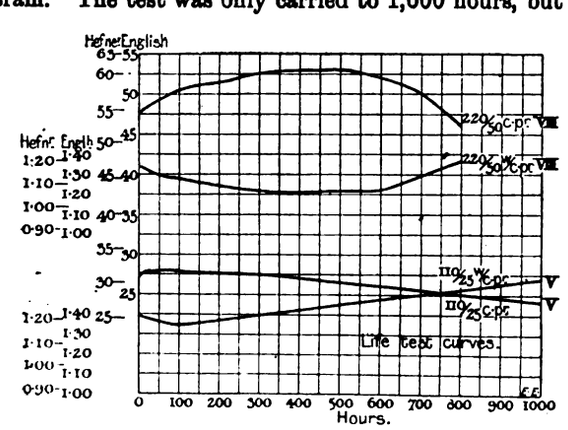

FIG. 4.—"Just-Wolfram."

quite possible that the lamp could have lasted up to 2,000 hours or more, with a proportionate reduction in the cost of renewals. After the 1,000 hours the drop in candle-power was exceedingly small, amounting to only 3 per cent. The tantalum tests (No. VI. on Fig. 5) give a much less favourable result than the above figures. The test is a typical performance on a direct-current circuit. The cost per 1,000 candle-hours works out at 9½d., or 73 per cent. more than the Osram lamp. The carbon-filament lamp results (test No. VII. on Fig. 6) were selected from a large number of tests, and represent the average English-made lamp. A comparison of the figures in the last column of Table II. shows that the total saving from the use of Osram lamps over carbon lamps when equal voltages are compared is 60 per cent. Test No. VIII. in Table II shows the high-voltage trials of tungsten lamps, which were made on an ordinary alternating current lighting circuit, 50 cycles, with a voltage variation of 5 per cent., most of the variation being up. The figures show that, even paying 7s 6d. for these 65-watt lamps, there is a saving of over 60 per cent. over the

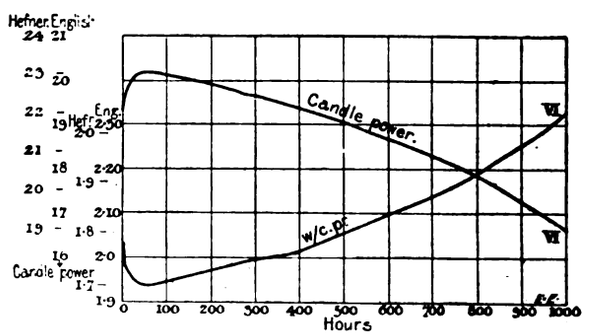

FIG. 5.—Tantalum Lamps.

average high-voltage carbon lamp (test No. IX. on Fig. 6) when all the factors of the cost are considered. In all of the above examples the price of current has been taken as 4d. per unit, which is fair average for lighting at the present time. Of course, with higher prices per unit the saving from the use of tungsten metallic-filament lamps is still greater.

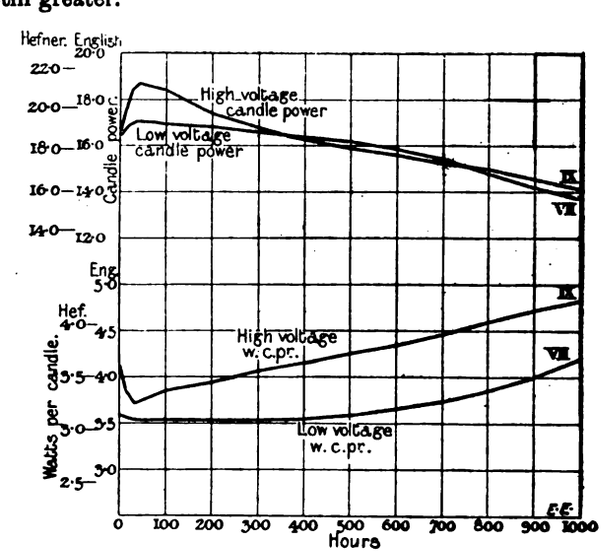

Fig. 6.—Carbon Lamps.

As an instance of the life of Osram lamps for public lighting, I append figures showing the life of the lamps installed in the streets of Canterbury, which have been kindly furnished by the borough engineer, Mr. C. A. Blaschek.

CANTERBURY.

Life of Osram Lamps Erected in the Streets, March, 1908. Osram Lamps.

St. George's-place.	(Lamps in open.)
Post No. 37	1,357 hours burning.
	*2,434 ,, ,,
Post No. 38	1,971 ,, ,,
	2,036 ,, ,,
	93 ,, ,,
Post No. 39	*2,434 ,, ,,
	*2,434 ,, ,,
Post No. 40	1,779 ,, ,,
	*2,434 ,, ,,
Post No. 41	*2,434 ,, ,,
	*2,434 ,, ,,
Post No. 42	1,665 ,, ,,
	*2,434 ,, ,,
Post No. 63	974 ,, ,,
	2 ,, ,,
	*2,434 ,, ,,
16 lamps	29,349 total hours burning

Average hours = 1,834.

NOTE.—Those marked * are still burning, therefore the actual average life on completion of test will be considerably higher.

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Dover-street and Oaten-hill.	(Lanterns enclosing the lamps.)
Post No. 179	1,402 hours burning.
Post No. 180	1,500 " " 484 " "
Post No. 181	*2,464 " " 829 " "
Post No. 182	*2,464 " " *2,464 " " *2,464 " "
Post No. 183	*2,464 " " *2,464 " "
Post No. 184	*2,464 " " *2,464 " "
Post No. 185	*2,464 " " *2,464 " "
Post No. 205	*2,464 " " *2,464 " "
Post No. 206	2,315 " " *2,464 " "
Post No. 207	712 " " 800 " " 639 " "
Post No. 208	1,068 " " 430 " " 736 " " 736 " " 1,960 " " 1,403 " "
Post No. 255	*2,464 " " *2,464 " "
29 lamps	51,974 total hours burning.

Average hours = 1,792.

NOTE.—Those marked * are still burning, therefore the actual average life on completion of test will be considerably higher.

(To be continued).

PISTON SPEED AND STEAM-ENGINE ECONOMY.

Prof. R. L. Weighton, M.A., recently read a paper before the North-East Coast Institution of Engineers and Shipbuilders (which is reproduced in the May issue of the *Transactions* of that institution), in which appeared an elaborate analysis of the results of a series of revolution trials carried out on the experimental engines in the engineering laboratory at Armstrong College, Newcastle-on-Tyne.

The primary object of the trials was to ascertain the exact effect upon the steam consumption per brake horse-power of running engines of ordinary proportions and design, and to discover also, if possible, the maximum permissible speeds of steam and exhaust in such engines, with due regard to economy. Two separate sets of trials were carried out, one with the engines arranged as quadruple and the other as triple expansion, otherwise the conditions were as nearly as practicable identical for both sets, as follows: Quadruples—cylinders, 7in., 10½in., 15½in., and 23in. diameter; 18in. stroke. Triples—cylinders, 10½in., 15½in., and 23in. diameter; 18in. stroke. Steam pressure in high-pressure chest, 138lb. per square inch, absolute; vacuum in condenser (barometer 30in.), 24½in. of mercury. Jacket steam shut off and jacket drains open. Receivers continuously drained by hand into hot-well. Amount of lubrication of steam and of bearings the same on both trials. Steam cut off in quadruples at 12½in., 10½in., 10½in., and 10½in. respectively; steam cut off in triples at 6in., 10½in., and 10½in. respectively. Engines in both cases linked up very slightly and to exactly the same amount in every trial.

The outstanding results of the trials recorded by Prof. Weighton may be summarised as follows:

1. For every reciprocating steam-engine, when change in power is brought about by change in piston speed, there is a certain limit of piston speed at which maximum power is attained, and beyond which the power will fall as the speed is increased.

2. For every reciprocating engine, when change in power is brought about by change in piston speed, there is a certain limit of piston speed with which is associated maximum economy of steam used per horse-power developed.

3. For the engines and conditions of the trials, maximum economy in steam used per brake horse-power occurred for quadruples at a piston speed of 441ft. per minute and for triples at a piston speed of 474ft. per minute, the corresponding mechanical efficiencies being for quadruples ·856 and for triples ·87.

4. The maximum economy piston speed depends on several factors, the exact influence of each of which remains to be ascertained, but to a very large extent it is determined by the mechanical efficiency of the engines. An increase in the value of mechanical efficiency will, other things being unaltered, not only raise the economy absolutely, but will advance the maximum economy point on the scale of piston speed.

5. Both maximum power and maximum economy piston speeds are for the brake power considerably lower than for the indicated power, and, therefore, if the indicated horse-power were alone considered, the piston speed of maximum economy would appear to be considerably higher than it is in reality.

COMBINED THREE-WIRE DIRECT-CURRENT AND ALTERNATE-CURRENT SUPPLY.

In the case of small new supply stations it is often impossible to deal satisfactorily with a number of isolated and distant consumers without an excessive expenditure on mains owing to the low voltage available. Herr W. Fuhrmann, in a recent article in *Elektrische und Maschinelle Betriebe*, suggests a simple and cheap way out of this difficulty. The direct-current generators for this purpose are fitted with two or three slip-rings in the well-known way adopted for three-wire working in many Continental stations, but the slip-rings, besides supplying the balancing choking coil, are now used to supply a certain amount of

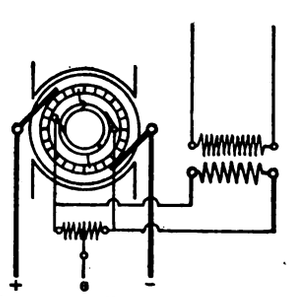

FIG. 1.

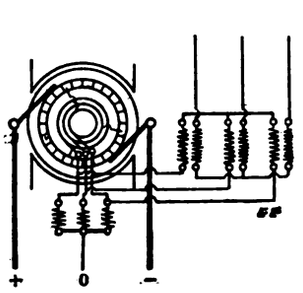

FIG. 2.

power to the primaries of ordinary single or three phase transformers as well. The secondaries of these transformers can be wound for any desired voltage and used to transmit power to the various isolated consumers. The arrangement is shown diagrammatically for the single-phase balancer in Fig. 1, and for the preferable three-phase balancer in Fig. 2. It might be supposed that the balancing choking coil and the transformer might be combined in the form of a single transformer, but this is not possible without interfering seriously with the balancing properties of the choking coil. When the frequency of the generators is below about 30, the method becomes inapplicable for lighting on the alternate-current side because of the flickering of the lamps, but with small high-speed generators this difficulty does not occur.

THE COLOUR OF LIGHTNING.

Mr. Spencer C. Russell read a paper recently before the Royal Meteorological Society on "Observations on the Colour of Lightning made at Epsom 1903 to 1907." He had for the past five years kept a record of the colours or series of colours noted during each thunderstorm or display of sheet lightning, and tabulated them under their respective colour. He had thus results of observations of fork lightning made during 57 thunderstorms, and 78 observations of sheet lightning. It appears that in fork lightning red is the colour of the most frequent occurrence, and this is followed closely by blue, the least frequent colours being orange and green. White is of the greatest frequence in sheet lightning, red and yellow being next. It seems that the presence of hail, when occurring in association with a thunderstorm, is intimately connected with blue lightning.

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THE MANUFACTURE OF ELECTRICAL CONDENSERS.*

BY G. F. MANSBRIDGE, MEMBER.

(*Continued from page 742.*)

As soon as supplies of good electrical foiled paper became available the manufacture of condensers on this principle was taken up by the Post Office, and subsequently by various commercial firms, under licence from the patentee. The process of preparing this foiled paper is fairly well known in the paper-making trade, but, as the matter will probably not be so familiar to members of this institution, a brief description may be of interest. As is well known, metallic tin may be thrown down from its solution either chemically or electrically in the form of an impalpable powder, and the preparation of the finely-divided metal is the first process. The ingot tin—previously granulated or "feathered"—is dissolved in nitro-hydrochloric acid, and after all scum and insoluble matter have been removed, the solution is diluted and the tin is carefully precipitated by metallic zinc, or by the action of a weak electric current. For the best results the most minute subdivision of the tin is essential since only the thinnest layer of metal is desired, and unless this layer is uniform, metal will be wasted or imperfect continuity will result. After precipitation the powder is repeatedly washed to free it from all traces of acid, and is sifted through sieves of the most minute mesh so as to eliminate all large particles of tin or any grit with which it may have become contaminated. A suitable adhesive such as size is added, and the tin mud is then passed to the coating machines. These are provided with mechanical stirrers to prevent the metal settling, and with rotating brushes and spreaders to distribute the metal evenly over the surface of the paper as the latter passes through the machine. In some machines the paper is passed over heated cylinders so as to dry the coated surface quickly, but as this is liable to reduce the efficiency of the adhesive it is preferable that paper for electrical purposes should be dried more slowly—for instance, by exposure to currents of warm air. The dried paper then presents a dull grey appearance, and microscopic examination shows that the surface is covered by a magma of minute crystalline particles forming a layer of appreciable depth. The paper then passes to the burnishing rolls, which consist of heated heavy steel calenders or friction rollers between which the paper is fed. These friction rollers compress the dull magma of tin powder into a coherent thin film having the lustre of the polished metal. During this process any comparatively large crystals of tin or particles of grit which may have escaped untrapped will be driven partly or wholly through the paper, but the effect of this is eliminated by the subsequent electrical treatment, as described later on. The paper is now passed to the slitting machines, where it is trimmed and cut to any desired width.

It is interesting to note that prior to the calendering process referred to the film of tin powder is non-conducting, the conductivity being produced by the action of the steel burnishing cylinders, which so consolidate the coating as to bring the particles into intimate contact each with its neighbour. Perfect contact between every particle of tin and its immediate neighbours can hardly be expected, but, in view of the entire want of conductivity before calendering, it is perhaps surprising that in properly calendered foiled paper, with a fairly heavy coating, the conductivity of the coating may be as much as 50 per cent. of that of a continuous strip of pure tin of equivalent weight. On the foiled paper as usually made for condensers the quantity of tin averages 25 grains to the square foot, and the conductivity is about 25 per cent. of that of pure tin, the resistance of a strip 1ft. wide averaging 0·3 ohm per foot run—that is, 0·3 ohm per square foot or per square metre. This density of coating gives a surface of 280 square feet to the pound of tin, or, say, 57 square metres per kilogramme of tin. The average thickness of the tin film is, therefore, as nearly as possible 0·0001in., or, say, 0·0025mm. Seeing that the material is semi-transparent, the current-carrying capacity of this film is surprisingly high, the fusing current in air being rather more than one ampere per inch of width for the standard coating of 25 grains per square foot; this is assuming that the paper has not been creased. Bending the paper round even a very small radius does not affect the continuity, but if the paper be very closely folded back on itself so as to put the film sharply in tension or compression, a certain amount of disintegration follows, and the fusing current is correspondingly lower. By using a greater density of coating, say 40 grains per square foot, the effect of creasing is greatly diminished, but there is no necessity for this higher density in condenser work, since the creases in the rolled condenser even at the centre of the roll are not very sharp.

Continuous reels of electrically-conducting foiled paper being available, the manufacture of a condenser is a very rapid and simple operation, since all that is necessary is to roll up together two strips of foiled paper, interleaved with two strips of plain paper, the number of turns being dependent on the capacity required. The foiled papers may be placed with their metallic sides facing each other, but separated by the two plain papers, in which case the two body papers form the dielectric on the opposite side, or, alternatively, the papers may be arranged so that the dielectric on each side is made up of one body paper and one plain paper. The latter plan is preferable, as it gives a more even distribution of the dielectric strain. Interleaving paper is invariably used for telegraph or telephone condensers, since the insulation otherwise obtainable is but a few megohms. The machine usually employed for the rolling operation accommodates two reels of plain and two reels of foiled paper, and is provided with a set of interchangeable winding mandrels of various diameters. The winding of the strips on to the mandrel is usually done by hand if the number of turns per condenser is small, but in some instances more than a hundred turns have to be wound on, and the mandrel may then be power-driven with advantage, but in this case a mechanical counter becomes essential. The placing of the strips in position and the starting must be done by hand, and this also applies to the insertion of the connecting lugs, which should be strips of annealed copper foil about 0·001in. thick and $\frac{3}{8}$in. or $\frac{1}{2}$in. wide. These strips are simply slipped into place between the foiled surface and the interleaving paper, and are so light that they readily retain their position. They should make contact with the foiled surface over practically its full width, and should protrude about 1in. so as to serve subsequently as a soldering point for the wire connection. The two lugs should be placed at the middle of the foiled strips rather than at the beginning or end, so as to avoid interposing any appreciable resistance into the condenser circuit. This plan has the additional advantage that thereby the innermost layers, which possibly may have been rather sharply creased, are not called upon to transmit any considerable current on charge or discharge, as would be the case if the lugs were placed at the inner end of the roll.

The necessity for having mandrels of different diameters arises from the fact that variously shaped condensers are demanded. Obviously plates of any desired capacity can be made on any one mandrel by merely varying the number of turns From first principles it would be expected that the capacity would be directly proportional to the area of the electrodes, but in practice it is found that, within limits, plates of high capacity require appreciably less area per microfarad than those of low capacity. This is particularly the case where the thickness of the plate is small in comparison with its length and breadth. There is, therefore, a saving in material as well as in labour by building the plates in as large units as possible. Further, it is found that plates built with narrow foiled paper require less material per microfarad than those built with wide paper, the treatment and material being otherwise identical throughout. This effect is doubtless due to the wider paper offering greater facilities for trapping the paraffin instead of allowing it to be expressed. The two effects taken together indicate that a condenser in the form of a cube would require less material than one in any other shape. The cube is, however, not the most suitable shape for manufacture, and as the conditions of service are often

* Paper read before the Institution of Electrical Engineers.

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such as to demand the adoption of thin, flat plates, the usual compromise has resulted. The standard sizes adopted by the Post Office are shown in the specifications included in the appendix. The capacity most in demand for telephone work is two microfarads, and as plates of this size form a convenient manufacturing unit, they are usually taken as the basis on which to frame standard data for manufacturing purposes. Condensers of larger capacity are almost invariably built up by assembling standard units rather than by direct manufacture in large plates. The usual sizes of paper at present in use are: for interleaving paper, 7⅛ or 4 inches wide by ½ mil thick giving about 400 square feet to the pound; for foiled paper, 6⅜ or 3½ inches wide by 1¼ mils thick giving 100 square feet of conducting surface to the pound, and consisting of 35 per cent. tin and 65 per cent. copper.

At one time an unfoiled margin was left on each side of the foiled strip, but since the introduction of the "breakdown process" subsequently referred to, this has been found unnecessary. The substance of the paper is gauged on a tenfold thickness by means of the usual screw micrometer, as specially made with large contact surfaces for paper gauging. With 1¼-mil foiled paper and ½-mil interleaving paper, the area required for a two-microfarad plate is about 12½ square feet for each electrode. The volume of the plate after waxing and pressing is approximately 7½ cubic inches, and the weight 7oz. The insulation between the electrodes taken at 60deg. F. with 400 volts after one minute's electrification usually lies between 1,000 and 2,000 megohms per microfarad.* Any lower insulation than 1,000 megohms per microfarad is an indication of imperfect desiccation, excessive pressure, or faulty material.

It should be noted that the specific insulation (resistivity) of foiled paper is lower than that of plain paper, the difference being due chiefly to the fact that the former is heavily sized. It is, however, only for special purposes that condensers of extremely high insulation are demanded. In such cases, by using the utmost care and material of the very highest quality, it is possible to obtain an insulation of nearly 20,000 megohms per microfarad (400 volts, 60deg. F., 60 seconds). Such condensers are invariably built up of sheets rather than by the rolling process, since it is necessary to use only perfect sheets, and the rolls of paper cannot readily be examined; under these conditions metallic foil may be used in preference to foiled paper. Three sheets of paper are usually interleaved between consecutive foils. The obvious, but often overlooked, fact may here be commented upon that increasing the number of interleaving papers, while increasing the actual insulation of the plate, does not increase the "megohms per microfarad," since the capacity falls in proportion to the rise of insulation, provided, of course, that there is no abnormal leakage through definite faults.

For certain purposes, such as absorbing the spark across the break of sparking coils, leaky condensers—that is, condensers with specially low insulation—are of advantage, since the high-resistance shunt afforded by the low insulation across the break materially assists in suppressing the primary spark and in thereby lessening the pitting of the contacts. The low insulation necessary may conveniently be obtained by rolling up foiled paper without any interleaving paper, the plate being in other respects treated in the ordinary way. The insulation obtainable will depend partly on the thickness of the foiled paper and partly on the intensity of pressing, but will usually be of the order of a megohm. An important detail in the manufacture of condensers for spark suppression is that there must be no appreciable resistance in the condenser circuit—that is, in the electrodes or thin connections. The insertion of even one ohm in series with the condenser of a high-frequency spark coil markedly increases the sparking at the primary contacts.

The value of the advance made by the introduction of foiled paper for condenser-making lies in the fact that in this material the dielectric and the conductors are more correctly proportioned to their work than is possible when solid metal foil is used. Owing, therefore, to what may be called the better design of the foiled-paper condenser, it is correspondingly cheaper, lighter, and smaller. Even when foiled paper, although the quantity of metal per unit area is extremely small, the conductance of the electrodes is in excess of the actual requirements, whilst if solid foil is employed, it is necessary to use fully 10 times the weight and volume of metal that would suffice if only the conductance had to be considered. The necessity arises from the fact that metal foil cannot be rolled in continuous lengths to give a greater covering surface than about 90 square feet per pound (about 18½ square metres per kilogramme), and even with this thickness the foil is extremely tender and requires delicate handling, as, if made of pure tin, it is only 0·0003in. thick. The metal foil is in addition expensive, and is by far the most costly item in the construction of a condenser. Further, when metallic foil is used, short-circuits are very apt to develop both during manufacture and in subsequent use. The short-circuits are due to grit in the foil, or to pinholes or other defects in the interleaving paper, or are consequent upon disruptive discharges caused by the application of a voltage in excess of the dielectric strength.

(To be continued.)

* The expression "megohms per microfarad," though incorrect, is so generally employed that the custom has been followed throughout this paper; the phrase should, however, invariably be interpreted as "megohm-microfarads."

ALUMINIUM CELL LIGHTNING ARRESTERS.

There has just been placed on the market by the General Electric Company (U.S.A.) a form of electrolytic lightning arrester known as the aluminium cell arrester for operation on alternating-current circuits. The arrester, as shown in Fig. 1, consists essentially of a series of concentric inverted

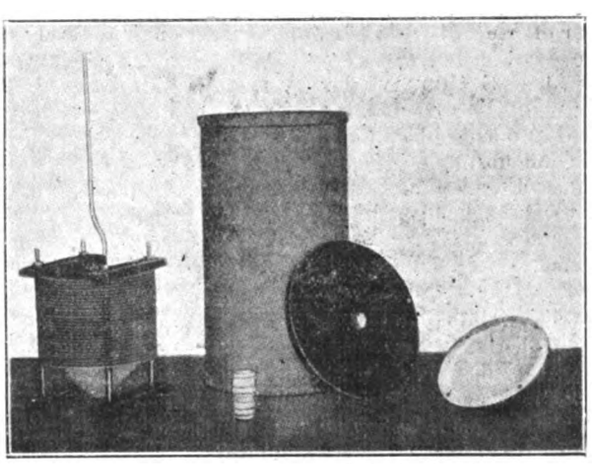

FIG. 1.—One Leg of 12,500-volt Lightning Arrester.

cones placed one above the other with a vertical spacing of about $\frac{3}{16}$in. The cones are insulated from each other except for the electrolyte, which partially fills them. Each cell then consists of two aluminium cones and the intervening electrolyte. A sufficient number of cells placed in series form a complete arrester, the electrical characteristics of which are the same as a single cell. The cones complete with the electrolyte are immersed in a tank of oil, which affords the necessary insulation and great heat-absorbing capacity.

The efficacy of the cones as a lightning arrester depends upon a thin film which is formed upon the surface of the aluminium by a special process of manufacture. This film may be compared with the safety valve of a steam-boiler which opens at a definite pressure and allows the steam to escape. Each cell, two adjacent cones with intervening electrolyte, is designed to operate normally at 300 volts. If the potential rises to any value greater than 300 volts and less than 420 volts, the film allows the discharge to take place, but a thicker film is immediately formed, and the current is again decreased to a small value. When the line potential becomes normal this extra thickness of film gradually dissolves, leaving the film in its normal condition. At 420 volts (about 40 per cent. above normal voltage) the film opens and allows a free and heavy discharge to take

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place. This voltage represents the maximum critical film value per cell. The plate area of the cells is sufficient to allow a discharge of more than 1,000 amperes at double normal potential, or 600 volts per cell. This represents a quantity of electricity many times greater than that usually liberated by an ordinary induced lightning stroke. Consequently it is not possible to get an excessive potential across the terminals by such discharges.

The aluminium cell arrester is designed to be connected to the line through the adjustable horn-gaps. These gaps may be set so that the voltage will break across at any desired rise above the normal operating voltage. When the conditions warrant, the gaps can be set so as to allow the arrester to discharge when the line voltage rises only about 25 per cent. The horn-gaps perform three important functions: first, they act as spark-gaps, as explained; second, they may be used as disconnecting switches; and, third, for subjecting the arrester to normal voltage. It is recommended that current be sent through the arrester every day or two, so as to assure proper formation of the film on the aluminium cones. The horn-gaps are so constructed that they can be easily short-circuited momentarily for accomplishing their purposes.—*Electrical World.*

LONDON POWER BILLS.

The report of the proceedings before the Select Committee of the House of Lords—presided over by Lord Cromer—on the London Power Bills which appeared in our last issue closed with a summary of the financial evidence given in support of the London and District Electric Power Bill on the 20th inst. The following day (Thursday) the committee was largely occupied in hearing evidence in favour of the Bill from railway engineers and other large consumers.

Mr. J. F. S. GOODAY (the general manager of the Great Eastern Railway) said that the Great Eastern Railway carried into and out of London every day a large suburban traffic, amounting on an average to about a quarter of a million. Electric traction, if adopted, would be applied first to the suburban lines. It afforded greater facility for handling that class of traffic and for having a more frequent service. When considering the question of electrification they had estimated that they would require about 40,000 h.p. He did not know of any existing station in London which could supply that power.

Mr. VINCENT L. RAVEN (chief assistant mechanical engineer to the North-Eastern Railway Company) said that his company had a very large suburban traffic in the neighbourhood of Newcastle-on-Tyne. When this was electrified they decided to take the power from the local supply company, and in that way saved the large capital expenditure involved in erecting a generating station of their own. They had been absolutely satisfied with the result.

The following also gave evidence: Mr. E. Duncan (consulting electrical engineer to Messrs. Maple and Co., Limited), Mr. A. L. Stride (chairman and managing director of the London, Tilbury, and Southend Railway Company), Mr. F. Ree (goods manager to the London and North-Western Railway Company), and Mr. J. S. Conradi (superintendent of Messrs. Vickers, Son, and Maxim's, Limited, Erith), who submitted a list of 56 firms who he said had in response to circulars given approval to the principle of the Bill.

On Friday last the committee heard evidence from Mr. A. LUPTON, chairman of the Yorkshire Electrical Power Company, who gave particulars of progress made in that undertaking since the incorporation of the company in 1901. The average price charged by his company was 1d. per unit for power purposes, and the supply to authorised distributors was rapidly increasing.

Sir HUGH BELL, recalled, explained an amended purchase clause submitted by Mr. Fitzgerald, K.C., on behalf of the promoters, to meet the objection raised in the course of inquiry that there was not security for the proper maintenance of plant as the time for the exercise of the purchase power approached. In its amended form the clause provides that upon 12 months' notice, at the expiration of 42 years, the purchasing body (county council or joint committee) may purchase upon payment of the amount expended and properly chargeable to capital account. Sub-sections provide that in the sixth and every succeeding year after starting supply the company shall, before arriving at the profit available for dividend, set apart for a maintenance and renewal fund such sums as the auditor may determine as necessary to maintain buildings, plant, and apparatus in proper condition. Out of such fund the company will undertake to make renewals, any question as to amount being determined on appeal to the Board of Trade, any surplus in the fund at the time of purchase to go to the purchasing authority. Sir H. Bell supplemented his former evidence by saying that he would increase the amount of support for which he had undertaken responsibility from £250,000 to £350,000. He mentioned the name of Sir Edward Tennant in connection with this.

On Tuesday, Mr. A. B. CAINE presented the case in opposition to the Bill for the St. Marylebone Borough Council. He repudiated the idea that the Council, having made a bad bargain by purchasing the undertaking of the Metropolitan Company a few years ago, must abide by the consequences. The Council had not made a bad bargain, and claimed that in fairness, after incurring statutory obligations, after having bought their experience on the faith of parliamentary assurances, they should not be exposed to competition from this new company.

Mr. A. H. SEABROOK (electrical engineer for West Ham) gave particulars of the Corporation works in that borough, and showed that the capacity of the works and the means for extension would meet any demand for many years to come; after which counsel argued in favour of the exclusion of West Ham.

Mr. CHARTERIS, in describing the position at Hampstead, claimed its exclusion on the ground that it was a residential district, that no demand for power would arise, that the Borough Council was successfully carrying out its obligations, and that Parliament had given its decision in reference to Hampstead.

Mr. W. L WILLIAMS, for the Stepney Council, said that the Council was justified in asking to be left free from the attacks of this speculating company.

On Wednesday Mr. COURTHORPE MUNROE addressed the committee on behalf of the boroughs of St. Pancras and Shoreditch. He maintained that the promoters had made out no case either as regards these boroughs.

Mr. S. W. BAINES (chief electrical engineer of St. Pancras) also gave evidence, and the case for Hammersmith was also presented.

Yesterday (Thursday) the witnesses on behalf of the London County Council were examined.

THE POULSEN STATION AT LIJNGBY.

This wireless telegraphy installation near Copenhagen employs masts 70m. high and a power of 10 kw. A 23-strand copper rope is suspended between two wooden masts 90m. apart, and from this a line leads to the station-house below. A wire network on the earth forms the counterpoise. In the station-house a 20-h.p. petroleum engine drives a 16-kw. direct-current dynamo giving 500 volts, which is used to work a copper-carbon arc in a hydrogen atmosphere and in a strong magnetic field. The copper anode is only cooled artificially with water for powers above 6 kw. As a receiver the well-known Poulsen ticker with telephone is used, by means of which signals from Cullercoats (near Newcastle), at a distance of 590 miles, are received. With waves 1,200m. long communication with the steamer "Hellig Olav" at a distance of 1,250 miles was possible. With a difference of wave-length of only 3½ per cent. it was possible both to receive and dispatch messages at the same time. In fact, a difference of only 1 per cent. is said to be sufficient for this purpose. The hydrogen around the arc is produced by feeding one or two drops of spirit into the flame chamber per second. Choking coils and resistances are entirely dispensed with.—*Elektrotechnik und Maschinenbau.*

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INSTITUTION OF CIVIL ENGINEERS.

The council of the Institution of Civil Engineers propose to award annually a prize to be called the Indian premium to the author, being a corporate member of the institution in practice in India, of the best paper received during the year on a subject connected with Indian engineering. This special award, which when made will be irrespective of any other recognition of the merits of such paper which the council may accord to it in the ordinary course, is derived from the proceeds of certain trust funds conveyed to the institution on the closing of the Royal Indian Engineering College, and will be of the value of about £33 annually.

The council further propose that the income of a legacy of £1,000 bequeathed by the late Mr. L. F. Vernon-Harcourt to the institution be applied, in general accordance with the testator's wishes, to provide for a biennial lecture on some subject relating to rivers, canals, or maritime engineering, to be delivered before meetings of students of the institution in London, and before such of the provincial associations of students as the council may determine from time to time.

The council recently have accepted, on behalf of the institution, a legacy of £1,000, bequeathed by the late Mr. F W. Webb, to be applied to establish a "Webb prize," to be awarded by the council once in every three years or oftener, as the council may think fit, for the best paper submitted to the institution on "Railway Machinery," or upon some branch of railway machinery which may be prescribed by the council.

SECOND SWISS SINGLE-PHASE RAILWAY.

The Locarno-Pontebrolla-Bignasco is the second single-phase railway to be constructed in Switzerland. It has a total length of 16·9 miles, with four tunnels, the total length of which is 939ft. The line crosses several small bridges and there are 12 stations and stopping places. The track is laid with 50lb. rails and the gauge is 39·37in. The Pontebrolla power-house furnishes the 5,000-volt single-phase current. Each car is equipped with four 40-h.p. single-phase series motors capable of hauling a 55-ton train over the heaviest grade on the line at a speed of 11·2 miles an hour, and on a level at 18·7 miles. The Maschinenfabrik Oerlikon furnished the equipment.

ARC LIGHT ELECTRODES.

At a recent meeting of the Armour Institute Branch of the American Institute of Electrical Engineers, Mr. A. B. Cornwell read a paper on "Arc Light Electrodes." Electrodes were grouped into three general classes: (1) carbon electrodes; (2) electrodes of carbon combined with other minerals; (3) electrodes of metallic oxides and of metals.

Carbon electrodes will maintain a steady arc on alternating current at a low voltage. This together with low cost are their chief advantages. To increase the conductivity of carbon electrodes they are copper coated. The ½in. carbon is in most general use, but experiments on the small carbons speak well for them. It is said that 5-16in. carbons have higher efficiency, whiter light, and hold a steadier arc. The expense of trimming, however, is increased with the smaller carbon. The life of the 5-16in. carbon is from 65 to 70 hours, while that of the ½in. is about 100 hours. The total increase in maintenance for the 5-16in. carbons is about 20 per cent.

The second class of electrodes is frequently spoken of as mineralised or impregnated carbons. The minerals are placed in the electrode as a core in a carbon shell or in the paste when the electrode is made. It is contended that the cored carbons prevent the arc wandering around the crater. Not all cored carbons are classed as mineralised carbons. A few of the minerals commonly used are silicates, chlorates, phosphates, magnesia, and borates of soda and potash. To reduce combustion, silicates, chlorates, phosphates, and boric acids are used. To augment conductivity, magnesia, borates of soda and potash, and boric acid are used. To increase luminosity, salts of lime and particularly the phosphates are added. The proportion of minerals in impregnated carbons reaches as high as 7 per cent. The arc does not give the continuous spectrum of a heated solid, but the line spectrum of a heated gas.

In the third class electrodes are made up of metallic oxides. The fundamental principle in the production of these electrodes consists in the combination of oxides possessing luminiferous properties with oxides of non-luminiferous properties, but which are more conductive. Pure metals, as iron and copper, are used as electrodes when a particular colour is desired. Magnetite and hematite are in quite common use. Titanium oxide makes the most luminiferous material, but is a poor conductor at ordinary temperatures.

One of the most notable examples of the use of mineralised carbons is in the flaming arc lamp. Electrodes of metallic oxides are used also in the magnetite arc lamps. Most of the light from such lamps emanates from the arc itself and very little from the electrodes. Tests made in the Electrical Testing Laboratories, New York, on a Koerting and Mathiesen flaming arc and a standard five-ampere single-globe enclosed arc show the flaming arc gives five times the luminous flux for the same energy consumption.

The flaming arc has a number of drawbacks. It must be trimmed once a day to the enclosed arc's once a week, requires a higher pole for mounting, and is a much more expensive lamp to buy.

In the magnetite arc the negative electrode contains oxides of magnetite, titanium, and chromium. The positive electrode used with this negative is usually a metal. Copper has been used to some extent. The magnetite arc shows a very good efficiency and has a good distribution. The life of a magnetite electrode is longer than that of a carbon, being about 175 hours for the magnetite to about 100 to 125 hours for the carbon. The copper electrode used with it has a life of nearly 3,000 hours in many cases. A magnetite arc requires no inner globe, and while designed to operate on direct current, it may be run from an alternating-current circuit with a mercury-arc rectifier.

THE ELECTRICAL EXHIBITION, MANCHESTER, OCTOBER, 1908.

We are pleased to be able to report that the organising committee is making good progress in connection with this exhibition. At the meeting of the committee held in the electricity department of the town hall, Manchester, on Tuesday, May 12, applications and inquiries for space for some 130 would-be exhibitors were dealt with and a very large number of allotments were made. Since that date applications and allotments are being dealt with as received, and there are ample indications to prove that the exhibition will be thoroughly supported by all branches of the industry.

A number of interesting and live exhibits have already been arranged for between the principal motor manufacturers and makers of textile machinery, machine tools, and the like. The exhibition is receiving the support not only of the Manchester and Salford Corporations, but of some 30 adjoining towns and the Lancashire Electric Power Company, which is in itself a strong indication as to the importance which is attached to it. It will undoubtedly serve as a great impetus to the industry, and this was admittedly wanted in many directions.

The electrical trade generally must not under-rate the importance of the exhibition, as it is their own, being run by themselves and for trade benefit only, and as Manchester is known to be the centre of one of the greatest manufacturing districts in the world, the far-reaching effect of such an exhibition is bound to bring beneficial results to all taking part in it.

We cannot do more than urge our readers who have not already made up their minds whether to exhibit to remember this fact, and, if they have not already made application for space, to do so at once. The committee of the exhibition met again on Tuesday last, when a number of important applications for special exhibits which are likely to be particularly attractive were arranged for.

PUBLICATIONS RECEIVED.

"RADIO-TELEGRAPHY," by C. C. F. Monckton. London: Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. Price, 6s. net.

Proceedings of the Royal Society of Edinburgh. Vol. xxviii., part IV.

Proceedings of the American Institute of Electrical Engineers, May, 1908. Vol. xxvii., No. 5.

"THE MANUFACTURES OF CANADA." *Bulletin II.*, Census and Statistics. Ottawa: L. E. Dawson.

Transactions of the North-East Coast Institution of Engineers and Shipbuilders. May, 1908. Vol. xxiv., parts 5 and 6. Newcastle-on-Tyne: Andrew Reid and Co., Limited.

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CITY OF LEEDS ELECTRIC LIGHTING ACCOUNTS.

We have received a copy of the revenue account of the city of Leeds electric lighting department for the year ended March 31, 1908, which was last week presented to the committee in charge of the undertaking. The total revenue was £113,436. 8s. 1d., and the total expenditure £48,648. 15s. 7d., leaving a gross profit of £64,787. 12s. 6d., from which, after paying taxes and interest on loans, etc., there is left a net profit of £36,336. 12s. From this sum £29,414. 19s. 3d. has been set aside for redemption of debt, leaving £6,921. 12s. 9d. to be carried to "surplus profit." The following is a comparison of the results of the past year's work with those of the preceding year:

	1906-7. £ s. d.	1907-8. £ s. d.
Receipts from sales for private lighting	79,251 1 11	80,928 6 3
Ditto street-lighting	4,536 1 6	4,661 10 3
Ditto power	24,472 8 0	27,846 10 7
Sundries	0 1 0	0 1 0
Total receipts	108,259 12 5	113,436 8 1
Working expenses	32,467 15 10	35,276 6 0
	75,791 16 7	78,160 2 1
Extraordinary renewals	14,272 2 0	13,372 9 7
Gross profit	61,519 14 7	64,787 12 6
Income tax, interest, and redemption fund	58,109 17 6	57,865 19 9
Surplus	3,409 17 1	6,921 12 9
Units sold	11,368,956	12,412,861
Average price per unit	2·28d.	2·19d.
Expenses per unit, including extraordinary renewals, interest, and redemption fund	2·21d.	2·06d.
Surplus per unit	0·07d.	0·13d.
Capital expended during year (less credits)	£15,467 19 3	£35,424 11 2
Total capital expended to end of year	£843,323 2 4	£878,747 13 6

The following statement analyses the year's receipts between sales for lighting and power purposes respectively, and indicates the growth of each branch of the business:

Lighting.

Number of 35-watt lamps installed at March 31, 1908	317,890
" " March 31, 1907	307,933
Increase during the year (3·2 per cent.)	9,957

	1906-7.	1907-8.
Units sold—Private lighting	5,627,089	5,771,597
Street-lighting	870,925	895,009
	6,498,014	6,666,606
Revenue	£83,787 3 5	£85,589 16 6
Average price per unit	3·09d.	3·08d.
Units sold per lamp installed	21·40	21·25
Revenue per lamp installed	5/6·22	5/5·47

Power and Heating.

Aggregate horse-power of motors installed at March 31, 1908	8,379
" " March 31, 1907	6,880
Increase during the year (in horse-power) (21·8 per cent.)	1,499

	1906-7.	1907-8.
Units sold	4,870,942	5,746,255
Revenue	£24,472 8 0	£27,846 10 7
Average price per unit	1·21d.	1·16d.
Units sold per horse-power installed	796	754
Revenue per horse-power installed	£4	£3 13 2

The revenue from sales of current for lighting purposes has been somewhat severely affected in the final quarter of the year by the introduction and rapidly increasing use of a new type of lamp, by means of which a large reduction is effected in the quantity of current consumed in the production of a given amount of illumination. It is hoped that the temporary loss of income by this cause may be ultimately recouped by a large influx of additional consumers, induced by the lower cost at which electric light can be obtained. The use of electricity as motive power again shows a satisfactory extension, the aggregate capacity of the motors installed on consumers' premises having increased by 21·8 per cent. during the year, and the sales of current for this purpose are also much higher than during any preceding year, although the consumption in proportion to the horse-power installed shows a decrease, no doubt due to reduced activity in some of the principal industries of the city. The recent reductions in the scale of charges for electricity used for power and heating purposes are estimated to affect the ensuing year's income to the extent of about £5,000, without allowing for the increase of business which is likely to result.

It will be seen that the revenue has again had to bear a considerable charge under the heading of extraordinary renewals, the bulk of this representing the cost of replacing plant of a capacity of 700 kw. which was only suitable for the now obsolete system of supply at a frequency of 83 periods per second. It is satisfactory to know that the replacement of the whole of the 83-period plant has now been provided for, and the charges for extraordinary renewals are, therefore, likely in the immediate future to be much smaller than in the past two years. Notwithstanding the favourable effect of contracts made during the period of lower prices, the expenditure has also been increased by an advance in the price of coal, the fuller effect of which will be felt in the ensuing year. The increased cost due to this cause during the past year is calculated to have been £1,336. The weight of coal used per unit sold has been reduced by about 5 per cent. The following statement shows the cost per unit in detail for past and the preceding year:

	Year ended March 31, 1907.	Year ended March 31, 1908.
Coal	·19d.	·21d.
Oil, water, and stores	·02d.	·02d.
Wages	·13d.	·12d.
Repairs, maintenance, and renewals	·15d.	·12d.
Rates, taxes, and insurance	·07d.	·08d.
Engineers' salaries	·08d.	·08d.
Office salaries and general expenses	·05d.	·04d.
Total ordinary working expenses per unit	·69d.	·67d.
Wages incurred on extensions but not chargeable to capital account, being paid to Corporation's permanent workmen	·00d.	·02d.
Extraordinary renewals	·30d.	·26d.
Interest	·60d.	·54d.
Redemption fund charges	·62d.	·57d.
Total charges per unit	2·21d.	2·06d.
Surplus profit per unit	·07d.	·13d.
Average price obtained	2·28d.	2·19d.

A 3,000-kw. steam turbo-alternator has been installed at the generating station during the year, and after deducting the 83-period plant discarded as before mentioned, the capacity of the plant is 12,740 kw. An additional turbine set of the same same capacity (3,000 kw.) is on order, and expected to be available for use before next winter. The maximum load upon the plant has been 8,300 kw., compared with 7,470 kw. in the preceding year, and, therefore, the load factor (being the proportion between the units sold and the quantity which would have been generated if the load had been continuous and uniform throughout the year) has been 17 per cent. During the previous year it was 18 per cent., and the decrease is due to the two facts already mentioned—viz., the reduced consumption per horse-power of motors installed on consumers' premises and the saving of current used for lighting purposes during the last quarter of the year by the introduction of more economical lamps.

CHECKING TROLLEY ACCIDENTS.

The *Electrical World* states that it will hereafter be required that the New York City street-railway companies file with the Public Service Commission a complete statement of the number and kind of trucks used, the weight of the car, length, style of fender, brake, and numerous other details. The commission took formal action to this effect last week in an effort to reduce the number of accidents on street railways in Greater New York. Commissioner Maltbie, who presented the resolution, is authority for the statement that in the six months ending Feb. 1 the street railways of this city killed 299 persons and seriously injured 944. The total number of accidents due to collisions of street cars was 1,196, and the number of vehicles and persons struck by cars was 7,059. According to him, at this rate in an entire year about 600 persons will be killed and 2,000 seriously injured. For injuries and damages the street railways last year paid out over £500,000.

ELECTRICAL ENGINEERS (LONDON DIVISION).

Orders for week ending Saturday, June 6.

MONDAY, JUNE 1.—"A" Coy.—Infantry drill, 7.30 p.m.*
TUESDAY, JUNE 2.—"B" Coy.—Infantry drill, 7.30 p.m.*
Medical inspection for recruits, 6.30 p.m.
THURSDAY, JUNE 4.—"C" Coy.—Infantry drill, 7.30 p.m.*
FRIDAY, JUNE 5.—"D" Coy.—Infantry drill, 7.30 p.m.*
* The officers' drill cup competition.

Men who have not signed on in the Territorial Force can do so on their Company night.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MARCONI'S WIRELESS TELEGRAPH COMPANY.

SIR,—An extraordinary general meeting of Marconi's Wireless Telegraph Company held on Monday, May 18, considered, and unanimously consented to, an increase of capital by the creation of 250,000 7 per cent. cumulative participating preference shares of £1 each. On Wednesday, May 20, an article, under the heading "Wireless Telegraphy—Marconi System's Improvements," appeared in the *Morning Post*, giving particulars of an interview between Mr. Marconi and a *Morning Post* representative.

In Mr. Marconi's narration of his company's achievements in improved apparatus and working speed the unbiassed man finds much to admire, especially in view of the energy and determination evident throughout all Mr. Marconi's undertakings. Indeed, all fair-minded persons, whatever their own particular interests, can but wish success to any keen scientific undertaking allied to honest commercial enterprise. When, however, Mr. Marconi—as reported in the *Morning Post*—proceeds to compare his attained Transatlantic wireless working speed with a seriously under-stated speed rate alleged to obtain over long-distance Transatlantic cables, anyone acquainted with the highly effective performances of the cables must, perforce, offer a respectful but none the less emphatic protest. Such action is necessary, not only in the interest of scientific accuracy, but also on behalf of cable shareholders, who could not have read the *Morning Post* article without considerable misgivings as to the safety of their investments.

Influenced by these considerations I wrote on May 21 to the editor of the *Morning Post*. A copy of my letter—which the editor of the *Morning Post* has, this morning, definitely declined with thanks—together with other correspondence which has ensued, I here submit, Sir, to your good pleasure and judgment.—Yours, etc.,

E. RAYMOND-BARKER.

12, Edge-hill, Wimbledon, May 27.

The following is an extract from the *Morning Post* of that part of the interview complained of:

Two great desiderata in telegraphy are rapidity of transmission and secrecy, and to those two points Mr. Marconi has been applying his inventive genius. Seen yesterday by a representative of the *Morning Post*, Mr. Marconi said that at the present moment, by the employment of a new form of discharger and improved methods of working introduced last year, the speed of message sending had been greatly increased. The speed now attained was as great as could be achieved by single transmission hand sending on land lines, and *greater than any which even expert operators had reached on long-distance—say Transatlantic—cables.* The limits of speed on such cables were well known, and regulated by various natural laws. Of course, on short-distance cables the speed was greater. Already, Mr. Marconi stated, wireless messages could be transmitted across the Atlantic at a speed of 24 words a minute, and with favourable circumstances and a highly-skilled operator—for, of course, the personal equation comes in—30 words a minute had been achieved between shorter distance stations, though this was not usual. Mechanical sending, employing punched paper strips as in the Wheatstone automatic system used in land wire telegraphy, might, he added, eventually increase the speed considerably. In any case the increase of speed was a comparatively small thing when what has already been achieved was considered.

The following is a copy of the letter by Mr. Raymond Barker which has not been accepted by our contemporary:

TO THE EDITOR OF *The Morning Post*.

Sir,—Regarding some of the statements made under the heading "Wireless Telegraphy—Marconi System's Improvements" in your issue of the 20th inst., I pray you to allow me to make some comments. My professional as well as personal interest both in submarine cable work and in radio-telegraphy, will vouch for the impartiality of my words. Without for a moment impugning the good faith of Mr. Marconi, I am of opinion that his words as reported by your representative will tend to mislead the non-technical public. Actual up-to-date Transatlantic wireless working speed—subsequently stated by Mr. Marconi to be 24 words a minute, or under favourable circumstances with a highly-skilled operator, 30 words a minute—is mentioned as being "as great as could be achieved by single transmission hand sending on land lines, and greater than any which even expert operators had reached on long-distance—say Transatlantic—cables."

In the *Electrician* of Oct. 12, 1894, will be found an article by Mr. Arthur L. Dearlove, A.M.I.C.E., M.I.E.E., giving full technical particulars of the Anglo-American Telegraph Company's 1894 Atlantic cable, including an electrotype print of actual signals received over this cable at 45 five-letter words a minute. On inspecting these signals the expert sees at a glance that the above speed might have been increased, and surely enough the *Electrician* of Nov. 30, 1894, in an article by Mr. Patrick B. Delany, records as highest speed with regular traffic during the month of September, 1894, 249 letters—say 50 words—a minute. The theoretical speed of this cable is, in my opinion, between 50 and 60 words per minute, which with duplex working would give a good hundred words a minute for that one cable. Here I have dealt with only one out of the many Transatlantic cables, most of which are duplexed, and are capable of attaining in each direction a speed far higher than that mentioned in your report.

The objection may be raised that Mr. Marconi was speaking of hand speeds. If so, it follows that the 30 words a minute by Morse code transmitted by his "highly-skilled operator" would, with the cable recorder code of equal time element signals, and in the hands of an equally expert cable operator, be 26 per cent. faster, say 38 words per minute. But, Sir, why do Mr. Marconi's statements, as reported by your representative, ignore the for a long time past every-day use of mechanical or automatic sending on the Transatlantic cables? This rapid method is mentioned—in your report—in connection only with land wire telegraphy, so the non-technical reader might very reasonably infer that in submarine work punched paper strip transmission is unknown, whereas it is now practically in universal use. Only quite recently the speed possible over long submarine cables has been still further greatly increased by the inventions of Mr. S. G. Brown. Any of your readers who may find themselves on our coasts anywhere in the neighbourhood of the great cable stations of Porthcurno, Valentia, or Waterville would do well to see for themselves what the cables are doing. They would be repaid by one of the most interesting sights in the world.

Again, I repeat that I am interested in both cable and radio systems. There is room for both, and all both parties ought to ask for is a fair field and no favour. In your representative's report of his interview with Mr. Marconi the fair field for the cables is not much in evidence.—I remain, Sir, your obedient servant, EDWARD RAYMOND-BARKER, M.I.E.E.

12, Edge-hill, Wimbledon, May 21, 1908.

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LINCOLN ELECTRICITY AND TRAMWAY DEPARTMENTS.

The accounts for the above undertakings for the year ending March 31, 1908, have reached us this week. The electricity undertaking accounts show a gross profit of £5,156 for the year, and a net profit of £1,547 after paying the interest and repayment charges on the loans outstanding. From this sum £1,000 has been repaid to the district fund account in respect of assistance received during the initial stages of the undertaking. The depreciation account has received the bulk of the balance. The tramway undertaking shows a deficiency of £76 after paying all capital charges, which is an excellent return for a line only 1 mile 6 furlongs long. The following is Mr. Stanley Clegg's report on the two undertakings:

Electricity Department.

I have pleasure in submitting a report of the working of this department for the year ending March 31, 1908. The output for the year has been 1,453,822, as compared with 1,282,426 units last year, or an increase of 13·4 per cent. This output has been made up as follows:

	1907-8.	1906-7.	Increase or decrease.
Private lighting	435,994	404,310	+ 31,684
Public lighting	65,270	65,460	- 190
Power (less Clayton and Shuttleworth)	89,564	79,983	+ 9,581
Clayton and Shuttleworth	702,120	568,359	+133,761
Traction	160,874	164,314	- 3,440
	1,453,822	1,282,426	+171,396

It will be seen from the above analysis that there is an increase in the amount of electricity supplied for private

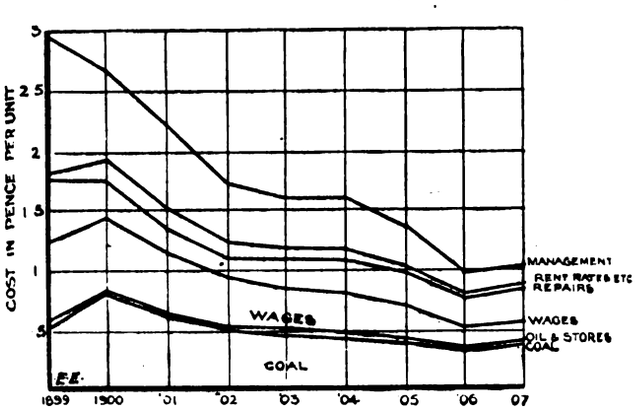
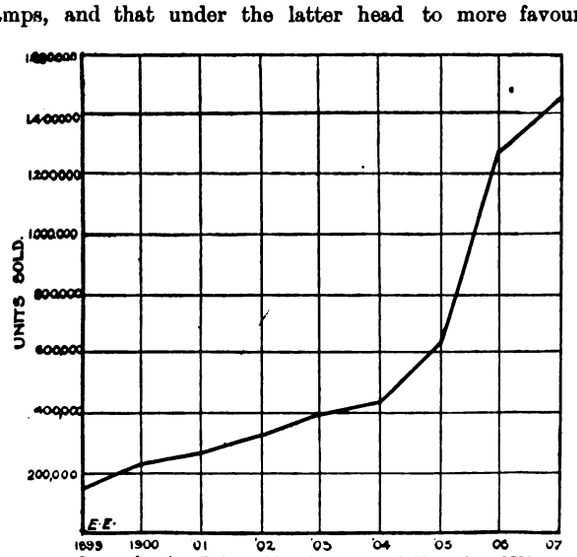


Diagram of the Cost of producing Electricity per Unit Sold at Lincoln for the past Nine Years. The year ending March 31, 1908, is plotted over 1907.

lighting and for motive power, with small decreases under the heads of public lighting and traction. The decrease under the former head is due to the extended use of metallic-filament lamps, and that under the latter head to more favourable



Curve showing Units Sold at Lincoln each Year since 1899.

weather and improved driving. I am glad to be able to point out that our increase in private lighting this year is 7,000 units greater than was the increase last year, which would go to prove that the reduction in price has stimulated the demand. This is further borne out by the fact that we have added the equivalent of 3,300 8-c.p. lamps to our lighting connections, as compared with 2,200 last year. The increased supply to Messrs. Clayton and Shuttleworth has been due to the fact that they have had a larger percentage of plant working for the full 12 months, but as they have now installed nearly the maximum amount of plant that we could guarantee to run, we cannot expect any large increase in the current year. The increase in the supply to power consumers other than Messrs. Clayton and Shuttleworth is somewhat disappointing as compared with last year, but is more than shown on the surface owing to the fact that some of our older power consumers have not used as much electricity this year as they did last. I give below an analysis of our costs, under the various heads, for the year ending March 31, 1908, as compared with the previous year:

	1907-8. d. per unit.	1906-7. d. per unit.	Increase or decrease. d. per unit.
Coal	·388	·324	+ ·064
Oil and stores	·035	·042	- ·007
Wages	·161	·159	+ ·002
Repairs	·244	·231	+ ·013
	·828	·756	+ ·072
Rents, rates, etc.	·053	·053	—
Management, etc.	·177	·184	- ·007
	1·058	·993	+ ·065
Interest and sinking fund	·613	·635	- ·022
Total	1·671	1·628	+ ·043
Output for year (units)	1,453,822	1,282,426	

We have unfortunately this year been unable to maintain our total cost per unit, exclusive of interest and sinking fund, below the level of 1d.; it will be seen, however, that this is entirely due to the increased price which we have had to pay for coal, over which, of course, we had no control. The only other head under which there is any considerable increase is that of repairs, which is largely explained by the fact that we have charged to revenue wages and materials amounting to £381, that were really capital charges; this compares with an amount of less than £200 included in last year's figures. For further reference I give an analysis of our working costs and output for each complete year since the works were opened:

	1906. d. per unit.	1905. d. per unit.	1904. d. per unit.	1903. d. per unit.	1902. d. per unit.	1901. d. per unit.	1900. d. per unit.
Coal	·378	·43	·47	·51	·58	·82	·55
Oil and stores	·051	·06	·07	·04	·05	·04	·10
Wages	·283	·36	·35	·37	·50	·57	·58
Repairs	·243	·22	·20	·18	·22	·28	·51
	·955	1·07	1·09	1·10	1·35	1·71	1·74
Rent, rates, etc.	·090	·12	·12	·13	·16	·18	·07
Management	·305	·42	·39	·47	·69	·76	1·10
	1·350	1·61	1·60	1·70	2·20	2·65	2·91
Output in units	636,029	431,473	399,797	339,626	263,216	225,170	155,203

The prices obtained from our different classes of consumers have been as follows:

	Units.	£ s. d.	Average price obtained per unit.
Private lighting	435,994	6,375 18 6	3·51d.
Public lighting	65,270	760 6 4	2·79d.
Power (less Clayton and Shuttleworth)	89,564	533 13 2	1·43d.
Clayton and Shuttleworth	702,120	2,995 10 7	1·024d.
Tramways	160,874	837 17 8	1·25d.
	1,453,822	£11,503 6 3	1·9d.

It will be seen that our average price obtained has again fallen, due to the reduction in our charges made at the commencement of the year, being this year 1·9d., as compared with 2·169d. per unit last year, and further showing the increased proportion of electricity sold for power as compared with lighting. The average price at which Messrs. Clayton and Shuttleworth have obtained their electricity has been 1·024d. per unit, being practically the same as last year, though the prices in their sliding scale were increased by 16 per cent., due to the rise in price of coal. This is accounted for by the fact that they have used 133,761 units more this year than last, making a bigger amount at the lower prices of the scale, and thus maintaining the same average price. At this figure their supply has given us a satisfactory return. The supply to the tramways, however, has been given this year at practically cost price. The new work

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executed during the year includes the following: A new well and water inlet from the Brayford, together with a complete new set of electrically-driven centrifugal pumps; these latter, during the six months they have been running, while pumping more water than last year, have saved us about 22,000 units, thus demonstrating their efficiency as compared with our older pumps. I estimate the monetary value of the above 22,000 units at about £70, the larger portion of which would have been on the coal bill, and which is a very respectable return on a capital expenditure of, say, £450. One Tirrill regulator, motor-generator, etc., for automatically regulating our pressure. One new Berryman heater for heating the feed water before it enters the economiser on the low-pressure side, and one enlarged feed heater for the high-pressure side. In addition the offices have been redecorated. The whole of the the plant has been kept in thorough repair out of revenue. This year we have been free from any serious breakdown or interruption of supply, which is greatly to the credit of the staff as a whole.

Tramways Department.

The tramways have, on the whole, had a fairly successful year. I give below an analysis of the costs under the various heads, and compare them with the same figures for last year:

	£ s. d.	1907-8. Per car mile run.	1906-7. Per car mile run.
Traffic expenses	1,381 3 1	2·28d.	2·512d.
Repairs and maintenance	757 15 5	1·25d.	·913d.
Management and general expenses	714 17 2	1·18d.	1·476d.
Power expenses	837 17 8	1·39d.	1·797d.
	£3,691 13 4	6·10d.	6·698d.

It will be seen that there is a reduction under every head save that of repairs and maintenance. The reduction under the head of traffic expenses is principally accounted for by the fact that we are working the line with two inspectors, instead of three, as was the case last year. Also, owing to the fact that we have had no serious snow fall this winter, we have been able to save £40 on cleaning and sanding of track. On the other hand, uniforms have cost us nearly £50 more this year than last; as the system was only opened in November, 1905, the first outfits were made to last until May, 1907, so that only one or two odd uniforms for new men were bought during the year ending March 31, 1907. Coming to general repairs, there is, unfortunately, an increase of over £200, which has nearly all been expended under the head of repairs of cars. Dealing with this item first, I find that the amount of £581 is made up of £293 odd in wages and £288 materials. The amount for wages is an excess on the previous year of about £40, and is mostly represented by the fact that early in the year we found it necessary to have another man in the shed. The item for material is about £160 in excess of last year. On looking through the details which go to make this amount, I find that armature repairs, relining of bearings, sundry replacements, together with an amount of about £30 which might really have been charged to capital, are responsible for the greater part, and, though the amount seems large, we cannot expect to run the system any cheaper in this particular. I hope, however, that this next year, now that we have relined the bearings of all our cars, we shall keep within last year's figure.

It will be noticed that the amount expended on electrical equipment of line is about the same as last year, and well within the amount of £90 guaranteed us by the "G.B." Company. On looking this amount up I find that only £54 of it is directly chargeable to the "G.B" equipment, the remaining £20 being for general expenses in connection with feeders, etc. The £54 is reduced by £21, which has been expended during the year in endeavouring to keep the "G.B." equipment under the Great Northern Railway crossing in a workable condition. Owing to the sinkage of the line and the poor nature of the ground under the crossing, it was impossible to keep the conduit watertight, and as the crossing lies in a hollow in the road the water flowed into it from every direction, and on several occasions we have been flooded out, causing leakage on the line, and even on one occasion making the adjacent studs alive. At the beginning of the current year I was forced to block off the conduit under the Great Northern crossing altogether, and am now putting in a cable bridging piece from one side of the crossing to the other, so that in future it will be unnecessary to use that portion of the conduit.

Power expenses, on the other hand, show a decrease of nearly £200, which is mostly represented by the fact that the charge was reduced from 1½d. to 1¼d. per unit. There is, however, this pleasing feature to be noted, in that whereas last year the cars ran 137,186 car miles and consumed 164,314 units of electricity, they have this year run 145,235 car miles, or an increase of 8,049, whilst using only 160,874 units, being a decrease of 3,440. The energy consumed per car mile has, therefore, fallen from last year's figure of 1·197 to 1·108 units, on which the tramway staff are to be congratulated, as it shows not only better driving, but also that great care has been exercised in the car-shed in maintaining and sending out the cars in proper order.

I have again taken the average working costs of about 70 other municipal tramways, working on the overhead system, for the year 1907, as this year's figures are not yet published, and obtained a figure for their total costs of 6·31d. per car mile run, so that this year we are able to congratulate ourselves on being ·21d. below the average, instead of ·35d. above, as we were last year. We are still the smallest municipal tramway running, our nearest neighbour being Lancaster, with 194,000 car miles and a total cost of 6·93d. per car mile. I also give a comparison of our figures for this year with those of Wolverhampton (the only other surface-contact system of which I can obtain records) for the year ending March, 1907:

	Lincoln per car mile run, 1908.	Wolverhampton per car mile run, 1907.
Traffic expenses	2·28	2·49
Repairs and maintenance	1·25	0·94
Management and general expenses	1·18	0·82
Power expenses	1·39	1·84
	6·10	6·09

Here, again, we show up much more favourably than last year, particularly having regard to the fact that they have run nearly 1,000,000 car miles.

Turning to the question of receipts, the slight fall which is shown this year per car mile is due to the fact that towards the end of the year we experimented with a more frequent service, which, while it has increased our total takings, has naturally slightly diminished our takings per car mile. The accelerated service mentioned above has so far had a satisfactory effect on the takings, and would have been more apparent in the balance-sheet were it not that during the whole of the time it has been in force our Saturday receipts have shown a marked shrinkage over those during the same period last year, thus largely discounting the increased takings during the rest of the week. The 7½ minutes' service to Cross o' Cliff Hill in a morning, with a 15 minutes' service to Bracebridge, between the hours of 9.30 and 12, continues to yield increased takings over the same period last year, when there was a uniform 10 minutes' service over the whole line.

It ought to be mentioned that our receipts this year include an extra amount of £125, which was taken during the Royal Show week, and which will require to be made up this year in the ordinary course of traffic.

Statistical Information for the City of Lincoln Electric Tramways for the two years ended March 31, 1908.

	1907. £ s. d.	1908. £ s. d.
Total borrowing powers	98 519 0 0	98,519 0 0
Borrowing powers exercised	43,072 0 0	44,072 0 0
Unexhausted borrowing powers	55 447 0 0	54,447 0 0
Gross capital expenditure	39,231 0 0	43,796 0 0
Traffic revenue	5,740 13 2	5,934 2 8
Total revenue	5,845 5 9	6,047 16 6
Working expenses	3,828 18 11	3,691 13 4
Interest on capital	1,150 6 0	1,472 15 10
Sinking fund	1,368 10 6	1,031 18 1
Car miles	137,186	145,235
Passengers carried	1,437,946	1,494,324
Number of units used on cars	164,314	160,874
Number of units used on car-shed lighting	5,647	6,495
Total number of units used	169,961	167,369
Number of units used per car mile	1·197	1·108
Average number of cars in use for 18 hours' day	4	5
Percentage of working expenses to receipts	65·50	61·04
Average traffic revenue per car mile	10·04d.	9·8d.
Average traffic revenue per mile of single track	£1,935 3 6	£2,000 7 11
Average total revenue per car mile	10·22d.	10d.
Average car miles per day per car	54·9	57·8
Average speed per hour	7 miles	7 miles
Average car hours per day	18	18
Average working expenses per car mile, excluding power cost	4·90d.	4·71d.
Average working expenses per car mile, including power cost	6·69d.	6·10d.
Average fare charged per mile	·428d.	·428d.
Average fare paid per passenger	·95d.	·95d.
Average number of passengers per car mile	10·48	10·29
Number of cars in stock	8	8
Total amount of sinking fund	£2,819 1 4	£3,881 18 7
Amount of sinking fund applied in reduction of debt	£2,819 1 4	£3,881 18 7

Total length of route, 1 mile 6 furlongs 68 yards. Mileage of track owned: single, 5 furlongs 153 yards; double, 2 miles 2 furlongs 8 yards—total, 2 miles 7 furlongs 161 yards. Scale of fares: 1d. and workmen ½d. Average distance, 1¾ miles.

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PARLIAMENTARY COMMITTEES.

Great Northern, Piccadilly, and Brompton Railway.

On Wednesday Lord Onslow's Committee passed the preamble of this Bill, which contains important provisions relating to the rearrangement of the present capital. By an agreement dated Jan. 13, 1903, between the Underground Electric Railways Company and Messrs. Speyer Bros. and the company, it is provided that the profits of the company in respect of each half-year available for dividend shall be applied first in payment of the 4 per cent. cumulative preference dividend on £3,200,000 capital, and, secondly, in payment of a 4 per cent. cumulative dividend on the remaining capital, and that any balance should be divided amongst the holders of the two classes of shares. It is proposed to cancel this agreement and to convert 33,450 £10 shares into 4 per cent. preference shares, and, further, to give power to the company to convert the remainder of the £3,200,000 capital into preference shares at any time. The dividend on the 33,450 £10 preference shares is to be guaranteed by the Underground Electric Railways Company.

Central Ireland Electric Power Bill.

In the House of Commons last week it was agreed, on the motion of Mr. JOHN O'CONNOR, to recommit the Dublin and Central Ireland Electric Power Bill to the committee by which it had already been considered. He stated that steps had been taken to meet the objections which appeared to have influenced the committee. The finance of the scheme had been set right, and the opposition of Dublin would be obviated. An instruction was also agreed to empowering the committee to reconsider their decision on the preamble of the Bill, except in so far as it related to the city of Dublin, the urban district of Rathmines and Rathgar, the urban district of Pembroke, and King's County.

The Bill accordingly came once again before the committee—of which Mr. Luke White was chairman—on Tuesday.

Mr. FREEMAN, K.C., said the promoters had struck out Dublin, Rathmines, Rathgar, and Pembroke from the Bill, and proposed to reduce the capital from £450,000 to £150,000, with the usual borrowing powers. When they were before the committee on the first occasion he was afraid that the promoters' financial support was not put forward properly. Now he could produce letters from various gentlemen who had already subscribed £6,000 for the preliminary expenses, and who were prepared to take a substantial interest in the company if the Bill passed. Although they had reduced the area and the capital they still believed they would be able to carry on a successful business. The position had improved, inasmuch as they were given to understand that the passing of the Patents Act would bring a number of foreign manufacturers to this country who would require cheap power.

Sir RALPH LITTLER, K.C., on behalf of the Dublin Alliance Gas Company, strongly protested against the procedure, which he said was contrary to all precedent. His clients were not consulted at all with regard to the recommitment, and if this course was to be adopted the position of petitioners against a Bill would be intolerable.

The CHAIRMAN held that the committee were bound to reconsider the Bill on the instruction of the House of Commons.

Sir RALPH LITTLER said that under those circumstances he was not in a position to give the committee any assistance, and must withdraw.

Mr. Lupton, M.P., and other witnesses for the promoters expressed the opinion that the scheme for the use of turf in the generating of the electricity would be profitable. Mr. Lupton undertook to support the scheme financially, and knew he could secure a considerable amount of capital for it.

The committee passed the preamble of the Bill subject to the insertion of clauses for the protection of the water and electric mains and pipes of the Dublin Corporation. The clauses having been gone through and adjusted, the Bill was ordered to be reported to the House for third reading.

APPOINTMENTS VACANT.

Junior Clerk, Electricity and Public Lighting Department, St. Pancras Borough Council. Applications to Mr. Barrett, town clerk, by June 1.

Traveller for the Midlands to represent manufacturers of electric lighting accessories and switchgear. Applications to J. H. Tucker and Co., King's-road, Hay Mills, Birmingham. See advertisement in last issue.

Switchboard Attendant, Eccles Electricity Works. Wages 24s. per week, which will be increased to 27s. per week at the end of six months' service. Applications to the Borough Electrical Engineer, Cawdor-street, Patricroft. See advertisement.

Professor of Mechanical Engineering, Poona College of Science. Salary, Rs 500 per month, rising by annual increments of Rs.50 to Rs.1,000, with a pension. Applications to the Secretary, Public Department, India Office, London, S.W., by June 15.

PERSONAL.

The Llandudno Urban District Council have decided to increase the salary of Mr. Morton, the electrical engineer, by £25, making a total of £325 per annum.

The Watford Urban District Council have appointed Mr. F. W. Purse, deputy electrical engineer of Warrington, to the position of chief electrical engineer to the Council.

On the occasion of his leaving to take up the position of chief assistant to the traffic manager of the Liverpool tramways, Mr. H. I. Palmer, chief clerk of the Bradford tramways traffic department, was last week presented with a gold watch, suitably inscribed, from the staff, and a silver match-box from the ticket staff.

Mr. A. A. Watkins, managing engineer to the Sheerness and District Electric Power and Traction Co., has been appointed manager and engineer to the Musselburgh and District Electric Light and Traction Co. Mr. Watkins takes up his new appointment three weeks hence.

Mr. G. H. Thomson, of the Swansea borough electricity department, has been appointed electrical engineer and manager to the Neath Rural District Council. At a farewell smoking concert held last week at the Longlands Hotel, Swansea, he was presented with a fumed-oak roll-top desk, subscribed for by the staff and workmen.

The officials and workmen of Wearmouth and Hylton Collieries held a social gathering in the Miners' Hall at which they presented Mr. W. R. Bird, who has held the position of electrical engineer at the collieries for the past 15 years, with a handsome gold watch and case of pipes, and a gold brooch for Mrs. Bird, on the occasion of his leaving to take up an appointment in New South Wales.

It is with regret that we record the death of Mr. Alexander Fairley, the late secretary and manager of the Altrincham Electric Supply, Limited. The deceased gentleman, who was 44 years of age, was appointed manager on the establishment of the Altrincham Electric Supply, Limited, in 1895, and in that capacity superintended the erection of the generating station at Broadheath.

LEGAL INTELLIGENCE.

POSTMASTER-GENERAL v. NATIONAL TELEPHONE CO.

In the Court of Appeal, consisting of the Master of the Rolls and Lords Justices Moulton and Buckley, judgment was delivered on Wednesday in the case of the Postmaster-General *v.* the National Telephone Co., on the appeal of the company from a decision of Mr. Justice Swinfen Eady, the case raising a question of great importance as to the extent of the monopoly enjoyed by the Postmaster-General under the Telegraph Act, 1869. Section 4 of the Act provides that the Postmaster-General shall have the exclusive privilege of transmitting telegrams within the United Kingdom; but Section 5 excepted certain descriptions of telegrams. The exceptions were telegrams in respect of which no charge was made and transmitted by a telegraph maintained or used solely for private use and relating to the business or private affairs of the owner thereof, and, secondly, telegrams transmitted by a telegraph maintained for the private use of a corporation, company, or person and in respect of which, or of the collection, receipt and transmission or delivery of which, no money or valuable consideration shall be, or promised to be, made or given. The company holds a licence from the Crown for 31 years from Jan. 1, 1881, to work and use telegraphs of which the transmitting and receiving instruments are to be telephones, and a royalty of 10 per cent. is payable to the Post Office on sums received. A portion of the defendants' business was the supply and maintenance for annual payments of telephonic lines between two places so as to afford communication between those two places alone. Although these lines are maintained by the defendants, they are worked and used without the intervention of any of its servants. In the special case which had been stated, instances were given of lines between different places of business where allied trades or businesses were carried on—namely, connecting fire brigade stations and other buildings, and lines connecting a theatrical ticket agency with theatres and a number of hotels. In each case the agreement with the defendants was executed and the rent paid by one only of the two parties so connected by the defendants' line. The first question for the Court to decide was whether the company in respect of those lines was liable for the royalties under its licence, or whether the telephones in question did not fall within the first exception to the Postmaster-General's privilege, since the "owner" or person paying for the line was not maintaining it solely for private use for messages relating solely to his business or private affairs. The second question was whether the defendants, by supplying and maintaining lines and apparatus for the fire-alarm system by means of boxes placed in the streets so as to enable anyone to communicate with the fire station, were concerned in transmitting telegrams in contravention of the plaintiff's privilege under the Act of 1869. Mr. Justice Swinfen Eady answered both questions in the affirmative, and the defendants now appealed.

The MASTER OF THE ROLLS, delivering a reserved judgment, said it was not easy to put a case of a telegram which would fall within the first exception and which would not fall within the second exception. The only distinction he could suggest was that the first might relate to the case in which a person who was owner of the telegraph or telephone also maintained it, and the second might include the case where the telegraph was maintained by a person who was not the owner. The appellants contended that telephonic lines between two places for affording communication between A and B, or one person and a multitude of persons, which were erected and main-

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tained by the appellants, but which were worked independently of the intervention of their servants, came within one or both exceptions. Mr. Justice Swinfen Eady based his judgment mainly on the words "solely for private use" in the first exception, but these words were not found in the second exception, and, moreover, he doubted whether the "solely" could fairly be read as applying also to the words "relating to the business or private affairs of the owner thereof." The second exception seemed to him to meet the present case. The telegraph was maintained by the appellants for the private use of their customers, and no money was paid for the transmission. The "private use" of the customer extended to the case where he wanted to communicate with the person at the other end of the wire, whether that person was his partner or employé, his banker or his broker. In short, he thought an A to B private wire was within the exception, just as much as an A to A wire from a private house to a stable or office. Assuming, then, that A to B private lines were not within the Postmaster-General's monopoly, a further question arose upon the terms of the licence granted to the appellants by deed, dated Nov. 29, 1884, Clause 2 of which seemed to describe minutely, and with perfect accuracy, an A and B line, but expressly to exclude an A to A line. The words in Clause 7, directing the company to pay a royalty of 10 per cent., seemed to refer to Clause 2, and the company, having accepted the licence in these terms, could not refuse to pay the royalty on the ground that, in truth, no licence was required as to A to B lines. It was admitted that from 1884 to 1897 royalties were paid on A to B lines, but that since 1897 payment had been refused by the company, though claimed by the Postmaster-General. He thought the parties to the deed bargained that A to B lines, whether or not within the monopoly, should be treated as being within it, and the conduct of the parties for 18 years supported that view. The result was that, in his opinion, the defendants were accountable to the Postmaster for royalties under Clause 7 of the licence in respect of all the classes of lines mentioned. As to the second question the licence had no application, and it followed that, in his opinion, differing from Mr. Justice Swinfen Eady, the answer should be that the defendants were not acting in contravention of the exclusive privilege of the Postmaster-General. But as the other members of the Court took a different view as to the answer to the first question, the appeal would be allowed upon both points.

Lord Justice MOULTON said, taking both the exceptions into consideration, he was of opinion that the Legislature intended that private telegraphs should be outside the monopoly of the Post Office to this extent, that such a telegraph might be used for sending telegrams relating to the business or private affairs of the owner, and that he was at liberty to deal with such telegrams when received just in the same way as he could with a message sent by himself without the intervention of a telegraph—*i.e.*, he could pay for its collection, receipt, or delivery. The exception thus granted reasonably protected the use of private telegraphs belonging to or maintained for a person for his private use. If, therefore, a firm chose to establish private telegraphs to their bankers or their customers for the convenience of their business, and made no charge for the transmission, collection, receipt, or delivery of any of the messages sent thereby, they appeared to him to be well within the exception. Nor did he think that it made any matter whether the actual telegraphic wires belonged to them or were only leased by them. In his view, therefore, an A to B line was outside the monopoly of the Postmaster-General. With regard to the agreement of November, he held the opinion that they applied only to telegraphs and telegrams which required the licence of the Postmaster-General, and that it was the common intention that telegrams which were statutorily outside his monopoly were not to be affected by it. He was also of opinion that telegraphs used only for the transmission of telegrams within the statutory exemptions—A to B lines, for instance—were outside the licence. Under these circumstances he thought the appeal should be allowed.

Lord Justice BUCKLEY agreed. The defendants were not accountable to the plaintiff for royalties in respect of the lines specified, and the lines mentioned in the schedule were not in contravention of the Postmaster's licence.

Accordingly the appeal was allowed by a majority of two to one, with costs.

COMPANIES' MEETINGS AND REPORTS.

CAPE TOWN CONSOLIDATED TRAMWAYS.

The annual meeting of the Cape Town Consolidated Tramways Co. was held last week, Mr. Robert Littlejohn presiding.

In moving the adoption of the report, the CHAIRMAN stated that the period covered by the report and accounts dated from June 6, 1906, the date of the registration of the new company, to Dec. 31, 1907. During this period the reaction from the abnormal inflation of general business in the Cape Colony during and immediately after the war had continued in virtually every department of trade in the Cape Peninsula. The Company's accounts only too faithfully reflected the general trade conditions there. After referring to the assets of the two estate companies in Cape Town, the total share capital of which their Company held, he said that since Dec. 31 last their Company had settled with the Municipality in respect of their account for roadmaking, and had paid its total liability to date in that connection. Although the making of these streets had been an expensive business, the outlay had, of course, very considerably increased the value of the Company's property. The Company did not intend to incur any further liability for streetmaking in the immediate future, and those portions of the estate which were still without streets could await the period of revived demand for building sites. In regard to the Company's other estates, the Cape Marine Suburbs and the Oudekraal Estates, not only development expenditure, but also the maintenance expenses in connection with these were, he said, for the present kept as low as possible. The Camps Bay tramways had suffered in common with other industries in the Cape Colony, and showed a loss in operation for the period under review of £2,954, but this sum included an amount of £800 in connection with the Kloof Line Amendment Bill, an expenditure which would not recur. The question of seeking parliamentary relief from working the more expensive portion of the Camps Bay tramways during the winter months, when traffic is at a minimum, was very carefully considered, and a Bill to afford this relief was promoted by the Company and passed by the Cape Legislature during the session of last year. In future for five months in the year—from May 1 to Sept. 30—they hoped to reduce the expenses of working the Camps Bay tramways by operating only, except on holidays and other special days stipulated for in the Act, that portion of the system which had a fairly steady traffic all the year round.

Mr. L. BREITMEYER seconded the resolution, which was carried.

RANGOON ELECTRIC TRAMWAY AND SUPPLY.

The second ordinary general meeting of this Company was held in Liverpool, Mr. Frank Tobin, chairman of the directors, presiding.

The CHAIRMAN, in moving the adoption of the report, said they had issued £50,000 in preference shares and £25,000 of ordinary shares. Outside the two large items of £40,000 for underground cables and £30,000 for the house-fitting department, the new capital raised had been expended on the enlargement of the distribution system. In the prospectus it was estimated that the takings of the tramway would be £1,000 per week. They were taking that amount, and as the time went on he hoped they would see the traffic grow, as had been the usual experience of tramways. They aimed at getting the working expenses down to 50 per cent., and he could safely say that even if they could not achieve that this year they would come within measurable distance of it, and would at any rate be far removed from the 70 per cent. of last year. Referring to the other part of the undertaking—public and private lighting—he said, with regard to the former, that the whole of the lighting contracted for with the Municipality of Rangoon was completed by the end of last month. As to private lighting—and he meant the whole of their supply service outside the Municipality contract—it was evident that they had underestimated the amount of demand for this purpose. It was only now that they could really take up the private lighting in earnest. Their complaint was, not that they could not get customers, but that they were not yet in a position to supply them. Government institutions, the Burma Railway, and many other public and private concerns were asking to be supplied, and the estimated gross revenue from contracts offered them—quite in addition to any contemplated in the prospectus—was £35,000. Their position this year was that the public lighting would be bringing in revenue for eight months, and that they would have made a start with private lighting, with, however, an almost certain prospect that in 1909 this last-named source of revenue would have attained a really satisfactory figure, and would, he hoped and believed, justify the confidence of their ordinary shareholders, and bring them the reward which their patience merited.

Mr. JAMES TAYLOR seconded, and the motion was carried.

CALLENDER'S CABLE AND CONSTRUCTION.

The annual meeting of Callender's Cable and Construction Co. was held on the 21st inst. at Hamilton House, Thames-embankment, E.C., Mr. Henry Drake presiding.

In moving the adoption of the report, the CHAIRMAN observed that the prohibitive price of metals and the stringency of the money market had rendered the Company's operations difficult and less remunerative than in previous years. The most pronounced factor in restricting business in heavy mains had been the abnormal price of copper which prevailed in the first eight months of last year, leading to the temporary abandonment of nearly all new enterprise in electrical supply, and to the curtailment of extensions of existing networks in every direction. This was not confined to the home trade, as diminished orders were observed in almost every area throughout the world in which the Company carried on its business. The continuing downward trend of the market offered no inducement to consumers to undertake new work or to fill up their deplenished cable stocks. The recent return of copper to its average price came after the season was at an end, and it might, therefore, be said that practically the whole of the Company's business during the past year consisted of extensions which were absolutely necessary in connection with electrical supply stations already in existence. The subsequent stringency of the money market had delayed that improvement in business which might otherwise have been expected. Their business in Germany had been consolidated, and their own Company had been registered under German laws with its headquarters in Hamburg, excellent results having already attended this step. The available balance for distribution was £81,357, and the directors recommended the payment of a dividend at the rate of 10 per cent. per annum, with a bonus of 5s. a share, carrying forward, after placing £10,000 to suspense account, a balance of £45,107.

Mr. JOHN VARLEY seconded the motion.

Mr. T. O. CALLENDER (managing director) observed that the past year had been a good deal less satisfactory than the two previous years. The most important reason for the falling off in the business was the uncertainty which prevailed in regard to the price of copper, which had fallen from £122 per ton to something below £60. However, the Company was doing a fair business, and their works were occupied

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to a very considerable extent. No large contracts had been placed with them, and, consequently, they were not so busy as they should have liked to be, but he was sure that the Company would get its fair share of all the business that was going. In his opinion an improvement in the business was sure to come, and the work waiting for execution which at present was hung up would, to a very large extent, be placed in the hands of this Company.

The report was unanimously adopted.

PERTH ELECTRIC TRAMWAYS.

The ninth ordinary general meeting of the Perth Electric Tramways (Western Australia) was held on the 22nd inst., Mr. Allen H. P. Stoneham, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said that since the Company was formed they had expended no less than £23,625 of undivided profits on capital account for extensions, they had repaid £18,989 of debentures, and had invested £6,210 in cash reserve fund, making a total of £48,824, which had been put aside out of profits in addition to paying dividends on the preference and ordinary shares.

Mr. OLIVER WETHERED seconded the motion, which was carried unanimously.

A dividend was declared at the rate of 5 per cent. on the ordinary shares.

WEST INDIA AND PANAMA TELEGRAPH.

The report of the West India and Panama Telegraph Co. for the half-year ended Dec. 31, 1907, to be presented at the meeting on the 3rd prox., states that the amount to credit of revenue (including £1,000 transferred from income tax account) is £37,262, against £34,203 for the corresponding half-year of 1906, and the expenses have been £23,028, against £21,611. The result is, therefore, a balance of £14,234, to which is added £1,747 interest on investments and £1,014 brought forward, making an available total of £16,995. The directors propose a dividend on the first preference shares of 6s. per share for the six months to Dec. 31, and on the second preference shares of £1. 6s. per share on account of dividends accrued to Dec. 31, 1907. leaving a balance to carry to current half-year's account of £557. The Board recommends payment of £1. 6s. per share to the second preference shareholders on account of accrued dividends. The traffic receipts for the six months show an increase of £2,074, as compared with the corresponding period of 1906.

NEW COMPANIES REGISTERED.

Santoni Arc Lamp and Engineering Co., Limited.—Registered May 13. Capital, £3,000 in £1 shares. Objects: to carry on the business of electrical and general engineers, contractors, manufacturers of electrical and mechanical appliances for lighting, power, and traction, and to acquire the business of the arc lamp department of D. Santoni and Co. formerly carried on at 15-17, Beauchamp-street, Brooke-street, E.C. No initial public issue.

W. H. Davis and Sons, Limited.—Registered May 18. Capital, £50,000 in £1 shares. Objects: to carry on the business of manufacturers of railway carriages and wagons, carts, trucks, vehicles, locomotives, engines, rolling-stock, conveyances, and railway and tramway plant, ironmasters, founders, engineers, etc., and to acquire the business carried on by W. H. Davis at Doncaster, Yorks, and at Langwith Junction, Derby. No initial public issue. Registered office: Bank-chambers, High-street, Doncaster.

Unity Motor Electrical and General Engineering Co., Limited.—Registered May 9. Capital, £1,000 in £1 shares. Objects: to carry on the business of garage proprietors, motor, electrical, and general engineers, machinists, fitters, tin and copper smiths, etc.; to acquire the business of the Unity Motor Electrical and General Engineering Works, Orchard-street, Bristol; and to adopt an agreement with A. A. Taylor. No initial public issue. Table "A" mainly applies. Registered office: 52, Queen-street, Bristol.

E. A. Prevette, Limited.—Registered May 14. Capital, £3,000 in £1 shares. Objects: to acquire patents and rights for inventions relating to an electrical burglar alarm and an electrical clock; to acquire the business of E. A. Prevette at 35, Grove-road, Eastbourne; and to carry on the business of electricians, mechanical, sanitary, gas, and water engineers, railway contractors, builders of electric tramcars, motorcars, etc. No initial public issue. Registered without articles of association. Registered office: 35, Grove-road, Eastbourne.

Humphris Patent Gear and Engineering Co., Limited.—Registered May 15. Capital, £100,000 in £1 shares. Objects: to adopt an agreement with the Humphris Engineering Syndicate for the acquisition of certain patents and rights referred to therein, to develop and turn to account the same, and to carry on the business of manufacturers of and dealers in motorcars, motors, cycles, carriages, vehicles, appliances, apparatus, lubricants, cements, solutions and enamels, engineers, indiarubber manufacturers, etc. No initial public issue. Registered office: 4, Albany-courtyard, Piccadilly, W.

Liens Registered.

Empire Roller Bearings Co., Limited (London).—Issue on May 12 of £450 6 per cent. debentures, part of series created April 28, 1908, to secure £600. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

United Flexible Metallic Tubing Co., Limited (London).—Issue on April 28 of £1,500 5 per cent. debentures, part of series created July 24, 1906, to secure £40,000. Charged on the company's undertaking and property, present and future. No trustees. Total amount previously issued of same series, £25,300.

Electrolytic Alkali Co., Limited (Middlewich).—Issue on April 25 of £250 and on May 2 of £100 debentures, part of series created July 9, 1904, to secure £50,000. Charged on the company's undertaking and property, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., 6, Castle-street, Liverpool. Total amount previously issued of same series, £36,550.

National Rail and Tramway Appliances Co., Limited (Liverpool).—Particulars of £1,000 debentures created by resolutions of Feb. 21 and March 12, 1908, have been filed pursuant to Section 14 (4) of the Companies' Act, 1900. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees. The debentures are issued as collateral security for the moneys owing on a mortgage dated Nov. 20, 1905.

Liverpool Storage Co., Limited.—A trust deed dated April 27 (supplemental to a trust deed dated Jan. 3, 1908. securing £20,000 debentures) has been registered. Property charged: certain land, containing 17,300 square yards, at Poulton-cum-Seacombe, with the erections thereon, and land containing 10,000 square yards at Barton-upon-Irwell, subject to certain restrictions. Trustees: H. Whitehead, Haslem Hey, and J. Parks, Bank House, Manchester-road, both in Bury.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Globe Telegraph and Trust Co.—The directors announce a final dividend on the ordinary shares of 5s. 9d. per share.

Dewsbury.—The District Council have agreed to extend the electric cable from Newgate to the Hopton Congregational Church.

Coventry.—The City Council have decided to extend the electricity mains to the Harefield Estate at an estimated cost of £300.

Worksop.—The Council have approved plans submitted to them by the electrical engineer for an economiser, estimated to cost £325.

Stepney.—The London County Council have sanctioned the borrowing of £9,500 by the Stepney Borough Council for electric lighting purposes.

Axbridge.—The Guardians have decided to secure the services of an expert to overhaul and report upon the condition of the generating plant at the workhouse.

Sheffield.—The Local Government Board will hold an inquiry on June 2 into the application of the City Council for sanction to borrow £20,000 for the purposes of the electricity undertaking.

Wireless Telegraphic Installation for the Royal Yacht.—The King's new yacht "Alexandra" is to be fitted with wireless telegraphy apparatus, and should be ready for use for the Cowes week.

Rotherham.—The Council are seeking sanction to a loan for the purpose of an electricity generating station, and an inquiry will be held by the Local Government Board into the application on June 2.

Maxim Electrical Co.—We are asked to announce that the above company have removed their offices and stores to Maxim Works, Shernhall-street, Walthamstow, N.E., which will be their only address for the future.

Bury.—At the meeting of the Electricity Committee of the Town Council it was reported that the profits for last year were £4,026. 4s. 6d. Of this sum £1,000 is to be allocated to the general rate, and the remainder to the reserve fund.

Greenock.—At the last Council meeting it was reported by Mr. J. A. Robertson, the engineer, that 345,398 units of electricity had been generated during March, or an increase of 49,703 units over the corresponding month of last year.

Boston.—The Board of Trade have revoked the Boston Electric Lighting Order, 1906, as confirmed by the Electric Lighting Orders Confirmation (No. 4) Act, 1906, as to the whole of the area of supply, as from May 12, 1908, and the revocation is to take effect from that date.

British Columbia Electric Railway Co.—An interim dividend on the preferred ordinary stock will be paid on May 30 at the rate of 5 per cent. per annum in respect of the half-year ended March 31, 1908, together with an additional dividend at the rate of 1 per cent. per annum for the nine months ended March 31, 1908.

Hanley.—The Electric Lighting Committee have received a letter from the Local Government Board stating that, of the desired loan of £21,969 for which application had been made, they sanctioned the borrowing of £20,643. The sanctions were referred to the Finance Committee with a request to raise the amounts therein named.

Electrical Orders.—The House of Lords Examiner had before him on Monday last a Bill to confirm electric lighting provisional orders relating to Bridgend (extension), Llandaff and Dinas Powis (amendment), and Llansamlet (amendment). The Standing Orders were found to be duly complied with, and the Bill was reported for second reading.

Sunbury.—The Board of Trade have revoked the Hampton Wick and District Electric Lighting Order, 1904, as confirmed by the Electric Lighting Orders Confirmation (No. 6) Act, 1904, as to so much of the area of supply as is included within the urban districts of Sunbury and Feltham and the parishes of Hanworth, Ashford, and Shepperton, as from May 12.

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Merritton (Ontario).—Mr. H. L. Aitkens, consulting engineer, of Toronto, has submitted to the Council his estimate of the cost of an electric light plant to be owned by the Municipality. It is as follows: wire, 1,410·52dol.; poles, 752·78dol.; supplies, 502·14dol.; arcs, etc, 275·50dol.; transformers, 882·70dol.; engineering and contingencies, 382·46dol.—total, 4,207·10dol.

Glasgow.—An outbreak of fire occurred about 11 o'clock on the night of the 25th inst. in that part of Glasgow Royal Exchange-buildings occupied by the National Telephone Co. The fire brigade were immediately summoned, and they were successful in suppressing the outbreak before any very considerable damage was done. It is estimated that the loss will not exceed £100.

Stirling.—Mr. Papworth, borough electrical engineer, submitted his monthly report to a meeting of the Lighting Committee on May 6. The report stated that for the four weeks ending April 11 the units generated were 27,176 as against 24,784 units generated during the same period last year. The total number of connections for all purposes was 24,095, as against 22,063 connections during same period last year.

Stoke-on-Trent.—At the last meeting of the Electricity Committee the electrical engineer presented his monthly report, in which he stated that during the month of April 35,100 units had been sold, an increase on the corresponding period of last year of 126 per cent.; and that the number of consumers now on the books was 365, representing a total of 15,501 32-watt lamps for lighting and heating, and 623½ h.p. in motors.

Southend.—At the last meeting of the Council the borough accountant reported that the income and expenditure on the electric lighting undertaking for the past financial year were approximately £20,870 and £18,670 respectively, showing an approximate profit of £2,200, as compared with £946 on the previous year's working. The Council decided to install festoons of bulb lamps near the bandstand enclosure at an estimated outlay of £245.

Electrical Development Co. of Ontario.—The Canadian Agency, fiscal agents of the Electrical Development Co. of Ontario, have authorised Messrs. Chaplin, Milne, Grenfell, and Co. to receive on their behalf for transmission to Canada certificates for common stock of the company, to be exchanged for 6 per cent. preference stock, pursuant to the terms of the scheme of arrangement, as notified in the company's circular to the shareholders, dated April 6, 1908.

Doncaster.—The Electric Lighting Committee require another £20,000 to provide for the general growth of the system in the city. The undertaking is developing so satisfactorily that there is a constant demand for new capital, chiefly for mains extensions, transformers, new sub-stations, etc. The Finance Consultative Committee have agreed to the expenditure of £20,000, and a Local Government Board inquiry is to be held relative to the proposed loan on June 2.

Grimsby.—At Monday's meeting of the Grimsby Electric Lighting Committee it was reported that a profit of over £2,000 had been made on the year's working, and the report was adopted as satisfactory. Mr. W. A. Vignoles, the engineer, said that he had been in further communication with the Admiralty with regard to the wireless station to be established at Humberstone, and he expected to be in the position to place an agreement between the department and the Admiralty for the supply of current.

Ontario.—The Canadian Agency, as fiscal agents of the Electrical Development Co. of Ontario, have authorised Messrs. Chaplin, Milne, Grenfell, and Co. to receive on their behalf for transmission to Canada certificates for common stock of the company to be exchanged for 6 per cent. preference stock, pursuant to the terms of the scheme of arrangement as notified in the company's circular to the shareholders, dated April 6, 1908. Common stock certificates should be endorsed in blank and deposited with Messrs. Chaplin, Milne, Grenfell, and Co.

Stock Exchange.—The Stock Exchange Committee has appointed special settling days as under: June 4—Mexican Light and Power Co.'s scrip for 1,500,000dol. 7 per cent. cumulative convertible preference shares of 100dol. each, fully paid; June 11—African Rubber Co.'s 30,000 vendors' ordinary shares of £1 each, fully paid, Nos. 5,001 to 35,000; and have ordered the British Aluminium Co.'s further issue of 20,000 ordinary shares of £5 each, fully paid, Nos. 40,001 to 60,000, and 20,000 7 per cent. cumulative preference shares of £5 each, fully paid, Nos. 40,001 to 60,000, to be quoted in the official list.

Norwich.—At the last meeting of the City Council the Electricity Committee recommended that the estimate of expenditure upon which the loan of £25,000 authorised by the Council on Feb. 19, 1907, to be raised for capital expenditure to Dec. 31, 1908, was founded, be amended by the substitution in the estimate of a water-tube boiler with feed-water economiser, steam feed, ash elevator, hopper brick-work foundations, etc., at an estimated cost of £3,650 in lieu of two boilers and other works estimated to cost £2,200; and that application be made to the Local Government Board for sanction to borrow the additional sum of £1,450. This was agreed to unanimously.

Haslingden.—Representatives of the Building Committee of the Guardians met representatives of Rawtenstall Corporation on the 23rd inst., when Rawtenstall made the following offer: to supply the workhouse building with electricity at the price of 3d. per unit, the Guardians to give a guarantee that they would take at least 25,000 units, the other conditions to be as previously. Rawtenstall also agreed to maintain the necessary cable. The Building Committee had resolved that further information be obtained, and a committee was appointed to visit Bury, Burnley, and other workhouses that have electricity installation and make inquiries.

Whitley.—At the last meeting of the Upper District Parish Council a letter was read from the Yorkshire Electric Power Co. enclosing the plan of electric power lines proposed to be erected between Thornhill and Skelmanthorpe, and requesting permission to erect overhead wires over certain public roads in the Whitley Upper district, which will cross Denby-lane, Ben Booth-lane, Wakefield main road (between Grange Moor and Grange Ash), also Flockton-lane. On the motion of Councillor Hinchliffe, seconded by Councillor Inman, it was decided to grant the company permission to erect the proposed overhead wires subject to the Acts of Parliament and regulations in respect thereto being complied with.

Bristol.—A gas explosion, which caused some alarm in the St. George district, occurred at the shop of a Mr. Coles, confectioner, etc., 69, Gerrish avenue, Whitehall, on the 23rd inst. Shortly after eight o'clock Coles went to a back room with the intention of lighting the gas stove. He struck a match, a loud report followed, and a huge flame shot from the stove, Coles being blown through the doorway in a semi-conscious condition. The kitchen was partially wrecked, and the glass roof blown off. The dining-room window was also blown out bodily, and fell into the street, the venetian blind was also torn and twisted, whilst a quantity of crockery which was on a shelf near the stove was blown to atoms.

Turbines in Mills.—The Falcon Spinning Co.—a new firm—is adopting steam-turbines for driving purposes at their Bolton factory, which is to contain nearly 100,000 spindles. The experiment will be watched with interest by millowners in that important cotton centre, as the Falcon Works will be the first mill in that part of the country to utilise such power. The equipment is being made at Messrs. Musgrave's Globe Works, Bolton. The turbines are of the Zoelly type, and are in pairs of 900 n.h.p. each, with a maximum of 1,200 n.h.p., running at a normal speed of 3,000 r.p.m. The dynamo is coupled direct to the shaft of the turbine running at the same speed. The generator is being made by Messrs. Siemens, and is on the three-phase system.

An Electric Light Regulator.—It is possible that the incandescent electric lamp will soon be susceptible to the same amount of regulation as gas, for there is now on the market a lamp operated by a chain which is capable of three degrees of illumination. One point sheds an illumination of 80 per cent. of its total capacity, which, in the case of the 16-c.p. lamp, is just sufficient to indicate the location of the lamp to one entering the room and who may want to reach the light in order to turn it up higher. This tiny glow does away with the necessity of groping around in the dark in the search for the lamp, often at the sacrifice of some bric-a-brac or furniture of the room. The second point of adjustment causes the filament to glow at about three-quarters of the lamp's capacity.

Redruth.—At the last Urban Council meeting the clerk reported receipt from the Telegraph Department of an enlarged plan of the route of the proposed underground cable, as desired by the Council. Captain Hooper thought it more desirable that the cable be laid in the carriage-way instead of the pavements. Instead of running through Fore-street, it should be diverted opposite the Wesley Chapel and proceed *via* Station-hill and Penrhyn-street to the bottom of West-end. Mr. Trestrail saw no reason why the cable should not be laid throughout on the south instead of the north side of the proposed route. This would avoid nearly all interference with pavements, and be found much easier for excavation. The clerk was instructed to write the Department embodying these suggestions.

Erith.—At a meeting of the Lighting and Tramways Committee of the Urban District Council, the electrical engineer submitted a return, in the form required by the Local Government Board, showing how the sum of £9,628 for mains, house services, etc., which was included in the loan of £19,878 sanctioned by the Local Government Board on March 8, 1905, had been expended, also an apportionment of the proposed loan of £5,000 between extension of mains, transformers, motors, house services, meters, etc. The return, which was made up to March 31, 1908, showed an actual expenditure of £9,835. 19s. 5d.—*i.e.*, £207. 19s. 5d. in excess of the sum of £9,628, included in the above-mentioned loan of £19 878. The committee recommended that this return be transmitted to the Local Government Board with a statement showing the proposed allocation of the further loan of £5,000.

Sutton Coldfield.—The annual report of the borough of Sutton Coldfield electric lighting undertaking for the year ended March last has just been issued. Mr. T. Duesbury, the engineer and manager, congratulates the department on its financial position, and on the fact that as the result of the year's working there was a balance to the good sufficient not only to cover all the heavy capital charges but to wipe out the deficit brought forward from 1907, and leaves a small balance to be carried forward. This favourable result had been obtained in the face of dearer coal. The capital expenditure during the period under review was £1,204, bringing the total up to £41,308, of which sum £6,429 had been repaid. The consumption for power, heating, and cooking purposes showed an increase larger than the percentage increase for lighting. The average price for all classes of supply was 3·24d. per unit. The gross profit before providing for capital charges, was £2,691, or 6·61 per cent. on the average capital outlay.

Plymouth.—At the last meeting of the Council Electricity Committee application was received for the supply of electric current to the houses in course of erection on the Hotel Metropole site, the Hoe, and the electrical engineer was instructed to lay the necessary cable. The monthly return on the working of the electricity undertaking showed that during April 176,579 units were sold, producing an estimated revenue of £1,808. 13s. 4d. In the corresponding month of last year the consumption of current was 153,012 units, and the receipts were £1,633. 14s. 7d. The Corporation trams were chiefly responsible for the increase to that of consumption and receipts, the cars paying £709. 10s. 2d. for 97,304 units, against £583. 19s. 11d. for 80,091 units last year. There was a small increase in the use of current for private lighting, and a proportionately large increase in the consumption for power purposes. At the end of April the number

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of consumers was 944, against 883, and the lamp connections 73,787, against 66,310 last year.

York.—An additional electric cable has been found necessary for the west side of the Ouse. The Electricity Committee report that the engineer has informed them that at present the east and west sides of the River Ouse are connected only by one distributor cable which has to supply current to the far end of Knavesmire, and that it is necessary there should be an additional cable, so as to provide a duplicate supply as well as to serve for bringing up the pressure. He estimates the cost of carrying out the work at £300. The committee have instructed him to advertise for tenders for carrying out the work. The committee's statistical return for the month of April states that the units generated were 111,387, and approximate units sold 92,734. The horse-power of motors connected during the month was 12, making a total to date of 1,040½. Two hundred and ninety-three 8-c.p. lamps were connected, bringing the total to 60,765, and the total equivalent 8 c.p. connected to date of 86,771.

Bolton.—A long discussion took place at the Town Council meeting on the question of rates and the contributions in aid thereof from profitable municipal undertakings. Mr. H. M. Harwood condemned the proposal of the Electricity Committee to vote £7,500 out of their profit in aid of the rates, and moved that the sum should not exceed £6,000, as last year. He said the net profit of the department this year was £2,900 less than last year, and it seemed curious that they should increase their dividend by £1,500. Mr. Alderman Berry thought they were justified in granting £7,500, and Mr. Marshall thought Mr. Harwood's attack on the committee was unfair. Mr. Alderman Knowles Edge was of opinion that to relieve the rates would do more good than to reduce the price of electricity. Mr. Waddington, who had seconded the amendment, argued that the system they were adopting was bad, and said the departments deluded the public by not only taking the profits made but estimating the profits for the ensuing year. The amendment was defeated by a large majority.

Bath.—The Town Council on the 25th inst. resumed the debate on the proposed sale of the electric light works to Mr. Schenk. A letter was read from the electric tramway company pointing out that the electric lighting and electric tramway could be managed with greater economy in conjunction with one another and pointing out that at the expiration of 32 years from the opening of the tramway the Corporation had the option of purchase, and any benefit which the tramway might derive from the amalgamation of the two undertakings at the present time would be of even more benefit to the city, as they would have the option of taking over the two undertakings in the amalgamated form at the end of the period stated. While the company could not make any definite proposal, they could at least guarantee the Corporation against any further calls upon the ratepayers, and make arrangements whereby the Corporation would not lease the undertaking entirely. It was proposed that the debate on Mr. Schenk's offer should be discontinued, but the Council decided by a majority to go on with the debate. An amendment was proposed by Mr. Johns, "That, while the Council declined the promised offer by Mr. Schenk, they would be prepared to lease the undertaking for a term of years to be decided by the Council." After considerable discussion the amendment was defeated by 28 votes to 8, and the report adopted, with the added clause: "That the sum of £22,500, which it is proposed should be paid as a deposit, should be paid down by Monday next, June 1."

Stalybridge.—On the 19th inst. Mr. H. R. Hooper held an inquiry at the general offices of the Stalybridge, Hyde, Mossley, and Dukinfield Joint Tramway and Electricity Board relative to an application by the Board to borrow £25,223 for electricity purposes. Mr. Simister, in making the application on behalf of the Board, said the plant covered by the last sanction was quickly loaded to its full capacity. Nevertheless, the demands for power had increased, and the Board had, after carefully considering the matter, decided to make application to the Local Government Board for sanction to the borrowing of a further sum of £25,000, and that inquiry was the result. Demands for power had been received from the persons and firms contained in the statement he now submitted. It was impossible to do this with safety with the present turbines and engines, and the Board estimated that they would require the extra machinery as follows: one 2,000-kw. turbine and condenser, with the necessary details; three Lancashire boilers and the necessary pipework, and other details; and auxiliaries, including pumps, valves, and other matters. The estimated cost of this plant was £20,223. The Board further estimated that they would require transformers which would cost £5,000, making a total, roughly speaking, of £25,000. If that application, therefore, were sanctioned, the Board would then be in a position to cope with the demands which were now, and which for a little time, at any rate, would be made upon them, and, taking the last sanction and the result as a criterion, they felt confident that this extra plant would put the electricity undertaking of the Board in a strong commercial position. Mr. Robert Blackmore, the Board's engineer, then gave detailed evidence, being examined at length by the inspector. Mr. Ives briefly cross-examined the witness as to the question of the cost of the making of electricity and the retailing price to consumers, and the inquiry terminated after the inspector had been formally thanked by Mr. Simister.

Bridlington.—The borough electrical engineer, Mr. A. J. Beckett, has submitted the following report of the past year's working of the Corporation electricity department to the Electricity Committee, and it will be read at the next meeting of the Town Council: "In presenting the yearly costs and results of the year's working, April 1, 1907, to March 31, 1908, I am pleased to say the year has passed without any interruption of the supply due to breakdown of plant or mains. During the year extensions have been made in the plant, comprising a new bore to the well 140ft. deep and pipework connected, and I am pleased to report an excellent supply of water, and of fairly good quality, very superior to the water previously taken from the sump. Cruse controllable superheaters have also been installed on both boilers. The whole plant had been thoroughly overhauled during the winter and spring months, and reported on satisfactorily by the inspector for the National Boiler and General Insurance Co. The distributing mains have been added to by large extensions running from Prospect-street to the pavilion in the esplanade, and an extension from Market-place to Mill-lane, Marton-road, in addition to several smaller extensions. Forty-one new consumers have been connected to the supply, equivalent to 2,500 8-c.p. lamps, and extra public lamps have been connected. In calling your attention to the figures presented, you will notice an increase in output of 29,391 units sold for the year, and an increase of 34,120 units generated, giving an increased revenue of £412, making a total revenue of £4,462 for the year, this in spite of the fact of the introduction of the new metallic-filament lamps to which most of the old consumers have changed over and all the new consumers have installed, the electrical energy for the same candle-power required being only 25 per cent. of that taken by the ordinary carbon-filament lamps, the total cost being £2,287, or an increase of £312 over last year, showing an increased gross profit from £2,076 to £2,175, or an increase of £99. This, I feel confident, you will regard as extremely satisfactory, when you take into consideration the fact that coal, for which we paid 8s. 6d. per ton, this year has cost 11s. 6d. per ton, making a difference of £212 for the year. Thirty pounds has also been charged more for water than the year previously. We have thus been at a disadvantage of £242 this year compared to last, and in spite of same show an increased gross profit of £99."

TRACTION.

Thermit Rail Joint.—The Birmingham Corporation have specified the use of the "Thermit" rail joint in connection with the reconstruction of their Bristol-road tramways.

Hackney.—The Borough Council have given their sanction to the scheme for the electrification of the tramways in Lea Bridge-road on the overhead trolley system. A through service of electric cars will thus be provided to Epping Forest.

Tottenham.—The electric trams now run direct from Wood Green to Stamford Hill. Hitherto the Wood Green trams have only gone as far as Tottenham, but the Bruce-grove extension has now been opened, thus linking up the two journeys.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending May 20, 1908, were £3,696; corresponding period last year £3,960—decrease, £264. Aggregates from Jan. 1, 1908, £75,904; aggregates from Jan. 1, 1907, £75,612—increase, £292.

Newport.—The total receipts of the Newport Corporation tramways for the week ending May 23, 1908, were £635. 16s. 6½d., a decrease of £211. 4s 7½d. as compared with the returns of the corresponding week of last year (Whit week). The number of passengers carried was 152,336.

Campbeltown and Machrihanish Light Railway.—The Board of Trade announce that they have confirmed the Campbeltown and Machrihanish Light Railway (Amendment) Order, 1908, amending the Campbeltown and Machrihanish Light Railway Order, 1905, by increasing borrowing powers and for other purposes.

Newcastle.—The new tramlines in New Market-street, Newcastle, are now completely installed, and as the thoroughfare is nearly ready for through traffic Colonel Von Donop, on the 19th inst., inspected the lines which, when opened in a few days, will carry the traffic from Scotswood to Byker, and be a substantial relief to the present congestion of the service in New Bridge-street.

Bury.—The Tramways Committee of the Council have decided to put in another cross-over on the Market-place, between the Peel and Lancashire Fusilier Memorials, for use in connection with the Bury-to-Bolton service. The use of this cross-over will obviate the necessity of the cars on the Bury and Bolton section going on to opposite the athenæum to reverse for the outward journey.

Great Harwood.—At the last meeting of the District Council Mr. T. Noble presented a report of the light railway inquiry at Blackburn. The impression was conveyed, he said, that the scheme would be proceeded with within the next two years, and the opinion was expressed that the suggested tramway would tend to link up the three townships of Harwood, Rishton, and Clayton by the erection of property *en route*.

Philadelphia.—Two electric tramcars crowded with passengers collided on the 21th inst. at Philadelphia while going at full speed The accident is believed to be due to a mistake on the part of a points man, who allowed an up car to run on to the down line. Both cars were wrecked, and the passengers were hurled into the road in all directions. Four persons were killed on the spot and 75 more were hurt, many severely.

Wallasey.—For some time past an agitation has been made by the residents of Poulton for a better method of transit to and from Seacombe Ferry. Their wants were partially met a short time ago by a service of 'buses, but at a meeting of the Wallasey Tramways Committee it was decided, after careful consideration, to recommend the Council at the next meeting to extend the tramway service from Wheatland-lane, Seacombe, to St. Luke's Church, Poulton.

New South Wales Government Railways and Tramways.—For the quarter ended March 31 the revenue of the New South Wales Government railways and tramways amounted to £1,181,229, a decrease of £31,727 compared with the corresponding period of 1907. The decrease was due to the falling off in the grain traffic. For nine months of the current financial year earnings show an increase of £164,604, which is gratifying in view of the fact that during the preceding year reductions in the fares and rates were made to the estimated value of £300,000.

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Penarth.—A special meeting of the Penarth Council has been held, when the proposed Penarth-Cardiff tramway scheme was discussed, and a suggestion made that a poll of the town should be taken as to whether the residents were in favour of the scheme, and, if so, whether it should be carried out by the Council or a private company. It was decided to write the Local Government Board in order to ascertain whether the Council have power, under the Public Health Acts, to take a poll of the town. Upon a reply being received the matter will be further considered.

Sao Paulo Tramway, Light, and Power Co.—The gross earnings of this company for the past year were 2,111.523dol., an increase of 92,819dol. on 1906, and net earnings 1,395,873dol., compared with 1,368,162dol. Three quarterly dividends of 2 per cent. each and one of 2½ per cent. have been paid, 100,000dol. placed to the credit of contingent account, and 244,974dol. carried forward. The company have secured an exclusive 30-year concession for the distribution of light and power in the municipality of Sao Bernardo, including the town of that name distant 10 miles from Sao Paulo.

Dumbarton.—The contractors for the Dumbarton County tramways had a trial run of the section of the line between Dumbarton and Alexandria last week. Everything worked satisfactorily. The Board of Trade inspection followed, and the line was thrown open for public traffic on a 10-minute service of cars between Dumbarton, Renton, and Alexandria. The contractors are now busy with the next section of the Glasgow to Loch Lomond route—viz., that from Alexandria to Balloch. The line between Dumbarton and the present terminal of the Glasgow Corporation system at Dalmuir will be completed for traffic next month.

Aldershot.—At a meeting of the County Council it was reported that the Light Railway Commissioners had settled the draft of the order authorising the construction of light railways in the urban districts of Aldershot and Farnborough, and had submitted it to the Board of Trade. Provisions had been inserted in the order for the protection of county interests, and with regard to the by-laws regulating the conduct of traffic, preventing overcrowding of the carriages, and dealing with other matters of good order and government, the power to make these by-laws had, as to the portion of the railway in the county, been vested in the Hants County Council.

Belfast.—At the meeting of the Tramways and Electrical Committee on the 18th inst., Sir Robert Anderson, Lord Mayor, presiding, a letter was read from Mr. Rodden, of the Whitewell and Cavehill Tramway Co., stating that having considered the Council's resolution relative to the establishment of a through service between Castle Junction and Glengormely, and also the terms of the Manchester-Oldham agreement *re* the distribution of fares, they were prepared to accept in principle the Corporation's proposal. The question of details, it was suggested, could be left between the manager and a representative of the company, which was finally decided upon.

Aberdeen.—A long and lively discussion took place at the last meeting of the Tramways Committee of the Town Council over a proposal to rearrange the tramway car fares in the city, to give additional ½d. fares or abolish the present ½d. fares on certain routes, and to rearrange the price of composition tickets, the price for the latter being, by a number, considered unsatisfactory. Ultimately the matter was remitted to the tramway manager and a sub-committee to bring up a report for consideration at a future meeting of the committee. It was unanimously agreed to recommend that Messrs. Griffiths and Millington, London, be granted a renewal of the contract for the advertising on the cars for the next five years at the former terms—£624.

Burton.—On the 19th inst. the members of the Tramways Committee witnessed an interesting tramway brake experiment with Mr. Pringle's (manager of the tramways) patent on the Bearwood-hill-road. The device consists of a foot-long bar of specially-hardened steel, fitted in a position under and behind each of one pair of wheels. When the brake is operated the bar drops into a notch of the rail, and forms a kind of wedge on to which the wheel runs. Even on a wet surface, when with hand and electric brakes the wheels are locked and skidding, the dropping of the new brake brings the car to a standstill. The experiments were most successful. On proceeding down the steep hill at the rate of 11½ miles per hour the car was brought to a standstill quite easily within seven or eight yards.

Glasgow.—The traffic returns issued on the 26th inst. for the week ending last Saturday is the semi-final one for the present financial year of the Glasgow Corporation tramways department, which ends next Sunday. From June 1, 1907, until last Saturday there were 221,934,616 passengers carried, as compared with 220,403,902 in the corresponding period of the preceding financial year, an increase of 1,530,714, while the receipts have been £886,931. 15s. 2d., in comparison with £872,865. 13s. 3d., an increase of £14,066. 1s. 11d. There are now 89¼ miles of double track open for traffic, or one mile more than a year ago. Last week the cars ran 399,526 miles, in comparison with 397,190 in the corresponding week of last May; carried 4,471,290 passengers, as against 4,522,913; and drew £18,217. 19s. 1d., in comparison with £18,192. 7s. 7d.

Erith.—At the last meeting of the Council Tramway Committee, in view of the approaching completion of the London County Council tramways to Abbey Wood, the clerk was instructed to communicate with the London County Council and suggest the desirability of an arrangement for through bookings between Erith and Beresford-square, Woolwich, and *vice versa*. The tramway manager submitted the undermentioned figures showing the financial result of the tramway undertaking for the year ending March 31 last: total income, £8,539. 0s. 11d., average per car mile 6·37d.; working expenses, £8,393. 8s. 3d., 6·26d.; gross profit, £145. 12s. 8d., 0·11d.; loan charges, £4,594. 13s. 4d., 3·43d.; net deficiency, £4,449. 0s. 8d., 3·32d.; passengers carried, 2,288,491; car miles traversed, 321,332.

Falkirk.—At a meeting of the Council Finance Committee held on May 13 the town clerk read a letter, dated May 6, from the Board of Trade as to the appointment of an arbiter in connection with the dispute with the tramways company as to payment of the accounts, and suggesting that in the circumstances it might appear desirable to the Burgh Councils of Falkirk and Grangemouth to accept by agreement with the company the appointment of an arbiter by the Sheriff of Stirlingshire. A letter was also read from the town clerk of Grangemouth, stating that his committee had unanimously agreed to accept the suggestion and to refer the whole accounts, provided the Town Council agree, and it was agreed to accept the suggestion.

Wrekenton.—The efforts of the Wrekenton and District Tramway Extension Committee to secure the original project of extending the Gateshead trams to the Mechanics' Institute at Wrekenton is likely to be accomplished. The railway company have agreed to run a locomotive engine over the level crossing and abandon the haulage ropes, which were considered by the Board of Trade to be dangerous to the trams crossing the railway at the north end of the village. Representatives of the railway company, tram company, and Gateshead Council will meet shortly to consider the defraying of the cost of erecting gates at the railway in question for the further safety of the public and in order to meet the wishes of the Board of Trade. As the cost will not be large, no difficulty is anticipated regarding the matter.

Light Railways Act, 1896.—The Board of Trade have recently confirmed the undermentioned orders made by the Light Railway Commissioners: (1) Wolverhampton and Cannock Chase Railway (Light Railway) Amendment Order, 1908, amending the Wolverhampton and Cannock Chase Railway Act, 1901, and the Wolverhampton and Cannock Chase Railway (Light Railway) Order, 1907, in reference to the fund deposited in respect of the application for the Act of 1901 and otherwise; (2) Clacton-on-Sea and St. Osyth Light Railway (Extension of Time) Order, 1908, reviving the powers granted and extending the periods limited by the Clacton on-Sea and St. Osyth Light Railway Order, 1904, for the compulsory purchase of lands, and for the completion of the railway and works by that order authorised, and for other purposes.

Dundee.—Some discussion took place at an adjourned meeting of Dundee Town Council over a proposal that the tramways department should make a payment of £1,000 to the common good. Mr. George Stevenson asked if such a step were legal, and what precedent there was for it. The Town Clerk replied that Dundee had exactly as much power to contribute to the common good from their tramway revenue as the city of Glasgow. Mr. Stevenson moved that the matter be remitted back, but, by 14 votes to 2, it was agreed to authorise the contribution. It was agreed to send a deputation to the Continent to inspect a trolley-car system with a view to its adoption in Dundee, and it was mentioned that if this system were adopted in Dundee there was a possibility of a private enterprise extending the system to outlying suburbs of the city.

Huddersfield.—The consent of the Board of Trade having been received for the doubling of the Huddersfield Corporation tramlines in St. John's-road, Lockwood-road, Bridge-street, Woodhead-road, Storthes, and Wakefield-road, a commencement has been made on the Moldgreen section from Somerset-road to the Boar's Head Inn. It is hoped that the permanent lines will be completed in a comparatively short space of time, and in the meantime a special section of rail has been laid on the setts in order to obviate breaking the ordinary service of cars. The other routes will be done in turn. The doubling of the rails in Westgate, Trinity-street, West-hill, and Westbourne-road is a matter still to be settled, and it will be remembered that last week this section formed the subject of an inquiry by Lieut.-Colonel Druitt on behalf of the Board of Trade.

Govan.—The Corporation Tramways Committee's report makes interesting reading. Chief interest has reference to the proposals for new routes and the extension of some at present in existence. After considering the report, the sub-committee on extensions resolved to recommend that the following lines be constructed as soon as possible: Radnor-park, Clydebank (after consultation with the Clydebank Town Council); Rouken Glen, *via* Thornliebank; Burnside. It was decided to recommend that in the first provisional order to be applied for by the Corporation parliamentary powers be asked for the construction of the following extensions: Cathcart-road (already approved of by the Corporation); Old Edinburgh-road; Crow-road; Clarence-drive; University-avenue; Baillieston to Langloan, Coatbridge (if the Tramway Committee are satisfied after visitation).

Birmingham.—The report of the Tramways Committee for presentation at the monthly meeting of the Council on June 2, 1908, is as follows: "The committee submit the accounts and balance-sheet for the year ended March 31 last. From these it is seen that the gross profit for the year amounts to £121,111. 18s. 2d., and after providing for interest and sinking fund on capital and paying £2,306, the balance of the expenses in connection with the Corporation Bill of 1907, there remains a net profit of £72,037. 7s. 8d. The committee propose to place the sum of £37,037. 7s. 8d. to the reserve fund, which will then stand at £64,013. 14s. 10d., and the balance, £35,000, will, as directed by the Corporation Act, 1903, be carried to the borough fund. The amount proposed to be carried to reserve fund is in excess of the amount based on the calculations made by the committee, and mentioned to the Council in June last, but the charges for interest and sinking fund will be heavier next year, and probably some of the expenses will be increased."

Bristol.—At the House of Lords on the 20th inst., the Bill promoted by the Bristol Tramways and Carriage Co. to extend the time for the construction of certain authorised tramways, and for the acquisition of lands in connection therewith, came before the Select Committee on Unopposed Bills, the Earl of Onslow presiding. Opposition had been offered to the scheme by the Corporation of

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Bristol, but that was recently withdrawn. Mr. Pritt, of the firm of Messrs. Sherwood and Co., parliamentary agents, appeared for the company, and explained that by the Bristol Tramways (Extensions) Act, 1904, the company were authorised to construct tramways and acquire lands and widen certain streets. It was necessary that these powers should be extended. The Bill proposed that the powers granted by the Act of 1904 for the construction of the tramways, other than tramway No. 2, shall be extended, and may be exercised by the company as regards as much as are within the city, for the period of three years from Aug. 15, 1908, and as regards the remainder for the period of three years from Aug. 15, 1909. The Bill also provides that if the tramways are not completed within the extended periods, the company shall lose their power, except as to so much as shall then be completed. Evidence having been called in proof of the preamble, the Bill passed the committee, and was ordered to be reported without amendment to the House for third reading.

Southend.—At the last Town Council meeting plans were submitted by the surveyor for the proposed esplanade extension from the Gutters to the Half-Way House. With regard to the cost of the work, the town clerk reported the Corporation were entitled to defray the same by raising a covering loan under the borrowing powers granted by the Light Railways and Electric Lighting Extensions Order, 1904. It was, therefore, in his opinion, unnecessary to make special application to the Local Government Board for borrowing powers, as it was quite practicable to carry out the Council's intention to execute the works as a public improvement by charging the amounts of the annual repayments of loan and interest necessitated by the work to the general district rate instead of to the light railway fund. The town clerk further reported that if the above course were adopted the loan repayments could be spread over a period of 40 years by the authority of the light railways order, and that application to the Local Government Board for borrowing powers, together with the delay attendant thereon, would be obviated. It was recommended that the suggestion of the town clerk be approved and adopted. The Light Railways Committee also approved this procedure, the minute adding: "The borough surveyor was instructed to invite separate tenders for the laying of the permanent way and the supply of the necessary rails, and the electrical engineer was directed to invite tenders for the supply of the overhead material required by him in connection with the proposed extension, and also to arrange for the work to be carried out by his department." The Council agreed to the reports.

Halifax.—At a meeting of the Halifax Tramways Committee on the 25th inst. the actual financial results for the year ended March 31 last were reported. The statement showed that on the electricity works the estimated profits were £3,804, but they actually proved to be £4,982, a gain of £1,178. Of this amount £859 accrued from increased revenue upon current supplied to the tramways, the total increase in income being £1,038, while there was a decreased expenditure of £140. Of the profits of £4,982 the committee have to put £3,000 to a special reserve fund, so that there remains a balance of £1,982. The committee resolved that the balance should be so dealt with as to credit the tramways department with approximately £1,800, equal to a reduction of ½d. per unit for the current taken from the electricity works. They recommended this revision of the figures since the Town Council decided some time ago that the departments were to be worked as one. The figures for the tramways department showed that the estimated expenditure was £84,651, whereas it had actually proved to be £84,760, an increase of £119. The estimated receipts were £81,810, and the sum actually taken was £81,870. It was estimated that the loss would be £2,841, and it proves to be £2,830. When the accounts are amended, crediting the tramways with a reduction of ½d. on electricity, the actual loss will be reduced to £1,090. The chief reason for the deficiency in the tramways department is the cost incurred by equipping the cars with the new Spencer brakes, and by paying out of revenue the cost of a considerable amount of material necessary for the re-equipment of the cars as authorised by the Council.

Exeter.—The audited accounts of the Exeter tramway undertaking for the 12 months ending March 31 have been presented to the committee, and will come before the Council at its next meeting. The number of passengers carried in the year was 3,754,705, and the number of miles run 388,084. The total receipts were £15,420, an increase of about £400 on the previous year. The receipts per car mile were rather over 9½d. There were expended on the wages of motormen and conductors £2,809, and on other traffic employés £92. The salaries of other officers and departmental staff amounted to £326, and the ticket check, including the wages of inspectors and clerks, totalled £306. The premiums paid on insurances were £234, and rates and taxes absorbed £513. On renewals and repairs and electrical equipment a sum of £1,136 was spent, and the cost of current was £3,959. The total of these working expenses amounted to £10,505, as against the income of £15,420, thus leaving £4,984 to be carried to net revenue. The expenses are about £1,000 in excess of those for the previous year, arising from increased number of car miles run. The past year was the first completed 12 months of the Alphington-street section, which has not come up to expectations in the matter of receipts. The £4,984 net revenue would in the case of a company be available for dividends and reserve fund. But the Council have to provide out of this sum interest and sinking fund on the capital expenditure. The loan charges (repayment of capital), less contribution from district fund account for proportion of charges re wood paving, amount to £2,727 per annum, and the interest on loans to £2,355. These two amounts plus income tax on profits are £132 more than the balance on the revenue account. Although, therefore, the income has increased, it has cost the undertaking about £1,000 more to earn the £400 augmentation. A good deal of the deficiency arose from the unfavourable summer, when the receipts fell considerably below the average.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Madrid.—The Public Works Department invite tenders for the construction of light railways. Tenders by Oct. 31.

Melbourne.—The City Council invite tenders for the supply and delivery of one 500-kw. motor-generator. Tenders by July 3.

Chelsea.—The Council invite tenders for the supply of engine-room stores. Particulars from the Town Clerk. Tenders by June 1.

Queensland.—The Postmaster-General invites tenders for battery glassware, etc., battery material and chemicals. Tenders by June 1.

Bangkok.—Tenders are invited for fishplates, fishbolts, bearing plates, etc., required for the Royal Siamese Railways. Tenders by Oct. 1.

Madrid.—The Public Works Department invite tenders for the construction of a railway from Betanzos to Feros. Tenders by June 23.

Dartford.—The Urban District Council invite tenders for surface-condensing plant. Particulars from the Clerk to the Council. Tenders by June 3.

Sofia.—Tenders are invited for the installation of electricity in mines. Particulars from the Director of Mines and Minerals. Tenders by June 19.

Liege.—Tenders are invited for the installation of an electric lighting system. Particulars from the Secretaire Communal at Amay. Tenders by June 25.

Madrid.—The Public Works Department invite tenders for the laying of tramway track in Madrid. Estimate, 582,670 pesetas. Tenders by June 25.

Herne Bay.—The Urban District Council invite tenders for the annual supply of petroleum, lubricating, and other oils. Tenders to the Town Clerk by June 3.

Stanislau.—The Municipality invite tenders for the establishment of an electric tramway system, also for the erection of a generating station. Tenders by Aug. 31.

Dartford.—Tenders are invited for the annual supply of stores to the electricity department, including meters, service cables, etc. Tenders to the Clerk by June 9.

Blois.—Tenders are invited for the construction and maintenance for 50 years of public tramways. Particulars from the Prefecture de Loir-et-Cher. Tenders by July 15.

Croydon.—Tenders are invited for the supply of sulphuric acid for one year, for the Croydon Gas Co. Tenders to Mr. W. Topley, secretary, Katherine-street, Croydon, by June 9.

Adelaide.—Tenders are invited by the Municipal Tramways Trust, Adelaide, for the supply, delivery, and laying of underground electric cables. Tenders to the Chairman by June 23.

Shrewsbury.—Tenders are invited for the annual supply of coal for the electricity works. Particulars from Mr. C. M. Johnston, engineer and manager. Tenders to the Town Clerk by June 5.

Hornsey.—The Town Council invite tenders for the annual supply of coal to the electric lighting station, Tottenham-lane, Hornsey. Particulars from the Town Clerk. Tenders by June 15.

Sale of Plant.—Tenders are invited by the Sheffield Corporation Tramways Department for the purchase of lighting plant. Particulars from the General Manager. Tenders by June 19.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Southampton.—The Harbour Board invite tenders for the alteration and extension of electrical crane running rails, etc., on the Town Quay, Southampton. Tenders to the Town Clerk by June 3.

Middlesbrough.—The Corporation invite tenders for the annual supply of various stores. Particulars from the Stores Superintendent, 42, Commercial-street. Tenders to the Town Clerk by June 6.

Bradford.—The Corporation invite tenders for the supply of clothing for the tramway employés. Particulars on application at the Tramway Offices, Bridge-street. Tenders to the Town Clerk by June 11.

Leeds.—The Tramways Committee invite tenders for the reconstruction of a portion of tramway track in Leeds; also for the construction of a portion of track. Specifications from the General Manager.

London, W.—The Great Western Railway Co. invite tenders for the supply of various stores for 12 months from July next. Particulars from Mr. G. Mills, secretary, Paddington Station. Tenders by June 15.

Norwich.—The Electricity Committee invite tenders for the supply and erection of one water-tube boiler with mechanical stoker, economiser, etc., wiring supplies (not cables). Tenders by June 9. See advertisement.

Plymouth.—The Corporation Electricity Department require tenders for the supply of about 7,500 tons of coal. Particulars from Mr. E. G. Okell, borough electrical engineer, to whom tenders must be sent by June 3.

London, S.W.—The Secretary of State for India in Council invites tenders for the supply of rails, fishplates, fishbolts, etc. Particulars from the Director-General of Stores, India Office, Whitehall, S.W. Tenders by June 2.

Oswestry.—Tenders are invited for the supply of stores for 12 months ending June 30, 1909, for the Cambrian Railways Co. Specifications and forms of tender may be obtained at the Stores Office, Cambrian Works, Oswestry. Tenders to Mr. S. Williamson, secretary, Oswestry, by June 6.

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Penrhiwceiber (Glam.).—The Penrikyber Navigation Colliery Co. invite tenders for the annual supply of stores from July 1, 1908, including miners' lamps and lamp glasses, electric lamps and fittings. Tenders to the Secretary by June 4.

Belfast.—The Tramways and Electricity Committee invite tenders for the supply and delivery of uniforms for the employés. Specifications, etc., from Mr. Andrew Nance, general manager of the tramways. Tenders to the Town Clerk by June 8.

Grimsby.—Tenders are invited for the lighting of such of the public streets of the borough as are not lighted by electricity from the Corporation electricity works for one year, for the Grimsby Urban Sanitary Authority. Tenders by June 6.

London, E.C.—The Directors of the Bombay, Baroda, and Central India Railway invite tenders for the supply of plates, etc., for accumulator cells. Tenders to Mr. W. Constable, secretary, Gloucester House, Bishopsgate-street, London, E.C., by June 2.

Barrow-in-Furness.—The Corporation invite tenders for the supply of steam coal required at the electricity works during nine months from June 1, 1908, to March 31, 1909. Particulars from the Borough Electrical Engineer at the Electricity Works. Tenders by June 10.

St. Pancras.—The Borough Council invite tenders for the supply of coal for use at the generating stations for 12 months. Specification, etc., may be obtained from the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W. Tenders to the Town Clerk by June 1.

Johannesburg.—Tenders are invited for a refuse destructor plant. Specification, etc., may be obtained from Messrs. E. W. Carling and Co., St. Dunstan's-buildings, St. Dunstan's-hill, London, E.C. Tenders to the Town Clerk, Municipal Offices, Plein Park, Johannesburg, by June 10.

Great Yarmouth.—The Tramways Committee invite tenders for the following stores for 12 months ending June 16, 1909: oils and grease, iron, bolts and nuts, brake blocks, unbroken coke, brushes and cleaning materials, electrical accessories, and miscellaneous stores. Tenders by June 2.

Worksop.—The Urban District Council invite tenders for the supply of a fuel economiser. Particulars from Mr. J. Crowther, Electricity Works, Worksop. Tenders by June 2. The electrical engineer has also been instructed to obtain tenders for the repair of No. 3 boiler at the electricity works.

Manchester.—The Tramways Committee invite tenders for the supply of a quantity of block tin. Forms of tender may be obtained on application to Mr. J. M. McElroy, general manager, Tramways Department. Tenders to the Chairman of the Tramways Committee, 55, Piccadilly, Manchester, by June 2.

Cleethorpes (Lincs.).—Tenders are invited for the erection of a new wireless telegraphy station at Cleethorpes, consisting of a power-house, torpedo instructor's house, and men's quarters, etc. Tenders to the Director of Works Department, Admiralty, 21, Northumberland-avenue, London, W.C., by June 12.

Ilford.—The Urban District Council invite tenders for the supply and erection of surface-condensing plant, and cooling tower, steam, and feed pipes, boiler feed pump, and extensions and alterations to main switchboard. Particulars from the Electrical Engineer. Tenders to the Town Clerk by June 10. See advertisement.

Stalybridge.—Tenders are invited for the supply and delivery of stores for the Generating Station and Tramways Committee of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board. Specification and form of tender may be obtained from Mr. Robert Blackmore, chief engineer. Tenders by May 30.

Clyde Navigation.—The Trustees of the Clyde Navigation invite tenders for the annual supply of stores, including electrical goods oils, indiarubber, asbestos and packing, etc. Particulars from the Superintendent of Stores. Tenders to Mr. T. Mackenzie, genera manager and secretary, 16, Robertson-street, Glasgow, by June 6.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

Adelaide.—Tenders are invited by the Municipal Tramways Trust for the supply, delivery, and erection of rotary converters, transformers, boosters, switchboards, and equipment for converter stations Nos. 1 and 2. Particulars from Mr. W. G. Goodman, the electrical engineer, 8, King William-street, Adelaide, S.A. Tenders to the Chairman by July 14.

Horton.—The Asylums Committee of the London County Council invite tenders for the supply of coal for one year for their various departments, including the central electric lighting station at Horton, Epsom. Particulars from Mr. H. Keene, clerk of the Asylums Committee, 6, Waterloo-place, S.W., to whom tenders must be sent by June 11.

Grimsby.—Tenders are invited for the following work in connection with the Scartho Sanatorium, for the Corporation: (Contract No. 12A) boiler seating; (14) fencing; (15) electric lighting of buildings. Particulars for No. 12A and 14 to be obtained from the Borough Engineer's Office, Town Hall-square, and for No. 15 from the Borough Electrical Engineer. Tenders by May 29.

Copenhagen.—The Commercial Intelligence Branch of the Board of Trade have received from his Majesty's Consul at Copenhagen a copy of the conditions and specification relating to a call for tenders for supply of 4,000 to 5,000 meters for electric lighting, delivery to extend over period from Aug. 1, 1908, to Aug. 1, 1909. Tenders should be marked "Tilbud paa Maalere," and should reach Direktoren for Belysningsvaesnet, Raadhuset, Copenhagen, by June 10.

Rio de Janeiro.—Tenders are invited for the supply of new lighting apparatus and accessories for the lighthouse on Raza Island. Tenders will be opened on June 2 in the Ministry of Marine (Secçao de Pharóes) at Rio de Janeiro. No deposit is required. Further particulars may be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

RESULTS OF TENDERS.

Plymouth.—The Electricity Committee have accepted the tender of Cory Bros., Cardiff, for 1,000 tons of coal at 14s. 1½d. per ton.

Leek.—The Urban District Council have accepted the tender of Crompton and Co. for the extension of the switchboard at the generating station for £99.

Portsmouth.—The Electric Light Committee have accepted the tender of Glover and Co., at £1,030, for the installation of high-tension electric cables in the East Southsea district.

London.—The Establishment Committee recommend the London County Council to accept the tender of the Argus Printing Co. for printing 100,000 copies of a guide to the Council's tramways.

Stoke-on-Trent.—The Electricity Committee recommend the acceptance of the tender of Messrs. Crompton's for the supply of instruments for £32 required in connection with the proposed new machinery.

Olympia.—The Edison and Swan United Electric Light Co., 36 37, Queen Victoria-street, London, E.C., supplied the whole of the electric light fittings which were used in the Royal box at the Royal Naval and Military Tournament at Olympia.

Plymouth.—The tender of Underhill and Co. has been accepted for the printing and stationery required by the electrical engineer's department for three years, and that of W. J. Jacobs and Sons for a similar contract for the tramways department.

Dundee.—The Electricity Committee have accepted the following tenders in connection with the new generating station: Aiton and Co., Derby, at £1,855, for steam and feed pipes and valves; Allen, Bedford, at £1,670, for circulating pumping machinery.

Southend.—The Corporation have accepted the tender of J. W. McLellan and Co., Glasgow, for the supply of 150 tons of steel rails and fishplates for the extension of the system to the Half-Way House, at £6. 4s. 9d. for rails, and £7. 9s. a ton for fishplates.

Grimsby.—The Corporation have accepted the following tenders: Hewins and Goodhand, Eleanor-street, Grimsby (Specification No. 61), foundations for engines; London Electric Firm, George-street, Croydon (Specification No. 63), arc lamp lowering gear.

East Ham.—The Council have decided to accept the tender of Messrs. Griffiths, at £14,333, with the alternative tender at £14,986 in the event of a new concrete bed having to be laid, for the construction of the tramway track in Romford-road from Manor Park Broadway to Green-street.

Leek.—In connection with the electricity works extensions we are informed that the following tenders have been accepted in addition to that of Mather and Platt for the gas-driven generator, reported in our issue of May 15: T. Grace and Son, Leek, buildings; Horsehay Co., Horsehay, gas-producer plant.

Glasgow.—The following tenders have been accepted: Craigpark Rubber Co., rubber-covered cables; W. T. Glover and Co., high-tension cables; Callender's Cable Co., low-tension cables; Chamberlain and Hookham Limited and Ferranti Limited, meters; Sloan Electrical Co., carbons; Ferranti Limited, additional switchgear, £453.

Bradford.—The Corporation have accepted the following tenders for supplies to the tramways department: United States Steel Products Export Co., copper bonds, £179; Bayliss, Jones, and Bayliss, steel rebars £119, and steel bolts £34; Forest City Electric Co., copper bonds, £118; H. P. Marshall and Co., pneumatic riveting hammer, £21.

Camberwell.—The Public Health Committee recommend the acceptance of the tender of Messrs. S. Burnby and Son, Warner-road, Camberwell, for the supply of plain and frosted electric lamps at the following prices: Plain lamps, 100 and 200 volts, 8 c.p., 7s. per dozen, 16 c.p. 7s., 32 c.p. 8s.; frosted lamps, 8 c.p. 7s. 6d. per dozen, 16 c.p. 7s. 6d., 32 c.p. 8s. 6d.

London.—The London County Council have received the following tenders for supply and erection of sand-drying apparatus for use in the Council's tramway department:

Mountain and Gibson, Bury	£650
Mountain and Gibson (alternative tender)*	620
Albany Engineering Co., London	730
E Newell and Co., Gainsborough	1,192
Heenan and Froude, Worcester	1,280
F. W. Rowlands and Co., Birkenhead	1,450

* Recommended for acceptance.

Partick.—The Corporation have accepted the following tenders for the supply of stores to the electricity department: McLellan and Co., engine-room stores; Chamberlain and Hookham and Electrical Co., meters; Siemens Bros., incandescent lamps; Sloan Electrical Co., arc lamp carbons; Englebert and Co. and Henry Wells Oil Co., lubricating oils; Callender's Cable Co., cable jointing requirements; British Insulated and Helsby Cables, service cut-outs; W. H. Keys, bitumen, pitch, and compound; Fleming and Co., tools and ironmongery; Robinson, Dunn, and Co., wood troughing; W. C. Yuile and Co., steel tubing; Walker and Cameron, coal.

Haslingden.—The following tenders have been accepted for work in connection with the erection of the destructor and electricity generating station combined: J. Tomlinson, masonry; T. Tattersall, Limited, joinery; J. Kay, plumbing; H. H. Tomlinson, slating; R. Whittaker, painting; T. Tattersall, Limited, plastering; T. Blackburn, Preston, steelwork; J. Tomlinson, chimney; Hodgson and

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Stead, Manchester, weighbridge. Also the tender of Dick, Kerr, and Co., Preston, overhead tramway equipment. Rest of Haslingden.

Southampton.—The following tenders have been received for alteration of the gantries of two electric cranes and other work appertaining thereto, for the Southampton Harbour Board:

D. G. Somerville and Co., London	£775
Day, Summers, and Co., Southampton	515
Stothert and Pitt, Bath	510
J. I. Thornycroft and Co., Woolston (accepted)	380

London.—The London County Council have received the following tenders for the supply of steel tyres for electric cars:

H. Bessemer and Co., Sheffield (accepted)	£5,825	0	0
Cammell, Laird, and Co., Sheffield	6,350	0	0
Brown-Bayley's Steelworks, Sheffield	6,725	0	0
Steel Co. of Scotland, Glasgow	7,400	0	0
Steel, Peech, and Tozer, Sheffield	7,747	18	4
Taylor Bros. and Co., Leeds	8,060	8	4
Hadfield's Steelfoundry Co., Sheffield	9,256	5	0
Standard Steelworks Co., London	10,100	0	0
Vickers, Son, and Maxim, Sheffield	10,350	0	0
W. Beardmore and Co., Glasgow	10,775	0	0

London.—The London County Council have received the following tenders for the manufacture, supply, and delivery of 175 sets of maximum traction swing bolster trucks required for tramways:

Brush Electrical Engineering Co., Loughborough	£26,670	0	0
Ditto (alternative, not to specification)	26,276	5	0
Mountain and Gibson, Bury—tender for foreign steel	26,775	0	0
Ditto (alternative, not to specification)	26,250	0	0
Heenan and Froude, Worcester*	27,037	10	0
Mountain and Gibson—tender for British steel	27,650	0	0
Ditto (alternative, not to specification)	27,125	0	0
United Electric Car Co., Preston	27,650	0	0
Magnolia Anti-Friction Metal Co. of Great Britain, London	28,043	15	0
Metropolitan Amalgamated Railway Carriage and Wagon Co., Birmingham	29,050	0	0
Thornewill and Warham, Burton-on-Trent	29,575	0	0
Hurst, Nelson, and Co., Motherwell	29,793	15	0

* Recommended for acceptance.

London.—The London County Council have received the following tenders for the supply and delivery of track rails and fastenings required for the construction and reconstruction of further lines included in the programme of tramway works for 1908-9:

For 2,000 tons.			
Société Anonyme des Aciéries d'Angleur, Belgium	£12,429	14	2
E. Le Bas and Co., London (made by Société Anonyme d'Ongrée, Belgium)	12,623	3	9
P. and W. MacLellan, London (made by Angleur Co., Belgium)	13,115	11	3
Bolling and Lowe, London (made by Phœnix Co., Ruhrort, Germany)*	13,191	5	0
Bolckow, Vaughan, and Co., London and Middlesbrough	13,306	17	6
W. Scott, Limited, Leeds	13,761	5	0
For 5,000 tons.			
Société Anonyme des Aciéries d'Angleur	32,098	6	8
E. Le Bas and Co.	32,523	10	0
P. and W. MacLellan	34,068	0	0
Bolling and Lowe*	33,803	10	0
Bolckow, Vaughan, and Co.†	34,640	0	0
W. Scott, Limited	35,832	10	0

* This tender is not in accordance with specification. † Recommended for acceptance.

OPENINGS FOR CONTRACTORS.

ABERCARN—Institute connected with Garw Chapel.

ABERDARE—Ten houses, Monk-street, Building Club.

ABERDEEN—Fishcuring premises, Poynernook-road, Messrs. T. Wood and Son; alterations and additions, premises, South College-street, Mr. P. Jamieson; house, Holburn-street, Mr. Grant; alterations and extensions, slaughter-house, Western-road, Mr. R. Laing.

ABERHAFESP—Council school, Montgomeryshire Education Committee.

ABERTRIDWR—Twenty-six houses, Eglwysilan Building Club.

ABRAM—Mortuary, Bickershaw-lane, District Council.

ACRISE AND PADDLESWORTH—Improvement, Council school (£730), Kent County Council.

ANSDELL—Institute (£5,000).

ARMAGH—Housing scheme (£12,600), Rural District Council.

ASHBY—Elementary school (£6,000), County Council.

ASHTON—Four houses, Pretoria-road, Mr. T. Williams; two houses, Wood's-lane, Mr. T. Higson; two houses, Princess-road, Mr. A. Watson; five shops, Wigan-road, Mr. E. T. Evans; temporary building, Bolton-road, Mr. P. Norris.

ASPATRIA—Shops, stores, etc., Fletchertown, Aspatria Co-operative Society.

AUCKLAND—Extensions, workhouse, Guardians.

BALHAM, S.W.—Additions, St. Peter's Church, Mr. W. Wallis.

BANBRIDGE—Housing scheme (£28,860), Rural District Council.

BARGOED—Fire station, Hanbury-road, Mr. J. P. Jones.

BARNET—County school, Herts County Council.

BARROWFORD—Eight houses, Guisburn-road, Mr. A. Sutcliffe.

BARRY—Improvement, clock tower (£1,000), Public Works Committee.

BATH—Various works at bathing establishments, Hot Mineral Baths Committee of Corporation.

BEDFORD—Additional length of cable, Ampthill-road (£250), and engine at electricity works (£998), Electricity Committee.

BELFAST—Vested school, Tate's-avenue. Mr. T. Houston, architect.

BELPER—Girls' home, Holbrook-road, Board of Guardians.

BERWICK—Lighting of town, electric flame arc lamps (£745), Council.

BETHNAL GREEN, E.—Improvements at Pritchard's-road School (£4,957), London County Council.

BETHNAL GREEN, E.—Improvements at Teesdale School (£8,967), London County Council.

BEXHILL—Isolation hospital (£1,600), Mr. G. Ball.

BIGGLESWADE—Alterations to the Golden Pheasant Inn (£260), Mr. C. Wells; additions to lavatories, Messrs. Wells and Winch.

BIRMINGHAM—Underground convenience, Station-street, Public Works Committee.

BIRSTALL—Roman Catholic church (£2,000). Messrs. E. Simpson and Son, architects.

BLACKO—Enlargement of Council school, Barrowford District Education Sub-Committee.

BOASLEY CROSS—Schoolmistress's house, etc., Devon Education Committee.

BODMIN—Alterations and extensions to the Bodmin County School, Cornwall Education Committee.

BOURNEMOUTH—Parish hall on north side Holy Trinity paris (£2,000), Churchwardens.

BRADFORD—District baths at Wyke, Corporation.

BRAMALL—Church (£7,000), Ecclesiastical Commissioners.

BRAWLEY—Elementary school (£570), Education Committee of North Riding County Council.

BRIGHTON—Bandstand, Aquarium terrace (£130).

BRIXTON, S.W.—Workshop, Brixton-hill, Mr. Hayward.

BROMLEY—House, Wendover-road, Mr. F. G. Cricketts; four houses and stable, Babbacombe-road, Messrs. Hill and Gurrs; eight houses, Foxbury-road, and four houses, Gilbert-road, Mr. W. J. Harrington.

BURGH HEATH—Church, Brighton-road (£4,000). Messrs. Whitfield and Thomas, architects.

BUSHEY—New Council offices and stables, Rudolph-road (£2,227), Urban District Council.

CADOXTON—Elementary school, Weston-hill, Barry Education Authority.

CAERLEON—Training college, Monmouth Education Committee.

CAMBERWELL, S.E.—House, Alleyn-park, Messrs. Perry and Co.; temporary premises, Dunstan-road, Mr. J. H. Collis; house, Beauval-road, Mr. J. P. Glanville; fire station, Camberwell New-road, Lambeth Borough Council.

CARDIFF—Drill hall, Cathays Park (£20,000).

CARNFORTH—New tower to parish church (£1,400), Parishioners of Carnforth.

CAVERSHAM—Improvements to police station (£120), Public Works Commissioners.

CHATHAM—Additions to workhouse, Medway Board of Guardians; alterations to house, Luton-road, Mr. E. Hodges.

CHESHIRE—Extensions and improvements, Parkside County Lunatic Asylum (£25,000).

CHESTERTON—Training college (£30,000), Eastern Counties Conference.

CHILTON BUILDINGS—Council school, Seaham Harbour, Durham County Council.

CLACTON—Public conveniences, Marine-parade (£1,600), Urban District Council.

CLEWER—Corrugated iron shed, St. Mark's, Rev. C. N. Nagel.

CLITHEROE—Extensions to public hall, Clitheroe Public Hall Co.

COALBROOKDALE—Secondary school, Wenlock Town Council.

COATDYKE—Hall to United Free Church (£450), Churchwardens.

CONNAUGHT—Sanatorium (£8,000).

CORSTORPHINE—Police station, Midlothian County Council.

COVENTRY—Sixty-five houses. Plans passed by Council.

CROSBY—Church, Vicar of Sainthorpe.

CROUCH END—Cottage hospital, Park-road, Hospital Committee; eight houses, Etheldene-avenue, Messrs. W. J. Collins and Son.

CROYDON—Replace feeder cable from Swan and power station (£1,077), County Council.

CROYDON—Church, Warwick-road, Mr. E. J. Saunders; houses and shop, London-road, Mr. C. S. Peach.

DARLINGTON—Two houses, Lowton-street, Messrs. G. Dickinson and Son; two houses, Oak Dean-avenue, Messrs. J. Guthrie and Son; builders' workshop, Bartlett-street, Messrs. Clark and Moscrop; alterations, house, Corporation-road, Messrs. J. P. Pritchett and Son; new shed, Whessoe Foundry Co., Hopetown, Mr. W. H. Bourne; seven houses situated in street on west side of Fairfield-street, Messrs. Clark and Moscrop; additions, house, 78, Westmoreland-street, Mr. J. Blenkiron; new premises, corner of Priestgate and Crown-street, Northern Echo Co.

DARTFORD—Ward at the infectious hospital, Bow Arrow-lane, Joint Hospital Committee.

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DARTFORD—Secondary school for girls (£19,000), Kent County Council.

DARTFORD—Improvement to St. Alban's Council School (£1,125), Kent County Council.

DATCHET—Additions, Milton Villa, and house, Montague-road; four houses, Penn-road, Mr. J. Lewin; houses, Bulstrode-way, Mr. Shannon; house, Bath-road, Salt Hill, Mr. E. A. Medcalf; house, Buccleuch, Mr. H. D. Bowyer.

DENHOLME—Alterations to Sunday school. Messrs. W. H. Sugden, architects.

DEVONPORT—Elementary school, Board of Education.

DEWSBURY—New wing to technical school (£2,000), Technical School Committee.

DINAS POWIS—Elementary school, Glamorgan County Council.

DODDINGTON—Extension, Doddington Council School (£100), Kent County Council.

DUBMIRE—Council school, Durham County Council.

DUDLEY—Extensions, workhouse buildings, Dudley Union.

DUNMOW—Bacon factory (£10,000).

EARLEY—Parish rooms (£700), Churchwardens.

EAST ARDSLEY—Small-pox hospital, Stoney-lane, Wakefield and District Small-Pox Hospital Committee.

EAST DEREHAM—Secondary school, Norfolk Education Committee.

EAST HAM—Forty-seven houses, Blenheim-road, Mr. W. G. Watson; store adjoining factory, Messrs. Searle and Searle; 12 houses, Marlowe road, Mr. J. Young.

EAST PECKHAM—Improvement, East Peckham Council School (£811), Kent County Council.

EDGEMONT—Alterations, Wesleyan chapel. Mr. J. S. Stout, Whitehaven, architect.

EDINBURGH—Law courts extension, Commissioners of H.M. Works.

EGRECOURT—Schools for the Sisters of Mercy. Messrs. H. Bryne and Son, architects.

ELTHAM—Additions to house, Westmount road, Mr. J. E. Edwards; alterations, etc., to building, Court-road, Mr. W. Pollock.

EMSWORTH—Council school (£5,658), Hampshire County Council.

ENFIELD—Factory, Ponders End, Ellmus Waterproofing Company.

FARNHAM ROYAL—House, Cherry Tree-road, Mr. H. D. Bowyer; house, Mr. E. Borton: house, Mr. W. J. Martin; house, Beaconsfield-road, Mr. L. Dowsing.

FENNY STRATFORD—New aisle, St. Martin's Church. Mr. J. Chadwick, architect.

FERRYHILL—Extension to chapel premises, local Primitive Methodists.

FINCHLEY—Thirteen houses, Moat Estate, Mr. H. Watts; two houses, Avondale-avenue, Mr. E. R. Porter.

FISHGUARD—Forty houses, Fishguard Building Club.

FLEETWOOD—Church institute, Walmsley-street, Churchwardens.

FULHAM, S.W.—Public library, Libraries Committee.

FYLDE—Workhouse (£9,229), Board of Guardians.

GERRARD'S CROSS—Two houses. Marsham-lane, Messrs. Lovell and Son; house, Pack Horse-road, Messrs. Franklin and Fisk; house, Bulstrode-way, Mr. H. Greeves; house, Layter's-way, Mr. E M. Newton; house, Oak End-way, Messrs. Lovell and Son; four houses, Oxford-road, Mr. G. Radcliff; additions, Heathfield, Mr. E. H. Nash; houses, Bulstrode-way, Mr. Shannon; house, London and Country Investment Co.; house Oval-way, Messrs. Hannett, Rafferty, and Co.; house, Bulstrode way, Mr. A. H. James; iron church, Marsham-way, Trustees

GLAMORGAN—Training college, Education Committee.

GLASGOW—New station buildings and a tenement building, Eglinton-street, Caledonian Railway Co.

GLENTIES—Housing scheme (£7,937), Rural District Council.

GLYNCORRWG—Fifty cottages, Glyncorrwg Colliery Co.

GORSEINON—Chemical works and six sheet mills, Messrs. Lewis; church with tower, Vicar.

GRAVESEND—Galvanised iron workshop, Windmill-street, Mr. J. Norris; house, Ferndale-road, Mr. W. Badman; six houses, Northcote-road, Mr. G. F. Tuffee; detached residence, Park-avenue, Mr. Russell; theatre, Prince's-street, Mr. W. Gould.

GREAT HARWOOD—House, Bridge-street, Mr. Duckworth; alterations, 14, Commercial-road, Mr. T. Loynd.

GREENBANK—Additional building, St. Anne's mission church (£400), Trustees.

GUISBOROUGH—Conversion of school into two-department school (£250), North Riding Education Committee.

HABROUGH—Church institute, Habrough Vicarage.

HADDINGTON—Additions, primary school (£800), School Board.

HALESOWEN—Council elementary day school in Tenter-street, Worcestershire County Council Education Committee.

HALIFAX—Extensions to shops in the Piece Hall, Messrs. E. Wilson and Sons; warehouse, Messrs. R. Horsfall and Son, architects.

HAMPSHIRE—Asylum, Park Prewitt Farm, County Council.

HANDSWORTH—Improvements to Woodhouse and Intake cemetery chapels, Handsworth Burial Board.

HARROW—Nine houses, Devonshire road, Mr. Watts; 11 houses, Oxford-road, Messrs. Crooke and Co.; five houses, Drury-road, Messrs. Clarke and Co.; additions to Havelock Arms, Station-road, Messrs. Benskin and Co.; iron school for Baptist Church, Messrs. McKilliam and Proctor; five houses, Newton-road, Wealdstone,

HANWELL—Extensions, superintendent's lodge in cemetery, Kensington Royal Borough Council.

HASLINGDEN—Infirmary, etc., Board of Guardians.

HASTINGS—Nurses' home (£3,000), Board of Guardians.

HEADCORN—Improvement, Headcorn Council School (£325), Kent County Council.

HECKMONDWIKE—Elementary school, Spen Valley Education Committee.

HIGHGATE—One hundred and twenty artisans' dwellings, Improved Industrial Dwellings Co.; four houses, Messrs. Frederick Bros.

HIGH WELWYN—House, Messrs. Powell and Co.

HOLYHEAD—Additions to school, Education Committee.

HOUGHTON-LE-SPRING — Thirty-three houses, Penshaw Staiths, Lambton Collieries, Limited.

HOVE—Extension of electric lighting main (£210), Corporation Electricity Committee.

HOWDEN CLOUGH—Mission church and school, People, Brownhill Parish.

HYTHE—Post office, Postmaster-General.

ILFORD—Surface condensing plant and cooling tower, Ilford Urban District Council.

ILFRACOMBE—Two houses on the New Barnstaple-road, Trustees of the Barnstaple Bluecoat School.

ILKLEY—Additions to Leeds Industrial Co operative Society's branch, Leeds-road, Society's Building Department.

KENDAL—Enlargement of school. Mr. S. Shaw, architect.

KENNINGTON, S.E—Shops. Kennington Park-road, Mr. E. H. Payne.

KETTERING—Additions, police station (£5,000, including purchase of land). Northampton County Council.

LANGLEY PARK—Trap-shed and storehouse at Langley Park Hospital, Lanchester Joint Hospital Board.

LANSDOWNE—Central schools of science and art (£25,000), Bournemouth Education Authority.

LASSWADE—Council offices, Parish Council.

LEEK—Improvement, cattle market (£250), Urban District Council.

LEICESTER—Extensions, technical school (£14,000), Education Committee.

LEWISHAM, S.E.—Buildings, High-street, Mr. H. T. Bonner.

LEWISHAM, S.E.—Fourteen houses, Bankwell-road, Messrs. Hatch and Hatch; 10 houses, Caterham-road, Messrs. H. and G. Taylor; seven houses, Catford-hill, Messrs. Norfolk and Prior.

LISMORE—Library (£1,249), Public Library Committee.

LIVERPOOL — Rebuilding of Adelphi Hotel, Ranelagh-place (£600,000), Midland Railway Co.

LLANDRINDOD WELLS—Steam laundry for Llandrindod Wells Steam Laundry Co.; free library and town offices, Council.

LONDON—Kingsway Hall (£25,000), West London Wesleyan Mission.

LONDON, N.—160 houses on Rockfield Estate, Crouch End, Messrs. W. J. Collins and Son.

LONDON, S.E.—Eleven houses, Denmark-hill. Mr. H. W. Hillman, architect.

MACCLESFIELD—Extensions in connection with Brunswick Wesleyan Chapel (£2 500). Mr. J. Wright, architect.

MAESTEG—Public mortuary, Council.

MALVERN—Council school, Somers Park-avenue, County Education Authority.

MANCHESTER—Offices for depôt master, Ashton-road Wharf, Midland Railway Co.

MANSFIELD—Five houses, Chesterfield-road, Messrs. Lucas Bros.; two houses, Bould-street, Mr. W Hill; two houses, Bould-street, Mr. J. James; five houses, Moor-street, Mr. J. W. Blood; alterations and additions to house, Leeming-street, Trustees of Brunt's Charity; two houses, Bagshaw street, Pleasley-hill, Messrs. Ely and Sutton; additions to houses, Broomhill-lane, Mr. J. H. Clayton; house, Layton avenue, Mr. H. Blythe; nine houses, Cavendish-street and Foster-street, Mr. J. R. Lawson; two houses, Victoria-street, Mr. S. Litchfield; two houses, Charles-street, Messrs. Cartledge and Parr.

MARCH—Girls' high school (£4,000), Isle of Ely County Council.

MARYHILL—Extensions of Possil Park School, School Board.

MEATH—Housing scheme (£2,028), Rural District Council.

MERTHYR TYDFIL—Additional accommodation at the General Hospital, Hospital Committee.

MIDDLESBROUGH—Alterations, workhouse infirmary, Board of Guardians.

MILLSTREET—Housing scheme (£33,130), Rural District Council.

MIRFIELD—Two houses, St. Paul's-road, Mr. H. Waddington; three houses at Northope, Mr. L. Carter; house at Greenside, Mr. P. Weldrick; three houses at Greenside, Mr. D. E. Swithenbank; extension of the lodge at the House of the Resurrection.

MOIRA—Housing scheme (£12,217), Rural District Council.

MONTON—Secondary school (£1,197), Eccles Education Committee.

MURTON COLLIERY—Additions and alterations to the Victoria Club and Institute. Messrs. Vaux and Mark, architects.

MUSWELL HILL—Five houses, Mr. J. Muddock.

NANTWICH—Elementary school, Beam-street, Council Education Committee.

NAVIN—Elementary school, Burgh School Board.

NELSON—Three business premises, Mr. H. Thomas; two semi-detached residences, Mr. Morgan George.

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NEWBURY—Commodious railway station, Great Western Railway Co.
NEWCASTLE—Wesleyan Sunday school, Ashfields, Trustees
NEW MILLS—Church, Church people of Furness Vale and Newtown.
NORBURY—Church of St. Stephen, Rev. A. G. Edwards.
NORTH SUNDERLAND—Cottages, South Main, Mr. Walton.
NORWICH—Chapel at workhouse, Guardians.
OTLEY—Alterations and additions at the police station, West Riding Standing Joint Committee
OXFORDSHIRE—County school (£2,000), Board of Education.
PARKESTON—Church, Great Eastern Railway Co.
PINNER—Two houses, West End-avenue, Mr. B. Colville; house, Moss-lane, Mr. T. Barnes.
PINXTON—Four houses for the Co-operative Society.
PLUMSTEAD—Conservative club, Plumstead-road, Mr. J. O. Crook.
POPLAR, E—Additions, Harley College, Messrs. Webster and Cannon; addition, London Small-Arms Factory, Messrs. Todd and Newman.
PORTLAND—Repairs at the drill hall, Dorset County Association.
PORTSLADE—Fire station, Urban District Council.
PRINCETOWN—Restoration of St. Michael's Church (£1,050), Churchwardens.
PUTNEY, S.W.—Twenty-four houses, Mr. E. Evans.
RAMSGATE—Secondary school (£2,100), Kent County Council.
READING—Goods sheds, Great Western Railway Co.
REDHILL—Extra wing to the Provincial Police Orphanage (£2,000).
ROCHDALE—Modern music hall.
ROTHESAY—Church, Bridgend-street (£4,500), Bridgend United Free Church
ROWLEY REGIS—Extensions, Blackheath and Knowle Schools, Education Authority.
RUTHERGLEN—Alterations, town hall (£10,000), Town Council.
SAFFRON WALDEN—Secondary school, Town Council.
ST. ELMSALL—Four houses and shops, Mr. F. Elliott.
ST. MARYLEBONE—Alterations, Aybrook-street sub-station premises (£4,000), Borough Council.
ST. PANCRAS, N.W.—Improvements at Aldenham-street School (£10,678), London County Council.
SALISBURY—Repairs, etc., to property, for the Trustees of the Salisbury Municipal Charities
SCARBOROUGH—Public conveniences, Town Council.
SEASCALE—Three houses. Mr. J. Hartley, architect.
SEEDLEY—Additional accommodation at Langworthy-road School (£2,000), Salford Education Committee.
SHEFFIELD—Installation of electric light from the town hall, etc. (£107), City Council.
SHEFFIELD—Additions at Malin Bridge Council School, Education Committee.
SHEFFIELD—Extension, wagon-repairing shop, Brightside, Midland Railway Co.
SHEERNESS—Higher elementary school (£8,360), Kent County Council.
SHILDON—Workmen's institute, North-Eastern Railway Co.
SHILDON—Houses, New Shildon, N.E.R. Co.; 18 houses, Shildon-road. Plans passed by Urban District Council.
SHOTLEY BRIDGE—Alterations, Shotley Bridge Wesleyan School, Trustees.
SKIPTON—Elementary school, Broughton-road, West Sussex Education Committee.
SKIPTON—Additions, infirmary, Guardians; consumptive block at workhouse, Guardians.
SKIPTON—Library (£4,000), Libraries Committee.
SLOUGH—Catholic church. Mr. B. Williamson, architect.
SOUTHAMPTON—Alterations and extension of electric crane running rails, etc., on the Town Quay, Harbour Board.
SOUTHAMPTON—Fire brigade station (£4,210), Town Council.
SOUTH BRENT—Additional building to Devon and Cornwall Sanatorium for Consumptives (£600), Hospital Committee.
SOUTHEND—Additions, 23, Surbiton-road, Miss C. A. Smith; bungalow, South-avenue, Mr. W. Goldsworthy; house, Leigh-road East, Mrs. Newnham; two villas, Cliff-road, Mr. W. Scott; coal-house and store, Eastwood-road, Albion Laundry Co.; houses and shops, West-road, Messrs. Burrill and Payne; bungalow, Chadwick-road, Misses Freeman; seven houses, San Remo-parade, Messrs. Erby and Chivers; house, Woodfield-road, Mr. W. Tagg; house, Highcliff-drive, Mrs. Wharf; four houses, Silverdale-avenue, Mr. W. Gimbrett; two houses and shops, Westborough-road Mr. W. Squire; motor-house, Rhododendrons, King's road, Mr. E. Goddard; four houses, North-avenue, Southchurch, Mr. E. A. Upson; three houses, The Lees, Mr. R. Bull; house, Grand-parade, Miss Dawbarn; two houses, Ailsa-road, Mr. J. Poulton; motor garage, London-road, corner of Boston-avenue, Messrs. P. A. and H. B. Ross; two houses, Hainault-avenue, Mr. C. Bedwell; five houses, Westborough-road, Mr. W. G. Whitby.
SOUTHEND—Refuse destructor adjoining pumping station (£11,000), Sutton-road, Prittlewell, Town Council.
SOUTHEND—Underground conveniences, shelters, etc., Town Council; public conveniences, Darlow Green, Council.
SOUTHFIELD—Additions, Albion Lamp Factory, Messrs. E. P. Bulled and Co.
SOUTHGATE—Four houses, Conway-road, Mr. F. Bartle; five houses, Harlech-road, Mr. E. A. Wright; four houses, Bound's Green, and four houses, The Mall, Mr. A. Ingram; four houses, Ullswater-road, Mr. W. J. Edwards; 12 houses, The Mall, New London and County Building and Estates Co.; two houses, Windsor road. Palmer's Green, Mr. F. E. Davis; eight houses, Park Green, Palmer's Green, Mr. Moss; public hall, billiard-room, Hopper's-road, Mr. C. Smith.
SOUTH MEDOMSLEY—Five houses, Mr. Gillies.
SOUTHPORT—Necessary buildings and accommodation at fire station, Tulketh-street, Watch Committee.
SOUTH SHIELDS—German sailors' home and chapel, Mill Dam. Messrs. Edwin F. Liddle and P. L. Brown, architects.
STAINTON—Improvements to school (£250), North Riding Education Committee.
STALYBRIDGE—Infants' school for St Paul's Higher Elementary and Technical School, Waterloo-road, Education Committee.
STAMFORD—Conversion of old buildings to seven villa residences. Messrs J. B Corby and Sons, architects.
STANNINGLEY—Alterations to the Primitive Methodist chapel and erection of Sunday school. Mr. W. G. Smithson, architect.
STIRLING—Slaughter-house. Town Council.
STEPNEY, E.—Electric lighting, Commercial-road, Brook-street, etc. (£540). Electricity Committee.
STEPNEY, E.—Warehouse, Artillery-lane, Mr. W. A. Lewis.
STOCKPORT—High school (£11,000). Messrs. Spalding and Spalding, architects
STOKE POGES—House Wexham-street, Mr. W. R. J. King; additions, Carton Towers, Mr. W. Judd.
STONE—Infectious diseases hospital, Yarnfield (£7,350), Hospital Committee.
STRAND (SWANSEA)—Extensive additions to Cambrian Cold Storage and Icemaking Co.'s premises (£4,000).
STREATHAM, S.W.—Five houses, Clairview-road, Messrs. Crunder and Co.; 15 houses, Messrs. F. T. Wooding and Son.
SUDBURY—Enlargement, grammar school, West Suffolk County Council Education Committee.
SUNDERLAND—New hospital for children, High Barnes. Messrs. Wm. and T. R. Milburn, architects, Fawcett-street.
SUNNINGHILL—House, Branksome Estate, Mr. F. Pizzey.
SWANSEA—Two electricity power stations, King's Dock (£30,000), Harbour Trustees.
TEDDINGTON—Fire station (£3,000), Council.
TENDRING—Plans passed for buildings at Lower Kirby, Beaumont, Elmstead, and Little Holland two houses, Mr. R. J. Sinfield.
THRAPSTON—Council school, Board of Education.
TOOTING—Extensions, Tooting library, Council.
TOTTENHAM—Eight houses, Wargrave-avenue, Mr. E. Evans; six houses, Shelbourne-road, Messrs. Warran and Stupart; 12 houses, Mr. J. H. Jolly; 26 houses, Messrs. Marshall and Griffin; alterations to houses, Westbury-avenue, Messrs Ford and Cruse; additions to Tottenham Polytechnic, Mr. H. G. Crotholl; studio, Chestnut-road, Messrs. Maynard and Perrey; two houses, Messrs. Leeke and Blake; studio, High road, Mr. Blackbee.
TOTTENHAM—Improvements at Tottenham-road boys' and girls' school (£5,654), London County Council.
TOXTETH—Buildings (£20,000), Board of Guardians.
TREGARON—Improvements, Tregaron County School (£500), Cardigan County Council.
TUMBLE—Elementary school, Lower Tumble, Carmarthen Education Authority.
ULCEBY—Wesleyan church (£1,427), Trustees.
WALLSEND—Factory, Wallsend Industrial Co-operative Society.]
WARWICK—Lavatory, Castle Hill (£800), Town Council.
WASHINGTON—Council schools and cookery centre, Seaham Harbour, Durham County Council.
WELLINGTON—Public baths, Walker-street, Urban District Council.
WEST ARDSLEY—Ten houses, Chapel-street, Mr. M. Buttery.
WHITBY—Church, Churchwardens.
WIDDALE—Improvements, Widdale School (£500), North Riding Education Committee.
WIGTON—Additions and alterations, Torpenshaw Vicarage; buildings, Biglands, Messrs. Barnes.
WILLESBOROUGH—House, Romney-road, Mr. J. Bull.
WILSDEN—Farm buildings, Mr. Greenwood; workshop at Harecrofts, Mr. S. Cooper.
WINDSOR—Eight houses, South Ascot, Mr. Walker.
WISBECH—Bandstand in park (£100), Council.
WORSBROUGH DALE—Additions, Wesleyan chapel, Trustees.
YARMOUTH—Shop, Blackfriars-road, Mr. W. Mays; additions, 68, Albion-road, Mr. J. Lamb; fishing premises, Admiralty-road, Mr. C. Gordon; fishing premises, Suffling-road, Mr. J. R. Nutman; fishing premises, East-road, Mr. J. R. Nutman; fishing premises, Suffling-road, Messrs. Bremner and Co.; additions, office, Pier-walk, Gorleston, Messrs. Camp, Limited; engine-room, Cobholm, Messrs. Watling and Co.; additions, office, Southgates-road, Messrs. Newhouse and Co.; house and shop, Prince's-road, Mr. W. Field.
YORK—Electricity purposes (£7,200), City Council.
YORK—Wesleyan Methodist church, Mr. E. Taylor, architect.

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PROVISIONAL PATENTS, 1908.

MAY 15.

10539. Electric hammer worked by an electrical current. Richard Berry, 142, Ledsam-street, near Monument-lane Station, Birmingham.

10552. Improvements in means for controlling the trolley poles of electric cars and the like. Solomon Henshaw and Joseph Swindells, 3, Brown-street, Market street, Manchester. (Application for patent of addition to No. 25415/05.)

10577. Improvements in or relating to alternating-current regulators. Luigi Donati, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, May 15, 1907, being date of application in Italy.) (Complete specification.)

10590. Improvements in electric incandescent lamp filaments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

10591. Electric fire, robbery, and burglary alarm. Hubert Leenders, 38, Chancery-lane, London.

10611. Improvements in or relating to alternate-current motors. Valére Alfred Fynn, 18, Blessington-road, Blackheath, London.

10614. Improvements in electrolytic meters. George Hookham and Sydney Holmwood Holden, 18, Southampton-buildings, London. (Application for patent of addition to No. 3327/05.)

10626. Improvements in or relating to electrical driving devices particularly adapted for clocks. August Anders, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, Sept. 11, 1907, being date of application in Germany.) (Complete specification.)

10627. Improvements in or relating to electrical driving devices particularly adapted for clocks. August Anders, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, March 28, 1907, being date of application in Germany.) (Application for patent of addition to No. 10,626/08.) (Complete specification.)

10631. Disinfector for telephone receiver and transmitter and the like. George Staples Pinchin, 59, West India Dock-road, London.

10632. New or improved clamping device for the brushes of electric switches and the like. Sidney Paterson and Montague John Dark, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

MAY 16.

10680. Improvements in and relating to safety devices for electric heating apparatus for liquids British Prometheus Company, Limited, George Cooper, and Frank Chester Sharp, 77, Colmore-row, Birmingham.

10687. Improvements in electrically-propelled vehicles. Russell Thayer, Chancery-lane Station-chambers, London. (Complete specification.)

10690. Electric incandescence lamps. Edward Alfred Gimingham, Birkbeck Bank-chambers, Southampton-buildings, London.

10697. Improvements in or relating to armatures for dynamo-electric machines. Willy Roos, 65, Chancery-lane, London. (Complete specification.)

10699. Improvements in telegraphic relays. Ernest George Berkeley Maxse, 24, Southampton-buildings, London. (John Theodore Piat, Réunion.)

10712. Improvements in electric light fittings for railway and like carriages. Frederick John Barter Collis, William Herbert Exley, and Henry Leitner, 4, South-street, Finsbury, London.

MAY 18.

10719. Improvements in or relating to magneto-electric ignition apparatus. Hermanus Willem van Raden, High-street-chambers, Coventry.

10723. Improvements in surface contact for electrical traction. James William Fillis, 25, Leven-road, Poplar, London.

10729. Improvements in telephone receivers which may be used as transmitters. Alexander Marr and Thomas Chalmers, 11, Craighall-avenue, Slade-lane, Levenshulme, Manchester.

10739. Novel or improved means for use in operating lock bolts by means of electricity applicable in a modified form for locking and latch bolt by means of electricity and adaptable also in a modified form for use alternatively with a locking or latching bolt. Thomas Oldbury Summers and Thomas Hill, Royal London Buildings, Wolverhampton.

10745. Improvements in or relating to friction clutches. Siemens Bros. Dynamo Works, Limited, 139, Queen Victoria-street, London. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Date applied for under Rule 13, Aug. 21, 1907. An invention comprised in application No. 18834, dated Aug. 21, 1907.) (Complete specification.)

10773. Improvements in and connected with holders for electric lamps. Andrew Frederick Rock, 77, Chancery-lane, London.

10759. Improvements in means for regulating the current in electric heating appliances. Norman Ellison Beves and the British Prometheus Company, Limited, 77, Colmore-row, Birmingham.

10760. Improvements in and relating to luminous electric radiators. The British Prometheus Company, Limited, George Cooper, and Frank Chester Sharp, 77, Colmore-row, Birmingham.

10764 Improvements in storage battery plates. Alfred Ord Tate, 7, Southampton-buildings, London. (Date applied for under Rule 13, Dec. 20, 1907. An invention comprised in application No. 28,132, dated Dec. 20, 1907.) (Complete specification)

10767. Improvements in storage battery plates. Alfred Ord Tate, 7, Southampton-buildings, London. (Date applied for under Rule 13, Dec. 20, 1907. An invention comprised in application No. 28132, dated Dec. 20, 1907.) (Complete specification.)

10768. Improvements in storage battery plates. Alfred Ord Tate, 7, Southampton-buildings, London. (Date applied for under Rule 13, Dec. 20, 1907. An invention comprised in application No. 28132, dated Dec. 20, 1907.) (Complete specification.)

10769. Improvements in storage battery plates. Alfred Ord Tate, 7, Southampton-buildings, London. (Date applied for under Rule 13, Dec. 20, 1907. An invention comprised in application No. 28106, dated Dec. 20, 1907.) (Complete specification.)

10784. Improved method of controlling electric motors for tramcars, lifts, and the like. The Johnson-Lundell Electric Traction Company, Limited, and William Arthur Price, 7, Southampton-buildings, London.

10792. Improvements in and relating to electric radiators or heaters. Charles Nunn Nettley, 60, Queen Victoria-street, London.

10796. Improvements in method of and apparatus for automatic regulation of rectifiers and rotary converters. Francis Bacon Crocker, 22, Southampton-buildings, London. (Complete specification.)

MAY 19.

10808. Improved method of producing pure metallic filaments for incandescent electric lamps. Christoph Heinrich Dorman, 82, Duckett-road, Harringay, London.

10810. New or improved anti-vibrating lead terminal for electrical ignition motors and the like. Joe Wood and Wright Wood, 32, John William-street, Huddersfield.

10825. New or improved electrical device for illuminated stage dancing. Arthur Quinn and Robert Broughton, 4, St. Ann's-square, Manchester.

10829. Improvements in electrical conductors. Isidor Kitsee, 18, Fulham-place, Paddington, London. (Complete specification.)

10838. Improved apparatus for electrically igniting miners' safety lamps in mines. John Charles Best, 33, Chancery-lane, London.

10845. Improvements in and relating to dynamo-electric machines. Crompton and Co., Limited, James Colquhoun Macfarlane, and Harry Burge, The Arc Works, Chelmsford. (Complete specification.)

10848. Improvements in electric terminals or clamps. John Berryman, 22, Stanley-road, Leyton.

10856. Improvements in electric ignition devices for inverted incandescent gas burners as used in street-lighting. Francis Thomas Cotton, 8, Quality court, Chancery-lane, London. (Complete specification.)

10860. Improvements in and relating to electrical time switches. James Jones and James Jones, jun., Chancery-lane Station-chambers, London.

10878. Improved method for regulating the degree of hardness of Rontgen tubes. Friedrich Paschen, 6, Lord-street, Liverpool. (Complete specification.)

10885. Improvements in and relating to the manufacture of filaments for electric incandescent lamps. Wolfram-Lampen Akt.-Ges., 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Nov. 29, 1907, being date of application in Germany.) (Complete specification.)

10889. Improvements in carbon-holders for electric arc lamps. Rosalie Chaudet, née Warnent, 1, Queen Victoria-street, London. (Date applied for under Section 91 of the Act, Nov. 29, 1907, being date of application in Belgium.) (Complete specification.)

10891. Improvements in and relating to the manufacture of filaments for electric incandescent lamps. Wolfram-Lampen A.-G., 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Oct. 7, 1907, being date of application in Germany.) (Complete specification.)

10893. Improvements in electricity meters. Chamberlain and Hookham, Limited, and Sidney Holmwood Holden, 18, Southampton-buildings, London.

MAY 20.

10918. Improvements in electrical ignition apparatus for internal-combustion engines. Henry Bevis and Herbert John Coates, Peel Works, Adelphi, Salford.

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10928. Improvements in apparatus for protection of electrical circuits and apparatus. John William Turner, 88, Clonmore-street, Southfields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on June 4.)

1907.

6092. Systems of electrical distribution. Taylor.

8562. Electro-deposition of zinc. Paweck.

10699. Pitch product for insulating electric cable trenches and for use for other purposes. Marriott.

10719. Electric motor starters. Mayes, and Ferranti, Limited.

10955. Telephone switch-operating mechanism. Potter. (Date applied for under International Convention, May 28, 1906.)

11271. Hertzian wave telegraphy. Muirhead.

11386. Contact breakers for inductor coils. Nicholls and Nicholls.

11466. Induction motors and the method of starting, connecting up, and controlling the speed of combinations of such motors. La Cour.

11476. Dynamo-electric generators and motors. Kay.

11594A. Electric motors specially adapted for rolling mills. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, May 21, 1906, originally included in No. 11594/07.)

11979. Electrode for arc lamps. Deutsche Beck Bogenlampen Ges. (Date applied for under International Convention, Jan. 29, 1907.)

12253. Alternating-current electromagnet. Beck and Deutsche Beck-bogenlampen Ges.

12563. Method of and apparatus for rendering electrolytic copper homogeneous. Jullien and Dessolle. (Date applied for under International Convention, May 31, 1906.)

16778. Printing telegraph receivers. Wright.

17254. Portable electric massaging and like apparatus. Le Fevre.

18259. Electric heating devices. British Thomson-Houston Company. (General Electric Company.)

18670. Method of transmitting signals to a distance by means of alternating electric currents. Meyer. (Date applied for under International Convention, Oct. 25, 1906.)

18742. Arc lamps. Heys. (Scott Electrical Company.)

19546. Magneto-ignition apparatus for internal-combustion engines. Codd.

19697. Suspension of electric motors for electrically-propelled vehicles. Von Kando.

20202. Electric rotary converters. Siemens Bros. Dynamo Works, Limited. (Siemens-Schuckertwerke Ges.)

20614. Electric cable or conductor connecting devices or means. British Insulated and Helsby Cables, Limited, and Allen.

21167. Switches for electric circuits. Pirdschun.

22605. Systems of electric power transmission for driving ships' propellers and other apparatus. Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.)

22806. Electrical contact breakers particularly for use with internal-combustion engines. Poppe.

23239. Electric switches. Bergmann.

24023. Electro-medical apparatus. Clymer and Woodhouse. (Date applied for under International Convention, Nov. 7, 1906.)

24671. Arrangements on electricicity meters for determining the maximum consumption. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, Nov. 8, 1906.)

25792. Joint-boxes for electric cables. Stratton, Beaver, and Claremont.

25967. Load equalisers for alternating-current supply circuits. Lincoln. (Date applied for under International Convention, Dec. 3, 1906.)

27385. Apparatus for the electro-deposition of metals. Cowper-Coles.

27739. Arc lamps and electrodes therefor. Janecek. (Date applied for under International Convention, Dec. 20, 1906.)

28451. Method of and apparatus for lengthening the burning life of electric incandescent lamps. Herrmann.

1908.

2569. Means for adjustably supporting electric incandescent lamps and shades or reflectors therefor. Rawlings and Smith. (Application for patent of addition to No. 8151/07.)

3556. Automatic telegraphic transmission instruments. Gell. (Date applied for under International Convention, Aug. 12, 1907.)

6746. Manufacture of incandescent filaments. Auger.

9023. Construction of electric condensers. Deniéport. (Date applied for under International Convention, Sept. 30, 1907.)

9552. Electrical block signalling apparatus for railways. Brown. (Date applied for under Rule 13, May 8, 1907. Patent of addition to No. 2413 of 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price.
	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-⅝
—— Ord., 1,125,000	1 ..	⅛-⅜
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	11/16-13/16
—— Ordinary, Nos. 1-125,000	1 ..	3/16-5/16
British Aluminium Co., Ordinary, 2,001-40,000	5 ..	3½-3⅝
—— 7 per cent. Cum. Pref., 1-40,000	5 ..	1-1⅛
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	4⅛-5⅛
—— 4 per cent. Funding Certificates, 1-20,000	5 ..	3⅝-4⅛
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	102-106
—— 5½ per cent. Loch Leven Deb. (Reg.), Red., 1-3,000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	6⅛-6⅜
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100 ..	102-106
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	93 98
British Westinghouse Elec. and Manuf. 10 per cent. Pref., 275,001-475,000	3 ..	7/16-11/16
—— 4 per cent. Mortgage Debenture Stock	100 ..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105 751	2 ..	0-¼
—— Non. Cum., 6 per cent., Pref.	2 ..	3/16-7/16
—— 4½ per cent. 1st Debenture Stock	100 ..	70-75
—— 4½ per cent. 2nd Debenture Stock	100 ..	55-60
Callender's Cable, Debentures	100 ..	106½-108½
—— Ordinary	5 ..	10-11
—— 5 per cent. Pref.	5 ..	5⅛-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	¼-¼
Crompton and Co.	3 ..	1⅛-1⅜
—— 5 per cent. Debentures	— ..	92-96
Dick, Kerr, and Co., Ordinary, 1,250 000	1 ..	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	100-103
Edison and Swan United, "A" Shares, 1-99,261	5 ..	⅛-⅜
—— "A" Shares, 01-017,139	5 ..	1⅛-2⅛
—— 5 per cent. Debentures	100 ..	85-87
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112,100	2 ..	¼-¼
—— 7 per cent. Cumulative Pref.	2 ..	1⅛-1⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	75-80
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅞-8⅛
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	87-90
W. T. Henley's Telegraph Works, Ordinary	5 ..	10¼-11½
—— 4½ per cent. Preference	5 ..	4⅝-5⅜
—— 4½ per cent. Debentures	100 ..	106-108
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15½-16½
—— 4 per cent. Debentures	100 ..	98-100
National Electric Construction Co., 1-170,000	1 ..	⅜-⅝
Parker, Thos., Limited, Ordinary	10 ..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref, 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	29-31
—— 4 per cent. Bonds	100 ..	100-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	7½-8½

Electric Lighting and Supply.—

Name.	Amount paid.	Last price
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅝-5⅛
Bournemouth and Poole, Ordinary	10 ..	10½-11
—— 4½ per cent. Cum. Pref., 7,501-15,000	10 ..	9⅛-10⅜
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10 ..	10½-11
—— 4½ per cent. Debenture Stock, Red.	100 ..	102-105
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅛-5
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	94-97
Brompton and Kensington, Ordinary	5 ..	6⅜-7⅛
—— 7 per cent. Preference	5 ..	6⅜-7⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5 ..	6-7
Cambridge Electric Supply Company, £10 Ord.	8 ..	12⅛-13⅛
Canadian General Electric Co., Common Shares	$100 ..	83-92
—— 7 per cent. Cum. Pref. Stock	$100 ..	107-109
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	99-102
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅛-3⅜
—— 4½ per cent. Cum. Pref., 1-80,000	5 ..	4⅛-4⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c Cum. Pref., 1-40,000	5 ..	3⅛-4⅛
—— ditto (1905) 40,001-80,000	5 ..	4⅛-4⅞
Chelsea Electricity Supply	5 ..	3⅛-3⅜
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	7⅜-8⅛
—— 6 per cent. Cumulative Pref.	10 ..	10½-11
—— 4½ per cent. Debenture Stock	100 ..	107-110
—— 4½ per cent. 2nd Deb. Stk., Red.	100 ..	95-99
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,630	50 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2⅛-3
—— 5 per cent. Preference, 1-50,000	5 ..	3⅛-4⅛
County of London Elec. Supply, Ordinary	10 ..	7⅜-8⅛
—— 6 per cent. Cum. Pref.	10 ..	10½-11
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	107-110
—— 4½ per cent. 2nd Debentures Prov. Certs	100 ..	96-99
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅛-⅜
—— 6 per cent. Cum Pref.	5 ..	¼-1
—— 4½ per cent. First Mort. Deb.	100 ..	65-75
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	81-84 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2⅛-2⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100 ..	90-93
Folkestone Electric Supply, Ord., Nos 1-10 000	5 ..	4⅜-4¼
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5 ..	5-5⅛
—— 4½ per cent. First Deb Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	6⅛-6⅝
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	95-98
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	90-93
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	⅝-¾ xd
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5 ..	7-8
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red	100 ..	97-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5 ..	1-1¼
—— 6 per cent. Pref.	5 ..	4⅜-4¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	83-88
Metropolitan Ordinary, 100,001-200,000	5 ..	4⅜-4⅞
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	107-111
—— 4½ per cent. Cum. Pref.	5 ..	4⅜-4⅞
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1 000	— ..	78½-80½ p.c.
Mexican Light and Power Co., Capital Stock	$100 ..	54-56
—— 5 per cent. 1st Mort. Gold Bonds, Sec., 1-4,000 ($500), 4,001-14,000 ($1,000)	— ..	84-86
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5 ..	5½-6
—— do., 57,010-75,000	5 ..	5½-6
—— do., 75,001-87,500 (issued at £22 prem., 16s. paid	5 ..	5⅛-5⅜
—— 5 per cent., Pref., 1-57,009	5 ..	5⅛-5½
—— do., 75,001-87,500 (issued at 10s. prem., 4s. paid)	5 ..	5⅛-5⅜ xd
Notting Hill Electric Lighting	10 ..	11¼-12¼
—— 4 per cent. First Mort. Debs. Nos. 1-500 (Reg.)	100 ..	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅜-6½
—— 4 per cent. Debenture Stock	100 ..	94-98
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120,507	1 ..	13/16-15/16
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	¾-1
—— 5 per cent. Debenture Stock, Red.	100 ..	96-99
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5 ..	4⅝ 5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15,000	5 ..	4⅜-5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96-98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	½-¾
—— 4 per cent. Debenture Stock	100 ..	70-74
South London, Ordinary	4 ..	2⅜-2⅞
South Metropolitan Electric Light and Power, Ord.	1 ..	⅞-1
—— 7 per cent. Cum Pref.	1 ..	1 1/16-1 5/16
—— 4½ per cent. 1st Mort. Deb.	100 ..	99-102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7½-8¼
—— 7 per cent. Pref.	5 ..	6½-7½
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5 ..	1-2
—— 5 per cent. Cumulative Preference, 50,001-80,000	5 ..	1⅝-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100 ..	87-90
Westminster, Ordinary	5 ..	7½-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	4⅜-5¼

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5 ..	6½-6⅝
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5 ..	7⅞-8⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	140-145
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	104-107
Barcelona Tramways, Ord., 1-20,000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	—
—— 5 per cent. Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅜-½
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1 ..	⅜-½
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100 ..	93-96
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Bombay Elec. Supply and Trams. Co., 6 per cent. Cum. Pref.	10 ..	10-10⅛
—— 4½ per cent. Deb Stock, Red.	100 ..	93-96
Brisbane Tramway Invest., Ord., 1-75,000	5 ..	3¾-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4 11/16-4 15/16
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	98-102
British Columbia Electric Railway Co., Ord Def.	100 ..	132-135
—— Ord. Pref.	100 ..	115-119
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	108-112
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40 ..	99-102
—— 4½ per cent. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	1¼-1⅜
—— 6 per cent. Cm Pf., 30 0001-60 000	10 ..	3¾-4¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	89-94
—— 4½ per cent 2nd Deb. Stock	100 ..	64-68
Bueno Ayres and Belgrano Trams	5 ..	4 11/16-4⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅝-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4⅝ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110-116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	96-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	98-102
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	92-95
Calcutta Tramways, Ord., Nos. 1-137,610	5 ..	6-7 xd
—— 5 per cent. Cum. Pref., Nos. 1-30,000	5 ..	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	103 106
Cape Electric Tramways, Nos. 1-480,000	1 ..	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4⅛-4⅜ xd
—— 4 per cent. 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5	5 7/16-5 11/16
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	88-91 xd
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12¼-13¼
—— 3½ per cent. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100 ..	94-97
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1852, 1-6957	$1,000 ..	80-85
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	⅝-1⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10¼
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296,500 2nd Mort. Deb. Stock	— ..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	1-1¼
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 ..	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	80-85
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 ..	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5 ..	4¼-5
——4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1 ..	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	11/16-13/16
—— ½ per cent. Deb. Stock, Red.	100 ..	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	88¾-89¼ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5 ..	½-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8¾-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	¼-⅜
—— per cent. Cum Pref., 300,001-545 000	1 ..	¼-⅜
—— per cent. Debenture Stock	100 ..	93-96
Provincial Tramways Co., Ordinary, 1-24 912	10 ..	4¾-5¼
—— per cent. Cum. Pref., 1-10.000	10 ..	9½-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5 ..	5⅛-5⅜
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100 ..	129-134
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-12,000	$500 ..	97½-99½ p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	¾-1
—— 4 per cent. Deb Stock, Red. 1940	100 ..	76-80
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100 ..	75-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5 ..	1-1¼
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	79 82
—— 4 per cent. Pref.	100 ..	90-92
—— ,, ,, deferred	100 ..	62-65
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100 ..	100-103
City and South London, Consolidated Ordinary	100 ..	39-41
—— 4 per cent Debenture Stock	100 ..	100-103
—— 5 per cent. Pref. Stock '91	100 ..	113-116
—— ,, ,, ,, '96	100 ..	112-115
—— ,, ,, ,, '01	100 ..	110-113
—— ,, ,, ,, '05	100 ..	106-109
Liverpool Overhead, 5 per cent. Pref	10 ..	10-10¼
—— Ordinary, 1-50,000	10 ..	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent Profit-Sharing Secured Notes	— ..	38-43
—— Deposit Receipts	— ..	39-43

Telegraphs and Telephones.—

Name.	Amount paid.	Last price
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	83-86
Anglo-American Telegraph Co., Ordinary	100 ..	58-61
—— 6 per cent. Preferred Ordinary	100 ..	102-104
—— Deferred Ordinary	100 ..	16-16½
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	98½-101½
Chili Telephone Co., 1-44,000	5 ..	7-7½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	84-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	7¼-8¼ xd
—— 10 per cent. Preference, 1-6,000	10 ..	15⅞-16⅝ xd
Direct Spanish Telegraph Co., Ordinary	5 ..	3¼-3½
—— 10 per cent. Cum. Preference	5 ..	8-9
—— 4½ per cent. Debs., 1-600	50 ..	99½-102½
Direct United States Cable Co.	20 ..	13½-14
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	99½-101½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25 ..	98½-100½ xd
Eastern Extension, Australasia and China, 1-300,000	10 ..	12⅞-13¼
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	100-102
Eastern Telegraph Co., Ordinary Stock	100 ..	129-134
—— 3½ per cent. Preference Stock	100 ..	83-86
—— 4 per cent. Mortgage Debenture Stock	100 ..	100-102 xd
Great Northern Telegraph Co. (of Copenhagen)	10 ..	28-30
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100 ..	100-102
Indo-European Telegraph Co.	25 ..	53-56
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1 ..	¾-1
Monte Video Telephone Co., Ordinary, 1-72,680	1	29/32-1 1/32 xd
—— 5 per cent. Preference, 1-86,492	1	13/16-15/16 xd
National Telephone, Preferred	100 ..	108-110
—— Deferred Stock	100 ..	109½-111½
—— 6 per cent. Cum. First Pref.	10 ..	10¾-12⅛
—— 6 per cent. Cum. Second Pref.	10 ..	10¾-12⅛
—— 5 per cent. Non-Cum. Third Pref.	5 ..	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	98½-100½
—— 4 per cent. Deb. Stock, Red.	100 ..	101½-103½
Oriental Telephone and Electric Company	1 ..	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1 ..	1⅛-1⅛
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	98-101
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6¼-6⅜
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	4⅝-5⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	99-102
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅛-1⅜
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100 ..	99-102
West India and Panama Telegraph Co., Ordinary	10 ..	9/16-11/16
—— 6 per cent. Cum. 1st Preference	10 ..	8⅜-8⅞
—— 6 per cent. Cum. 2nd Preference	10 ..	9-10
—— 5 per cent. Debs., Red., 1-800	100 ..	101-104
Western Telegraph Co., 1-207,930	10 ..	13½-13⅞
—— 4 per cent. Debenture Stock, Red.	100 ..	100-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week. Ending	1908.	1907.	Increase or decrease. Week.	Current year.	Miles of track open. 1908.	1907.	Accounts for past year. Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	May 20	1,390	1,305	+ 85	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 23	291	285	+ 9	—	8	8	,, 15	15,283	3,603,789	378,834	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 23	2,725	2,580	+ 195	+14,804	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 24	1,040	1,096	- 56	+ 279	23·53	23·53	March 31	55,408	11,686,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 16	6,314	6,182	+ 132	—	56½	56½	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 20	1,123	1,349	- 225	+ 97	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	,, 21	547	1,757	- 1,210	- 126	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·79b
Bolton Corporation	,, 24	2,344	2,933	- 619	+ 552	42	42	March 31	111.294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 20	1,472	2,084	- 612	- 1,115	29¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 16	4,698	4,547	+ 151	+ 2,121	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 24	837	1,217	- 380	- 407	17·191	17·191	,, 31	50,652	10,759,310	1,798,505	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 22	4 833	6 472	-1,633	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 23	1,263	1,369	- 106	—	19¾	19¾	,, 31	62,699	11,967,488	1,205,83	1·31	12·48	5,825	8·21
Burton Corporation	,, 24	256	328	- 72	—	9⅞	8½	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	May 23	162	156	- 34	—	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 23	6,518	5,473	+1,045	- 1 954	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62 29a	55,357	5·22a
Charing X, Euston, & Hamp. Ry.	,, 23	3 290	—	—	—	7¾	6½	—	—	—	—	—	—	—	—
City and South London Railway.	,, 24	2 801	3 057	- 253	+ 6,302	9	6½	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 6	181	195	- 14	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 14	443	459	- 16	- 461	15½	15½	Dec. 31	25,032	5,966,364	891,998	—	6·74	—	4·78
Croydon Corporation	,, 22	1,575	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502,408	1 08	9·76	3,125	6·67
Darwen Corporation	,, 22	233	306	- 53	- 78	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	,, 16	184	202	- 18	— 233	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	,, 22	132	170	- 38	+ 46h	6¾	6¾	—	—			—	—	—	—
Dublin U.T.	,, 22	5,474	6,768	-1,294	- 1,598	54¼	48¾	—	—			—	—	—	—
Dundee City Tramways	April 8	1,144	1 195	- 51	—	22	22	May 15	57,672	15,554,905	1,162.792	·878	11·9	4,352	7·3
East Ham Corporation	May 23	879	1,082	- 203	- 6·6	14	14	March 31	47,140	15,049,240	1,062,151	·74	10·49	3,636	7·14
Glasgow Corporation	,, 23	18,217	18,192	+ 25	+14,056h	177½	169	May 31	887,381	224,063,098	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 20	265	332	- 67	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	,, 23	5 260	4,300	+ 950	+32,701	9¼	9	—	—	—	—	—	—	—	—
Halifax Corporation	April 14	1,413	1,283	+ 130	—	52·574	37	,, 31	77,996	18,899,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	May 23	1,591	1,879	- 288	- 294	35½	35	,, 31	81,196	15,252,150	1,804,745	1·22	10·79	2,770	5 9d
Hull Corporation	,, 23	2,370	2,576	- 205	- 319	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 2	410	449	- 39	—	10½	10½	,, 31	26,499	6,586,754	645,117	·89	9 58	2,225	6 5
Ilkeston Corporation	,, 20	157	183	- 26	- 35	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 6	249	256	- 7	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7 55	1,73	4 95
Lancashire United Tramways	,, 20	1,367	1,425	- 59	+ 1,160	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 16	6 514	6 605	+ 91	+ 26	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5 58
Leicester Corporation	,, 23	2,317	2,606	- 288	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 16	10,788	10,897	- 109	- 2,113	104	104	Dec. 31	563,793	122,094,528	12,115,934	1·108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 24	1,475	1,754	- 279	- 750h	9·25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 9	33,231	32,116	+1,175	+ 15,957	98	98	March 31	1378,014	314,227,090	30,130,297	1·05	10 98	—	8 56
Lowestoft Corporation	,, 23	174	219	- 45	—	3½	—	Sept. 30	11,079	2,622,922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 21	194	124	+ 70	—	3¼	2	March 31	5,913	1,186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 23	15,519	17,869	-2,320	+ 4,837	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 23	8,885	8,129	+ 756	+20 271	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 24	15,491	16,085	- 595	+ 2,343	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 23	140	152	- 12	- 149	2¾	2¾	March 31	7,309	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 23	3,643	4,205	- 562	- 3,435	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 23	635	817	- 212	- 203	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10 01	1,525	6·87
Oldham Corporation	,, 3	1,894	1,871	+ 23	- 321	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·2d
Portsmouth Corporation	,, 16	1,827	1,893	+ 66	—	28½	28½	,, 31	98,911	20,668,825	2,199,823	1·15	10 79	—	—
Reading Corporation	—	—	—	—	—	13½	13½	,, 31	32,661	8,130,179	918,825	·96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	,, 18	4,656	4,560	+ 96	- 644	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	
Sheffield Corporation	,, 24	5,694	5,961	- 267	- 1,753	66½	65¾	March 25	276,907	73,966,299	6,804,656	·898	9 767	4,174	
Southampton Corporation	,, 6	1,079	932	+ 147	+ 202	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 20	372	472	- 100	- 74	9	9	,, 31	20,076	4,431,728	390,538	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 24	1,111	1,537	- 426	- 2,299	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 21	283	237	+ 46	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 23	886	934	- 108	+ 7	12 68	12·43	‡ ,, 31	42,810	8,312,592	890,906	1·23	11·53	3,376	—
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965,296	429,785	—	10 724	1,989	6·95
West Ham Corporation	,, 14	2,187	2,514	- 327	— 1,641	14·7	14·7	,, 31	122,881	35,502,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 20	804	1,362	- 558	- 565	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·095

* 1905- figures. ‡ 1907-8 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

*Replies for the "Technical Problems" Column should reach the Editor within ten days of the issue in which the problem appears. Many Engineers, both at home and abroad, make use of this section of "*THE ELECTRICAL ENGINEER,*" where difficulties are found in their work, to get help from fellow readers, and others are invited to do so.*

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OVERLOAD CAPACITY.

No chain is stronger than its weakest link, and fracture only occurs when the load on this weakest point exceeds the breaking stresses. Some damage may be caused if the elastic limit is exceeded, and a good engineer so designs the structure made to his specification that there is an ample factor of safety. When two engineers, however, co-operate and do not agree as to the factors of safety, the strength of one part may become a source of danger to the other. For example, we know of one instance where a large dam was being built for a water supply in this country, and the design for this dam prepared by the engineer of the scheme was laid before an eminent expert, who advised increasing the weight to improve the strength of the masonry dam. His advice, while perfectly sound, was rejected because the foundations obtainable in the district would not bear safely the extra weight. Electrical engineers are more concerned with the problem raised by Mr. C. Turnbull in his article concerning overload in electrical plant, appearing elsewhere in this issue. This was the subject of an informal discussion last week before the Newcastle Section of the Institution of Electrical Engineers. The importance of economy in a steam-driven plant for a central station has too often dwarfed the question of safety. Switchboards with their numerous maximum, minimum, and reversed current cut-outs have been relied on to protect dynamos against self-destruction in their well-known willingness to supply all the demands made upon them. If this property of the dynamo which will give enormous currents on short-circuit were counterbalanced by want of power in the engines, the liability to damage would be largely reduced. We quite agree with Mr. Turnbull that the engine-makers frequently give much more powerful engines than are asked for, with the result that the dynamos are not sufficiently large to run consecutively at the most economical load for the engine or turbine. The one case quoted by the author in which a 3,500-kw. set was more economical at 6,900 kw. than at the nominal full load, is an instance in which the dynamo is excessively overpowered by the turbine. A small additional expense on the dynamo would have made the set much more valuable, and would have relieved the engineers in charge of considerable anxiety. There have been many attempts made to secure standard rating for dynamos and motors, but the rating of engines for central-station work is still left to the individual caprice of the manufacturers. Obviously, in the instance quoted the turbine manufacturer prided himself on the overloading capacity of his turbine, which worked most economically at 100 per cent. overload. In case of competition he might sell this turbine for any nominal full load between 3,500 kw. and 6,900 kw. Another manufacturer of the same type of prime mover may have widely different views on the overload question, so that competitive tenders would be far from comparable. We think that when such prime movers are used to drive dynamos there should be a limit to the overload, which should be fixed in view of the capacity of the dynamo. It is preferable to make the engine the weak link in the chain, as then the effect of overload is to slow up the engine, which does no damage whatever. The electrical engineer should also see that the connections between the dynamo and the feeders leaving the station are ample in carrying capacity for the possible overload current from the dynamos. As Mr. Turnbull says, too many of our switchboards have been designed on lines which leave no margin for overload, and we might add that quite a number of such switchboards have departed this life, the

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funeral expenses being paid by insurance companies. We shall be pleased to receive any communications on this interesting subject from central-station engineers or others who have to do with the design or working of electrical plant.

HULL TELEPHONES.

As we have said so many times, we are not overwhelmingly concerned with some of the niceties or crudities of the telephonic controversy, but what we are concerned about is good working at the lowest rate. We have always been ready to give the greatest credit to those individuals who embarked their capital in early days in spite of official coldness, and who in no very long time proved conclusively that telephony was not only commercially practical, but it was a necessity in the march of civilisation. It may be said that we have had four phases in telephonic development: the first, official coolness accompanied by official fear; the second, private success and amalgamation; the third, preliminary action by the Government in the shape of trunk lines and experimental stations; the fourth, municipal enterprise, latterly, if not always, accompanied by Government disloyalty and private competition. It is wonderful that a municipal exchange continues to exist, but, according to the Hull report before us, it does, and flourishes. The inducement for municipal action was the reiterated assertion that a cheap, efficient, all-in system could be given—that the charges, either by a flat rate or by the message system of the Government and the private companies, were excessive. Of course, we fully understand that at the present moment we do not state the whole case, which includes the very controversial topic of apparatus. In this connection one side says: "Oh, yes; cheap and nasty. Soon deterioration will be heavy and efficiency depart." The challenging side says: "Oh, no; your objection to this apparatus is that you have not control and cannot levy royalties for usage"; and go further, saying, "Your apparatus is dear, inefficient, insanitary, and no more free from depreciation than ours." A pretty controversy, but one we are avoiding just now. The total capital account at Hull is £54,747. 7s. 9d—shillings and pence will not be subsequently mentioned. This gives cost per station as £22·36 against £24·04, the cost last year, there having been during the year connections made, and so hitherto dead capital brought into play. Of the capital £43,202 was borrowed, repayable in twenty-five years. The balance was obtained as a temporary loan. Of the first amount £2,257 has been repaid, and of the latter £651. In addition to these repayments, there is an accumulated reserve fund of £2,846. If—and again we accept the full force of that if—the undertaking goes on successfully as heretofore with repairs and maintenance out of revenue, the concern seems as if the capital account would be extinguished in from twelve to fifteen years instead of twenty-five. The revenue for the year was £9,567, and after all payments £1,055 remained as net profit, which amount is included in the reserve fund. The chairman, in moving the adoption of the accounts, congratulated Mr. A. R. Bennett, their consulting engineer and the great advocate of municipal telephony, upon the results being in accord with what he foretold would happen. This undertaking at Hull gives food for much thought. Is it real, or is there something in the work or the accounts which would lead to a less satisfactory conclusion? If everything can be supported, then the undertaking goes a long way to prove the correctness of the view that a flat rate of a comparatively few pounds is enough for an efficient unlimited service.

ELECTRIC LIGHTING EXTENSIONS.

When once a householder has experienced the comfort and convenience of electric lighting, he is more readily persuaded to use the same regularly. In the ordinary way this trial cannot be made until he has come to a decision in the matter and experienced the inconvenience of the wiring period. Mr. W. H. Allen, the borough electrical engineer of Loughborough, has arranged a short cut for prospective consumers, which enables them to enjoy a free trial of electric light for a few nights before signing a contract with the Corporation. His letter gives the full details of the temporary lighting plant used for the purpose. Sixteen-volt Osram lamps are employed, which which by their high efficiency greatly reduce the weight of the accumulators which would otherwise have been necessary. We feel sure that the scheme is a good business proposition, and that in Loughborough it will be the means of bringing on to the Corporation mains many consumers who otherwise would have adhered to older and more dangerous forms of illumination.

I. M. E. A.

Lest any of our readers should be mystified by the letters which stand at the head of this article, we hasten to explain that they refer to the Incorporated Municipal Electrical Association. In another part of this issue we give in full the programme arranged for the thirteenth annual convention, which will be held this year in Nottingham from June 30 to July 3. The meetings will be held in the University College, and on the morning of the first day Mr. Herbert Talbot, who is chief electrical engineer of Nottingham, and president of the association, will deliver his presidential address. The papers which have been promised cover practically the whole field of a central-station engineer's experience, and are, therefore, likely to arouse some useful and interesting discussions. The social side of the convention will this year be a great feature, for Nottingham is situated within easy reach of some of the finest spots in this country, and the day excursion to Dovedale should be well patronised. The agenda for the annual general meeting, which will be held on Thursday, July 2, does not look very exciting. We would remind members who propose to attend the convention to place themselves immediately in communication with Mr. C. McArthur Butler, the energetic and capable secretary of the association, whose address is Staple Inn-buildings, Holborn, London, W.C.

RECENT PROGRESS IN TUNGSTEN METALLIC FILAMENT LAMPS.*

BY H. HIRST, MEMBER.

(*Concluded from page 769.*)

SPECIAL APPLICATIONS.

Twenty-five volt Osram Lamps.—What I have said as to the likelihood that the metallic-filament lamps will raise the standard of illumination, owing to the impossibility of making small candle-power lamps, applies only to those cases in which the lamps are connected on to standard supply systems at 110 volts, or two in series across 220-volt circuits. The advantages of the pure tungsten filaments can be obtained with small candle-power lamps when a lower voltage of supply is adopted. As an example of this, Osram lamps for 25-volt circuits have been standardised for both 10 c.p. and 16 c.p. These lamps consume respectively 10 and 16 watts, and for this consumption give the same candle-power as the ordinary carbon-filament lamp

* Paper read before the Institution of Electrical Engineers.

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taking 40 and 60 watts. It is somewhat difficult to make use of these low-voltage lamps when only continuous current is available from the public mains. Then, in order to reduce the voltage, motor-generators, double-commutator balancers, or rotary converters have to be used. While these are quite serviceable commercially when large numbers of lamps have to be supplied, the low efficiency of small sets and the attention which the additional rotating machinery involves will limit the extensive application in this direction. When alternating currents are distributed, the case is entirely different, as static transformers can be used, which require no attention and have high efficiency. The low voltage required for these small candle-power lamps can then be obtained at a cost which brings them into effective competition with the incandescent gas mantle for private house lighting. The opinion has often been expressed, and is still held by many, that the cost of the transformer, together with the losses in the same, would more than nullify the saving from the use of metallic-filament lamps. The iron loss in such transformers is constant, and goes on whether the lights are burning or not Hence, to get the best result, these transformers, like those still largely used for reducing high pressure to, say, 220 volts for house lighting, must be designed with a minimum of iron loss so as to obtain a high all-day efficiency. For use with these lamps special transformers have been constructed on the above lines, from which the following figures have been obtained on test: the iron loss on the transformer designed for 300 watts output is as low as five watts. Table III. shows the units taken per year by this and two other transformers of a larger size to overcome iron losses.

TABLE III.—Details of Iron Losses of Small Transformers.

Output of transformer in watts.	Number of 16-c.p. Osram lamps alight at one time.	No load.	Iron losses.	Units taken per year.	Cost per year at 4d. per unit.
		Watts.	Percentage		£ s. d.
300	19	5	1·67	44	0 14 8
750	47	10	1·33	88	1 9 4
1,500	94	17	1·13	149	2 9 8

The cost per year at 4d. per unit is given in the last column. The copper losses in these transformers are not large, and only occur when the lamps are being used. The total loss in the copper of the transformer, and in the wires between the transformer and the lamps, will not be appreciably higher than the copper losses in the cables alone when carbon lamps are used. Table IV. shows the financial results from the use of these 25-volt 16 c.p. Osram lamps in a private house requiring 25 lamps. I have assumed that the smallest size of transformer in the preceding table will suffice, as 19 lamps alight at one time is about the extreme maximum load in such a house. The total saving in current shown in the last column varies with the number of hours the lamps are in use; at 500 hours' use the saving in current is £6. 4s. 9d. on a yearly bill of £9. 10s. when carbon lamps are used. The current account is thus reduced 65 per cent., but the bill for lamp renewals will be somewhat higher.

TABLE IV.—Annual Costs for Current on an Installation of 25 16-c.p. Lamps, of which 19 are burning at one time (16-watt Osram lamp *v.* 60-watt carbon lamp).

Number of hours per annum at maximum load.	Maximum load in watts.		Units used per annum with Osram lamps.			Units used for carbon lamps.	Cost of current at 4d. per unit.		
	Osram lamps.	Carbon lamps.	Osram lamps.	Transformer.	Total.		Osram lamps.	Carbon lamps.	Saving.
							£ s. d.	£ s. d.	£ s. d.
300	304	1,140	91	44	135	342	2 5 0	5 14 0	3 9 0
400	304	1,140	122	44	166	456	2 15 3	7 12 0	4 16 9
500	304	1,140	152	44	196	570	3 5 3	9 10 0	6 4 9
600	304	1,140	182	44	226	684	3 15 3	11 8 0	7 12 9
700	304	1,140	213	44	257	798	4 6 6	13 8 0	9 1 6
800	304	1,140	243	44	287	812	4 15 6	15 4 0	10 8 6

TABLE V.

No. of hours per annum of maximum load.	Osram lamps. Current	Osram lamps. Lamp renewals.	Carbon lamps. Current.	Carbon lamps. Lamp renewals	Total. Osram lamps.	Total. Carbon lamps.	Total saving with Osram.
	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.	£ s. d. %
300	2 5 0	1 10 0	5 14 0	7 1	3 15 0	6 1 1	2 6 1 38
400	2 15 3	2 0 0	7 12 0	9 6	4 15 3	8 1 6	3 6 3 41
500	3 5 3	2 10 0	9 10 0	11 10	5 15 3	10 1 10	4 6 7 43
600	3 15 3	3 0 0	11 8 0	13 3	6 15 3	12 1 3	5 6 0 44
700	4 5 6	3 10 0	13 6 0	16 7	7 15 6	12 2 7	6 7 1 45
800	4 15 6	4 0 0	15 4 0	19 0	8 15 6	16 3 0	7 7 6 45½

Table V. shows the complete balance-sheet obtained by adding the cost of current to the lamp renewal charges for both carbon and Osram lamps. These tables clearly show that private houses in those areas over which electricity is distributed in the form of alternating current can at once realise to the full the exceptional radiating properties of the tungsten filament. As some engineers may object to my statement above as to the copper losses of the transformer being small, I give below a formula which will enable them to calculate what the comparative cost of Osram and carbon lamps would be if these copper losses are taken into account. Using the following symbols:

a = open-circuit loss in watts;
b = number of lamps;
c = candle-power;
d = cost per unit;
e = average hours of running per year;
f = copper loss on average load;

the cost of lighting with Osram lamps per year works out at

$$8{\cdot}76\,a\,d+\frac{b\,c\,e\,d}{1{,}000}+\frac{f\,e\,d}{1{,}000}.$$

The yearly cost of lighting with carbon-filament lamps as against this works out to be

$$3{\cdot}5\,\frac{b\,c\,e\,d}{1{,}000}.$$

This under the assumption of an efficiency of one watt per Hefner candle for the Osram lamp and 3·5 watts for the carbon-filament lamp.

The saving in running cost, therefore, is per year:

$$3\,5\,\frac{b\,c\,e\,d}{1{,}000}-8{\cdot}76\,a\,d-\frac{b\,c\,e\,d}{1{,}000}-\frac{f\,e\,d}{1{,}000}$$

$$=d\left(\frac{2{\cdot}5\,b\,c\,e-f\,e}{1{,}000}-8{\cdot}76\,a\right).$$

If we take the cost of an actual installation as an example, and figure on 25 16-c p. lamps (b equal to 25, c equal to 16) and take from actual measure:

a	=5
f (to be on the safe side the maximum copper loss has been taken, not the average)	=12
d	=4d.
e	=1,000

Under these conditions the saving works out, as per above formula, to £15. 14s. 9d. on a total of £23. 6s. 8d., equivalent to a *saving of 67·4 per cent.* If we had not transformed down, but taken the smallest obtainable candle-power—namely, 28-watt Osrams (against 16-c.p. carbon lamps)—the saving would have been £11. 13s. 4d., equal to 50 per cent. If we take further into consideration the cost of renewals and the additional cost of the transformer, we find:

First cost of transformer	£2 2 0
Amounting to an annual outlay (reckoning on five years' amortisation) about	0 9 0
Cost of renewals for Osram lamps, 25 × 3s.	3 15 0
Cost of renewals for carbon lamps, 25 × 1s. 3d.	1 11 3
Difference	2 3 9

The actual saving is, therefore, £15. 14s. 9d. minus £2. 12s. 9d. = £13. 2s, which is equivalent to 56·2 per cent. The no-load losses have decreased the original saving in running cost by 4·5 per cent.; the copper losses by 1 per cent. (therefore, from 67·4 per cent. to 62 per cent.). An

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unexpected objection has arisen to the use of these small transformers from certain central-station engineers—they find that the iron losses are so small that they will not keep the meter running. If this is the case, these iron losses, which should be borne by the consumer, fall on the station—which is obviously incorrect. There is no reason why this should not be done if the station engineer is allowed to charge for the same. With the high-pressure distribution, using transformers in consumers' houses, which was common practice 10 years ago, the electricity meters were always placed on the low-tension side of the transformer, and the price per unit was fixed with due consideration of this fact. I would suggest, therefore, that those supply engineers who wish to make use of Osram lamps to extend their private-house load should themselves supply these small transformers and charge the consumers a slight increase per unit to cover the iron losses, and also the capital expenditure involved.

There is another large field for these low-voltage lamps in connection with isolated plants for the supply of country houses, workshops, etc. Where small units of light are quite sufficient, the cost of the generating plant can be reduced very largely as the output required falls in the ratio of the efficiency of the filaments used in the lamps Thus the maximum load in any given case falls in the ratio of 3½ to 1, and neither the factory inspector from the Home Office nor the fire insurance company claims that supply at 25 volts is dangerous. The same reduction in the cost of generating plant in mains can be realised when designing electric lighting equipment for the numerous small towns and villages within the United Kingdom yet to be supplied with electrical energy. In such undertakings the capital burden to be borne by the relatively few consumers obtainable is the chief deterrent. While the saving from the use of the metallic-filament lamp may not bring the capital down quite in the above ratio, it will make many schemes feasible which hitherto have been passed by.

Discussion.

Mr. Haydn T. Harrison, in opening the discussion, referred to the author's comparison of tungsten lamps with the incandescent gas mantle, and said Mr. Hirst seemed to overlook the important fact that the gas mantle showed a decrease of candle-power after a certain time. He had made experiments and had found that in the first 100 hours of burning the candle-power of the gas mantle dropped 20 per cent., and after 500 hours burning it dropped 40 to 50 per cent., whereas the tungsten lamp after 1,000 hours burning only dropped 10 per cent. in candle-power. He then referred to a B.T.H. patent, in which it was claimed that when tungsten was heated to a temperature below that of oxidisation in the atmosphere it was ductile and could be drawn. If this was so, it might open out considerable possibilities. He had found in practice that big units of light were appreciated, because they could be more readily diffused. One of the disadvantages in incandescent electric lighting was the high intrinsic brilliancy of the filaments. He never advised the use of Osram lamps in private houses unless they had been frosted or put into globes which rendered the filaments invisible. Where big units were required of from 500 c.p. to 600 c.p., it was more economical to use a group of Osram lamps giving this candle-power than to use arc lamps, because the cost of carbons, labour, etc., in arc lamps was more than the cost of lamp renewals.

Mr. B. M. Drake (Messrs. Drake and Gorham, Limited) said the advent of the metallic-filament lamp was most welcome to the electrical industry, and particularly to those who were connected with private plants. From the central-station point of view he could well understand that the new lamps were not so acceptable, because many small stations had already got as many consumers as they were ever likely to get. He advised engineers-in-charge to use their endeavours to get people to use their light in a proper way, and to go in for large units. With regard to the name of these lamps, he preferred the term "metal lamps" to "wire lamps," as suggested by Mr. Mordey. The difficulty with these lamps was their brittleness, but Mr. Hirst's company had largely overcome this difficulty, and when lamps were sent in the casings the breakages did not amount to more than 2 or 3 per cent. The tantalum lamp was much stronger, and no special precautions were necessary. There was a general feeling that metal lamps had a longer life in winter than in summer. If this were so, might it not be due to the temperature? It had been stated also that metal lamps when exposed to snow lasted much less time. This, he said, might be due to the greater number of times the lamps were switched on in the winter, or to the temperature. With regard to the competitive forms of lighting, acetylene was preferred by many on account of its closeness to sunlight, but the cost was high. The cost of petrol gas seemed to vary according to the district and the veracity of the salesman. This proved that the metal lamps had put them in the running once again, and he was sure that it would benefit the industry.

Dr. Louis Bell (Edison Illuminating Company, Boston) referred to the development of the metallic-filament lamps in America. First came the tantalum lamp, which was welcomed, but which was soon pushed aside by the tungsten lamp, for the reason that the distributing circuits in America were alternating current, and the tantalum lamp had a short life on these circuits. The tantalum lamp worked badly both at high frequencies and at very low frequencies, and this was due, in his opinion, to the continual heating and cooling more than anything else. The heating and cooling increased with the increase in the frequency. He found that at 60 cycles and above the life was materially limited, whilst at very low frequencies of five or ten cycles the lamps could hardly be put in fast enough to keep them alight. Next came the tungsten lamps, which were first put on the market by the General Electric Company of America in the shape of a 100-watt 80-c.p. lamp. In America they were working at 1¼ watts per English candle. The large lamps were most welcome, because they afforded a good substitute for the uneconomical enclosed arc lamps. The importation of German lamps had forced American manufacturers to go in for lower candle-power lamps, and the standards manufactured were 100 watts, 60 watts, and 40 watts. They were like the Osram lamps, and were a great success. One of the questions uppermost in their minds was what was the most economical efficiencies at which to run these lamps. At one watt per English candle the lamp was being overrun; at 1¼ watts the life was admirable. With regard to the use of these new lamps, he said the lamps should always be in such a position as to be out of the field of vision. In common American practice tungsten lamps were never used except in this way. As a rule, the American central stations furnished renewals at a small charge, and in that way were able to control the output of these lamps.

Mr. H. W. Handcock hoped some means would be found for settling the question of standardisation, and so avoid the confusion caused by the arbitrary use of the Hefner and British standards. He thought we might lay stress on the advantage that accrued to the central stations as regarded the less sensitiveness of the new lamps to variation in voltage, and on the fact that the candle-power of the carbon-filament lamp was not so well maintained as was that of the metallic-filament lamp. He regretted that the offer which Mr. Hirst said he had made to the London stations, to supply them with lamps so that they might control its distribution, was not accepted. He thought that from a business point of view the author was right, and the central stations had missed a golden opportunity.

Mr. A. A. Campbell Swinton said it was not at present proved that the Welsbach burner owed its high efficiency to the property named by the author.

Mr. C. C. Paterson did not see why it should be impossible to standardise metallic-filament lamps by candle-power. If they could standardise the carbon-filament lamp with its high voltage variation, they ought to be able to do so with a lamp which varied in a much less degree. He regretted that the author had expressed so many of his results in Hefner candle, which was not generally understood here, and suggested that the British candle should be used.

Mr. T. H. Lowden complained that the paper referred only to the "Osram" lamp. He denied the author's statement that 40-50 c.p. was the lowest unit obtained in a commercial lamp, and he mentioned that the British Thomson-Houston Company was at the present moment selling a 220-volt 32-c.p. lamp. He had reason to know that a 25-c.p. tungsten lamp would soon be on the market. With regard to the blackening of lamps, he said he had never yet known a lamp to go black which had been properly exhausted.

Mr. C. H. Wordingham considered that the metallic-filament lamp was a blessing to the industry. To hear of central-station engineers talking of raising their prices to keep out their best friend was painful in the extreme. The people to get the revenue from were those using gas. He suggested that inventors might devote their attention to doing for the "Osram" lamp what they had done for the Welsbach mantle—viz., to invent a simple and useful anti-vibration holder.

Mr. Leon Gaster said it was necessary to impress upon the consumer the fragility of these lamps. He referred in this connection to a German prescription which was sent out with the lamps, and which stated that the lamp must not be dusted with a dry cloth, as this set up an electrostatic discharge and broke the filament. It was pointed out that the lamp should be dusted with a damp rag.

Mr. J. S. Raworth said he could remember the time when we paid 25s. for carbon-filament lamps, and when the box was opened half were broken. There need be no fear about the fragility of the metallic-filament lamps, for what had been cured in the case of carbon lamps would be cured in this case.

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The PRESIDENT (Colonel Crompton) said Mr. Wordingham seemed to be a little hard on the supply companies. There were many cases where gas did not compete at all, and where they had got all the consumers they were likely to get. Therefore, any reduction must come out of dividends, and the money spent in replacing the lamps must come out of the revenue of the consumers. The next few years would be a great anxiety to a certain class of central station.

Mr. HIRST, in reply, said that throughout he had been trying to keep the manufacturer in the foreground and the trader in the background. We were not well organised in this country for introducing a new and delicate scientific thing. In America and on the Continent the manufacturer, the central-station engineer, and the trader were in direct contact with the consumer. Here it was quite different, and that was why we met difficulties that were not met with in other countries. He would like to use such shades as Dr. Bell said were introduced in America, and the lampmakers had their ideas for getting over the fierce light, but the trouble was that they could not get in touch with the consumers. Series running had proved a success from the moment we had known how to pair them. He did not think that a lamp with a lower unit was commercially possible immediately. There was an exaggerated idea about the lamp breaking. Breakage was due rather to the careless way of opening and handling the lamps rather than breakage in transit. The reason he used Hefner candle-powers was that the lamps came from the country in which Hefner candles were generally used.

A cordial vote of thanks was accorded Mr. Hirst for his paper—the last of the session 1907-8.

CONCERNING OVERLOAD IN ELECTRICAL PLANT.

BY C. TURNBULL, M.I.E.E.

In the early days of electricity supply the steam-engine was almost always more powerful than the dynamo which it drove. It has even happened that the dynamo has been replaced by one of twice the capacity without going beyond the engine's power. Engine building was an established industry when dynamos came into being, and engine builders were accustomed to build to liberal proportions, while electrical manufacturers were not then emancipated from the instrument makers, who suffered from the delusion that it was merely necessary to touch two wires together to enable them to carry any current. It was standard practice in those old stations to have an engine which could run its dynamo off its legs, and a switchboard which would not safely carry all the current which the dynamo could give it. Switchboards even yet have not entirely overcome this fault. In one board made by a well-known firm the shunts were screwed up against the slate. Hence the currents had to get into the shunt terminals through a small nut on one side only, the bolt being slender. The board was close up against the wall, and everything was made as inaccessible as possible. There was trouble when full load came on after the board had been in use for a few years and the guarantee time had run out.

A pilgrimage round the stations of Britain shows up many choice specimens of design, and brings one to the conclusion that much of our switchboard work is a disgrace to a civilised land. With such boards, overload is out of the question. One is anxious enough when full load comes on. Engines are still frequently made more powerful than the dynamos attached to them. In three recent cases of large sets which I happened to notice, this fact was specially noticeable. They were by different people, so that one cannot put it down to one maker's idiosyncrasy. The most glaring case was that of a 3,500-kw. set, which gave better economy to 6,900 kw. than at nominal full load. It would probably have given up to 8,000 kw. with the by-passes open. The most economical load was at 5,000 kw. In a case of this kind one must come to one of two conclusions: either the nominal rating is a misnomer, or else there is an astonishing waste of potential power. One can hardly believe that the dynamo would be capable of doing from 5,000 kw. to 7,000 kw. continuously at ordinary power factors with good regulation, and if it were not able to do this it could not work on the best part of the curve. Probably some £700 more spent on the dynamo would have enabled it to stand up to the engine's full load, and this small sum would have given the owners of the plant some 2,000 kw. extra capacity. This would have also saved in running costs, as less plant would have been in operation if this set could have run at these heavy loads.

It is a positive injury for a maker to supply the engine so much more powerful than its dynamo, for it shifts the economical part of the consumption curve beyond the user's reach, and in case of a short puts an unduly heavy strain on the dynamo. A more suitable engine would slow down under heavy overload and save the plant from damage, but in such a case as the above there is much more chance of the dynamo being burnt out. One sometimes hears that dynamos need not be made with great overload capacity. It is difficult to agree with such a contention. Overload is likely to come on during the time of peak when the plant is well heated up. The stresses which a dynamo must endure when a partner breaks down are tremendously severe, and the breakdown of one machine may wreck the whole of the running plant if the dynamos be not liberally proportioned. It is under such circumstances that the melancholy engineer determines that future machines shall be fully strong enough. Good overload capacity enables one to face such contingencies, if not with an easy mind, at any rate with hope.

There is another thing which particularly applies to direct-current sets, that commutators run much better below full load. If the dynamo be large enough, one can run the plant at full load continuously without trouble, whereas otherwise one has usually to be continually touching up the commutator and brushes. With reciprocating engines one may have a variable cut-off, such as is fitted by Belliss and Morcom. If the dynamo be large enough, one may run continuously at nominal full load, and allow the cut-off to deal with anything in excess which may come on. The ordinary throttle-valve arrangement usually prevents one from ever getting the best results from the set, as any excess load either slows the engine or else opens the by-pass valves, which one does not care to use regularly. But if the dynamo be not large enough, one is debarred from working regularly on this later cut-off, though it is still economical, and new plant must be ordered before it should have been required. When ordering plant it is particularly necessary to find out what is the greatest power the engine will give. Sometimes a maker's standard engine happens to be considerably above the size specified, in which case it is better to spend a little money in enlarging the dynamo to bring it up to the engine power.

It was stated by a man who had looked into the matter that very few stations needed any more plant if they used their overloads. Actually, however, few engineers seem to care to use the nominal overloads, at any rate on the older sets. It seems that had a very little more money been spent on the dynamo end in most of our stations, their owners might have saved money both in capital and running costs. For the purpose of discussion I put forward the following points:

Definition of Overload.—(1) The consumption curve usually slopes down to a certain point and then up again. Full load might be defined as the point where the most economical load is exceeded by, say, 10 per cent. Overload is beyond this. (2) Combined plant must give at least the specified power. It must also be capable of running continuously at full load as specified above, and at such overload as may be agreed. The maximum overload of the plant should be the maximum overload of the engine, the dynamo being made to suit. The dynamo should also be capable of running continuously at any load which the engine would do economically. In the case given above the 3,500 kw. set would have been made to run continuously at something over 7,000 kw. under this specification.

In conclusion, I must apologise for bringing in one particular set to such an extent, but it was necessary to give point to the paper.

MECHANICAL DRAUGHT.

The question of the correct system to use in connection with the water-evaporating portion of a central station has

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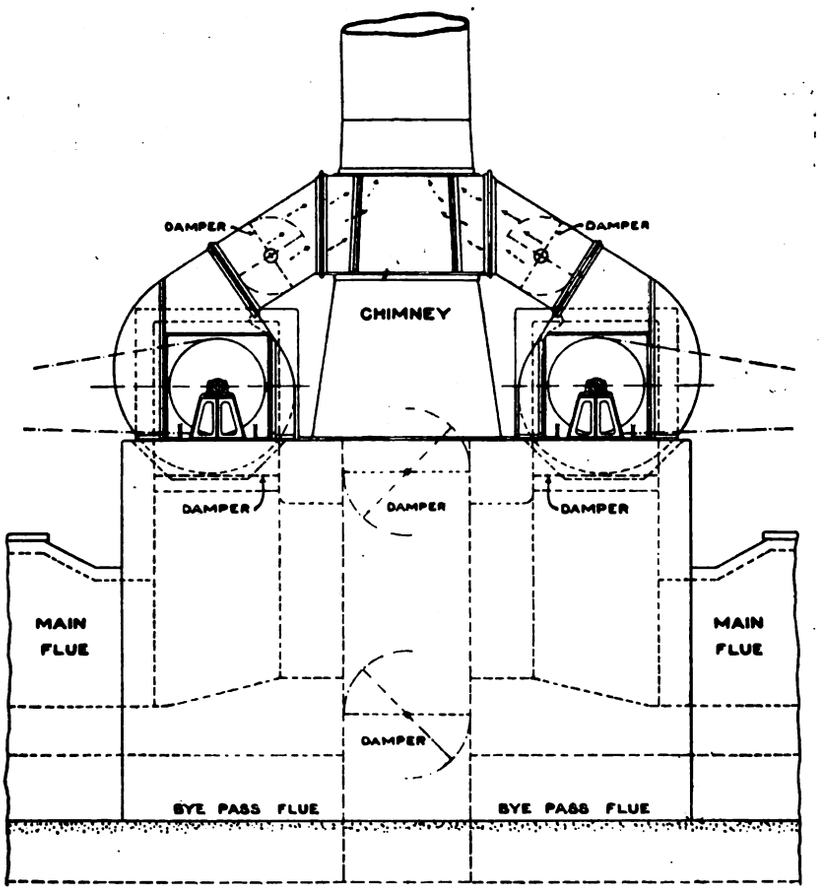
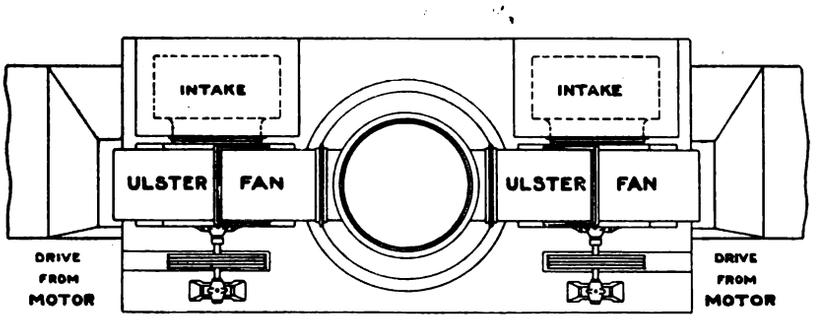
been discussed a considerable number of times in the technical Press, and the relative merits of natural, forced, and induced draught have been therein elaborated upon. In view of the fact, however, that mechanical draught is becoming of increased importance in connection with the modern tendency towards incorporating the chimney structure with the steel framework of electricity supply stations and similar steam-raising plants, it may be worth pointing out the particular value of induced draught in central stations.

The first point to be noted is that the load on an electricity supply station is, in spite of the gradual increase of the decrease in cost of plant installed but a uniformly economical combustion in the boiler, no matter what load may be imposed upon it within reasonable limits.

Another point which is of interest in this connection is that whereas, in order to maintain a sufficient draught in the chimney dependent only upon the natural ascension of hot air, some 15 to 20 per cent. of the heat generated by the boiler is lost in creating the draught, a mechanically forced or induced draught can be obtained at a very little expenditure of power. For example, in a bank of boilers of steaming capacity of between 3,000 h.p. and 4,000 h.p. the energy required to run an inducer fan capable of giving



ELEVATION



PLAN

MUSGRAVES

differential tariffs inducing high diversity factor, a very fluctuating quantity, and with systems of natural draught it is an extremely difficult and sometimes expensive matter to keep the boiler-house in readiness to cope with possible demands upon it. It is often necessary to keep steam up on at least one extra boiler, inasmuch as economical rates of combustion cannot be obtained with the ordinary set of boilers with natural draught, such boilers being heavily taxed at times. By mechanical apparatus, which can vary at will the rate of passage of air through the furnace fires, it is possible to obtain a very facile and speedy means of adjusting the boiler to the load, this involving not only all the necessary draught for the boilers when in full work only amounted to 30 h.p., and this, combined with the possibility of reducing the height of the chimney simply to the minimum allowed by the local building conditions for the avoidance of nuisance, renders the cost of both construction and upkeep of a boiler-house extremely low.

This question of height of chimney becomes of increased importance when, as is frequently the case, the chimney is not a separate structure, but becomes an integral part of the framework of the boiler-house. An increase in height—and, therefore, weight — of the chimney involves a strengthening of the ironwork of the main structure, and

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thus a cumulative expense is incurred. Still further the question of foundations has to be consideeed. Many modern power-houses are, for the sake of obtaining a cheap and convenient supply of water for condensing purposes, placed upon the banks of a river, and the ground in such a situation is frequently of a marshy and unstable nature. The erection of a heavy brick chimney of considerable height would involve a large expense in piling and foundation work which can be avoided by the use of forced or induced draught with short chimneys.

The introduction of a fan permits the products of combustion to be cooled to a practical limit by means of an economiser, or other heat abstractor. This, taken in conjunction with the fact that experience has proved the marked economy resulting from a high rate of combustion consequent upon the reduction of great areas, the use of small coal and thick fire, points to the further use of mechanical draught as new stations are erected. A case in point is the induced plant which was recently erected at the Derby Corporation electricity works. A plant consisting of chimney stack, two electrically-driven fans and accessories, was installed by Messrs. Musgrave and Co, Limited, of St. Ann's Ironworks, Belfast. The fans, of the Ulster type, were each capable of delivering about 100,000 cubic feet of flue gases per minute and maintaining a draught of 2in. water column at the fan inlets when gases of combustion were at 500deg. Each fan is driven by a 70-h.p. enclosed protected motor operated by means of direct current at 550 volts. The variation in load on the central station is met by a variation in speed of the motors by shunt regulation from 620 to 800 revolutions. The power is transmitted from the motor to fan by means of endless cotton ropes. Part of the fan casing projects below the level of the foundation of the pit, and the general arrangement is shown by the illustration attached.

The fan wheels are carried on steel shafts provided with specially designed fan bearings designed by Messrs. Musgrave. These bearings have a length of not less than four diameters, and are of the ring oiling type with white metal liners. A special water-cooling device is provided for the inner bearings.

These fans, which are in duplicate, discharge directly into the chimney stack through central openings in the latter, framed and stiffened with heavy steel plate and angle-iron compensation rings. The suction and discharge connection between the flues and the fans, and also between the fans and the stack openings, are fitted with dampers for isolating the fans when not in use.

The chimney, which is 8ft. in internal diameter clear of the brickwork lining and some 130ft. high, is constructed with a very large splayed steel base, which is bolted directly to the foundation, the chimney in this case being, therefore, self-supporting. The firebrick lining extends for some distance up the chimney above the point where the hot gases enter from the fan, the stack, etc., being built in four sections or rings of steel plate varying from $\frac{7}{16}$in. to $\frac{1}{4}$in. in thickness Provision is made by dampers in the main flues at the base of the stack to allow the plant to be worked with natural draught when required.

The Corporation engineer of Derby, Mr. T. P. Wilmshurst was responsible for the specification, and his wisdom in selecting the induced type of draught is amply demonstrated by the increased favour with which this method on operation is being regarded in modern central stations of Great Britain.

A NEW TYPE OF ELECTRIC FURNACE FOR THE SMELTING OF IRON.*

BY PROF. B. IGEWSKY (KIEFF, RUSSIA).

It may easily be shown that a supply of electrical energy equal to 500 kw. is sufficient for the smelting of one ton of steel. Electrical engineering of the present day has already constructed dynamos capable of developing ten times as much energy, and is, indeed, able to supply such energy at a very cheap rate, particularly when a gas engine is used to drive the dynamos. With such conditions the electric furnace should be capable of producing steel more cheaply than by the open-hearth process; the crucible steel process, which is becoming obsolete, may be excluded as a method for the production of steel on a commercial scale.

Many works already employ electric furnaces, such as Stassano, Kjellin, and Heroult electric furnaces. These furnaces work very successfully, but they all employ low-tension electric current (not exceeding 100 volts), or they themselves act as transformers. The author will describe

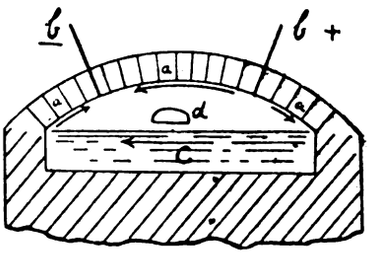

FIG. 1.—*a*, *a*, Firebricks; *b*, *b*, Electrodes; *c*, Smelted Metal; *d*, Working Opening.

a method of working with high-pressure electric current, of which he has had seven years' experience. The furnace is one of a type employing what may be called second-class conductors, such as magnesia, lime, silicates, or their colloids, such as Al_2O_3, $2SiO_2$, which, on being greatly heated, become conductors. It is absolutely necessary that the current should pass in the thinnest possible layer over the lower surface of the bricks, as shown in Fig. 1. The resistance to the current should be very great in such a furnace. The pressure should be 1,000 volts for each

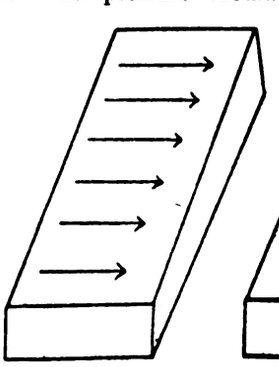

FIG. 2.

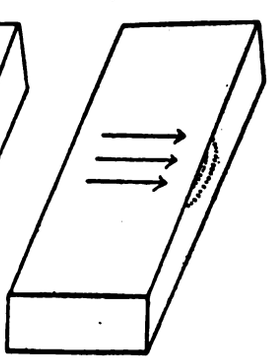

FIG. 3.

metre space between the electrodes. By bringing the electrodes nearer together, or placing them further apart, or by providing the furnace with a number of electrodes, and only charging those which are immediately needed, it is possible to obtain a furnace which will work with all strengths of current in ordinary use. Such a furnace should work as steadily as an incandescent lamp, and should develop the highest temperature that the bricks can support. The problem is, however, not entirely solved. Difficulties are presented owing to a phenomenon analogous

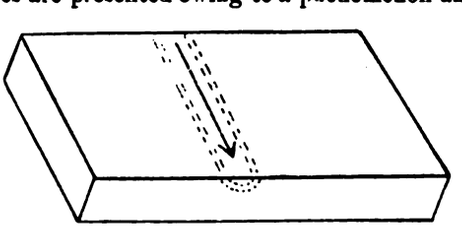

FIG. 4.

to that which the author has found to occur in the blast furnace, and to which he gave the name of differentiation. The electric current only flows over the surface of the brick during the earlier stages (Fig. 2). In a very short space of time it concentrates itself along the lines of least resistance. Little by little the path selected becomes the only zone affected and the remaining surface remains quite cool (Fig. 4) Differentiation can be obviated by dividing each electrode into a number of smaller electrodes furnished with regulators. Such a system could be employed for the firing, *e.g.*, of porcelain

* Paper read before the Iron and Steel Institute.

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The application of the principle to the manufacture of steel and to the fusion of other smelted materials is more easily solved by the furnace being made to revolve, and supplied with a sufficient number of electrodes, so that the current does not suffer interruption. In such an arrangement the bricks will at one time form the vault and at another the bottom of the furnace. By this means the variations in temperature can be avoided, and each brick passing beneath the metal will have the same conductivity over the whole of its surface as any other brick. In

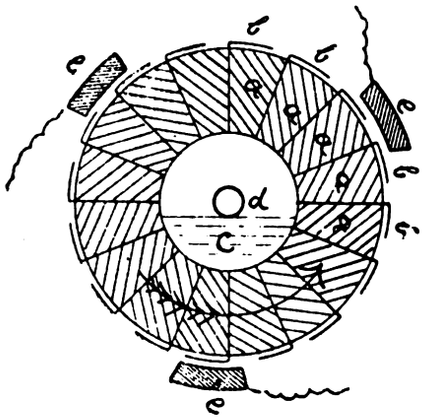

FIG. 5.—*a*, *a*, Firebricks; *b*, *b*, Electrodes and Parts of Collector; *c*, Smelted Metal; *d*, Working Opening; *e*, *e*, Brushes which remain immobile during the rotation of the furnace.

addition to this the bricks will be automatically moistened with slag, so that their surfaces become better conductors than their interiors. If the principle of a revolving furnace be adopted, it is necessary that it should be furnished with a commutator, otherwise the current will short-circuit through the metal. Fig. 5 shows a plan for a rotating furnace using three-phase current, while Fig. 6 gives a front view of a furnace installed in the Emperor Alexander II. Polytechnic Institute at Kieff.* The opening through which the charge is worked, the outlet, and the motor which rotates the furnace about 20 times per minute are shown in the figure. Fig. 7 is a view of the back of the furnace from the side of the commutator, which was made

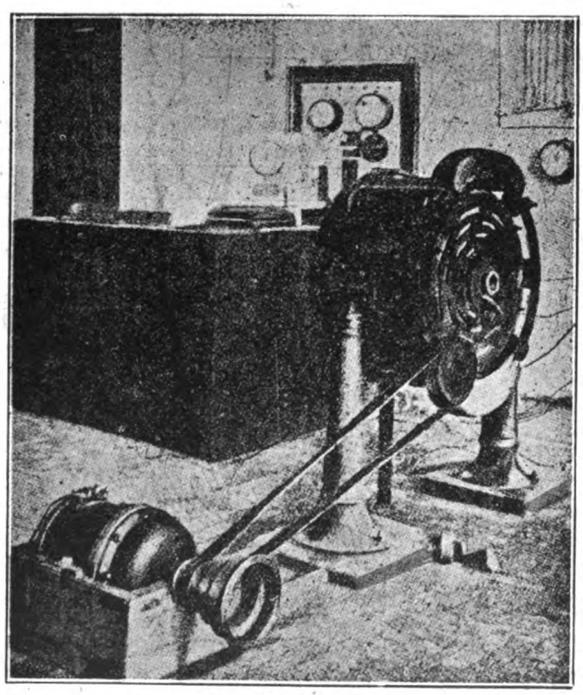

FIG. 6.

larger than usual in order to give access to the furnace from that side. This was for experimental purposes, but is not essential. It is possible to construct a free commutator connected with the furnace by a cable. In the illustration the rollers can be seen as well as the pivot which allows of the furnace being tilted in order to empty

* The author wishes to record his thanks to the designer of the furnace Mr. A. E. Tzaref.

it completely. Fig. 8 shows the form and dimensions of the bricks, *a* being the outside bricks, and *b* the whole of the arrangement devised for the purpose of cooling the furnace, or as an air-chamber for reducing heat losses. In practice it was not found necessary to adopt this plan. a_1

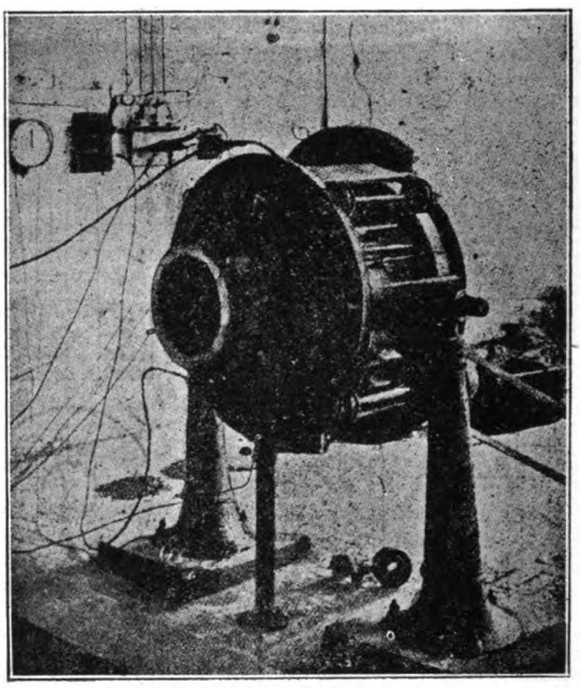

FIG. 7.

shows the inside bricks which have to be changed more frequently, and a_3 the circular bricks for the front and back walls of the furnace with the working opening and the opening for the outflow of the metal and slag. C I shows the space for the electrodes, while Fig. 9 gives the

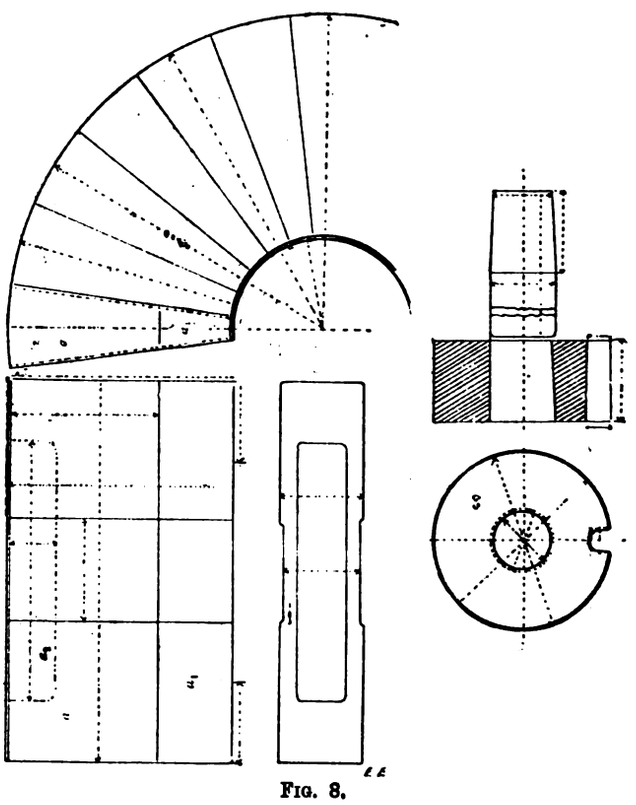

FIG. 8.

front and side elevation of the furnace. All the plates are of cast iron; *a a*, a_3 a_3 are bricks, *b b* are electrodes placed between the bricks, and *c'c'* parts of the commutator, *e e* are the electric brush holders. The inside diameter of the furnace is 175mm., and the depth 215mm. The cubic capacity is 5·17 litres. The space that can be occupied by metal is, however, only about 2 litres, and at the commencement little more than 10 kg. can be charged

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In the course of time the interior bricks wear, and the capacity of the furnace becomes greater. The author prefers a three-phase electric current, but usually employs a continuous current of 250 volts and 50 to 60 amperes—*i.e.*, 12 kw. to 15 kw. When cold the furnace is a non-conductor.

The process of smelting is conducted in the following sequence of operations: The flame of a gas or Bunsen burner is made to impinge through the working opening, and when the furnace has been slightly warmed a little damp potassium hydrate is charged and the furnace is rotated. It will now be found that the furnace acts as a conductor, and the electric current begins to warm it. After a short time sodium hydrate is added, and when the interior of the furnace is red hot sodium carbonate is charged. The corrosive alkalis which evaporate within

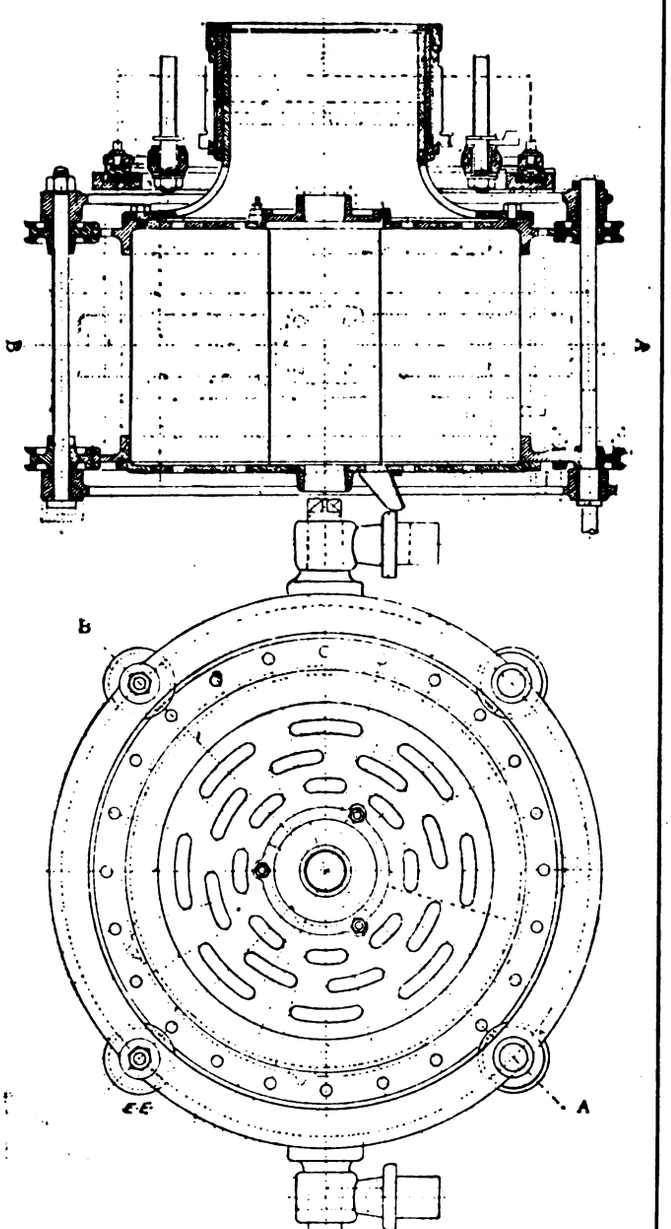

FIG. 9.

the furnace do not cause as much harm as might be expected. Rapid heating is, however, a danger to the bricks, which begin to crack. The best plan is to warm the furnace with gas during the night preceding the experiment. When the temperature of the furnace reaches a light red heat cast iron may be put in, and then scrap, or the order can be reversed. In the first case the author is in the habit of adding the new material gradually as the charge melts. In the latter case, when the iron becomes sufficiently hot, the smelting takes place at once on the addition of cast iron. If a quantity of cold metal be suddenly introduced at one time, it is easy to reduce the temperature to such an extent that short-circuiting occurs, as shown in Fig. 10; *a*, *b*, *d*, and *e* bear the same significance in this figure as they do in the preceding illustrations, *c* being the cooled metal which causes the short-circuiting of the conducting brushes. The same thing occurs if the furnace becomes cool with the metal inside; small furnaces cool down in an exceedingly short time. In a large furnace where there is a considerable margin of heat, such an accident is hardly likely to occur. Indeed, in order to bring them into working condition, it would suffice to charge some hot slag from some other furnace and to avoid having recourse to soda, which could not be other than injurious to the bricks. The outer bricks of the author's furnace are of fireclay, and the inner of fireclay or dinas. The fireclay bricks are fairly good conductors, but the dinas bricks are exceedingly poor conductors. The author has, however, used both for years with successful results.

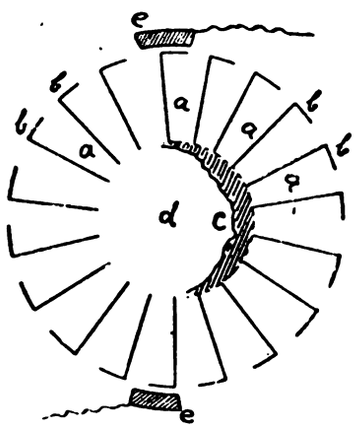

FIG. 10.—*a*, *b*, *d*, and *e* represent the same as in the preceding illustrations; *c*, the cooled metal which causes the short circuit of the conducting brushes.

With fireclay bricks care should be taken that less slag should be used. With dinas bricks it is his custom purposely to add fluorspar, cryolite, magnesia, and similar

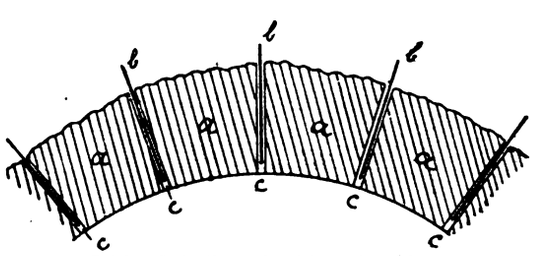

FIG. 11.—*a*, *a*, Bricks; *b*, *b*, the ends of iron electrodes; *c*, *c*, slag and drops of smelted steel in crevices between the bricks.

substances, in order to increase conductivity. Magnesite bricks appear to be ill-adapted to the purpose, because they conduct too easily, while the current of 250 volts

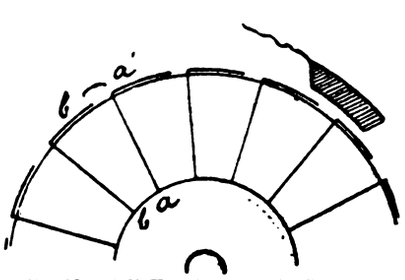

FIG. 12.—*a'*, *b'*, Voltaic Arc on the Collector.

would with the existing dimensions of the furnace be too great for these bricks. Experiments with dolomite and other bricks have not yet been carried out by the author.

The electrodes in the furnaces illustrated are of iron. At first sight it seems astonishing that they could be made to work in a furnace in which steel is being smelted. As a matter of fact the electrodes melt and become slightly absorbed in the interstices of the bricks. But as the heat is developed on the surfaces of the bricks lining the inner side of the furnace, the crevices around the electrodes remain at a moderate temperature, because they retain the slag and even drops of metal which act as conductors (Fig. 11). The author at first employed electrodes of 3mm. to 4mm. in thickness, so as to drive them into the furnace from time to time by means of a hammer, but as

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that appears to be unnecessary he now employs thin sheet-iron electrodes. There are in the furnace 24 electrodes placed at intervals of 23mm. from each other. As in the furnace filled with liquid steel only the 14 upper bricks constitute the working surface, a difference in potential of $\frac{250}{7}$, or nearly 35 volts, is obtained between adjoining electrodes. As a result sparks are emitted on the collector on replacing each electrode, and frequently the spark is transformed into a voltaic arc. As shown in Fig. 12, the path of the voltaic arc to the collector is shorter than that through the conducting brick. On the distance between these electrodes being reduced to 12mm., the difference of potential falls to 17½ volts, and the formation of the arc becomes impossible. The author has, however, adopted an alternative. Each flat piece of the collector is divided into three parts, connected to each other with rheostat wires. By these means each electrode becomes gradually shut off whenever the difference of potential reaches the vicinity of 12 volts, and the formation of a voltaic arc is impossible. Besides that, he has fixed an additional description of brush on the electrodes, joined to the rheostats. This brush similarly serves to lessen sparking. The method employed to obviate sparking is the only complicated part of the furnace, the remaining principles being quite of an elementary nature.

The manipulation of the furnace is likewise exceedingly simple, although with its present very small dimensions it requires constant attention. As a rule, the author smelts a small quantity of cast iron and afterwards adds scrap. The softest steel produced possesses an ultimate strength of 56·8 kg. per square millimetre, with an elongation of 20 per cent.

On smelting iron turnings with charcoal (1 per cent.) steel was produced with an ultimate strength of 85·6 kg. per square millimetre, and an elongation of 3 per cent. Experiments for the production of steel from cast iron by the ore process were also successful, and the fireclay bricks suffered less than might have been anticipated. The advantages of a furnace of the construction indicated above are as follows: (1) high voltage and low expenditure of current; (2) the possibility of using any form of current ordinarily employed; (3) compactness and high efficiency; (4) great homogeneity of the metal produced; (5) the minimum amount of surface contact with air or with the walls of the furnace; (6) slag at a high temperature, and therefore favourable to the reactions needed for the refining of the metal; (7) a minimum superheating of the surface; (8) the avoidance of carbon electrodes; (9) the possibility of using the furnace for the production at a high temperature of any material in a fluid state.

A MODERN TRANSFORMER WORKS.

The Foster Arc Lamp and Engineering Company, Limited.

No prefatory explanation is surely necessary in calling attention to auto-transformers, for the advent of the metallic-filament lamp, for which the pressures of the various circuits in this country are too high to enable it to be burned except in series, has invested these voltage-reducing devices with a prominence which cannot be mistaken. There are many who, guided largely by the analogy of the carbon-filament lamp, regard the auto-transformer as only a temporary expedient for the present difficulty of running the new lamps in the ordinary way. It is pointed out that when carbon lamps were first introduced they were made for circuits of only 50 or 60 volts, and that the standard was gradually increased by improvements in manufacture, and also by the encouragement which the lamp-makers received from the engineers of the electric supply companies and of the municipal authorities. At all events, a similarly rapid development for the metallic filament lamp is a consummation devoutly to be wished for; but whether this consummation is to be immediate, or whether it is to be deferred to some remote and speculative future, is at present the concern of the chemists. The incontestable fact is that the present use of transformers in connection with metallic-filament lamps has given a remarkable fillip to the manufacture of these devices, many types of which are at present on the market, and are well known.

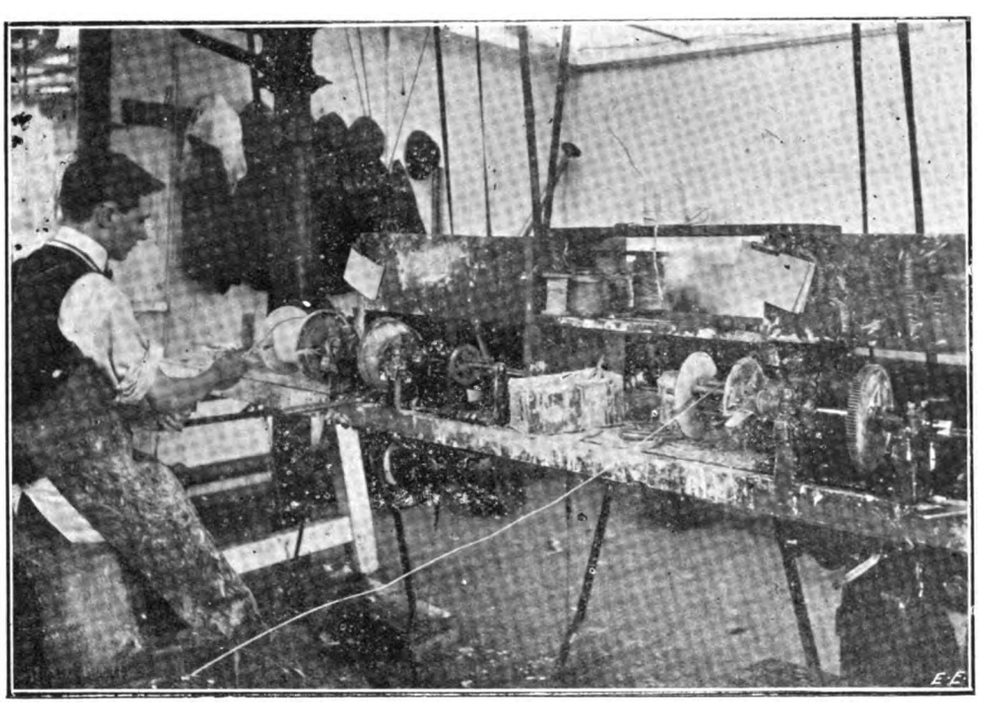

FIG. 1.—Portion of the Winding Shop showing Friction-Driven Machines.

We thought that many of our readers would find interest in an account of the manufacture of auto-transformers, and of the apparatus used in connection therewith, and we went down to Wimbledon one afternoon for the purpose of seeing the Foster transformer undergoing its various stages of manufacture. The Foster Arc Lamp and Engineering Company, Limited, readily placed every facility in our way, and it is through their courtesy in allowing us to go over their works, as well as through the readiness of their capable staff to answer any questions and to give information, that we are enabled to present our readers with an account of the interesting process employed in making the Foster transformer.

As is well known, the Foster Arc Lamp and Engineering Company have won deserved fame in connection with the manufacture of the Foster enclosed arc lamp. But we do not propose to deal with this part of their business now, for the space available for this article would not enable us to do justice to these extremely modern and well-equipped works. We must accordingly limit our observations to but a

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portion of Messrs. Foster's works—*i e*, the transformer department.

The transformers are made in the recently extended section of the premises at Worple-road, Wimbledon, and although the accommodation is comparatively small, there is not a little to be seen that is of interest. Indeed, a feature of the whole of Messrs. Foster's works is its compactness. No superfluous floor space, no disused rooms, no large patches of unoccupied space, no idle machinery, strike the eye, and (incidentally) swell the establishment charges. And, judging from the amount of work in hand and the briskness in the shops, we should say that, taking the value of the output per square yard of the factory, Messrs. Foster compare favourably with the best works in the country. Yet there is no evident sign of overcrowding and inconvenience. The order and arrangement of the works offer no ground for unfavourable comment. Indeed, the impression formed of the works is very much in accord with what might be expected by those who know anything of the manufactures there.

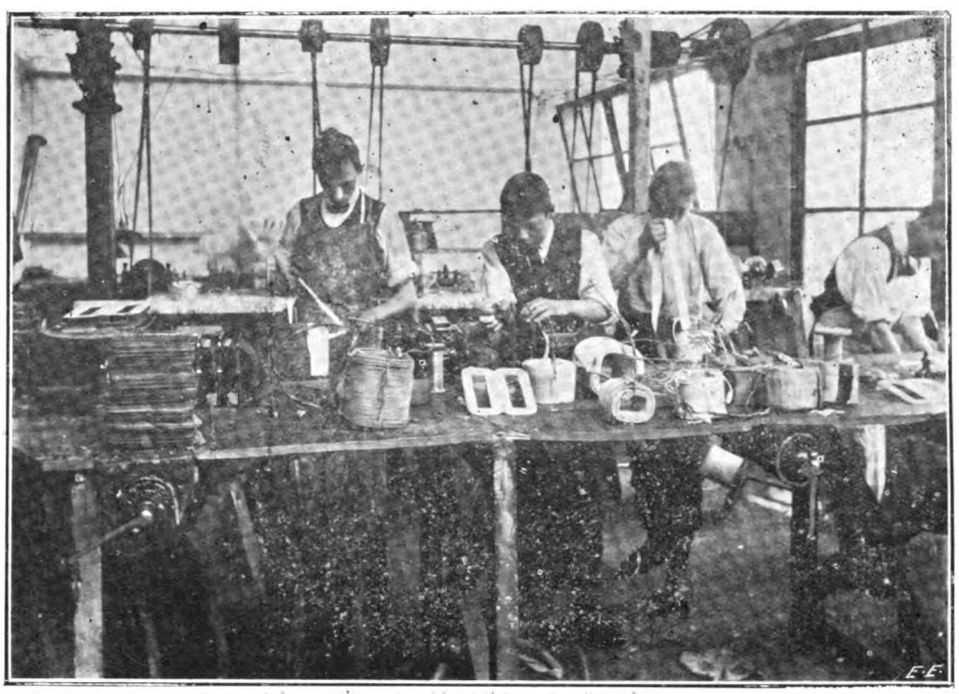

FIG. 2.—Assembling Parts of Auto-Transformers.

Details of each transformer are worked out in the drawing office, and the number of turns, size, and width of wire, the weight and quality of the iron to be used, and all necessary particulars are entered upon a card which is sent into the works. A special former is taken according to the specification. The winding of the coils is done by friction driven machines of various sizes. These machines, two of which are shown in Fig. 1, were designed and made by Messrs. Foster. Power is obtained from the main shaft, to which each winding machine is connected by a pulley and belt. The power is transmitted from the main shaft to the auxiliary shaft of the machine, to which is connected a friction plate. This latter drives a spindle on which the coil to be wound is fixed. Reverse motion and variable speed is obtained by means of a striking platform operated by the foot of the winder. Each layer of winding is insulated with a special fireproof and waterproof varnish which will stand about 50 per cent. overload without danger. The coils when wound are then baked for two hours in a stoving oven, heated by gas to a

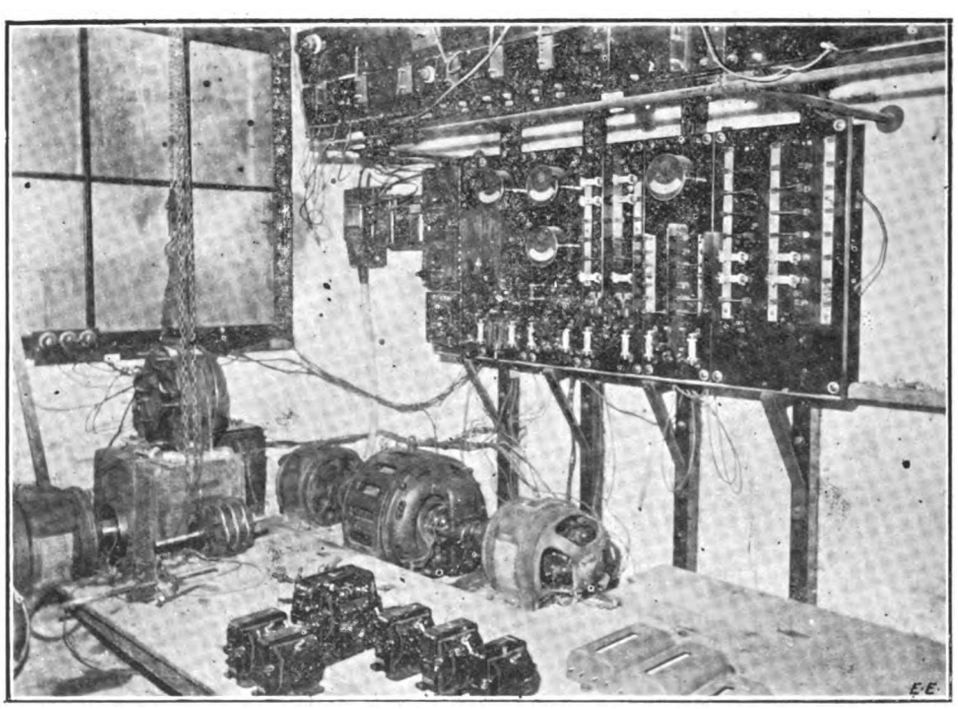

FIG. 3.—Corner of the Test Room.

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temperature of about 200deg. F. When thoroughly dry, and while still warm, they are covered with a heavy insulating tape and with another coating of varnish, after which they are baked a second time, each coil coming out of the oven in a solid mass and ready to be fitted.

alternating-current three-phase motor taking power from the Corporation mains at a pressure of 220 volts. The motor is connected by means of belting to a main shaft which runs through the three rooms.

Enough is probably known about the Foster transformer,

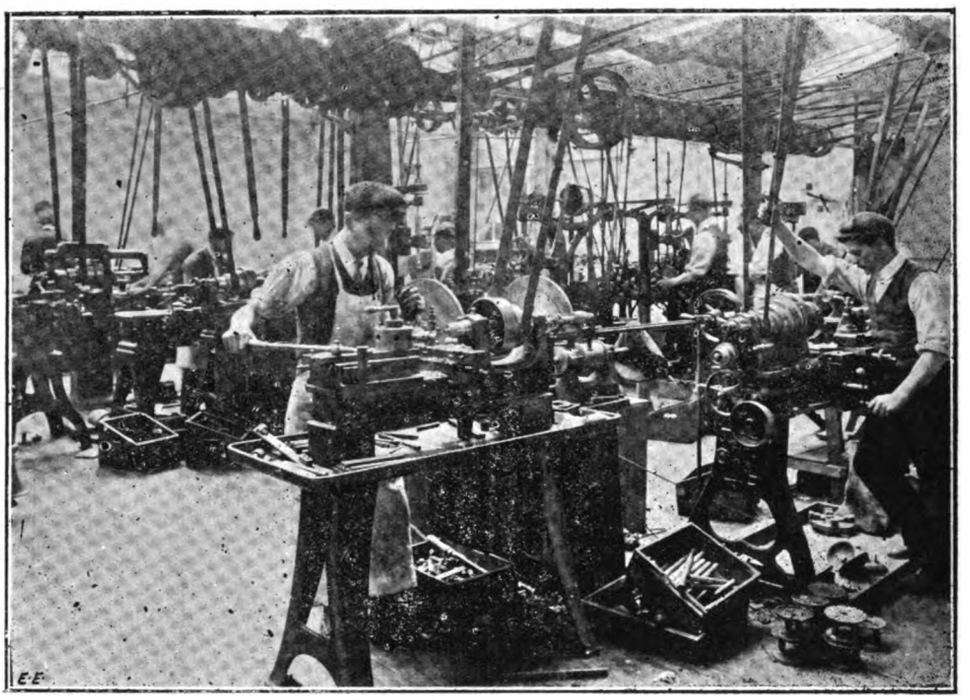

FIG. 4.—View of the Machine Shop.

A view of one of the benches in the assembling shop is shown in Fig. 2. To the left of the picture is seen the iron laminations, which are next inserted into the coils. A special quality of iron of low hystereis is used for this purpose. The coils are then fixed in strong cast-iron boxes of very neat and workmanlike design, and the leads connected to split sockets, but exposed terminals are provided where specified. The cases are then given a coating of insulating paint and a coating of enamel, and when dry are ready for testing. A corner of the test-room is shown in Fig. 3. Fig. 4 is a view of the machine shop, part of which only could be included in the photograph. This shop contains tool lathes of various sizes, all of modern

a group of which is shown in Fig. 5, so that extended reference need not be made to it here. However, a few points might be noted. The open-circuit losses are kept as low as 1 per cent. of the output, and often lower, the open-circuit losses in the Ball transformer varying between 0·5 watts to 1·5 watts. The efficiencies of the bulk of the transformers vary between 95 per cent. and 98 per cent. for sizes of 500 watts and upwards, but are never less than 94 per cent. There is practically no magnetic leakage at all, and the transformers run dead silent on all loads, which is very desirable, especially for private houses. As will be seen from Fig. 5, the transformer occupies very little room, and lends itself to very easy fixture either to walls, floors,

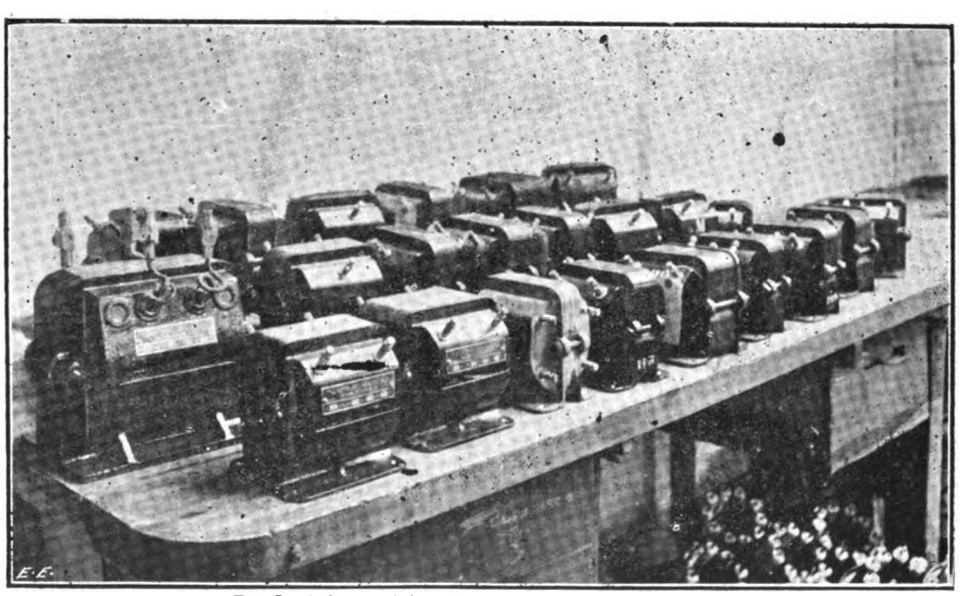

FIG. 5.—A Group of Auto-Transformers of various sizes.

pattern; capstan lathes; eight sensitive drilling machines; drilling machines with two and three spindles for drilling holes of different sizes in castings on one machine; planing, milling, and grinding machines, and the usual complement of polishing buffs, etc. All the machinery in this room and in the transformer-winding room adjoining it, as well as in another small shop, are driven by a 20-h.p.

or ceilings. All current-carrying parts are efficiently insulated from earth, and have an insulation resistance of not less than eight megohms, but they generally test out to 20 megohms. Notwithstanding the date, we understand that the demand for May increased by 30 per cent. Mr. H. Hirst in his Institution paper referred to losses in transformers. We are able to give some calculations made in

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connection with Foster transformers, and these figures are compared in the following table with those quoted by Mr. Hirst. The figures for the Foster transformer are given in italics, and appear on the top line in each case :

Output in watts.	No. of 16-c.p. Osrams alight.	No-load watts.	Per cent.	No-load units per annum.	Cost per annum at 4d. per unit
300	19	*5·6*	*1·2*	*31½*	*£0 10 6*
		5	1·67	44	0 14 8
750	47	*7*	*0·935*	*61*	*1 0 4*
		10	1·33	88	1 9 4
1,500	94	*12*	*0 8*	*105*	*1 15 0*
		17	1·13	149	2 9 8

In conclusion, we might add that the design of the Foster auto-transformer is by Mr. E. R. Grote, who has designed all the lamps and apparatus made by the company since its inception.

ELECTRIC FANS.

The use of fans with electric motors attached has increased so much in recent years, that any new type offering advantages in speed regulation and low current consumption is of considerable interest.

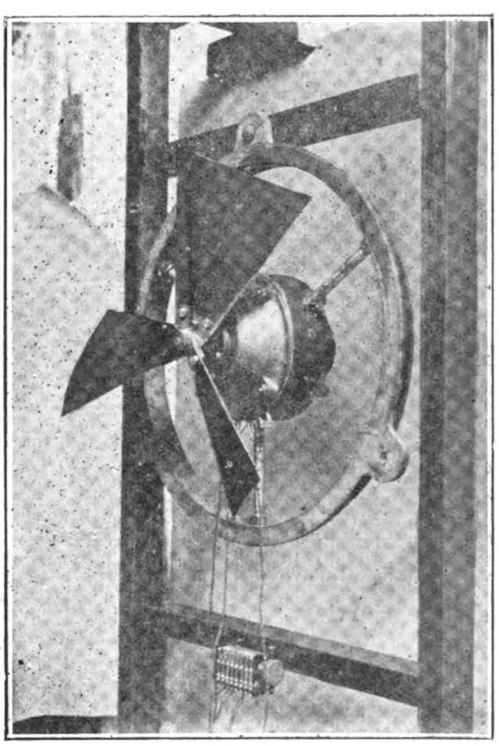

FIG. 1.—Complete Fan with Motor Controller (Mitcham Fan Co.).

The illustration (Fig. 1) shows a new type of fan motor made by the Mitcham Electric Fan Company, Limited, working under patents granted to Mr. Howard Lacy. The outstanding features of the motor are its simplicity of construction, its low current consumption, and the ability to vary its speed without the use of external resistances and without cutting out or in sections of the field. These motors are designed for use on direct-current circuit. Figs. 2 and 3 show a diagram of magnet winding for which patents have been granted to Mr. Lacy.

The field coils of the motor are wound with three different gauges of wire, on the principle illustrated, and, as will be observed by closely studying the diagram, the direction of winding around the core is changed at the end of every two layers. It is not the intention of this article to discuss the theory underlying this method of winding, but rather to deal with the results of such a winding when applied to the field coils of motors. There has been, and there is still, considerable controversy as to the apparently revolutionary nature of this winding, but for the purpose of this article it is sufficient to state that the form of winding illustrated offers in use certain distinct advantages with regard to speed control. As will be observed from the diagram of the field winding, the beginnings and endings of each size of wire are left outside the coil, and these, together with the armature leads, are brought to the controller. The controller is simply a switch to permit of the mechanical grouping of the beginnings and endings of the wires employed. Step 1 on the controller places the wires on each field coil in series with relation to each other, and the armature is in series. Step 2 on the controller brings two wires in parallel (or, more correctly, in multiple, as one cannot speak of wires running in opposite directions as being in parallel). Step 3 on the controller connects all the wires in each of the field coils in multiple.

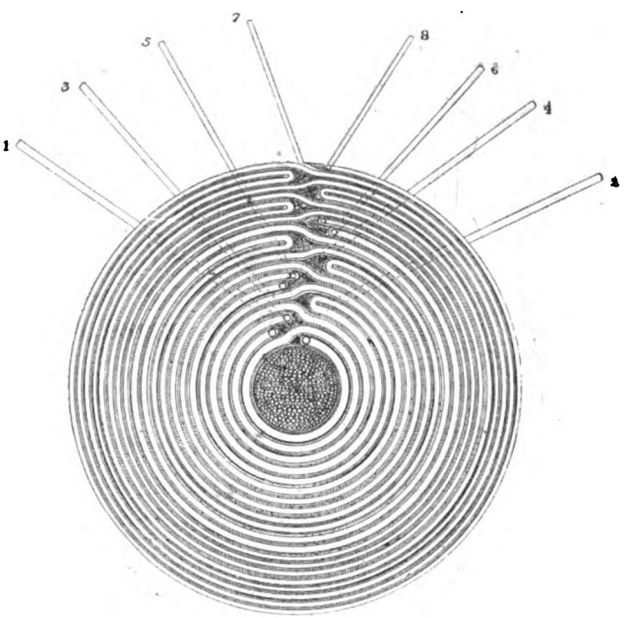

FIG. 2.—Diagram of Lacy Winding.

By means of these arrangements it is possible to run the motor and fan at, say, for the first speed, 500 r.p.m.; second speed, 700 r.p.m.; third speed, 900 r.p.m.; or, as the speeds are lettered on the controller, "low," "normal," and "high." By this means a fan which is extremely economical in use has been obtained.

It is often desirable to be able to vary the speed and power of fans in such places as public halls or restaurants, so that in the absence of occupants the room could be rapidly cleared of impure air, whereas, while the room is occupied, the fans would be run at a much lower speed.

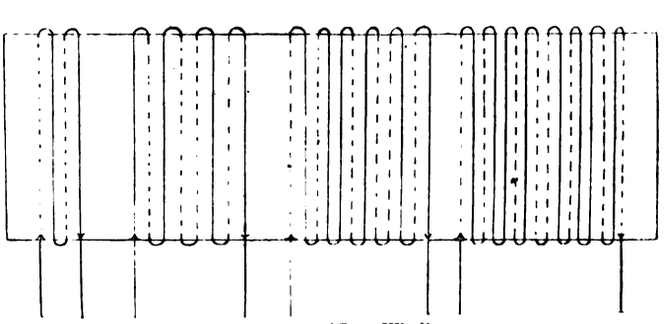

FIG. 3.—Diagram of Lacy Winding.

By means of this new electric fan this is done economically, as there is no waste in resistances controlling the current passing to the motor. It is as well to point out that with the new form of field winding commutation troubles practically cease to exist, and hence the motor is extremely economical as far as repairs and renewals are concerned. The following figures as to the running made on a 24in. air-propeller show the variation in current, the revolutions, and the air discharged at each of the three speeds before referred to :

	Revolutions.	Watts.	Cubic feet of air discharged.
High speed	900	275	6,000
Normal speed	700	200	4,700
Low speed	500	175	3,500

The motors are substantially made, and are economical in price, in running, and in upkeep. A large number of these fans in sizes from 12in. to 36in. is ready for the market,

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and there should be a ready sale for what appears to be an extremely efficient air-propeller.

It is well known to practical users that a heavy loss can be sustained to an extent quite unsuspected by the uninitiated by using an inefficient fan, a small first cost being no criterion of cheapness in the purchase of such a machine, as its original cost may soon be exceeded many times over. As an instance of what we have just stated, Messrs. John Gibbs and Son recently replaced in their own forge a blower of a well-known American make by one of their own make direct electrically driven by means of their patent entirely enclosed dustproof type electric motor,

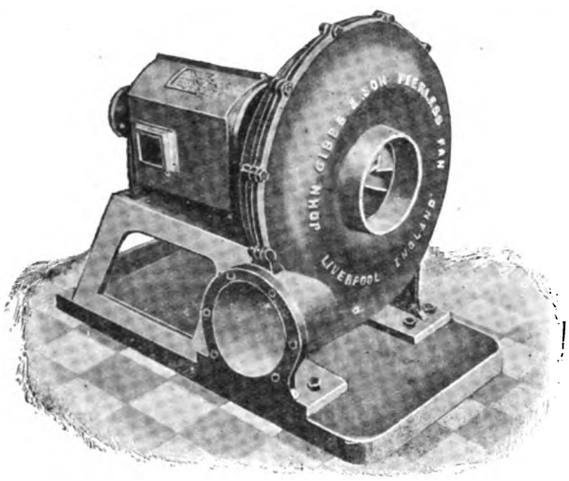


FIG. 4

the result being a saving in the power bill of £2 per quarter, although the machine replaced was much less powerful than the one now installed, the draught being now greatly improved.

We illustrate some of the different types of fans manufactured by Messrs. John Gibbs and Son, ventilating engineers, of Liverpool. These machines are made to suit Admiralty requirements, the highest temperature rise of any part of the machine not exceeding 70deg. F. Most careful attention is also paid to the insulation, and every machine is tested before leaving the works, being run for several hours, the temperature rise, insulation resistance,

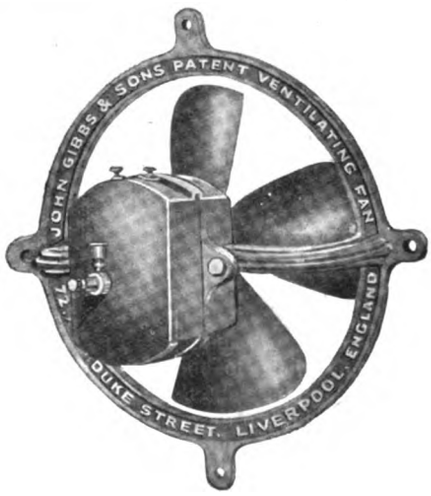


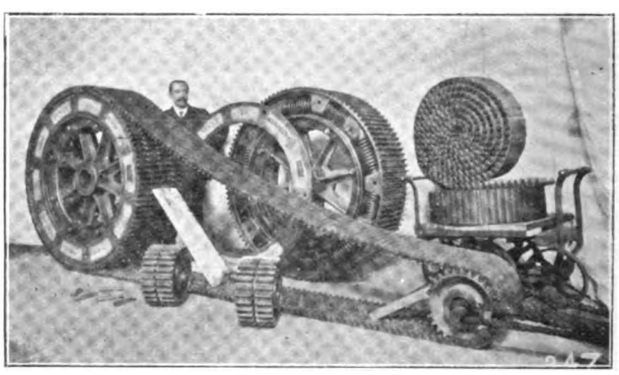
FIG. 5.

speed, air output, and current consumption being taken; a duplicate of the test is supplied to the customer with each machine. Fig. 4 shows one of their volume fans direct driven by their patent entirely enclosed dustproof type electric motor, which is suitable for all ordinary purposes. Fig. 5 shows one of their watertight type electric fans direct driven by one of their patent entirely enclosed watertight type motors, especially suitable for working in high temperatures and damp steamy atmosphere. As an example of what these machines will stand we might mention that several of this type of machine are in use by the leading steamship companies, and working satisfactorily in a temperature in some cases as high as 200deg. F., which figure speaks for itself as to the quality and excellent workmanship of these mechanics, as no motor unless of the very highest class would possibly withstand such a temperature without breakdown. Another type which Messrs. John Gibbs and Son have supplied to the torpedo-boat destroyers of the British Navy, was adopted after passing satisfactorily the most stringent tests. This type is also made in slightly cheaper form with cast-iron case for ordinary shore use, and is the most efficient machine for its size now on the market. The fan blades of all their machines are secured by means of a simple device patented by them, whereby the blades and boss are interlocked, making it impossible for them to fly out.

TRANSMISSION OF HIGH POWERS BY CHAIN.

The accompanying illustration is of interest as indicating the extended use of chain gearing. Whereas 10 years ago 50 h.p was considered a fairly heavy drive for chains, it is now quite usual to transmit up to 200 h.p. by this means. Higher powers still may be transmitted by standard chains using several strands, but the difficulty with this method is that the load may not be evenly distributed over all the chains.

The illustration shows two drives, each designed for transmitting 200 h p by two chains, and an even distribution of the load is assured by the special type of driven wheel This wheel is of the compensating type, and consists of three main parts—viz.: boss with eight arms; two rings bolted to the arms; two outer toothed rings, one



for each chain. The outer and inner rings have projecting lugs, between which are fitted suitable springs. The toothed rings are independent of each other, and act separately on their own sets of springs, so that if one chain tends to take more load than the other, it simply closes its set of springs until the load is equalised. In addition to this compensating effect the springs absorb irregularities in the load, so that there is less wear and tear, not only in the chain gear, but also in the electric motor, as the latter is freed from the vibration which would be set up by a train of spur gearing. The cover has been removed from one of the wheels in order to show its construction, and it will be noted that the springs are of two sizes, which are placed alternately. The larger set transmit the power and the smaller soften the recoil.

Messrs. Hans Renold, Limited, the designers and makers of the chain drives, say these are the largest spring whee that have ever been made for chain driving—each weighs about two tons. The drives are part of an installation to transmit over 500 h.p. for a coaling plant supplied by Messrs. Head, Wrightson, and Co., Limited, of Thornaby-on-Tees, for a tidal dock in Japan. The chains shown drive hauling drums from electric motors, and are in use about 140 hours per week. The pinions have 28 teeth and are 15¾in. diameter, the large spring wheels have 108 teeth and are 60in. diameter, the width being 17½in. The driver wheel makes 286 r.p.m. and the driven 74, so that the ratio is practically 4 to 1, and the chain speed 1,170ft. per minute. The chains are 1¾in. pitch and 8in. wide, the centre distance being 11ft. 5in. Each chain has a breaking load of 70,000lb., and the total pull on the drive is 5,650lb., giving a factor of about 25 with the two strands.

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THE MANUFACTURE OF ELECTRICAL CONDENSERS.*

BY G. F. MANSBRIDGE, MEMBER.

(*Continued from page 771.*)

Now with respect to these short-circuits or disruptive discharges, however produced, condensers made of foiled paper have the peculiar advantage of possessing to an almost perfect degree the property which in a pneumatic tyre is called self-sealing, and consequently they are practically proof against short-circuit, and can be subjected to much higher voltages than is permissible with those made from metallic foil, any momentary short-circuits produced by a disruptive discharge being instantly and automatically sealed. This automatic sealing is brought about in the following way: owing to the extreme thinness of the conducting film, the small quantity of heat generated at the point of short-circuit by the sudden discharge of the condenser through that point is sufficient to cause the film of metal immediately surrounding the point of breakdown to be fused into minute globules. The segregation of these globules from each other and from the surrounding metallised surfaces effectually isolates the point of breakdown, and the defect is instantly sealed up. So rapid, indeed, is this effect, that if a pin is stuck into an insulated charged condenser so as to produce short-circuits between the foiled papers, the short-circuits seal up without fully discharging the condenser, and a dozen or more of such short-circuits may be created one after the other before the condenser becomes fully discharged. Consequent upon the observation of such an effect as this, the author conceived the idea of electrically treating the foiled paper before making it up into condensers in such a way as practically to eliminate all pinholes or defective places by subjecting them momentarily to currents of such strength as to produce a minute non-conducting ring round each defect, thereby isolating it from the surrounding surface (U.K. Patent 22,139, 1905, G. F. Mansbridge). The apparatus for doing this is of the simplest character. All that is necessary is to pass the paper, foiled side uppermost, over a conducting roller and to maintain a suitable potential difference between the roller and the foiled surface. When any pinhole or weak place in the paper reaches the roller a short-circuit occurs, and the momentary rush of current, concentrated round the defect, produces a bright spark at the defective spot on the foiled surface. As in the case of the finished condenser, the effect of this spark is to isolate the defect by volatilising or fusing the film of metal immediately around it. In this way all the weak places in the dielectric are detected and isolated before the paper is brought into use, and, in consequence, it is possible to use thinner paper, both foiled and plain, than would otherwise be safe. The process of isolating or removing these faults is quite automatic, and the apparatus once set requires practically no adjustment; all that is necessary in this respect is to see that the current at the moment of short-circuiting is sufficiently strong to fuse the metallic film in the immediate neighbourhood of the defect, but is not so strong as to burn the paper. If current from lighting mains is employed, a series resistance is necessary to limit the short-circuit current. With 100 volts this resistance should be about 15 ohms, and with 200 volts about 150 ohms. Experience shows that the searching effect of the voltage is increased by connecting a condenser of considerable capacity—say 20 microfarads—across the potential terminals, but a series resistance of about 50 ohms in the condenser circuit is needed to tone down the suddenness of the condenser discharge.

The values given above for voltage, capacity, and resistance are in no sense "critical," and they may be varied considerably without seriously affecting the result. In adjusting the values the best conditions may easily be found if regard be had to the fact that the result desired is the production of a small uncharred hole surrounded by a minute ring of perfectly clean white paper. Fig. 1 is a microphotograph of a typical "breakdown" point after treatment by the afore-mentioned process. The hole made by the spark is shown as a dark spot, and the ring of paper from which the metal has been completely removed may be seen round the hole, although the want of contrast between the polished metallic surface and the white paper renders the ring somewhat indistinct in the photograph. As the process of eliminating these defective places in the paper is largely one of breaking down the weak spots, the operation is generally described as the "breakdown process." The voltage used may conveniently be one-half of that with which the finished condenser is finally to be tested—that is, if only single interleaving papers are to be used. If the

FIG. 1.—Micro-Photograph of a "Breakdown Point" after Electrical Treatment.

condensers are to be made for 1,000 volts or thereabouts it is necessary to use double or treble interleaving papers, and in this case the obvious course is to fix the breakdown pressure at a figure which will result in the dielectric of the foiled paper being strained during the breakdown process to an extent rather greater than will be the case when it is finally used. The author's experience is, however, that the majority of defects are shown up and removed by a comparatively low voltage, and that there is little to be gained by using more than 200 volts for this process if the condensers are for telephone or telegraph work.

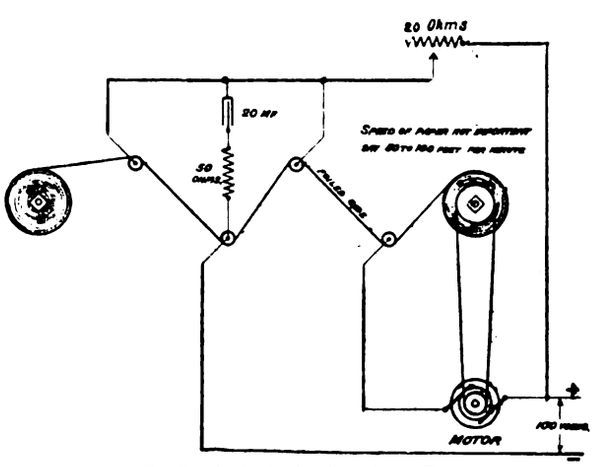

FIG. 2.—Device for treating Tinfoil Paper.

As regards the direction of the current, there appears to be little to choose. If anything, the preference may be given to connecting the positive pole to the plain side of the paper, but the device works quite satisfactorily with alternating current. When the breakdown device is driven by an electric motor, it is of advantage to have two rollers making contact with the foiled side of the paper at separate points, preferably not less than 2ft. apart. The current driving the motor may then be led along this strip of foiled paper between the two rollers, so that should there be any break in continuity in the foiled surface the current driving the motor would be broken when the fault passed the first roller, and the stopping of the machine would call attention to the want of continuity. With

* Paper read before the Institution of Electrical Engineers.

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paper made by reputable makers such breaks rarely occur, but there must always be a risk of this, and as the device is simple and automatic it is worth while to adopt it. Fig. 2 shows the connections of the breakdown rollers as arranged for motor driving. If the apparatus is mechanically driven, a suitable relay may be connected between the second and fourth rollers, so that a local circuit is completed and a bell rung whenever there is any break of continuity between the two rollers. Joints in the paper may have to be made from time to time. These must, of course, be made electrically continuous, and a simple way of effecting this is, after the ends have been joined by lapping and pasting in the ordinary way, to paste on to the foiled surface a 6in. strip of foiled paper placed face downwards, so that part of the foiled surface of the strip makes contact with one side of the break and part with the other. It is not desirable to paste the whole of the surface of the strip, since the continuity of the film may thereby be destroyed; the usual plan is to paste merely the edges on each side, leaving the middle portion clean. Good flour paste is found to give satisfactory results.

(To be continued.)

A NEW FORM OF MARINER'S COMPASS.

M. Dunoyer has devised an interesting form of electromagnetic compass which is described in a recent number of *La Revue Electrique*. It consists of two coils mounted on a common axis and each connected to a two-part commutator,

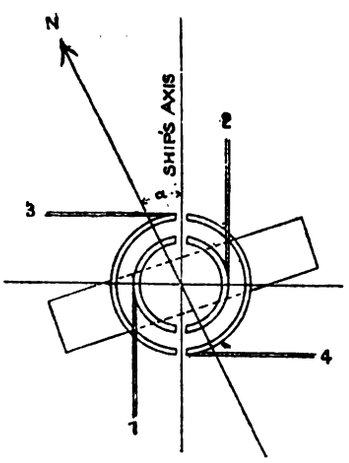

FIG. 1.

and kept rotating continuously in the earth's field by a small motor. The alternating currents induced in each coil are commuted, and the mean value can be indicated on any form of direct-current galvanometer. The brushes on the two commutators are set so that the commutation axis for one is in line with the ship's axis and that of the other is at right angles to this axis. If, now, the ship's axis deviates by an angle α (Fig. 1) from the magnetic meridian,

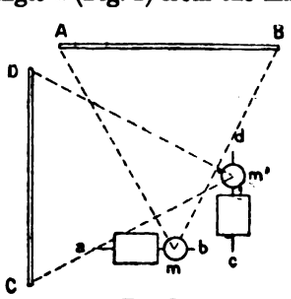

FIG. 2.

the mean current of one coil will be proportional to sine α and that in the other coil to cosine α. The ratio of the two currents is, therefore, quite independent of the actual strength of the field or of the speed of rotation, and forms an exact measure of the angle α. For the purpose of recording this ratio at every instant, two moving coil pivot-suspension reflecting galvanometers are employed. The axes, $a\ b$ and $c\ d$ (Fig. 2), of these galvanometers are in the same plane, but at right angles to one another. Two straight-filament lamps, A B and C D, throw their beams on to the two mirrors, $m\ m'$, and these are reflected on to a common screen marked with the points of the compass. With no current in the galvanometer the setting is such that the images of the two filaments cross at the centre point. As soon as the coils are rotated and the galvanometers connected, each spot is deflected by an amount proportional to the main current in the corresponding coil,

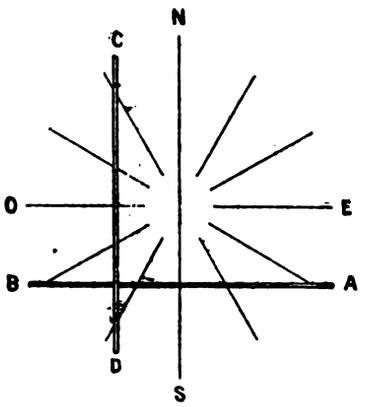

FIG. 3.

and the crossing point moves away from the centre on to some particular radius depending on the angle α. Variations in speed of rotation or in the value of the field alter the positions of the images, but their crossing point remains on the same radius. In actual practice this form of compass has been found to indicate accurately within about 3deg.

THE EFFECT OF ALTERNATING CURRENTS ON TANTALUM LAMPS.

An explanation of the shortened life of tantalum lamps on alternating circuits is given by Signor Scarpa in *Elektrotechnik und Maschinenbau*. He suggests that it is due to rapid mechanical vibration set up by electrodynamic action in the long straight parts of the filament. This gradually induces a crystalline state of the material, and numerous points of breakage occur in the filament. The writer made experiments with a microscope having a micrometer eye piece, and sending first a direct current and then an alternating current through the lamp whilst under observation. The apparent thickness of the filament was double as great with the alternating as with the direct current, owing to the rapid vibration set up. At the same time the brightness of the filament appears greatest at the outer edges. The apparent thickness also varies periodically in accordance with the natural frequency of the filament. With vertically arranged U-shaped carbon filaments the vibrations could be noticed by eye. The writer is of opinion that in the osmium lamps the vibrations are considerably less than in the tantalum lamps, owing to the smaller weight and increased damping, and this explains the longer life of the former. In order to eliminate this effect of an alternating current as far as possible, the parts of the filament should be kept equidistant everywhere, so as to delay the crystallisation.

BLEACHING FLOUR BY ELECTRICITY.

Mr. F. J. Postel recently addressed a meeting of the Electrical Club, of Chicago, on the subject of "Bleaching Flour by Electricity," a report of which appeared in the *Electrical World*. The art of bleaching flour in this way began with the discovery that flour when passed through air containing considerable ozone became bleached or whitened. Before this process came into common use among millers, flour was graded very much according to its colour, the whitest flour bringing the best price. With the bleaching process it is possible to sell naturally darker grades of flour at the best prices. Chemical analysis

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reveals no change in the flour due to the bleaching, although it is claimed that the bleached flour will keep and bake somewhat better than the unbleached.

According to Mr. Postel's history of the development of apparatus for manufacturing ozone and bleaching flour, considerable effort was wasted in the early days of the process by lack of electrical knowledge on the part of the inventors. Much secrecy was maintained about the apparatus used in the process at first. Several rival companies came into the field with different apparatus for producing ozone, or nitrous acid. One of these is a chemical process. The companies exploiting electrical processes have all been absorbed by one company—the Alsop Process Company, of St. Louis. This company makes a simple outfit consisting of a small dynamo which is connected in series with an inductance coil. The circuit is made and broken by a reciprocating make-and-break device, which also works an air-pump for forcing air through the chamber in which the make-and-break occurs. This results in a series of flashes which generate ozone in the air being pumped through the chamber. The air is then piped to places where the flour is falling in streams for exposure to the gas. Another advantage which, from the consumer's standpoint, bleached flour has, is that the miller can use certain nutritive parts of the wheat in ordinary white flour which heretofore he was accustomed to eliminate from the best white flour because they made the flour dark and unsaleable.

200,000-VOLT INSULATORS.

The following is a summary of some experimental work done upon the suspension type of insulator manufactured by the Locke Insulator Manufacturing Company, of Victor, New York, whom Messrs. Geipel and Co. represent in this country.

The underhung insulator as first developed consisted essentially of several conventional type line insulators, and these when tested gave such excellent results that it was quickly recognised as the proper method of insulating extra-high potential lines. Since lines erected in this manner are usually of considerable importance, the matter of mechanical weakness was first under consideration, and as the conventional type line insulators have no great amount of strength in tension some new development was necessary. This feature was first taken care of by using a single shell of porcelain, on the outside of which was cemented a metal cap and on the inside of which was cemented an eye-bolt. Mechanically, the device was very nearly ideal, since mechanical strength in excess of 20 tons could be readily obtained, but electrically the device is not a

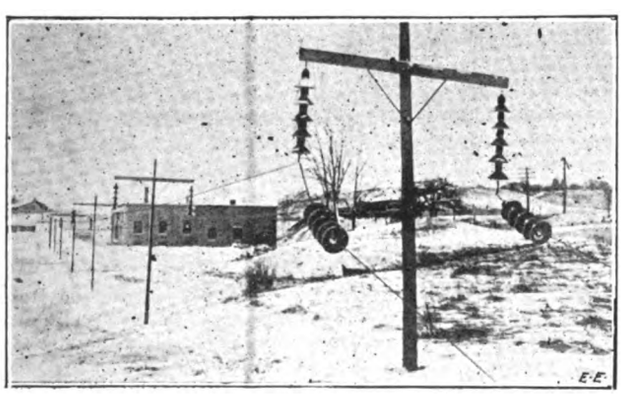

FIG. 1.

success when built in this manner, since the condenser effect causes a piling up of potential around the end units, and if made of reasonable size will be found not to have dielectric strength comparable with the flash-over potential. For this reason it was found necessary to introduce two pieces of porcelain which could be made thin, and, therefore, of good quality, and would permit of great electrical test—approximately 100,000 volts—being applied upon the unit. Also, it added materially to the leakage distance of the whole device. The shells of this underhung insulator were tested to flashing-over potential for about five minutes before assembling, and after assembling the unit was tested to 100,000 volts for a period of five minutes. A mechanical test of 5,000lb. was then applied to the device in order to find assurance that the porcelain and cement had been properly put together and were of good quality.

The mechanical features of this insulator are not without interest. It will be noted that each of the shells is recessed on the inner side, and that inner connection is made by means of a "U" bolt, which springs out in the recess, and then the annular space is filled with Portland cement, which is allowed to obtain its permanent set under water. Analysing the mechanical strains which fall upon this sort of a joint, it is found that from the upper end of the "U" bolt strains may be transmitted at 45deg. through the porcelain and cement to the expansion cap which supports the whole device through throwing the porcelain into compression and permitting of the development of any desired mechanical strength. The device shown in Fig. 1 has a mechanical strength, ultimate, of something in excess of 14,000lb., though for this excessive value the cement should be allowed to set for several weeks under water. The insulator will normally be used in a vertical position about 25,000 volts per unit, four units bein allowed for a 100,000-volt

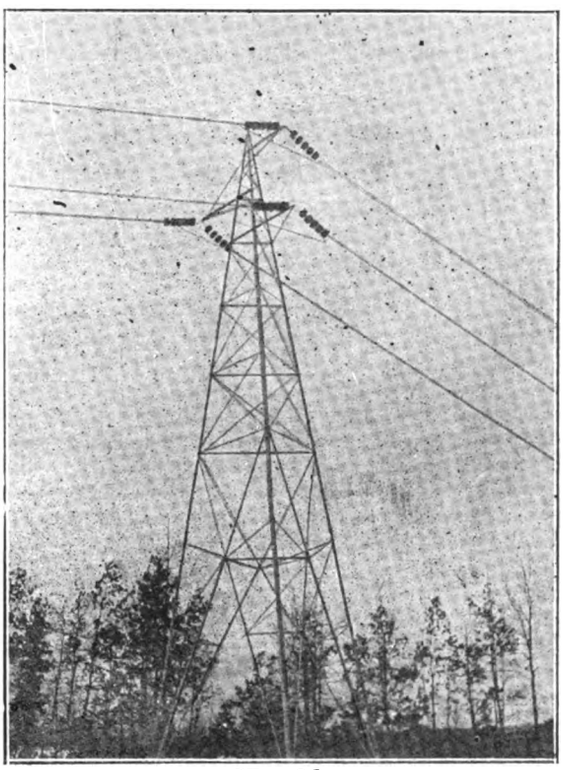

FIG. 2.

star-connected line. For corners it will, of course, be necessary to use the insulators in a horizontal position to by-pass the line wire, as shown in Fig. 2. The illustrations also show the experimental line which has been operating at Victor for a period of several months at 200,000 volts.

HULL TELEPHONES.

The following is a summary of the statement of accounts for the year ended March 31, 1908, which the city accountant submitted at a meeting of the Hull Corporation Telephone Committee:

During the year the expenditure on capital account had been £1,882. 13s. 10d., which made a total of £54,747. 7s. 9d. The year's revenue had amounted to £9,567. 9s. 3d., and the expenditure £5,596. 5s. 5d. The interest on loans and repayment charges amounted to £2,916. 2s. 10d., leaving a net profit of £1,055. 1s. In accordance with the committee's resolution of April, 1907, the balance on net revenue account at March 31, 1907, had been applied during the year to the following purposes: preliminary expenses (capital account) written down, £214. 1s. 2d.; transfer to reserve fund, £1,577. 14s. 2d. The income from rentals again showed a steady increase upon the previous year. The reduction in the profit was due to increased cost of maintenance and repairs, and to additional payments in respect of royalties, rents, rates and taxes, and increase on loan charges. The reserve fund had been credited with the interest earned during the year, and now stood at £1,633. 18s. 7d. In addition thereto, a balance of £1,055. 1s. remained on the net revenue account.

Mr. A. R. Bennett, the telephone engineer, also presented his annual report, in which he said that the total conduits laid now measure 34 miles 1,671 yards, and the underground mileage equals 3,578 miles 1,064 yards metallic circuit, or 7,157 miles of single wire. The total overhead mileage is now 518 miles 1,223 yards of metallic circuit, or 1,037 miles of

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ingle wire. The cost per station now stood at £22·36, as compared with £24·04 last year, and that amount would further decrease as more of the spare cable and plant became occupied. The amount carried forward for unexpired rentals equalled £4,250, compared with £4,391 last year. At first sight it would appear that the revenue would decrease, but that difference was due to proportioning the whole of the Corporation telephone rentals to March 31, and the revenue due for this year had already exceeded £10,000.

The report was adopted by the committee.

INSTITUTION OF ELECTRICAL ENGINEERS.

Annual Premiums and Awards

The Council have awarded the following premiums and prizes for papers and communications made during the past session:

The Institution prize, value £25, to Messrs. Gerald Stoney and A. H. Law for their paper on "High-Speed Electrical Machinery."

The Paris Electrical Exhibition premium, value £10, to Mr. J. S. Peck for his paper, "Protection Devices for High-Tension Transmission Circuits."

An extra premium, value £10, to Mr. J. F. C. Snell for his paper, "The Cost of Electrical Power for Industrial Purposes."

An extra premium, value £10, to Dr. A. Russell for his paper, "Dielectric Strength of Insulating Materials and Grading of Cables."

An extra premium, value £10, to Dr. W. W. Haldane Gee for his paper, "Electrolytic Corosion."

An extra premium, value £10, to Mr. T. M. Barlow for his paper, "Heat Conductivity on Iron Stampings."

A first students' premium, value £10, to Mr. H. R. Speyer (Frankfort-on-Main) for his paper, "The Electrification of the Mansfield Copper Mines."

A second students' premium, value £8, to Mr. L. H. A. Carr (Manchester) for his paper, "Electricity and Matter."

Three students' premiums, value £5 each, to Mr. A. Hamilton (Glasgow) for "The Brown-Mackenzie System of Electric Block Signalling"; Mr. H. W. Gregory (London), "The Motor Converter"; and Mr. P. C. Jones (Manchester), "Starters and Control Gear."

The Council have awarded two Salomons scholarships, each of the value of £50, to Mr. Herbert Carnegie, Finsbury Technical College, London, and Mr. Alfred Hutt, Central Technical College, London. A David Hughes scholarship, value £50, has been awarded by the Council to Mr. Clifford Higgins, Central Technical College, London.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The programme for the thirteenth annual convention, which will be held at Nottingham from June 30 to July 3 inclusive, was issued this week. The president of the association is Mr. H. Talbot, Nottingham. The meetings will be held in the University College. The programme for the first day (Tuesday, June 30) is as follows:

10.30 a.m. Meeting at the University College. The mayor (Mr. Councillor Spalding) and the sheriff (Mr. Councillor Carey) have kindly consented to be present and welcome the association. Presidential address by Mr. Herbert Talbot, chief electrical engineer, Nottingham. The following paper will then be read and discussed: "The Experiences of a Convener in the Establishment of an Electricity Undertaking," by Bailie Whiteman, convener of the Electricity Committee, Govan.

12.45 p.m.—Luncheon at the Mechanics' Large Hall by kind invitation of the chairman (Sir John Turney, J.P.) and members of the Electricity Committee. Invitations to the luncheon are issued to members and delegates by the committee, and cannot be obtained of the secretary of the association.

2.30 p.m —Special cars will leave the Mechanics' Hall for the Trent Bridge car-shed and repair shops, and will later take the members to the St. Ann's power station, where tea will be provided. The power stations and car-sheds will be open for inspection at all times during the convention.

The works of the Brush Electrical Engineering Company, Loughborough (14 miles from Nottingham), will be open for inspection during the convention, as will also the generating stations of the Derby Corporation.

Wednesday, July 1, will be devoted to a whole-day excursion to Dovedale. The cost, including railway and brake fares, luncheon and tea, will be 12s. 6d. per head.

Thursday, July 2, is the "big" day. At 10 a.m. the annual general meeting will be held, for which the following is the agenda: (1) Election of president for 1908-9. (2) Place of meeting for convention, 1909. (3) Election of officers and council for 1908-9. The following are the present officers and council (those marked thus * retire and are eligible for re-election; the remainder hold office for another year): president—H. Talbot*; vice-presidents—S. L. Pearce*, W. W. Lackie*; past-presidents—F. A. Newington, J. E. Edgcome, S. E. Fedden; hon. solicitor—Alderman G. Pearson*, hon. treasurer—J. E. Edgcome* (past-president); hon. secretary—H. Faraday Proctor* (past-president); council—Alderman Bruce, J. K. Brydges*, J. Christie, A. A. Day*, Alderman Dowson*, V. A. H. M'Cowen*, H. Richardson*, C. E. C. Shawfield, Councillor Sinclair*, Alderman J. P. Smith, Alderman Sir John Turney, Alderman Wilkinson*, G. Wilkinson, T. P. Wilmshurst. (4) Annual report of the council. (5) Balance sheet. (6) Any other competent business.

1 p.m.—Adjourn for luncheon, Victoria Hotel. (Table d'hote, 2s. 6d.)

2.30 p.m.—The following papers will be read and discussed: (1) "Some Considerations on the Design of a Generating Station," by Mr. H. Richardson, chief electrical engineer, Dundee; (2) "The Reconstructions of an Electric Lighting Scheme," with Observations on the Working of a Combined Steam and Water Power Plant, by Mr. C. M. Shaw, chief electrical engineer, Worcester.

The association dinner (members and their friends) will be held at the Exchange Hall, Nottingham, at 7.30 for 7.45 p.m. Evening dress. Tickets, 7s. 6d. each (exclusive of wine), may be obtained of the secretary before June 22, after which date the price will be 10s.

Friday, July 3, is the closing day of the convention, and the following papers will be discussed at the sitting, which commences at 10 a.m.: (1) "Alternating-Current Accumulator Sub-Stations," by Mr. A. M. Taylor, assistant electrical engineer, Birmingham; (2) "The Work and Equipment of a Testing and Standardising Department," by Mr. H. A. Radcliff, superintendent of the testing department, Manchester Corporation Electricity Works.

Mr. C. McArthur Butler is secretary, and his address is Staple Inn-buildings, Holborn, London, W.C.

INSTITUTION AND SOCIETY NOTES.

Newcastle Local Section.

The following is a list of the nominations to the committee of the Newcastle Local Section of the Institution of Electrical Engineer for the year 1908-9. Those whose names are marked with an asterisk are new members proposed: Chairman—Mr. A. L. E. Drummond; vice-chairman—Mr. W. D. Hunter; past-chairmen—Prof. W. M. Thornton, Mr. H. L. Riseley, Mr. James Pigg; committee—Messrs. J. H. Holmes, G. G. Stoney, G. Ralph,* C. S. Vesey-Brown,* A. S. Blackman, C. Turnbull, F. Tremain, J. A. Anderson,* E. Fawssett,* H. W. Clothier, H. Henderson,* T. M. Clague, W. T. Dalton, A. H. Law, G. S. Whitmore; hon. secretary—Mr. C. Faraday Proctor; hon. treasurer—Mr. W. A. Clatworthy.

Royal Institution.

A general monthly meeting of the members of the Royal Institution was held on Monday, the 1st inst., the Duke of Northumberland, president, in the chair. Mr. Franklin Adams, the Right Hon. the Duke of Devonshire, Dr. W. Heptinstall Millar, Lady Martin, Mr. P. Mavrogordato, and Mr. J. Ziffo were elected members. The chairman announced that he had nominated the following gentlemen as vice-presidents for the ensuing year: the Right Hon. the Earl of Halsbury, Dr. Donald W. C. Hood, Dr. Ludwig Mond, the Right Hon. the Earl of Rosse, Mr. Alexander Siemens, the Right Hon. Sir James Stirling, Sir James Crichton-Browne (treasurer), and Sir William Crookes (hon. secretary).

PERSONAL.

We regret to record the death of Sir John Evans, antiquarian and geologist, who passed away on the 31st ult. in his eighty-fifth year.

The *London Gazette* announces that the partnership between Messrs. J. D. Jones and B. J. Boddington, carrying on business as electrical engineers at 150, Finchley-road, London, N.W., has been dissolved by mutual consent.

The South Shields Town Council have appointed Mr. Edward Harvey, assistant tramways manager, Sunderland, as manager of the Corporation tramways.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

QUESTION No. 1,066.

SIR,—In your issue May 22, p. 737A, second column, about 25 lines from the bottom:

$$\text{H P.} = \cdot 045 + \frac{\text{number of strokes per minute} + \text{stroke in inches}}{4{,}000}$$

Surely the + sign is wrong, and should be × sign.—Yours, etc., G. WARD.

FREE TRIALS OF ELECTRIC LIGHT.

SIR,—It may be of interest to some of your readers to hear of a little scheme which we have just put in hand to assist us in obtaining new lighting consumers. A great argument with a prospective consumer is to be able to give him a trial in his own premises for two or three nights free of charge, without going to the expense of drilling holes and plugging his ceilings, etc., or laying a service in.

We have set up a 20-volt battery, consisting of five four-volt 20-ampere-hour cells in celluloid cases by the Accessible Battery Company, and six 16-volt 16-c.p. Osram lamps complete with opal shades and lampholders, etc. We have a number of 1½in. rubber suckers complete with hooks (similar to those used for window dressing), and by giving these a thin coat of gum they can be made to adhere to a smooth surface for a lengthy period The lamps are hung from the hooks on the suckers, and a flexible is taken back to a main switch and fuses on the battery box.

This arrangement has the advantage that we are able to move the lamps into any position, until we find the most economical and effective lighting point, and by these experiments we are able to guarantee a prospective consumer the cost per hour for his lighting. Nothing pleases a prospective consumer so much as a free trial, and the fact that you give him a free trial immediately increases his confidence in you, and in the majority of cases brings off the order.—Yours, etc., W. H. ALLEN,
Borough Electrical Engineer.

Loughborough, June 1, 1908.

BEACON RESISTANCE WIRE.

SIR,—I shall be obliged if any of your readers can inform me from whom I could obtain "Beacon" resistance wire; and, failing this, if you can tell me the specific resistance and temperature coefficient of this alloy.—Yours, etc., GUY MARSHALL.

88, Warwick-road, Carlisle, June 1.

A LIVE-WIRE INDICATOR.

Messrs. Hartmann and Braun have recently brought out the indicator, shown in Fig. 1, for showing whether direct-current or alternate-current conductors of 1,000 volts and upwards are live or not. It is an electrostatic instrument consisting of a fixed part and a moving needle mounted on centre points. The whole is carried on an insulating handle fitted with a contact point, which can be fixed in either of two positions at right angles to one another.

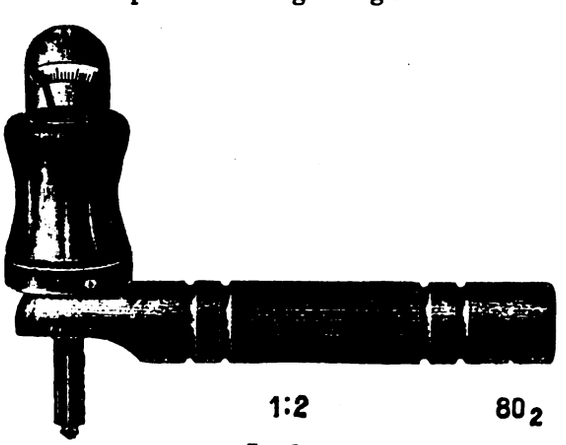

FIG. 1.

The needle and scale are protected from draughts by a glass cover. As soon as the contact point is touched against or brought close to a high-tension conductor, the instrument becomes charged and the needle is repelled across the scale. The effect is accentuated by the presence of the hand on the handle adding to the capacity of the instrument, but the deflection occurs in any case, even with only a single-pole connection. The instrument weighs about a third of a pound.—*Der Elektrotechniker.*

FORTHCOMING EVENTS.

TUESDAY, JUNE 9.

Faraday Society.—At 8 p.m., in the library of the Institution of Electrical Engineers, 92, Victoria-street, S.W., "The Utilisation of Atmospheric Nitrogen in the Production of Calcium Cyanamide and its Use in Agriculture and Chemistry, by Dr. A. R. Frank.

FRIDAY, JUNE 12.

Physical Society.—At 8 p.m., at the Royal College of Science, Imperial Institute-road, South Kensington, "Experiments on a Directive System of Wireless Telegraphy," by Messrs. E Bellini and A. Tosi; "On the Lateral Vibration and Deflection of Clamped Directed Bars," by Dr. Morrow; "On the Resistance of a Conductor of Uniform Thickness whose Breadth suddenly Changes, and on the Shapes of the Stream-Lines," by Prof. Lees; "On the Self-Inductance of Two Parallel Wires," by Dr. Nicholson; "On Homogeneous Secondary Radiation," by Dr. Barkla and Mr. Sadler; "Notes on the Motion of a Corpuscle and on Cloud Formation," by Prof. Morton.

Institution of Electrical Engineers.—Thursday, June 25, annual conversazione at Natural History Museum.

Incorporated Municipal Electrical Association. — Tuesday, June 30, to Friday, July 3, inclusive, annual convention at Nottingham.

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WIRELESS STATIONS ON THE PACIFIC COAST.

Plans have been completed by the United Wireless Telegraph Company to install 11 new wireless stations on the Pacific Coast. The largest, a 5-kw. station, will be at Ketchkan, Alaska. Seven will be installed on the trans-Pacific steamships and three will be land stations, the location of which will be decided later. All except the 5-kw. station will be 1-kw. or 2-kw. installations. At present trans-continental communication is only possible when the conditions are most favourable.

LONDON POWER BILLS.

The case for the Stepney Borough Council in opposition to the London and District Electric Power Bill was heard on Thursday, the 28th ult.

Mr. W. C. P. Tapper, the borough electrical engineer of Stepney, handed in to the committee tables showing that the estimates of the promoters of the Bill offered no advantage to his Council.

Mr. Courthope-Munro presented the case for Shoreditch and St. Pancras. With regard to the latter, he said the Council had invested £500,000 of the ratepayers' money in the electrical undertaking, which had been conducted on business lines, since 1891. It was for the promoters to show public grounds for including the borough in the supply area of the company. No justification had been shown for allowing the competition of the company. Mr. S. W. Baynes, borough electrical engineer of St. Pancras, gave reasons for his opinion that in three or four years the Council would be able to generate electricity as cheaply as, according to their estimates, the company would be able to supply in bulk. Mr. C N. Russell, electrical engineer to the Shoreditch Borough Council, said his Council opposed the form of competition the company might introduce. A bulk supply of the kind proposed was not necessary. The whole matter should be dealt with by the existing authorities, with possibly a central body to control in the interests of London generally.

Mr. Snowden, counsel for the Hammersmith Council, also objected to the nature of the competition the Bill would introduce, and said his Council would be able to meet all future demands.

Mr. Freeman, K C., addressed the committee on behalf of the London County Council, and said that everybody had come to the conclusion that the only way to solve the question once and for all was to give a bulk supply from one large central generating station. The Council did not object to the engineering details of the scheme promoted by this company, because they were to a great extent similar to the details of their own scheme. But counsel criticised the financial details. He said there should be a strong provision to make sure that the Bill should not act as a block against another scheme of supply, and he suggested that conditions should be inserted requiring subscription of £600,000 within 12 months, and substantial progress with works within two years. Further, he criticised the domestic financial clauses advocating the usual sliding scale applied to dividend and prices. He dealt with the purchase clause in the Bill, arguing in favour of the terms laid down in the Electric Lighting Act, 1888, for purchase by the local authority upon the "then value" of the undertaking. The alternative suggested by the promoters was that the auditor from time to time should certify the expenditure of capital. But the difficulty that would arise was that at certain periods before it could be said that plant was worn out it might be superseded by new inventions that a new company would use. An auditor could not determine whether new machinery should be substituted, or whether existing plant was obsolete or not. The Council were strongly in favour of inserting the words of the Electric Lighting Act, which met all requirements. The next proposal of the company that the purchaser should make up the average dividend to 6 per cent. was without precedent. Proceeding, counsel said that the London County Council required the Kitson clause in the form laid down in 1900 modified to suit the area inserted in the place of the promoters' clause, the undertaking to be purchased under the terms of the Electric Lighting Acts, a sliding scale for the division of the surplus profits, and they thought it desirable that when the time came for purchasing, the payment need not necessarily be in cash, but in stocks of good guarantee. Questioned by the chairman, Mr. Freeman said the Council recognised the advisability of establishing a large bulk supply. They were not prepared to undertake the work themselves, and did not oppose the present proposal, though they had objections to the purchase clause. The Council had endeavoured not to make any suggestion that would tend to wreck the Bill. They were not asking more than the public interest seemed to require, and did not wish to suggest anything that would prevent the raising of the capital.

The Chairman here announced that the committee would hear the case for the London Electric Supply Bill before coming to any decision.

Evidence in support of Mr. Freeman's statement was then given by Mr. Felix Cassel, K.C., chairman of the Parliamentary Committee of the London County Council, and Mr. H. E. Haward, comptroller to the London County Council, also gave evidence, and the committee adjourned.

On Friday last Mr. Erskine Pollock, K.C., appeared for the Middlesex County Council, and submitted that Middlesex should not be put into the area of supply. Middlesex might be in a position to institute a similar scheme to this in a few years time. He protested against the proposal that the London County Council should be the purchasing authority in the county of Middlesex.

On Monday, June 1, Mr. Blennerhasset, K.C., put the case for the Westminster City Council. The position of Westminster was, he said, an exceptional one. They had no electrical undertaking at, present, but the Council had power to purchase in 1931 the undertakings of authorities now supplying the district with electricity. They had a splendid site of their own on which they could erect a generating station. They had other advantages, and he asked that no company should be permitted to come into their district to supply power except with the consent of the Council. If the projected company came in, it would be impossible for the municipal authority to exercise their right of purchase Mr. Frederick Pilditch, chairman of the Law and Parliamentary Committee of the Westminster Council, stated that there were seven companies which the Council had the right to purchase in 1931. If these were amalgamated, the Council could supply power from a cental station in Marylebone, which they also had the right to acquire, but if that station was inadequate for the purpose the Council could build another on their own land, on the bank of the Westminster Canal, to which coal could be conveyed cheaply. Answering Mr. Talbot, K.C., representing the promoters, the witness admitted that if the effect of certain clauses was to detract from the value of the existing companies the purchase of these companies would cost so much less.

Mr. Saunders opposed the measure on behalf of the Islington Borough Council, as, he said, it would deprive the Council of their most profitable customers, the consumers of power. The borough had expended £449,000 on their undertaking, and every inducement had been given to consumers, as was shown by the fact that in 1903 there were 76,000 units supplied, and in 1907 1,100,000 units.

Mr. Reader Harris, K.C., on behalf of Ealing and Barnes, asked that they be kept out of the scheme because they would get little advantage from it, and possibly they would suffer damage. Second, they were not necessary to the Bill, and, in the third place, there was no precedent for including them, but many for excluding them.

Sir Ralph Littler, K C, on behalf of the city of London, asked that the promoters should not be allowed to come into the City to tear up the streets, a proceeding which would lead to indescribable inconvenience and confusion, and great loss to business people. In 1914 the City would be in the position of being able not only to supply electricity, but they would have the means of generating it. If necessary the City could take a bulk supply from the proposed company, which would have stations outside the City. He did not call any witnesses for the city of London.

Mr. Pryor, giving evidence on behalf of the Westminster

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and St. James's and Notting Hill Electric Companies, expressed the opinion that the state of the money market would not permit of £3,000,000 being raised within the time specified for the scheme.

On Tuesday Sir A. Kennedy, engineer to the Westminster Company and joint engineer to the Central Company, gave evidence in support of the petition of the Westminister, St. James's, Kensington, and Central Companies against the Bill. He said the Bill would be of no benefit to the West-end non-industrial area. The power users were scattered over a wide area, they took but small quantities, and, commercially speaking, it would not be worth while for a new company to lay a new system of distributing mains; the promoters had made no provision for such expenditure. The areas of the West-end companies should be excluded from the Bill as they were excluded from the Administrative Company's Bill.

The Hon. Sydney Holland, on behalf of the four companies supplying the West-end, said circumstances had greatly changed since the Bill of the Administrative Company was introduced, and as the result of the inquiry upon that Bill the companies were now ready and willing to provide for any demand for electrical power, and there was now no evidence that the price in London was so high as to restrict the use of electricity for power purposes. The Administrative Bill had a very strong financial backing from 64 promoters. On behalf of the companies he claimed that their areas of supply should be excluded from the field upon which the new company proposed to operate, because the existing companies, having raised their capital under parliamentary conditions, should not now be subjected to unfair competition from a company having no similar obligations, a more favourable purchase clause, a longer lease of life, and powers of outside supply. On broad grounds the promoters had not proved their preamble and had put forward no evidence to justify the intrusion of this disturbing influence into the London electric world.

Mr. J. Falconer, who was chairman of the company promoting the Administrative Company's Bill, was called by Mr. Balfour Browne, K C, on behalf of the eight companies opposing the present Bill, to explain why the earlier project was given up. In the course of last autumn a meeting of the promoters of the Administrative Bill was held, and, upon full consideration of all the circumstances, there appeared to be no reason to suppose the Bill, if passed, would be a commercial success. The circumstances had materially altered from a commercial point of view. In 1905 the average price for electricity for power purposes in London was 2d. per unit, and the promoters of the Bill of that year, after having had an elaborate engineering scheme prepared, came to the conclusion that they could supply at ¾d. with good business profit. At that time the existing companies and local authorities were not in a position to compete effectively with plant such as the promoters were prepared to set up. But when they reconsidered the position eight months ago the conditions were entirely altered. Companies were prepared to supply at 1d., and it was found that they had made contracts with consumers ranging up to seven years. In 1905 the promoters had agreements with nearly all the companies in the industrial area on terms that could not possibly be repeated now, agreements that they should not extend their plant, but take a bulk supply on arbitration terms at a price less than the plant would cost. After three years the promoters foresaw, under pressure of public opinion, that the cost of electrical energy had been so reduced that there was no longer the prospect of success there was in 1905, and, therefore, the promoters decided not to reintroduce their Bill and to wind up their company. They were satisfied they could not put forward proposals that would enable them to get the strong financial backing essential for such an undertaking. The financial position had the main influence upon the decision not to revive the project.

Mr. J. Conacher (manager for the Metropolitan Electric Supply Company) gave evidence on behalf of the eight companies, which was continued on Wednesday. In his view the bulk supply of electricity in London should be in substantially the same hands as now.

STEPNEY ELECTRICITY ACCOUNTS.

Mr. W. C. P. Tapper, as engineer and manager of the electricity works, has just submitted to the Electricity Supply Committee of the Stepney Borough Council his annual report on the results attained by the department under his control during the year ended March 31, 1908. The revenue account for the year under review is summarised in the following table:

Income.

Sale of current for private lighting, power, and heating	£32,886	11	0
,, ,, ,, public street lighting	5,768	15	3
	38,655	6	3
Less irrecoverables	73	1	11
	38,582	4	4
Miscellaneous receipts	28	8	7
Rentals of meters and other apparatus on consumers' premises	393	2	3
Public lamps—attending and repairs	2,355	9	10
Rent receivable	90	0	0
	£41,449	5	0

Expenditure.

Generation	£15,847	15	11
Distribution	840	12	4
Public lamps—attending and repairs	2,355	9	10
Rents, rates, and taxes	1,801	1	5
Management expenses	3,136	6	3
Parliamentary and legal expenses	207	2	6
Special charges	158	8	6
	24,346	16	9
Balance, being excess of income over expenditure	£17,102	8	3

After meeting all charges there is a net surplus of £1,928. To this, however, should be added for comparative purposes £1,219, which has been charged to net revenue account in respect of interest accrued on capital account to March 31, and is in addition to a full year's interest. The net profit, therefore, on the same basis as previous years is £3,147, an increase over last year of £753, in spite of a decrease of 7 per cent. in the revenue per unit, the latter being 1·62d. per unit against 1·74d. last year. The reserve fund has been credited with £1,000.

The table of statistics which appears in the report shows that the units generated during the year have reached 6,438,592, an increase of no less than 1,160,694 over the previous year. The maximum load slightly exceeded that estimated for the year, reaching 2,831 kw., being an increase of 417 kw. The units sold also show a very substantial increase—the highest since the opening of the station—the total sales being 5,712,684 units, 961,502 units in excess of last year's sales. The greater part of this increase has been for power purposes, and is extremely satisfactory in that it provides a good load in the daytime, which is especially welcome during the summer months, when the plant would otherwise be standing more or less idle. Another satisfactory feature has been the 30-watt lamp equivalents connected during the year—viz., 58,448. This is in excess of all previous years, and brings the total connections up to 245,581.

With reference to the new metallic-filament lamps, Mr. Tapper says: "The outstanding feature of the year, from the lighting point of view, has been the adoption by a very large proportion of the consumers of the new metallic-filament lamps. These lamps mark an enormous advance in the utilisation of electrical energy for lighting purposes, the saving in energy per candle-power being from 50 per cent. to 75 per cent. of that taken by the carbon-filament lamp, according to the type adopted. The new lamp results in as great an economy in the use of electricity as that effected in the consumption of gas by the introduction of the gas mantle, and at the extremely low prices ruling in Stepney to long-hour users electricity is undoubtedly cheaper than gas for equal candle-power. To the use of these lamps must be attributed the reduced increase in the sales for lighting purposes, in spite of the very much larger number of lamps connected."

BURTON CORPORATION ELECTRICITY AND TRAMWAYS DEPARTMENT.

We have received from Mr. P. J. Pringle, the borough electrical and tramways manager, copies of his reports to the Burton Town Council on the work of the department under his charge during the year ended March 31, 1908.

Electricity.

Dealing first with the electricity department, the balance sheet shows a surplus for the year under review of £1,104. 10s. 9d. compared with £793. 11s. 11d. last year. Of this surplus, £636.

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1s. 10d. has been appropriated to wipe off capital expenditure and £468. 8s. 11d. has been carried to renewals fund. Last year the amount wiped off the capital expenditure amounted to £309. 10s. 7d., and £484. 1s. 4d. was carried to renewals fund. The increased surplus this year is particularly satisfactory in view of several adverse conditions that have had to be met. The average price of fuel compared with last year has increased 33·7 per cent. and this has reduced the surplus by approximately £580. The high-efficiency metallic-filament lamp has reduced revenue in many directions, and the cold summer caused £250 less revenue to be derived from Messrs. Bass and Co.'s motor demand. The depressed state of trade has, in addition, affected the lighting and motor demand and the expansion of new business. It will be seen, therefore, that if conditions had been normal Mr. Pringle would have had an exceedingly satisfactory year to record. The gross profit has increased from £5,828 last year to £6,117 this year, and amounts to 7·5 per cent. on capital expenditure, and the sinking fund contribution amounts to 3·36 per cent. on capital. Both of these figures may be considered satisfactory as compared with a good many undertakings. This year there has been a larger increase in units sold than ever before, excepting the first year of the tramway load. The sale of motor units has increased by £404. 12s. 2d., and this load is now almost as important as the traction load for the Corporation tramways. Motor unit sales amount to 412,384, and tramways (excluding the light railway consumption) to 514,423 units, The motor unit sales now exceed the lighting unit sales by 22·5 per cent. New lamp connections for the past six years are as follows: 1902-3, 1,500; 1903-4, 2,573; 1904-5, 3,365; 1905-6, 1,704; 1906-7, 1,341; 1907-8, 1,659. Notwithstanding the further depressed condition of trade, a greater number of lamps have been connected than last year, principally owing to two of the staff being employed in their spare time as canvassers.

The increased sale of tramway units is principally due to having 12 months' running of the Burton and Ashby cars against nine months last year, and the Corporation's own consumption being increased from 1·16 to 1·19 units per car mile. Out of 72 corporation tramways, there are only 18 showing a slightly lower consumption per car mile. The works costs and total costs per unit for the last six years are set out below, and also the grand total costs, which include capital costs.

	1902-3. d.	1903-4. d.	1904-5. d.	1905-6. d.	1906-7. d.	1907-8. d.
Fuel	·39	·36	·33	·302	·317	·39
Oil, waste, water, and stores	·10	·06	·06	·061	·056	·06
Wages	1·12	·47	·31	·303	·251	·209
Maintenance and repairs	·26	·25	·29	·203	·197	·153
Works costs	1·87	1·14	99	·874	·821	·612
Rents, rates, and taxes	·40	·23	·15	·155	·140	·127
Management	·26	·15	·17	·163	·129	·116
Total costs	2 53	1·52	1·31	1·192	1·090	1·055
Capital charges	2·48	1·24	·97	1·035	1·037	·86
Grand total costs..	5·01*	2·76	2·28	2·227	2·127	1·915

* Tramways not running.

Out of a total of 737·25 h.p. in motors connected 481·75 h.p. is on the restricted-hour principle. This is the supply of power which is entirely cut off during the hours of peak load in the winter months, so there are no generating station or mains capital charges to allocate to this load. This power is sold at 1d. per unit down to ½d., and the mean price at which the 412,384 motor units has been sold is ·99d. per unit. This system has been introduced for two winters, and its effect on the load factor on the alternating-current side of the system is as follows:

Load factor—	1903-4.	1904-5.	1905-6.	1906-7.	1907-8.
Lighting and motor (alternating current)	—	9·84	9·67	12·7	16·6
Traction	—	28·3	25·3	18·0	19·75
Combined	*12·5	16·7	14·92	15·0	17·93

* Eight months only.

It will be seen that the load factor for this year has increased by 30·7 per cent. This year the department has connected on 48 kw. of lighting and 257 h.p. in motors, but the maximum demand on the station has only increased from 511 kw. to 515 kw. During the past two years in which this system has been introduced there has been a total increase of 78 kw. lighting and 477 h.p. in motors, representing an increase of 36·7 per cent. in total connections, while the maximum demand at the station has only increased from 492 kw. to 515 kw., or 4·67 per cent., and the units sold have increased 79·9 per cent. and the load factor improved 71·6 per cent. It will be noted that the output of motor units for this year has increased 30·9 per cent., and the revenue from restricted-hour consumers amounts to £1,010.

Tramways.

The tramways report is not so satisfactory. The gross revenue account for the 12 months shows a surplus of income (£15,921. 18s. 5d.) over expenditure (£11,176. 11s. 6d.) of £4,745. 6s. 11d., compared with £5,012. 1s. 6d. last year, and represents 5·1 per cent. on the capital expenditure. The repayment of debt and interest charges amounts to £4,866. 10s. 6d., compared with £4,889. 0s. 5d. last year. After paying interest (£2,750. 6s. 3d.) and contributing £1,282. 11s. 5d. to redemption fund and £784. 10s. 10d. to sinking funds and £1,000 to renewals fund, there is a deficiency for the year of £1,121. 3s. 7d. Mr. Pringle comments upon the way the revenue has gone down from year to year, although important reductions have been made in the operating expenses, and he attributes this entirely to the serious trade depression in the town. It is obvious that if the tramways had been able to maintain their revenue their financial position would have been distinctly favourable. The committee are following a bold and sensible policy in again providing £1,000 as a renewals fund, notwithstanding that apart from this there is a small deficit.

A brighter feature which may be emphasised in connection with the Burton tramways is the success of trials with the groove skid emergency brake, the invention of the capable manager, Mr. P. J. Pringle. The matter of equipping the Burton cars with this brake is to be formally discussed by the Tramways Committee, but we learn that the committee in any case propose to fit up six of the cars which operate on the dangerous gradient route, and that they may in addition decide to equip the whole of the remainder of the cars. It may be of interest to mention that the general manager, chairman, and vice-chairman of the Huddersfield tramways made an inspection of this brake last week.

CONSULAR REPORTS.

Batoum (Russia).

In his report on the trade of Batoum and district for the year 1907 Mr. Consul Stevens makes some remarks on the machinery employed in the oilfields which might be commended to the notice of British electrical manufactures. Mr. Stevens notes that the demand for all class of machinery was fairly brisk at the oilfields during 1907, and it is satisfactory to note that the imports of British material compare favourably with the last few years. Until lately, he says, nearly all electrical appliances were supplied by Germany, but in 1907 several British firms entered the market with fair success. Electrical power, he points out, has been considerably used on the oilfields, its great advantage being economy of space. Mr. Stevens mentions a recent rival to electrical motors which has appeared in the form of natural-gas motors. By means of a conduit pipe the gas issuing from the well is collected and used as fuel for the motor.

Rome.

Mr. Consul Morgan's report on the trade of Rome and district for the year 1907 is noteworthy for an interesting paragraph on the local tramways, which we give herewith. Roman trams, says the report, have tried to keep pace with the extension of the city, but local topographical conditions are not very favourable, both on account of the hilly character of the town itself as well as of the narrowness of some of its old streets. The tramway company complain in their last annual report that their efforts to extend the service does not find a satisfactory response on the part of the municipal authorities, who seem either slow or reluctant in sanctioning the desired new concessions, notwithstanding the fact that during 1907 the tramway company, pursuant to an existing agreement, contributed to the municipal funds a sum of £27,572, their share of the year's profits, as against £27,346 distributed among the shareholders. The passenger traffic on the lines seems to be increasing regularly: 1903, 27,356,019; 1904, 31,256,405; 1905, 35,018,967; 1906, 36,239,511; 1907, 43,849,585. Since the issue of the tramway company's report, the mayor of Rome has made a statement embodying the views of the administration in regard to the tram service. The Muncipality does not contemplate buying out the existing company, but will construct lines of its own. It is generally held that the public will benefit by a competition of that kind. A similar statement was made with regard to the gas supply.

Poland and Lithuania (Russia).

Some extracts from the consular report on the trade of Poland and Lithuania for the year 1907 show that, in spite of the unsettled condition of the country and the inevitable industrial dislocation which follows from political chaos, there is still scope for foreign industrial enterprise. Mr. Consul St. Clair reports that the number of subscribers to the telephones in Warsaw is rapidly increasing. Within the course of six years the number has increased by 414 per cent., and now amounts to about 11,000. As the central telephone station is only constructed to provide for 13,000 members, it is proposed to erect another station in the near future. Manufacturers and merchants complain of the very high fee, which is £7 a year, and efforts are being made by them to have it reduced to £3. The Warsaw-Lodz

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line is little used, as it is often more convenient to use the telegraph ; 75c. is paid for three minutes' talk. Besides this it is difficult to talk, as the Lodz telephones are of an old type. The authorities have taken up the matter, and it is intended to supply the line with new telephones.

It was expected that the electric trams would run at the end of the year, but there has been much delay and there is still plenty of work to be done, although the rails are already laid almost everywhere. It is intended to start omnibuses, which will begin to run at the same time as the tramcars, and will circulate throughout the town. There will be 80 altogether and 320 horses. The omnibuses will be made by transforming old tramcars.

In the second half of the year the larger streets were illuminated by electric light, but these works also were much delayed, and the electric company asked the authorities for a postponement up to July, 1908. The company themselves sustained losses by the delay amounting to £1,700. Electric lighting was introduced at Warsaw by degrees, at first only in 40 streets where the rails for electric trams were laid. In view of this the output of gas considerably diminished. The gas-works, however, did not dismiss their men for fear that troubles might ensue, but the number of working days per week was reduced to four. At the same time the gas company decided to extend gas lighting to the outskirts of the town where no electric light has been installed.

COMPANIES' MEETINGS AND REPORTS.

URBAN ELECTRIC SUPPLY.

The annual general meeting of the Urban Electric Supply Co. was held on Wednesday, Mr. P. D. Tuckett, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said that the progress made had not, on the whole, been as rapid as might be wished, but it was substantial, and the results were better than the net profit might suggest. There was an increase of £3,323, or about 10 per cent. in the gross profit, but against this, in addition to increases under the heads of head office expenses, travelling, debenture interest, etc., there were exceptional items charged. The net result of the year's work was that the contractors had been called upon to find £73 less than last year under their guarantee, which seemed a small advance, until consideration was given to the exceptional item of £2,200, to which he had referred, and to the additional outlay on coal, which amounted to £672. With these points in view, the results were not so unsatisfactory as might appear at first sight. The directors were doing all they could to discourage the locking up of capital in free wiring, which, however, had its advantages, especially at places where houses were commonly taken on three years' agreements, and consequently some assistance had to be given in wiring premises to secure the use of electric light at all. Speaking of the prospects, the Chairman said that the industry was passing through a period of transition between the extravagant hopes of a few years ago and the solid and permanent prosperity of years to come. The industry was thoroughly well established and progressive. With regard to the Company's future, there was no question of the ability of Edmundson's Electricity Corporation to meet the guarantee of dividends up to 1910. A rough approximation of the position in 1911 was as follows: Assuming the gross profits to increase by £4,000 a year, and the head office expenses to be £2,500, and taking the additional capital charges as £17,500, there was likely to be some £22,700 available for depreciation and preference dividend in 1911, which left no prospect of an ordinary dividend in that year, but the business was sound and progressive, based upon definite concessions of increasing value, and it was only a question of time to see dividends earned on the ordinary shares.

The report was adopted.

DURHAM COLLIERIES ELECTRIC POWER.

The report of the Durham Collieries Electric Power Co. for the period of two years from March 31, 1906 (which was the date of the last balance-sheet), states that the trading account covers the period during which the power station has been in operation. The gross profit and the compensation referred to below have sufficed to cover the ordinary working expenses of the Company. The loss shown by the profit and loss account is attributable to interest on debentures and temporary loans required in consequence of the subscribed share capital having been insufficient to meet the cost of completing the enlarged undertaking. The results hitherto attained form no adequate measure of those to be expected after the full load provided for by existing contracts is reached. In the early part of 1907 the arrangements for raising more capital on debentures, which had been pending for several months, were carried to completion, and an issue of £150,000 5 per cent. first mortgage debentures was successfully made. The whole of these debentures were subscribed for, and have now been paid up in full. At the same time 28,367 preference shares and 5,000 ordinary shares were offered to the existing shareholders in proportion to their holdings. The response received from shareholders was, however, very small. Shortly before the issue of the debenture prospectus an agreement was entered into with the Newcastle-upon-Tyne Electric Supply Co., by which that company undertook to operate this Company's power station upon favourable terms for a period of 42 years. On April 1, 1907, the agreement referred to came into force, and has since that date been working satisfactorily, and secures a fair rate of gross profit upon the output. This arrangement was followed up in June, 1907, by an agreement with the Newcastle Co., under which at its expense the whole of this Company's plant was to be made capable of working in unison with that of the Newcastle Co. by being converted from a periodicity of 50 cycles per second to one of 40 cycles. The conversion was an operation of considerable magnitude, and although it has been carried on without intermission, it was only during February of the present year that the changing over of the principal portions of the machinery was completed, and even now some minor changes have to be made. The effect of the change of frequency, essential as it was under the altered circumstances of the agreement for working in harmony with the Newcastle Co. instead of in competition with it, was that the electrical plant of the colliery companies, who are and will be the Company's largest customers, had also to be converted. While this was being done the increase in the output from the station and the development of a paying load were necessarily kept back, with the result that the growth of the Company's revenue has been correspondingly retarded. By way of compensation for this delay the Newcastle Co. has paid a sum of £6,000. The Newcastle Co. has agreed to install, at its own expense, generating plant which will almost double the capacity of this Company's generating station, and agreements have been made which provide for the laying of mains to supply this Company's customers. An important main is now being laid by the County of Durham Electrical Power Distribution Co. at its own expense, upon the cost of which this Company will pay interest. A further agreement has now been entered into with the Newcastle Co., under which it will operate the distribution system as well as the generating plant. This agreement is subject to the ratification of the shareholders of this Company, and will be submitted at the ordinary general meeting. The result of this and other arrangements which have been made, including a delimitation of area of supply, is that the Newcastle Co. and its associated companies, which might have been formidable competitors, have become powerful allies, and that the systems can now be worked as a harmonious whole, to the great advantage of the revenue of all companies concerned and of the efficiency and regularity of the supply to customers. The prospects of a large increase in the Company's business in the near future are good, inasmuch as consumers have now nearly completed the adaptation of their plant, and are from time to time installing new electrical machines with a view to the more complete electrification of their collieries. The effect is not only to increase the consumption of current, but to greatly improve average load. Inquiries have been received from other neighbouring collieries, and negotiations for the supply of electricity to fresh important undertakings are in progress. A considerable sum of money is required before this Company can discharge its existing liabilities, and it is also necessary to make provision for extensions of the plant and distribution system, which will undoubtedly be needed as the business continues to expand. The confidence which the directors feel in the future of the undertaking, provided it is equipped with sufficient funds, is endorsed by the fact that the Newcastle Co. and its associated concerns have already undertaken large responsibilities under existing agreements, and that the Newcastle Co. is prepared to undertake further liabilities under the above-mentioned agreement for operating this Company's distribution system. It is now proposed that an issue of £100,000 6 per cent. second mortgage debentures should be created, and that £50,000 of these should be issued with the least possible delay. Resolutions increasing the Company's borrowing powers and authorising the creation of these debentures will be submitted to an extraordinary general meeting to be held at the close of the ordinary general meeting. The directors have elected Mr. Andrew Wilson Tait, a partner in the firm of Messrs. George A. Touche and Co., to a seat on the Board.

MADRAS ELECTRIC SUPPLY.

The report of the Madras Electric Supply Corporation for the year ended Dec. 31, 1907, to be presented at the meeting on the 10th inst., states that the construction of the generating station is not so far advanced as the Board expected, owing to delays in obtaining the necessary bricks and other materials. The plant, machinery, and appliances are, however, ready for installing in the station. The mains in the compulsory area have been laid as required by the terms of the licence, with the exception of a small length, the materials for which were diverted to extensions required for the supply of some intending consumers. The contracts for the tramway generating plant, the feeders, and the erection and equipment of the sub-station, necessary for the supply of the tramways, have all been let, and it is hoped that the commencement of tramway supply will be made at the beginning of next year. There are a number of consumers already connected with the mains, with an equivalent of 3,686 lamps of 8 c.p. These are being supplied from the small temporary plant, and it is not considered advisable to make further connections until the permanent machinery is at work. Applications have been made to the Government for extensions of the licence to enable the Company to supply current in Fort St. George and to the Port Trust in Madras.

ANGLO-PORTUGUESE TELEPHONE.

The report of the Anglo-Portuguese Telephone Co. for the year ended Dec. 31, 1907, states that the assets and liabilities in Portugal have been made up at the exchange ruling on that date. Steps have been taken to safeguard the Company from the effects of any rise in the gold premium during the current year. The profit and loss account shows a gross revenue of £39,695, of which operating,

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management, and general expenses absorbed £21,506, and royalties to the Portuguese Government £1,103, leaving a gross profit of £17,085. After providing for debenture interest £2,426, sinking fund £1,155, and income tax £413, there remains a net profit of £13,089. Including £3,655 brought forward, the total amount available for disposal is £16,745. In November last the directors paid an interim dividend of 3 per cent. free of income tax, amounting to £3,000. They now recommend the proprietors to declare a final dividend of 5 per cent., free of income tax, making a total distribution of 8 per cent. for the year 1907. This will absorb a further sum of £5,000, and of the balance it is recommended that £5,000 be placed to reserve (increasing the same to £15,000), and that £3,745 be carried forward. As in the previous year, the profit and loss account was credited only with the proportion of subscriptions for which the Company had actually rendered service during the year. The proportion of the year's subscriptions unearned at Dec. 31, amounting to £14,009, has been treated in the balance-sheet as a liability of the Company. Since the commencement of the present year there has been a continuous improvement in the business of the Company.

WEST INDIA AND PANAMA TELEGRAPH.

The report of the West India and Panama Telegraph Co. for the half-year ended Dec. 31, 1907, states that the amount to credit of revenue, including £1,000 transferred from income-tax account, is £37,262, against £34,203 for the corresponding half-year of 1906, and the expenses have been £23,028, against £21,611. The result is, therefore, a balance of £14,234, to which is added £1,747 interest on investments, and £1,014 brought forward, making an available total of £16,995. The directors propose a dividend on the first preference shares of 6s. per share for the six months to Dec. 31, and on the second preference shares of £1. 6s. per share on account of dividends accrued to Dec. 31, 1907, leaving a balance to carry to current half-year's account of £557. The Board recommends payment of £1. 6s. per share to the second preference shareholders on account of accrued dividends. The traffic receipts for the six months show an increase of £2,074, as compared with the corresponding period of 1906.

BIRMINGHAM AND MIDLAND TRAMWAYS.

The report of the Birmingham and Midland Tramways for the year ended Dec. 31, 1907, states that the total revenue for the year from all sources amounted to £83,837, compared with £92,582 for the preceding year, but the latter figure included the receipts for the first six months of the year of the Dudley-road tramway in Birmingham, which has since passed into the hands of the Corporation. The expenses for the year amounted to £38,652, compared with £44,951 for 1906. After providing for all expenses chargeable to revenue, including rents, repairs, and maintenance, placing £1,500 to depreciation and renewals accounts, and adding the £552 brought forward from the last account, there remains £44,236. The directors propose to place to the debenture redemption fund £3,550, to pay a dividend on the preferred ordinary shares at the rate of 4 per cent. for the year ended Dec. 31, 1907 (less tax), and to carry to next account £83. The total expenditure on capital account during the year amounted to £24,820, and included the completion of the car-sheds and workshops at Tividale, the Bearwood-road sub-station, and additional plant and cable in connection with the development of the electric light undertaking.

TRAMWAYS AND LIGHT RAILWAYS ESTATES.

The report of the Tramways and Light Railways Estates Co. for the year ended Dec. 31, 1907, states that the total revenue for the year, including £196 brought forward, amounts to £1,400, and the expenses amount to £813, leaving a credit balance available for distribution of £587. The directors recommend to apply £100 to reduction of goodwill account and to pay a dividend at the rate of 3 per cent. per annum on the shares for the year ended Dec. 31, 1907, leaving to be carried forward £186.

NEW COMPANIES REGISTERED.

Buffalo Forge Co., Limited.—Registered May 20. Capital, £5,000 in £1 shares. Objects: to carry on the business of iron-founders, manufacturers of and dealers in machinery, specialists in heating, ventilating, and general engineering and forge plants, engineers, etc. No initial public issue.

Bradninch and District Electric Supply Co., Limited.—Registered May 20. Capital, £2,000 in £1 shares. Objects: to carry on at Bradninch and elsewhere in Devonshire the business of an electric light company in all its branches. No initial public issue. Registered without articles of association. Registered office: Kensham, Bradninch, Devon.

Grasse and Cannes Electric Tramways Syndicate, Limited.—Registered May 22. Capital, £2,100 in 2,000 ordinary A shares of £1 each and 2,000 deferred B shares of 1s. each. Objects: to construct, lease, or acquire tramways and light railways in France or elsewhere, to equip, maintain, and work the same by electricity or other power, etc. No initial public issue. Registered without articles of association.

Oxford Tramways Syndicate, Limited.—Registered May 21. Capital, £55,000 in £1 shares. Objects: to adopt an agreement with the City of Oxford Electric Tramways, Limited, to acquire, hold, or deal with any stocks, bonds, debentures, or securities in the said company or any other company formed for the purpose of constructing, financing, or working all or any of the tramways authorised by the Oxford and District Tramways Act, 1907, and to carry on the business of railway and tramway owners, electric light and power suppliers, electrical engineers, metal workers, contractors for the supply of electrical plant, etc. No initial public issue. Registered office: Queen Anne's-chambers, Westminster.

Taikoo Dockyard and Engineering Co. of Hong-Kong, Limited.—Registered May 23. Capital, £800,000 in £100 shares. Objects: to acquire docks, patent slips, engineering and boiler shops, houses, buildings, machinery, plant of all kinds, launches, lighters, vessels, ships, and land at Hong-Kong; to adopt an agreement with John Swire and Sons, and to carry on the business of dock owners, shipbuilders, mechanical and marine engineers, constructors of engineering works, docks, wharves, piers, factories, workmen's dwellings, warehouses and buildings, repairers of ships and vessels, shipowners, etc. No initial public issue. Registered office: 8, Billiter-square, E.C.

Liens Registered.

St. Helens Cable and Rubber Co., Limited.—A trust deed, dated April 29, 1908, to secure £100,000 debenture stock, has been registered. Property charged: freehold hereditaments at St. Helens, leasehold hereditaments at St. Helens and Warrington, and the company's undertaking and property, present and future, including uncalled capital, subject to a certain indenture dated Dec. 20, 1906. Trustees: T. O. Callender, Hamilton House, Victoria-embankment, W.C., and D. Sinclair, Prescot, Lancs.

APPOINTMENTS VACANT.

Station Superintendent, Carlisle Electricity Works. Salary, £130 per annum. Applications to Mr. S. Allen, city electrical engineer, by June 15. See advertisement.

Professor of Mechanical Engineering, Poona College of Science. Salary, Rs 500 per month, rising by annual increments of Rs.50 to Rs.1,000, with a pension. Applications to the Secretary, Public Department, India Office, London, S.W., by June 15.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Rome.—The Municipal Council have approved a scheme for the erection of a municipal electric power station.

Merritton (Ont.).—The Municipal Council have had under consideration a scheme for electrically lighting the town.

Huntsville (Ontario).—A scheme for the electric lighting of the town is to be prepared by order of the Municipal Council.

Bury.—The Council have decided to allot £1,500 of the profit from the electricity undertaking to the relief of the general rate.

Toronto.—The Toronto Electric Light Co. have decided to erect a sub-station at the north-west corner of Tecumseh and Defoe streets.

Bargoed.—The Rhymney Valley Electric Lighting Syndicate will be prepared to supply electric light for the compulsory area of Bargoed by Sept. 25 next.

Bexhill.—The Corporation are considering the advisability of opening an electricity showroom. This step is owing to the success of the electric light undertaking.

Lowestoft.—The Local Government Board will hold an inquiry on June 12 into the application of the Town Council for sanction to borrow £1,661 for electric lighting purposes.

Liverpool.—The Local Government Board have sanctioned the borrowing of £3,000 by the City Council for the purchase of land at Beaumaris-street upon which to erect an electric power sub-station.

Pisgah.—The Parish Council have decided to adopt the Lighting Act, and to obtain reports for lighting with either gas or electricity the whole of the villages in both the parishes of Pisgah and Kenfig Hill.

Swansea.—It is estimated that the Swansea electric lighting undertaking will, after providing for all charges and wiping off a deficit of £450 on the working of the station, show a net profit of about £500 on last year.

Beckenham.—The Urban District Council have decided to extend the electric light cable through Woodbastwick-road and Cromwell-road. The light is to be installed in Alexandra School at an estimated cost of £225.

Stepney.—The Borough Council Electricity Committee are recommending the lighting of a portion of White Horse-street, Brook-street, and Govel-lane by means of six-ampere flame arc lamps at an estimated outlay of £540.

Newhaven.—During a terrific thunderstorm on Monday night at Newhaven, Sussex, the wireless telegraphy station was struck by lightning, considerable damage being done. The operator had a narrow escape, receiving a severe shock.

Bengal and Assam.—The Government of Eastern Bengal and Assam are considering the question of the lighting of the station of Shillong by electricity, and are prepared to receive applications for a licence for the introduction of a suitable scheme.

Wolverhampton.—The Corporation electricity department shows steady progress for the past year, and the profits are increasing. The total consumption for power and lighting was 361,600 units, as against 307,000, and the gross profit was £2,587, against £2,455.

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Arbroath.—It was intimated at the last meeting of the Streets Committee of the Town Council that the electric company intended to commence the opening up of the streets for the purpose of laying the electric cable. Permission was granted on the usual conditions.

Wireless Telegraphy in China.—The Grand Council has decided to establish a wireless telegraphic service of its own with a special code, so as to avoid leakage of State secrets. The "wireless" is being established throughout the Chinese Empire, and is to be of the most up-to-date system.

Stoke.—The electrical engineer reports that in April 35,100 units were sold from the Corporation works, an increase compared with last year of 126 per cent. The number of consumers now on the books was 365, representing a total of 15,501 32-watt lamps for lighting and heating and 623½ h.p. in motors.

Electric and Ordnance Accessories Co.—The works of this company will be closed from 6 30 p.m. on Friday, June 5, until 7.30 a m. on Wednesday, June 10, on account of the Whitsun holidays. The offices will be closed Friday, June 5, from 6 p.m., until Wednesday, June 10, 9 a.m.

Holywood (co. Down).—At the monthly meeting of the District Council last week, Mr. George Murdoch presiding, letters were read regarding the proposed electric lighting of the town, and it was decided to have a consultation in committee with an electrical engineer regarding the approximate cost of the scheme.

Sevenoaks.—An employé of the Sevenoaks Gas Co. took a lighted match at midday to discover a leakage in their offices situated in the centre of the town. A violent explosion followed, which practically wrecked the offices, the plate-glass and other windows being blown into the streets. Several people had extremely narrow escapes.

Colchester.—The Corporation have decided to replace the present Nernst lamps by Osram lamps as renewals became necessary, and that, as an experiment, new 210-volt, single, 60-c p. Osram lamps be fitted to the existing 16-c.p incandescent electric lamps, and to six lamps in High-street now lighted by means of Nernst lamps.

Hammersmith.—At the last meeting of the Borough Council Electricity Committee it was reported that the premises of 24 additional consumers, representing a maximum of 857 8 c p. lamps, had been connected to the mains, that nine consumers had been disconnected, and that the total number of consumers taking current from the Council's mains was 2,179.

Cardiff.—On the Electrical Committee's minutes coming forward for consideration of the Council, Alderman Carey announced that they had at last got permission to go on the Bute property, after struggling to get that permission for years. One of the first customers to take electricity, as a result, was Hill's Dry Dock, which would want anything from 800 h.p. to 2,000 h.p.

Oldham.—At the fortnightly meeting of the Oldham Electricity Committee the engineer's report stated that the units sold were: for lighting and power, 47,679, against 31,050 during the corresponding quarter last year; and for traction, 159,776, against 143,842—a total of 207,455, against 174,892. The number of lamps connected to date were equivalent to 122,236 lamps of 8-c.p.

South Wales Electrical Power Co.—The House of Commons Examiner has had before him the South Wales Electrical Power Distribution Bill. It has gone through the Upper House and is unopposed, the object being to make further provision in regard to the undertaking of the South Wales Electrical Power Distribution Co. The Bill has been sent for second reading.

Ladysmith (Vancouver Island).—Mail news from Ladysmith, one of the towns which came into existence during the South African War, states that the people have gone in for an electric lighting scheme in preference to total darkness in the streets. At a poll on the question, 136 of the voters went for the scheme and only 16 against, so that the question was well carried.

St. Helens.—The balance-sheet on the Corporation electricity undertaking shows an income of £19,476 and an expenditure of £19,209, leaving a balance of £267, of which £100 has been placed to the credit of the accident fund account. The balance will be carried to the reserve fund. It is proposed to make application to the Local Government Board for sanction to borrow £10,426 for extensions to the electricity undertaking.

Liquidations.—The *London Gazette* announces that the Electric Traction Construction and Equipment Co. has been wound up voluntarily, and Mr. C. R. Jeeves, the assistant secretary to the company, has been appointed liquidator. A general meeting of the members of the Industrial Storage Battery Syndicate will be held at Mildmay-chambers, Bishopsgate-street, London, at 12 noon on July 1, for the purpose of receiving the liquidator's report.

Lincoln.—The accounts of the Corporation electricity undertaking for the year ending March 31 last show that the income totalled £11,670. 10s., and the expenditure £6,408. 4s. 10d. The profit on the trading account was £5,262. 5s. 2d., of which £3,715. 8s. has been repaid on loans and interest and £1,000 granted in aid of the rates, while £76. 1s. 6d. was paid to meet the deficiency on the tramways account, the net profit, therefore, being £470. 15s. 8d.

Blackburn.—Mr. J. H. Bailey, the borough treasurer, has issued reports showing the result of the past 12 months' working of the electrical undertaking belonging to the Corporation. The income for the year was £34,760. 17s. 6d., and the expenditure £17,703. 4s. 4d. From the £17,057. 13s. 2d. balance carried to net revenue account, all but a sum of £1,483. 5s. 5d. was expended in interest on loans, sinking fund, etc., this latter amount being transferred to reserve fund.

Leyton.—At the District Council meeting it was reported that it was the intention of the Lighting Committee to propose to put the largest engine upon the lighting side of the shed, and add additional machinery for generating electricity for tramway purposes. The largest engine would be mainly used in the summer for traffic purposes, and in the winter it would be assisting the other motor for lighting purposes. The Chairman said that the machinery was in the nature of a stand-by, which the engineer had advised them they should have.

Hebburn.—One man was killed and four of his comrades were injured by an explosion which occurred during the work of sinking an electric cable tunnel under the Tyne between Hebburn and Wallsend for the Newcastle and District Electric Supply Co. The disaster occurred in the shaft in Messrs. Robert Stephenson and Co.'s shipyard at Hebburn. Messrs. MacAlpine, of Glasgow, are the contractors for the work. It is surmised, in the absence, up to the present, of any official explanation, that the accident was due to the failure of compressed-air engines.

Bray.—At the meeting of the Urban District Council last week the electric lighting scheme came up for discussion on the recommendation of a committee that a sum of £5,000 be expended upon the existing works for the purpose of making the concern efficient and self-supporting Mr. Bradshaw, chairman of the Electric Committee, set forth the details for the improvements, which he believed were the only way out of the fact that the works involved a loss of £1,000 per annum. After a lengthened discussion the matter was postponed till a special meeting be held.

Wednesbury.—The Local Government Board have now sanctioned the whole amount required to be borrowed in connection with the electricity undertaking of the Corporation, with the exception of about £800 for fitting up overhead wires for conveying current to the King's Hill district, which matter is under consideration by the Board of Trade. The work of laying down the new plant is being pushed forward as fast as possible, and at the very earliest possible moment the arrangement by which the Corporation will generate their own electricity will be put into force.

Fleetwood.—The Council have granted the application of Mr. Hanson for 2½ per cent. of the cost of extensions at the electric works, for preparing the quantities and supervising the work, subject to his entering into an agreement, to be prepared by the clerk, to be responsible to the Council for the proper supervision of the work, and subject also to the total expenditure on such extensions—including the 2½ per cent.—not exceeding the amount to which the Council had previously consented—namely, £1,700. Two Reason arc lamps are to be fixed on approval opposite Balmoral and Buckingham places.

Hull.—At the last meeting of the Corporation Electric Light Committee the question of the extensions at the station, Sculcoates-lane, came up for consideration on the report of the chairman and the engineer, who recommended that consequent upon the increased efficiency of the new metallic-filament lamps, which had only just been placed upon the market in a really satisfactory form, it would be wise to postpone any extension of the station so as to see precisely what the effect of those lamps was going to be. The question of an extension of the plant for the new generating station was consequently deferred until next Christmas.

Epsom.—At the last meeting of the Council the electrical engineer reported that the £35,440 loans for main extensions, plant, etc., had been expended, and a full statement thereof prepared by the accountant was submitted. In order to meet present and future liabilities, and provide for further extensions, the Lighting Committee recommended that application be made to the Local Government Board for sanction to borrow £1,500 for the purpose of carrying out mains extensions as and when required, the engineer to prepare plans and estimates for submission to the Local Government Board. The recommendation was adopted.

Electrical Development Co. of Ontario.—The Canadian Agency (fiscal agents for the Electrical Development Co. of Ontario) are informed by cable that the amending by-law, as set forth in the terms of the circular to shareholders dated April 6, was unanimously adopted at an extraordinary general meeting of the company held in Toronto on May 28. This by-law provides that the dividend on the new preferred stock shall be 6 per cent. non-cumulative until Jan. 1, 1910, and thereafter cumulative, instead of 5 per cent., as originally provided; further, the right of the company to redeem the preferred stock at 110 and accrued dividend is cancelled.

Fulham.—The Electricity Committee of the Borough Council have had under consideration the question of the lighting of the south branch library, which at the present time is not so efficient as it might be, and have given the borough electrical engineer instructions, subject to confirmation by the Council, to change all the 8-c.p. lamps in the reading room and lending department to 16-c.p. lamps; to install three 35-watt metallic-filament lamps in the reading room, suspended from the three beams over the reading tables, 12ft. to 15ft. from the floor, and to fix one drop pendant with one 50-c.p. lamp in the entrance hall in place of the present three-light fitting.

Madras Electricity Supply Co.—The report for the year ended Dec. 31 states that the construction of the generating station is not so far advanced as the Board expected, owing to delays in obtaining the necessary materials. The plant, machinery, and appliances are, however, ready for installing in the station. The mains in the compulsory area have been laid as required by the terms of the licence, with the exception of a small length. The contracts for the tramway generating plant, the feeders, and the erection and equipment of the sub-station, necessary for the supply of the tramways, have all been let, and it is hoped that the commencement of tramway supply will be made at the beginning of next year.

Sunderland.—The satisfaction which is felt in Sunderland at the success of the tramways undertaking is just about counterbalanced by the lack of success of the electricity concern. This has, during the past year, had a most unfortunate time. On the previous year there had been a deficit of £690, and then in the autumn of last year the shipyard load, owing to trade depression, fell off tremendously.

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On the past year the deficit has been £1,908 on the working, £2,000 has been lost over the Laing failure, and these, with the adverse balance from the previous year, make a total debit balance of £4,598. The coming 12 months is likely to add to this, as there is not much prospect of a trade revival.

Bridgend.—The electrical engineer presented his quarterly report at the last meeting of the Urban District Council and in which he stated that the units sold for private lighting during that period totalled 15,911, and the receipts £277. 19s. 10d., compared with 15,149, at £266. 6s., in the corresponding period of last year. For the public lighting 15,977 units were supplied, compared with 14,489 last year. He drew attention to the fact that, although the use of the Osram lamps had reduced the consumption of energy, the revenue was £18 2s. 8d. higher than for the corresponding quarter of last year. The Chairman of the Lighting Committee said the report was highly satisfactory, and the increasing revenue was an indication of progress.

Urban Electric Supply Co.—The Urban Electric Supply Co. (formed to work electric light and tramway undertakings in various parts of England and Scotland) announce a gross profit of £35 300 for the past year. This is £2 100 more than the previous year's, but the net profit balance of £22,500 shows no appreciable difference. The balance stated is £10,000 short of the amount required to pay the guaranteed 5 per cent. dividends on the issued preference and ordinary capital. The deficit—which is of the same amount as last year's—will be made up by Edmundson's Electricity Corporation. Edmundson's undertook the construction and general management of the Urban Co.'s works till the end of 1910, and meanwhile guarantee the 5 per cent. dividends on the issued capital.

Dunfermline.—In connection with the dilemma in which the Dunfermline Town Council have found themselves through their dilatoriness in carrying out their electric lighting provisional order, it is intimated that Messrs. Gibbings and Chaunbler, Liverpool, have withdrawn their offer to erect a generating station and carry on the undertaking until the revenue proved sufficient to cover the charges. Sir Alexander Kennedy is in communication with the Fife Power Co., and it is said that as a basis of an agreement the company would grant the Corporation the option of acquiring certain cables at the end of a number of years, and also the transfer of customers whose consumption does not exceed 4 h.p. The latter concession would practically mean that the burgh would have all the lighting customers.

Stock Exchange.—The Stock Exchange Committee has appointed special settling days as under: June 12—Tennessee Copper Co.'s 5,000,000dol. capital stock in 200,000 shares of 25dol. each (ex dividends Nos. 1 to 7); June 17—Fresno Copper Co.'s 389,008 shares of 4s. each, 3s. paid, Nos. 1 to 389,008. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to British Columbia Electric Railway Co.'s further issue of £100,000 preferred ordinary stock. The committee has been asked to allow the following securities to be quoted in the official list: Mexico Tramways Co.'s 6,000,000dol. additional general consolidated first mortgage 50-year 5 per cent. gold bonds; Montreal Street Railway Co.'s £460,000 4½ per cent. sterling debentures in lieu of the scrip now quoted.

Maidstone.—At the last meeting of the Urban District Council a report from the Electricity Committee was adopted which recommended that a Entz reversible booster, with the necessary switchgear, with a storage battery for the supply to the light railways, be installed. The Chairman stated that the existing battery at the electricity works would be replaced with larger plates. The figures of the scheme would come to £1,200, and the annual charges to £289. The guaranteed saving per annum was: estimated number of units generated for traction supply, 600,000; pounds of coal burned per unit generated, 5·81b. For 600,000 units 1,500 tons must be burnt. Thirty per cent. saving on this was 465 tons, and at present prices this amounted to £308. 1s. They would, therefore, obtain a spare plant for the traction supply for next winter, and at the same time effect a saving.

International Telegraph Conference.—At the plenary sitting of the International Telegraph Conference on the 27th ult., a letter signed by all the submarine cable companies was submitted by the representative of the Anglo-American Telegraph Co. calling attention to the serious damage caused to Transatlantic cables by trawlers fishing off the Irish coast. Cables were constantly being damaged and broken. At present no fewer than six cables between Europe and North America belonging to different companies were interrupted from this cause. The representative of the Deutsche Atlantische Telegraphen Gesellschaft suggested an alteration in the equipment of trawlers which would prevent further damage. The delegates were requested to bring this important matter before their respective countries with a view to the modification of the law of the year 1884 in the sense desired.

Kirkcaldy.—Some time ago a suggestion was made by the burgh chamberlain that he should directly collect the moneys due for the sale of electricity, and he pointed out that centralisation and not departmentalism was the order of the day. The burgh electrical engineer objects to the change. He states that the commercial work of this department is on an entirely different basis from that dealt with by the town chamberlain, inasmuch as it is bound up with a great deal of technical work peculiar to such an undertaking, and requires special knowledge gained by experience. He has no hesitation in saying most emphatically that the chamberlain's suggestion is quite impracticable. A meeting of the Finance Committee of the Town Council was held on Tuesday evening and after a long discussion it was found impossible to come to a decision, and the question was left over for a future meeting.

Hanley.—At the last meeting of the Electricity Committee the engineer was authorised to make the necessary addition to his clerical staff, to provide for a complete system of stores and prime cost books. The engineer was also instructed to provide an electrical exhibition at the horticultural fête. The engineer reported that in the month of April there had been connected 12 new lighting consumers, taking 361 lamps; that extensions had been made on the premises of eight lighting consumers, equivalent to 202 lamps; and that three new power consumers had been coupled to the mains, equivalent to 270 lamps. A letter had been received from Messrs. McIlroy Bros. stating that they had been assured by an eminent electrician that it would be much to their advantage to put down an installation and produce their own light, but before doing so they wished to ask the committee if they could see their way to meet the firm in the matter. The chairman and the engineer were requested to interview Mr. Clarke McIlroy on the subject.

Dundee.—The revenue of the electricity department of the Council for the year ending April was £34,973, as compared with £31,109 for the preceding 12 months. The expenditure totalled £25,231, leaving a balance of £9,741. This, with a balance of £914 from the preceding year, gives £10,655, which is disposed of as follows: to interest, £5,095; expense of loans, £52; application to sinking fund, £4,430—leaving a carry-over to the current year's account of £1,077. From the details it is shown that the cost of generation was £11,665, as against £11,254 for the preceding year. There was a marked increase in the coal account, which represents a charge of £6,374, as against £3,263 for the year ending April, 1907. This, however, is to a large extent made good under the heading of machinery and plant repairs. During the past year the cost of this item was £1,117. For the year ending April, 1907, the expense under this heading was £4,197. The charges for lighting and power supply will be regulated in accordance with a scheme at present engaging the attention of the Electricity and Finance Committee.

Lancaster.—The report of the borough accountant upon the electricity undertaking shows that for the past year the income is £9,881. 3s. 7d., as compared with £9,353. 16s. 7d. for the previous year, whilst the total expenditure is less by £181. 11s. 7d.; there is a reduced expenditure on new mains, etc., of £533. 13s. 7d. The total net profits are £1,078. 13s. 3d., as compared with £369. 14s. 8d.; these profits have been allocated as arranged when considering the estimates in March—viz., £500 to district fund, £500 to stock redemption fund for the purchase and cancelling of stock (and consequent earlier extinction of debt), and £78. 13s. 3d. to reserve fund. The sale of current for lighting shows an increase of £246. 13s., and for motive power (including special contracts) an increase of £440. 14s. 10d.; for tramways there is again a decrease, amounting to £197. 12s. in money, and 4·45 per cent. in units. The total capital expenditure is £63,220. 10s. 10d., and the debt outstanding £58,293. 14s. 1d.; against this there is £3,677. 5s. 2d. in the stock redemption account.

Dudley.—The annual report of the municipal electrical undertaking at Dudley has been issued. The total capital expenditure now stands at £86,808. 12s. 5d., compared with £81,410. 13s. 7d. last year. The year has been one of steady growth in the number of new connections made to the mains, the prominent feature being the increase in the number and horse-power of the motors taking a supply from the Corporation's mains. There has also been a larger amount of current supplied to the tramway company than hitherto. The amount of current sold has fallen slightly below the engineer's estimate, owing to the exceptionally bad trade which has prevailed since Christmas, this falling off being noticeable under every head of supply. The year's working has resulted in a gross profit of £5 977, being an increase of £733 over that made last year. Financial charges for interest, repayment, and bank charges absorb £5,641, an increase of £165 over the previous year's requirements, the surplus for the year being £336. The net profit was £335. 19s. 3l. The total unappropriated profits to March 31, 1908, amount to £871.

Tunbridge Wells.—The accounts for the year ended March 31 last of the Corporation electricity undertaking show a net profit of over £1,100. Under the revenue account, the income (less an allowance of £103 for bad debts) was £14,675. 6s. 9l. The sale of electricity brought in £14,108. 13s. 4d., private consumers contributing the whole of this except a sum of £2,576. 6s. 8d. derived from public lamps. Of the other sources of revenue the chief was £426 for meter rents. The expenditure amounted to £8,829. 13s. 5l., the principal items being £5,739 under the heading of generation of electricity, £1,189 for salaries and management expenses, £752 for distribution, £749 for public lamps, and £345 for rents, rates, taxes, and insurance. The sum of £5,845. 13s. 4d. was carried to the net revenue account, where loan charges absorbed £4,703. 15s. 5d., leaving £1,141. 17s. 11d. to be carried to the appropriation account. The reserve fund now amounts to £5,218. The only items of capital expenditure during the year have been £318. 4s. 3d. on mains and £31. 19s. 3d. on arc lamps, etc. To date the capital expenditure has been £81,826, the loans sanctioned but not yet borrowed amounting to £14,544.

Calmon Asbestos and Rubber Works.—At the forthcoming first German shipbuilding exhibition, under the distinguished patronage of H.R.H. Prince Henry of Prussia, the Calmon Asbestos and Rubber Works, Hamburg, will present an exhibit which is likely to prove of universal interest. For years shipbuilding engineers have been striving to do away with all woodwork in men-of-war, as experience in recent sea fights has proved that the danger to the ship and crew is by no means confined to the direct effects of shells and other projectiles, nor yet to the highly dangerous splinters of steel and wooden inside structures of the vessel itself catching fire. The Calmon Works have now succeeded in producing a material which can be put to all the purposes and worked in exactly the same way as any ordinary wood, such as mahogany, walnut, oak, maple, etc. It can be planed, sawn, and turned, is cheaper in price, and of light weight. It has the advantage of diminishing the danger of splinters, and, being quite fireproof, entirely removes the danger of fire spreading through the ignition of

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furniture and fittings. The Calmon Works will show at the exhibition two cabins suitably fitted for an officer of high rank, and consisting of a living-room and a bedroom, the walls and ceilings of which, together with the whole of the furniture, tables, bookcase, wardrobe, linen-press, toilet table, bed, sofa, mirror, picture frames, etc., are made entirely of this new patented material, which is called Calmon's patent asbestos wood.

York.—Mr. H. R. Hooper, Local Government Board inspector, resumed his inquiry at York on Wednesday into the application of the Corporation for power to borrow £31,000 in respect of the city's electric lighting undertaking. Mr. Hooper first paid attention to the application for £7,000 for suspense account, which had been reduced by agreement to £4,460. Replying to the inspector, the town clerk said he was not aware that the committee had asked for an interpretation of the section. The officials, however, had directed the committee's attention to the fact that it should be dealt with and not carried forward. The inspector requested that he should be supplied with information as to the interest paid on revenue deficits and income derived from certain streets and from the service supplied by each distributor, adding that the engineer was not to be blamed for the heavy capital charges and excess, as all these sums were expended before his appointment. The inspector remarked that the Corporation were expending about ½d. more per unit for capital charges than for cost of production. The amounts to be sanctioned on suspense account were not to be all expended before the account was closed, but the account must be closed and the unexpended balance carried forward to tide them over the period between the closing of the account and the obtaining of sanction for new loans. The inspector went on to intimate that he should adjourn the inquiry *sine die*, in order to see if, when he had information placed before him relating to two building contracts, he required to make fresh inquiries *re* certain figures. The inquiry was accordingly again adjourned.

Cheltenham.—The monthly report of the electrical engineer shows that on May 11 there were 980 consumers, with the equivalent of 64,462 8-c.p. lamps connected to the private supply mains of the Council's works, the corresponding figures for last year being 904 and 60,859 respectively. A letter was read from Mr. C. E. Rainger making application for supply of electric energy free of charge for the illumination of the interior and exterior of the winter garden for the fancy dress ball. It was resolved that a charge of 2d. per unit be made for current supplied to the Pageant Committee or any other applicants for illumination at the forthcoming pageant, provided that the cost of any service cable, etc., required is paid by applicants. The electrical engineer reported that he had searched the records of the coal tests, but could not find any instance in which analytical tests similar to those to be made by Mr. Embrey had been carried out by Mr. Kilgour. The late engineer had made frequent evaporation tests such as were made by himself at the present time, but these tests were very different to the chemical tests, which required not only a properly equipped chemical laboratory and apparatus, but a trained analytical chemist to perform the test. With reference to a complaint that bricklayers' work was done by one of the employés of the electricity works who was not a bricklayer, the electrical engineer reported that he had had an interview with Mr. Merrett and Mr. Betteridge at the works, and had explained that the only bricklayers' work done by this employé was the replacing from time to time of a few bricks in the boilers and flues when cleaning out the same, and he thought they were satisfied with the explanation.

Nottingham.—In the annual report of the Nottingham Electricity Committee it is stated that the demand still continues and extensions of the mains have been carried out from time to time to meet the requirements of new consumers. Mr. H Talbot, the electrical engineer, reports that no additional plant has been required, owing to the increased number of consumers who have taken advantage of high-efficiency metallic-filament lamps. The total horse-power installed at the three generating stations is as follows: Talbot-street station, 8,925 h.p.; St. Ann's power station, 6,040; Eastcroft destructor, 720—making a total of 15,685. There have been 46 extensions of the distributing mains, making a mileage of 55·94, an increase of 1·68 miles. The number of applications for a supply of electricity at March 31, 1908, was 3,462, compared with 3,257 at March 31, 1907, an increase of 205. The number of 8-c.p. lamps, or their equivalent, has increased from 321,240 to 349 699 during the same period. There were 841 motors, representing 3 418 h.p., connected to the mains at March 31, 1908, an increase of 99 motors and 484 h.p. The number of units sold during the 12 months for various purposes was as follows: for lighting, 4,112,648; for power, 1,709,208; for traction, 5.294,979 — total, 11,116,835 — an increase of 1,586,739 units; 50·95 per cent. of the units used for private lighting were at the reduced rate of 1½d. per unit. The accounts show that the sale of current realised £89,380, public lighting £1,541, and rent of meters £1,491, the total income being £92,794. The expenditure amounted to £47,087, the chief items being: coal, £18,815; oil, waste, and water, £2,953; wages, £7.157; repairs to engines and boilers, £3,680; rates and taxes, £6,965; and salaries, £4,126. There was thus a balance of £45,706, of which £13,681 went in interest on consolidated stock and loans, £12,654 in repayment of loans, and £11,500 in aid of the general district rate, £5,500 being transferred to the reserve fund.

TRACTION.

Madras Electric Tramways.—The traffic receipts for the fortnight ending May 31, 1908, amounted to Rs.18,129, against a total of Rs.17,096 for the corresponding period of 1907.

Brisbane Electric Tramways Investment Co.—Traffic receipts of the Brisbane tramways for the month of May amounted to £15,548; corresponding month last year, £13,275—increase, £2,273.

Ashton.—The traffic receipts of the Corporation tramways for the week ending May 16, 1908, amounted to £378. 6s. 8½d., against a total for the corresponding week of last year of £372. 15s. 5½d.

Milan.—A car of the Inter-Provincial Tramways, running between Lodi and Treviglio, ran off the rails on the 1st inst., and fell down a slope. The driver was killed and 25 persons were injured, eight seriously.

Gloucester.—The transfer ticket system is working admirably on the tramcars, and will be the means of placing the light railway concern on a much more profitable basis. The parcels delivery system is also paying its way.

Colchester.—During the past year the Corporation cars have travelled 340 539 miles, as against 353,331 last year, being a decrease of 12,792 miles. The passengers carried have been 2 308,721, as against 2,514,599, a decrease of 205,869.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending May 27, 1908, converted to gold, were £4,203; corresponding week, 1907, £3,824—increase, £379. Aggregates from Jan. 1, 1908, £80,107; aggregates from Jan. 1, 1907, £79,430—increase, £671.

Brighton.—Statistics presented to the Corporation Tramways Committee show that the revenue for the past year was £3,452 less than in the previous 12 months. After providing for interest, sinking fund charges, and general expenditure, there is a net deficit of £969. Last year there was a profit of £2,410.

Hebden Bridge.—On Monday a tramcar was proceeding in the direction of Hebden Bridge, and when passing over Mayroyd crossing a light cart, which was proceeding in the opposite direction, collided with the side of the car and two large windows were broken. The cart was not much the worse, but one of the passengers had his hand cut by the flying glass.

New South Wales.—Mr. Waddell, New South Wales Treasurer, announces that the revenue for the past 11 months had been exceedingly satisfactory, and he estimates that the financial year will close with a surplus of over £1,500 000. All great public enterprises, the Treasurer states, including railways and tramways, are yielding handsome returns, after paying interest and working expenses.

Rhondda.—Another development in the progress of the Rhondda Valleys found fruition on Friday last, when a test was made of the tramcar system on the first section available to Ferndale from Porth. Crowds of people lined the route. The area covered by the new line embraces a group of towns with a population of 135 000. Mr. H. J. Nisbett, chief engineer, hopes to have the whole system in operation within a month.

Blackburn.—The accounts of the tramways department for the year have been issued by the borough treasurer. The total receipts were £59,821. 14s. 10d., equal to 13·01d. per car mile, and the working expenses £38,197. 3s. 3d., equal to 8·31d. per car mile, leaving £21,624. 11s. 7d. to be carried to net revenue account. After payment of instalments and interest on loans, etc., there remains a net profit of £804. 11s. 4d.

Belfast.—At the weekly meeting of the Tramway and Electrical Committee on the 25th ult., Sir Robert Anderson, Lord Mayor, presiding, the general manager, Mr. Nance, submitted a report recommending the reduction of the car service at a saving of between £6,000 and £7,000 per annum, and a scheme for the readjustment of the fares was also submitted and approved of by a majority. The question of fares will be fought bitterly.

Camberwell.—The Borough Council have been informed by the Highways Department of the London County Council that the latter propose to commence at once with the construction of the new tramway line from the present terminus at Dulwich Library, in Lordship-lane, to Dartmouth-road, Forest Hill. This new extension, which will be worked upon the underground conduit system, will prove an immense boon to a very large number of residents who are employed in the City and West-end.

Skipton.—In the *London Gazette* notice is given that application is intended to be made under the Light Railways Act to the Light Railway Commissioners by Mr. Philip Crawshaw Hemingway, of Thurgoland, near Sheffield, for an order to incorporate a company and to authorise the company to make and maintain a railway in the rural district of Skipton. The parishes through which the railway will pass are the following—viz.: Threshfield, Conistone-with-Kilnsey, Kettlewell-with-Starbottom, and Buckden.

Aston.—On the evening of the 1st inst. a collision occurred at the corner of Sutherland-street and Lichfield-road, Aston, between a B.E.T. tramcar and a lorry loaded with bottled ale belonging to Messrs. Kenway, New-street, Birmingham. The lorry was turning out of Sutherland-street into the main road when the tramcar, which was proceeding towards Erdington, came along, and before anything could be done it crashed into the horse, hurling the animal to the side of the road and smashing the shafts off the vehicle. The front of the tramcar was severely battered, but fortunately both drivers escaped without injury.

Bury.—The Corporation Tramways Committee have decided that, commencing on June 1, the motormen, conductors, point boys, cleaners, and overhaulers, together with all employés who receive weekly wages and have to work overtime, shall have one week's holiday with pay, provided they have been on the permanent staff of the department for 12 months immediately preceding June 1 in each year, such holiday allowance to be considered as a bonus for efficient service during such period of 12 months, and shall be forfeited by an employé who fails to carry out his duties in a satisfactory manner and to the interests of the department.

Sao Paulo Tramway, Light, and Power Co.—The report for the year ended Dec. 31 last shows gross earnings of 2,111,523dol. as compared with 2,018,703dol. for the previous year, an increase of 92,819dol.,

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and net earnings of 1,395,873dol., compared with 1,368,162dol. during 1906. Out of gross earnings there have been applied to operating and maintenance charges, 715,649dol.; bond interest, Government and municipal taxes, etc., 359,422dol.; and three quarterly dividends of 2 per cent. each and one of 2¼ per cent., aggregating 691,476dol. Of the balance there was placed to the credit of contingent account 100,000dol., and to the credit of profit and loss there was carried the sum of 244,974dol.

Dumbarton.—The completion of the whole tramway system, which will enchain the city with Loch Lomond, is now within very measurable distance. June 8 is given as the date when the contractors will leave their endeavours to the consideration of the Board of Trade, and there is more than a little credit due to Mr. Don (the vigorously practical representative of Messrs. J. G. White and Co.) for the manner in which this undertaking has been implemented. It is computed that in a few days the system west of Dumbarton will be finished, inclusive of a service for Jamestown, and as the best of progress is being made at the opposite end, there is every reason to believe that the date stated will see the finish of the whole contract.

Pontypridd.—The report of the engineer to the Pontypridd Electricity and Tramways Committee for the past month shows that the increased revenue is being maintained. The electrical department showed receipts amounting to £543. 6s. 10d., as against £467. 12s. 11d. for the corresponding period. The takings for the cars on the Treforest and Cilfynydd route totalled £769. 7s. 6d., as against £742. 15s. 8d., but the figures on the Trehafod route made up for the deficiency, the increase on this section being practically £200. The receipts for the corresponding period of last year included the Whitsun holidays' traffic. It was estimated that the workmen are taking full advantage of the conveniences afforded them, and last month no less than 63,000 used the cars.

Burnley.—The Corporation of Burnley have obtained powers in connection with their tramway system from the Police and Sanitary Committee of the House of Commons, authorising the municipality to provide (but not to manufacture), maintain, and run omnibuses within the borough in connection with its own tramways, and in connection with any tramways over which the Corporation have running powers. It was explained that Burnley not only ran tramways in its own district, but it also had them on lease in various adjoining areas. They had proved a remunerative undertaking, and served a total population of something like 240,000 or 250,000 people. From 1902 to 1907 the tramways undertaking resulted in a net profit of £20,792, and in 1907 close upon 12,000,000 passengers were carried.

Glasgow.—During the financial year of the Glasgow Corporation Tramways Department the receipts were £907,460 as compared with £887,381 in the preceding year, an increase of £20,079. According to the weekly official statement the number of passengers carried up till Saturday night was 226,487,350, as compared with 224,960,409 in the corresponding period of the preceding year—an increase of 1,526,941 passengers—while the revenue for the same period was £905,221. 11s. 9d., as against £890,992. 6s. 8d. The drawings on Sunday amounted to £2,239. 1s. 2d. Last week the cars ran 399,122 miles, as against 397,047 in the corresponding week of last year; the number of passengers was 4,552,734, in comparison with 4,556,357; while the receipts were £18,289. 16s. 7d., as compared with £18,126. 13s. 5d., an increase of £163. 3s. 2d.

Brighton.—The position and prospects of the Brighton Corporation tramway system are the subject of an interesting report from Mr. William Marsh, the engineer and manager. It is based on the working of the undertaking for the 12 months ended March 31, which resulted in a loss of £969. 4s. 10d. Mr. Marsh, in regretting that the gross profit was not sufficient to meet all the statutory capital charges, points out that the average return on the whole capital invested amounted to £4. 15s. 10d. per cent., "a result only attained by a very few tramway companies as distinct from municipalities." The year's revenue was affected, he says, by only part of the Easter traffic being included in the year's working, and by practically the absence of summer last year. Nearly all the decreases occurred during the cold summer months, and he tells his committee, "You have the satisfaction of knowing that Brighton is not the only town in the country where the tramways have not been so successful as in previous years." No money was spent on capital account, but £528 expenditure of a capital nature was defrayed out of revenue during the past 18 months, which, of course, affected the financial result.

Sunderland.—The Corporation tramways have during the past year made a net profit of £10,101, of which £3,348 has been devoted to the relief of rates, and the remainder to reserve and to improvements. The receipts totalled £69,023, of which £68,797 was from traffic revenue. The expenditure was £40,817, a decrease of £5 on the previous year, and made up of £18,689 for traffic expenses, £5,149 general expenses, £4,082 general repairs and maintenance, and the cost of current was £12,895. The traffic receipts are £3,267 less than the previous year, which is accounted for by the depression in trade, and that owing to the summer being wet and cold, the Roker traffic, on which the undertaking depends for its surplus, fell off considerably. Still, it was the second best year the concern has experienced, and in view of the conditions prevailing in the town the result may be regarded as satisfactory. In addition to the net profit mentioned, the management were able to pay £8,512 interest on capital, and £9,380 for repayment of capital. The passengers carried numbered 16,987,898, so that the average number of journeys per head of the population was 70. The undertaking is thoroughly prosperous, and has now a reserve of £34,268, and has paid £30,027 in relief of rates since the Corporation took it over.

Cavehill and Whitewell Tramways Co.—The report of the directors of the Cavehill and Whitewell Tramway Co. for the year ended Dec. 31 last, which will be submitted to the forty-first annual meeting on Friday next, contains the following: "The unfavourable weather conditions and the strike of dock labourers and carters in Belfast have had an adverse influence upon the traffic receipts for the year. The total receipts, including the profits from the Belle Vue Gardens, amounted to £4,429. 16s. 3d., and the working expenses (including £1,151. 10s. 5d. paid to the Corporation for current at 2d. per unit) amounted to £3,376. 15s. 2d., leaving a profit on working of £1,053. 1s. 1d., from which must be deducted debenture and other interest of £914. 4s. 11d., leaving a net profit of £138. 16s. 2d., which the directors propose to carry forward. The revision of fares which was put into operation in October last has had satisfactory results. In May, 1907, the directors entered into an agreement for the sale of the company's lines to the Corporation subject to the Corporation obtaining the necessary powers to purchase. The promotion of an Act of Parliament for that purpose was approved by a large majority of ratepayers, but the Bill was successfully opposed in the House of Commons. The directors are now endeavouring to arrange with the Corporation for the much needed through service of cars.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Madrid.—The Public Works Department invite tenders for the construction of light railways. Tenders by Oct. 31.

Cologne.—Tenders are invited for six electric cranes for the Prussian Government Railways. Tenders by June 25.

Bukarest.—Tenders are invited for the supply of steel bars and steel wire required by the War Office. Tenders by June 13.

Rome.—The Admiralty invite tenders for the supply of electric cables. Estimate, £4,000. Tenders by June 12.

Melbourne.—The City Council invite tenders for the supply and delivery of one 500-kw. motor-generator. Tenders by July 3.

Bukarest.—Tenders are invited for the supply of 800 tons of mineral oil for the Roumanian State Railways. Tenders by June 16.

Bangkok.—Tenders are invited for fishplates, fishbolts, bearing plates, etc., required for the Royal Siamese Railways. Tenders by Oct. 1.

Portsmouth.—The Corporation invite tenders for the supply of coal for the electric lighting station. Tenders to the Town Clerk by June 17.

Madrid.—The Public Works Department invite tenders for the construction of a railway from Betanzos to Feros. Tenders by June 23.

Brussels.—The Société National des Chemins de Fer Vicinaux invite tenders for overhead equipment for electrical railways. Tenders by June 17.

Bukarest.—Tenders are invited for the supply of brass bars, brass tubes, and copper, etc., required by the War Office. Tenders by June 23.

Brussels.—The Société Nationale des Chemins de Fer Vicinaux invite tenders for the construction of a line from Olloy to Ognies. Tenders by June 30.

Sofia.—Tenders are invited for the installation of electricity in mines. Particulars from the Director of Mines and Minerals. Tenders by June 19.

Liege.—Tenders are invited for the installation of an electric lighting system. Particulars from the Secretaire Communal at Amay. Tenders by June 25.

Madrid.—The Public Works Department invite tenders for the laying of tramway track in Madrid. Estimate, 582,670 pesetas. Tenders by June 25.

Paris.—The Municipality invite tenders for two electric motors and two centrifugal pumps. Particulars from the Hotel de Ville de Paris. Tenders by June 18.

Stanislau.—The Municipality invite tenders for the establishment of an electric tramway system, also for the erection of a generating station. Tenders by Aug. 31.

Buxton.—The Urban District Council invite tenders for the supply of coal for their electricity works. Particulars from the Electrical Engineer. Tenders by June 8.

Dartford.—Tenders are invited for the annual supply of stores to the electricity department, including meters, service cables, etc. Tenders to the Clerk by June 9.

Blois.—Tenders are invited for the construction and maintenance for 50 years of public tramways. Particulars from the Prefecture de Loir-et-Cher. Tenders by July 15.

Bradford.—The Guardians invite tenders for the installation of an electric lighting main cable at the workhouse, Horton-lane. Tenders to Mr. Crowther, the clerk, by June 12.

Malvern.—The Urban District Council invite tenders for the supply and erection of 50-kw. steam alternator, exciter, etc. Tenders to Mr. Whatley, clerk to the Council, by June 29.

Croydon.—Tenders are invited for the supply of sulphuric acid for one year, for the Croydon Gas Co. Tenders to Mr. W. Topley, secretary, Katherine-street, Croydon, by June 9.

Stepney.—Tenders will shortly be invited for the annual supplies to the electricity department, including arc lamp carbons, meters, demand indicators, time switches, coal, etc.

Dundee.—Tenders are invited for the supply of electricity meters for the electricity department. Particulars from Mr. H. Richardson, the general manager. Tenders by June 15.

Adelaide.—Tenders are invited by the Municipal Tramways Trust, Adelaide, for the supply, delivery, and laying of underground electric cables. Tenders to the Chairman by June 23.

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Stockton-on-Tees.—The Electricity Committee invite tenders for the supply of coal for 12 months to the electricity works. Particulars from the Electrical Engineer. Tenders by June 10.

London.—The London County Council invite tenders for the manufacture, supply, and delivery of tramway feeder pillars. Particulars from the Clerk of the Council. Tenders by June 23.

Cologne.—The Prussian Government Railways invite tenders for the supply of copper plates for locomotive fireboxes, copper wire, copper tubes, and copper bars. Tenders by June 26.

Shrewsbury.—Tenders are invited for the annual supply of coal for the electricity works. Particulars from Mr. C. M. Johnston, engineer and manager. Tenders to the Town Clerk by June 5.

Hornsey.—The Town Council invite tenders for the annual supply of coal to the electric lighting station, Tottenham-lane, Hornsey. Particulars from the Town Clerk. Tenders by June 15.

Sale of Plant.—Tenders are invited by the Sheffield Corporation Tramways Department for the purchase of lighting plant. Particulars from the General Manager. Tenders by June 19.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Willesden.—The Urban District Council invite tenders for the supply and erection of 300-kw. converting plant. Particulars from Mr. J. G. Bruce, the electrical engineer. Tenders by June 18.

Middlesbrough.—The Corporation invite tenders for the annual supply of various stores. Particulars from the Stores Superintendent, 42, Commercial-street. Tenders to the Town Clerk by June 6.

Bristol.—The Electrical Committee invite tenders for the construction of an extra high-tension sub-station at Pembroke-road, Shirehampton. Tenders to the City Electrical Engineer by June 19.

Bradford.—The Corporation invite tenders for the supply of clothing for the tramway employés. Particulars on application at the Tramway Offices, Bridge-street. Tenders to the Town Clerk by June 11.

Poplar.—Tenders are invited for a new hot-water boiler and works in connection therewith at the Poplar and Stepney District Sick Asylum. Tenders to Mr. W. Foskett, clerk to the Managers, by June 16.

Leeds.—The Tramways Committee invite tenders for the reconstruction of a portion of tramway track in Leeds; also for the construction of a portion of track. Specifications from the General Manager.

London, W.—The Great Western Railway Co. invite tenders for the supply of various stores for 12 months from July next. Particulars from Mr. G. Mills, secretary, Paddington Station. Tenders by June 15.

Trimdon Grange.—The Trimdon Coal Co. invite tenders for a six months' supply of general stores, including oils, grease, etc. Particulars from Mr. J. Penney, Deaf Hill Colliery, Trimdon Grange. Tenders by June 20.

West Sussex.—The West Sussex, East Hants, and Chichester General Infirmary Committee invite tenders for the supply and fixing of hot-water heating and supply boilers. Tenders to Mr. A. Marshall, secretary, by June 16.

Bradford.—The Corporation invite tenders for electric lighting installation at the town hall extension. Particulars from the City Architect, Whitaker-buildings, Brewery-street, Bradford. Tenders to the Town Clerk by June 10.

Norwich.—The Electricity Committee invite tenders for the supply and erection of one water-tube boiler with mechanical stoker, economiser, etc., wiring supplies (not cables). Tenders by June 9. See advertisement in last issue.

Belfast.—The Tramways and Electricity Committee invite tenders for the supply and delivery of uniforms for the employés. Specifications, etc., from Mr. Andrew Nance, general manager of the tramways. Tenders to the Town Clerk by June 8.

Grimsby.—Tenders are invited for the lighting of such of the public streets of the borough as are not lighted by electricity from the Corporation electricity works for one year, for the Grimsby Urban Sanitary Authority. Tenders by June 6.

Cornsay.—Tenders are invited for the annual supply of general stores—including wire ropes, steel and metal castings, etc.—for the Cornsay Colliery. Particulars from Messrs. Ferens and Love, Market-place, Durham. Tenders by June 13.

Carlisle.—Tenders are invited for the installation of electric light at the new secondary school at Carlisle. Particulars from Mr. W. J. Hide, the consulting engineer, 42, Produce Exchange-buildings, Victoria-street, Liverpool. Tenders by June 5.

London, E.C.—Tenders are invited for the supply and delivery of (*a*) wrought iron, (*b*) steel material, for the Bengal and North-Western Railway Co. Tenders to Mr. Alexander Izat, managing director, 237, Gresham House, Old Broad-street, London, E.C., by June 12.

Swindon.—The Great Western Railway Co. invite tenders for the annual supply of stores, including steel plates and sheets, steel bars and blooms, steel castings, tubes and fittings, solid-drawn steel tubes, etc. Particulars from the Stores Superintendent. Tenders by June 15.

Colne.—The Electricity Committee invite tenders for the supply of induction motor-generator and high-tension transformer, high and low tension switchgear, and high-tension, lead-covered, paper-insulated cable. Tenders to the Chairman of the Electrical Committee by June 15.

Ealing.—The Town Council invite tenders for the supply of best cylinder oil, crank-chamber oil, paraffin, engine oil, best rope waste, and stoneware pipes required at the electricity works. Tenders to Mr. J. Douglas Knight, the borough electrical engineer and manager, by June 27.

Barrow-in-Furness.—The Corporation invite tenders for the supply of steam coal required at the electricity works during nine months from June 1, 1908, to March 31, 1909. Particulars from the Borough Electrical Engineer at the Electricity Works. Tenders by June 10.

Johannesburg.—Tenders are invited for a refuse destructor plant. Specification, etc., may be obtained from Messrs. E. W. Carling and Co., St. Dunstan's-buildings, St. Dunstan's-hill, London, E.C. Tenders to the Town Clerk, Municipal Offices, Plain Park, Johannesburg, by June 10.

Melbourne.—The Postmaster-General invites tenders for the erection of wireless telegraphy stations at Cape York, Thursday Island, Goode Island, Port Moresby, and Freemantle. Particulars from the Australian Commonwealth, Victoria-street, Westminster. Tenders by Aug. 26.

Oswestry.—Tenders are invited for the supply of stores for 12 months ending June 30, 1909, for the Cambrian Railways Co. Specifications and forms of tender may be obtained at the Stores Office, Cambrian Works, Oswestry. Tenders to Mr. S. Williamson, secretary, Oswestry, by June 6.

Christiania.—The Commercial Intelligence Branch of the Board of Trade are informed by his Majesty's Consul at Christiania that the Kongsberg Small-Arms Works have issued a call for tenders for the supply of a number of steel tubes and plates. Tenders to Kongsberg Vaabenfabrik, Kongsberg, by June 12.

Cleethorpes (Lincs.).—Tenders are invited for the erection of a new wireless telegraphy station at Cleethorpes, consisting of a power-house, torpedo instructor's house, and men's quarters, etc. Tenders to the Director of Works Department, Admiralty, 21, Northumberland-avenue, London, W.C., by June 12.

Spain.—The Public Works Department, Madrid, will shortly invite tenders for the installation of a new submarine telegraph cable from Cadiz to Teneriffe, thence to Gran Canaria, Palma y Gomera, from the latter island to Hierro, from Gran Canaria to Fuerteventura, and from thence to Lanzarote. Estimate, £172,420.

Bath.—Tenders are invited for (1) supply of a Cornish boiler of 16 n.h.p.; (2) supply of a 10-n.h.p. horizontal steam-engine, and a donkey pump; (3) the erection of a chimney stack, in connection with extending the supply of steam power at their workhouse laundry, for the Guardians. Tenders to the Clerk by June 6.

Adelaide.—The Postmaster-General invites tenders for the supply of telephone and telegraph instruments, switchboards, telephone line material, six tons sulphate of magnesia, one ton sal-ammoniac, crushed, etc. Particulars from the Australian Commonwealth, 72, Victoria-street, Westminster. Tenders by July 1.

Ilford.—The Urban District Council invite tenders for the supply and erection of surface-condensing plant, and cooling tower, steam, and feed pipes, boiler feed pump, and extensions and alterations to main switchboard. Particulars from the Electrical Engineer. Tenders to the Town Clerk by June 10. See advertisement in last issue.

Clyde Navigation.—The Trustees of the Clyde Navigation invite tenders for the annual supply of stores, including electrical goods, oils, indiarubber, asbestos and packing, etc. Particulars from the Superintendent of Stores. Tenders to Mr. T. Mackenzie, general manager and secretary, 16, Robertson-street, Glasgow, by June 6.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors, 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

Aberaman.—The Powell Duffryn Steam Coal Co. invite tenders for the annual supply of stores, including electrical goods, indiarubber and asbestos, girders, channels, and rails, etc. Particulars from the Stores Manager, Aberaman Offices, near Aberdare. Tenders to the Directors of the Powell Duffryn Steam Coal Co., 101, Leadenhall-street, London, E.C., by June 15.

Horton.—The Asylums Committee of the London County Council invite tenders for the supply of coal for one year for their various departments, including the central electric lighting station at Horton, Epsom. Particulars from Mr. H. Keene, clerk of the Asylums Committee, 6, Waterloo-place, S.W., to whom tenders must be sent by June 11.

Adelaide.—Tenders are invited by the Municipal Tramways Trust for the supply, delivery, and erection of rotary converters, transformers, boosters, switchboards, and equipment for converter stations Nos. 1 and 2. Particulars from Mr. W. G. Goodman, the electrical engineer, 8, King William-street, Adelaide, S.A. Tenders to the Chairman by July 14.

Camberwell and Lewisham.—The London County Council invite tenders for the roadwork and platelaying required for the construction, on the underground conduit system of electric traction, of the authorised tramways from Dulwich Library (Lordship-lane) to Forest Hill, Camberwell, and Lewisham. Particulars from Mr. Fitzmaurice, chief engineer of the Council. Tenders by June 30.

Copenhagen.—The Commercial Intelligence Branch of the Board of Trade have received from his Majesty's Consul at Copenhagen a copy of the conditions and specification relating to a call for tenders for supply of 4,000 to 5,000 meters for electric lighting, delivery to extend over period from Aug. 1, 1908, to Aug. 1, 1909. Tenders should be marked "Tilbud paa Maalere," and should reach Direktoren for Belysningsvaesnet, Raadhuset, Copenhagen, by June 10.

Glasgow.—Tenders are invited for the construction of three branch railways for the Young's Paraffin Light and Mineral Oil Co.—viz.: (1) railway from near Addiewell Works to Beads coal mine; (2) railway

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from near Gavieside to Alderstone shale mine; (3) railway from Hopetoun Works to Niddry shale mine. The permanent-way material will be supplied by the company. Tenders to Mr. John Fyfe, managing director, 7, West George street, Glasgow, by June 13.

Christiania.—His Majesty's Consul at Christiania reports that the Norwegian State Railways have issued a call for tenders for the supply of 30,400 pairs of carbon points of various dimensions. Tenders are to be marked "Anbud paa Kulspidser," and delivered at Styrelsens Expeditionskontor, Christiania, by June 12. Copies of the conditions and specification may be examined by British makers on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

RESULTS OF TENDERS.

Rugby.—The Urban District Council have accepted the tender of Bornand and Co. for the supply of 830 yards of service cable.

St. Pancras.—The Guardians have accepted the tender of J. C. Christie for the supply of incandescent electric lamps at 8s. 6d. per dozen.

Chester.—The tender of Brook, Hirst, and Co. has been accepted for the supply and fixing of switchboards at the proposed sub-station at the Cross for £107.

Moose Jaw.—The tender of the Canada General Electric Co. has been accepted for the supply of a 500-kw. steam turbine generating unit for the sum of £7,436. 5s.

Lancaster.—The Town Council have accepted the tender of the British Thomson-Houston Co. for a new switch panel at £67, and for a pressure regulator for £302. 10s.

Hanley.—The Town Council have accepted the tender of the British Westinghouse Co. for the supply and erection of the new 500-kw. (No. 2) steam generating set.

Preston.—On the recommendation of the Tramways Committee, the Town Council have accepted the tender of Foster Bros. and Co. for the erection of a tramway shelter for £50. 15s.

Oldham.—The contract for overhauling and keeping in order the fire alarms for Oldham Corporation for seven years has been given to J. R. Norris, Volt Electric Works, Manchester-street, Oldham.

Adelaide.—The Adelaide Tramway Trust have accepted the tender of Smith and Tymms for the construction of 5¼ miles of permanent way, forming what is known as the "inner system" of the Adelaide electric tramway service.

Ontario.—The tender of the Electrical Construction Co. has been accepted for the wiring of the new isolation hospital to be erected at London, Ont., for £121, and that of Sheldon and Co. for the installation of the heating apparatus for £1,225.

Bermondsey.—The Electricity and Street Lighting Committee recommend the acceptance of the following tenders in connection with the plant extension: Babbock and Wilcox, for boiler, at £2,025; Siemens Bros., for steam dynamo, with Howden engine, for the sum of £1,828; and the tender of Dean and Beale for the condenser at £3,374.

Leyton.—The Urban District Council have accepted the following tenders: Lancashire Dynamo and Motor Co., for a dynamo, £650; Underfeed Stoker Co., £434 for a mechanical stoker; Bertram Thomas, at £86, for a switch panel and extension of switchboard; and that of the Oliver Arc Lamp Co. for the conversion of 24 lamps of their own make to flame arcs.

Leyton.—The following tenders have been received for the supply and maintenance of telephonic communications and electric call bells to firemen's residences (23 bells and four telephone circuits): National Telephone Co., £54. 10s. per annum; Stuart and Moore, £18. 10s. per annum; Headland and Headland, installation of new system £220. 15s., maintenance £11 per annum, existing system maintenance £18 per annum. The Council have decided to enter into a seven years' agreement with Messrs. Stuart and Moore, the system to be handed over to the Council at the end of seven years in thorough working order.

Walthamstow.—The Urban District Council have accepted the following tenders for the supply of plant for the generating station: Babcock and Wilcox, boiler-house plant, £7,420; Siemens Bros. Dynamo Works, two engines and dynamos, £3,595; Ledward and Beckett, condensing plant, £2,270. 10s.; Alphons Custodis Chimney Construction Co., chimney, £856; Johnson and Phillips, switchboard £641. 15s.; Paterson Engineering Co., water softening and purifying plant, £425. Estler Bros.' tender for the supply of 14 sets of patent block-system signals, with lamp attachments, at £19. 10s. per set, was also accepted.

Southwark.—The Borough Council have received the following tenders for an induced-draught plant to be installed at the electricity station:

J. Howden and Co.	£672	0	0
Electrical Ordnance Accessories Co.	485	0	0
Sturtevant Engineering Co.	470	0	0
J. Crawford	467	10	0
Crompton and Co.	455	10	0
Bumsted and Chandler	455	0	0
Mather and Platt	455	0	0
Lancashire Dynamo and Motor Co.	443	15	0
Heenan and Froude	419	0	0
Siemens Bros.	417	0	0
Baxter and Gaunter	405	10	0
Musgrave and Co.	404	15	0
Pooley and Austin	397	0	0
Davidson and Co.	395	0	0
Matthews and Yates	374	10	0
Buffalo Forge Co.	347	10	0
General Electric Co.	344	10	0
Electrical Construction Co. (provisionally accepted)	330	0	0

OPENINGS FOR CONTRACTORS.

ABERAMAN—Station adjoining Powell Duffryn Colliery Co.'s works.

ABERDARE—Fifty-seven houses, Graig-y-Hyfan Estate, Senghenydd, Universal Building Society.

ABERDARE—Ten houses, Monk-street Building Club.

ABERDOVERY—Additions to golf clubhouse; architects, Messrs. Deakin and Howard Jones.

ABERTRIDWR—Twenty-six houses, Eglwyilan Building Club. Mr. G. A. Treharne, architect.

ABERTRIDWR—Twenty or more houses, Old Mill Cottage Club. Mr. J. H. Phillips, architect, Windsor-place, Cardiff.

ALDERSHOT—Electric light installation at residence, Rev. O. Farrell.

AMBLESIDE—Infectious diseases hospital, Urban District Council.

AMMAN VALLEY—Intermediate school, Managers of Amman Valley Schools.

ANNFIELD PLAIN—Two houses, Mr. T. H. Parker.

APPLEDORE—Manse in connection with Baptist church, Rev. E. Whitton.

ARMAGH—Workmen's dwellings (£12,600), Rural District Council.

BAGNALL—Improvements, Bagnall Council School (£224), Education Committee.

BARGOED—Seven houses, Mr. G. Barnett; six houses, Deri, Mr. D. Williams; two houses, Mr. A. Jones.

BARGOED—Fire station (£382), Rural District Council.

BANBRIDGE—Workmen's dwellings (£28,860), Rural District Council.

BANBURY—Elementary school, Education Committee.

BARNES—Nine blocks of flats. Plans passed.

BARNSLEY—Alterations, Clarence Hotel, Managers.

BARNSTAPLE—Four houses, Fort-terrace, Mr. Prideaux; four houses, Yeo Vale-road, Mr. W. Carter.

BARRY—Shelter on Barry Island (£600), Public Works Committee.

BATTERSEA, S.W.—Shops and warehouses, York-road, Messrs. Goodwyn and Sons.

BECKENHAM—Electricity undertaking (£5,107), District Council.

BECKENHAM—Office etc., Council's depôt Urban District Council.

BECCLES—Secondary school (£5,000), Suffolk County Council.

BELFAST—Hall connected with All Souls' Church, Trustees.

BELMONT—Alterations, asylum (£10,640), Metropolitan Asylums Board.

BERKSHIRE—Modern schools (£5,000), master's house (£1,500), County Council.

BEXLEY—Extensions, library, Urban District Council.

BILLINGFORD—Primitive Methodist chapel, Trustees.

BILLINGHAM—Two houses, Mr. Ayres.

BIRKENHEAD—Alterations and extensions, Argyle Theatre of Varieties, Manager.

BISHOP'S STORTFORD—Alterations and additions, workhouse infirmary, Guardians.

BLACKPOOL—Church of St. Peter, Lytham-road, Messrs. Potts.

BLACKPOOL—Detached house, Durham-road, Caroline street; three houses, Read's-road, Mr. Thomas Hartley; six houses, Jackson-street and Arnold-street, Mr James Wood; two houses, Whitegate drive, Mr. Fred Ayre; two houses, St. Helier's-road, Mr. James Hodgson; houses, Bryan-road, Mr. George Ellis Whittaker; two houses, Lytham-road, Mr. Thomas Carter; three houses, Exchange-street, Mr. James Carter; 16 houses, Ormond avenue, Mr. Stephen Orme; lock-up shop and three offices, Charnley-road, Co-operative Society; three houses and shop, Bank-road and Johnson-road, Mr. A. Cardwell; house, Whitegate-drive, Mr. John Lees; alteration, house, Rothsay-road, Co-operative Society; alteration, house, Boscombe-road, Mr. Frank H. Gorst; additions, house, Beech-avenue and Bryan-road, Mr. M. A. Butler.

BOTESDALE—Business premises, Messrs. Aldrick and Bryant.

BOURNEMOUTH—Additions to Boscombe Council School, Education Committee.

BOW AND BROMLEY—Buildings, Fairfield-road, Mr. E. Evans.

BRADFORD—Electric light installation at town hall, Town Council.

BRAMPTON-EN-LE MORTHEN—Re-erection of temporary hospital, Hospital Committee.

BRENTFORD—Enlargement, Ealing-road Council Schools (£1,427), Middlesex County Council.

BRENTWOOD—Girls' school, Essex Education Authority.

BRIDGNORTH—Grammar school, Salop County Council.

BRIDGWATER—Improvements to municipal buildings (£8,500), Town Council.

BROADSTAIRS—Two houses, Edge End-road, Mr. C. Philpott; house, St Peter's road, Mr. J. W. Hall.

BUCKHAVEN—Public slaughter-house; conversion of Cameron House into hospital, Town Council.

BUCKLEY—Two houses, Padeswood-road; architect, Mr. J. E. Tate.

BURNHAM—Conversion of Primitive Methodist chapel into private residence.

BURSLEM—Extensions, manufactory, Newcastle street, Messrs. Ford, Limited.

BUSHEY—Enlargement, Merryhill School, County Council.

CARDIFF—Warehouse, Wood-street. Mr. Wm. Corbett, architect, Castle-street.

CASTLETON—Branch baths (£8,500), Town Council.

CHADSMOOR—Elementary school, Cannock Education Committee.

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CHATHAM—Secondary school (£10,250), Kent County Council; convenience, Military-road (£1,609); architects, Messrs. West Bros.

CHELTENHAM—Theatre, Regent-street, local syndicate.

CHESHUNT—Alterations and extensions, Firs, High-street, Waltham Cross, Mr. C. E. Maxfield; iron building, Marsh-lane, Rev. P. Wonnacott; motor garage, Mr. G. H. Fell; house, Appleby-street, Mr. R. T. Bates.

CHICHESTER—New secondary school for girls, Stockbridge-road. Mr. Haydn P. Roberts, architect, Education Offices, Horsham.

CLACTON—Temporary iron church, Pier-avenue, Trustees.

CLAPHAM—Shop, Lytham-road, Messrs. Dartnell and Banks; houses and shops, Clapham Common Messrs. Corsellis and Berney.

CLWTYBONT—Vestry, Disgwylfa Calvinistic Methodist Chapel. Mr. Evans, architect.

COMBE HAY—Elementary school (£1,400), Somerset Education Committee.

CONNAH'S QUAY—Public hall, Local Company.

CORK—Villa at Gregg's Cross; architect, Mr. J. F. M'Mullen.

CORNWALL—Alterations and extensions, Bodmin County School, Cornwall Education Committee.

CORSTORPHINE—Renovation, etc., of St. Peter's Church, Mr. R. Murray.

COSTA RICA—Temple of Peace (£20,000), Mr. Andrew Carnegie.

COVENTRY—Children's homes at Foleshill and Stoke, Board of Guardians.

COVENTRY—Enlargement, Radford School (£11,200), Education Committee.

CROMPTON—New mill, Hawk Mill Co.; four houses, Beal-lane, Mr. W. Nutter.

CROWTHORNE—Parish hall (£2,000).

CROYDON—Group of schools, Tavistock-grove (£12,100), Education Committee.

DARFIELD—Elementary school (£10,320), West Riding Education Committee.

DARLINGTON—Elementary school on the east side of railway, Education Committee.

DENHOLME—Classrooms, etc., Messrs. W. H. and A. Sugden.

DERBY—Rebuilding south porch and western doorway of Breadsall Church (£350), Trustees.

DEVONPORT—Municipal buildings (£60,000), Finance Committee of Council.

DISLEY—Alterations, co-operative stores, Managers.

DODWORTH—School (£4,000); alterations to existing school (£540), Education Committee.

DONCASTER—Electricity undertaking (£2,000), Council.

DUDLEY—High school for girls (£18,000), Education Committee.

DUNDEE—Central reading-room (£3,000), Free Library Committee.

DUNDEE—Shops, etc., East Dock-street, Mr. W. Peggie; alterations, property, St. Andrew's-street, Mr. T. Russell.

EASTBOURNE—Strong-room, Finance and General Purposes Committee.

EAST DEREHAM—Enlargement of Toft Wood School and alterations to schools, Norfolk Education Committee.

EAST COWTON—Church (£15 000), Trustees.

EAST HAM—Elementary school, Altmore-avenue (£16,941), Education Committee.

EAST HARDWICK—Elementary school, Board of Education.

EBBW VALE—Alterations and additions, Catholic schools. Mr. A. S. Cameron, architect.

ELLESMERE PORT—Elementary school, Bebington and Neston Education Committee.

ELY (CARDIFF)—Bottling stores, Crosswell's Cardiff Brewery, Limited. Mr. J. T. Jenkins, architect.

EMSWORTH—Schools (£5,658), Hants County Council.

EVESHAM—Elementary school, County Education Committee.

EXETER—Alterations and additions at Higher Summerlands for the Guardians.

EXETER—Workshop, etc., and additions to the main building at the Devon and Exeter Boys' Reformatory (£876); architects, Messrs. E. H. Harbottle and Son.

FALKIRK—Public baths, Town Council.

FARNHAM—House, Frensham Hill, Mr. S. Castle; house, Binton Park, Mr. A. J. Stevens; three houses, Gold Hill, Mr. Hobbs; house, Heath End, Mr. Ellis; house, Rowledge, Mr. Chandler; house, Hindhead, Dr. Bulley.

FARNBOROUGH—Elementary school (£2,200), Hants County Council.

FARNINGHAM—Boys' home; architect, Mr. Spalding.

FLETTON—Technical school, Hunts County Council.

FOLKESTONE—Harvey Grammar School (£11,200), Education Committee.

FROME—Extensions, elementary schools (£3,500), Somerset Education Committee.

FYLDE—Pump-house (£173), Guardians.

GLAMORGAN—Infants' school, Pencoed; elementary school, Abertridwr; improvements, Rhydygwern Council Schools, near Machen; alterations and additions, Neath-road County Schools, Briton Ferry; alterations, Neath County Schools; renovations, Vernon-place Schools—Briton Ferry Education Committee.

GLYNCORRWG—Three fire stations, Urban District Council.

GLEADLESS—Enlargement of Provided school, West Riding Education Committee.

GOSPORT—Institute connection with Christ Church (£2,000), Trustees.

GRANGEMOUTH—Supplementary and higher-grade school, Parish School Board.

GRANGETOWN—Church, St. Barnabas, Ecclesiastical Commissioners.

GRANTHAM—Isolation hospital (£650), Rural District Council.

GRAVESEND—Theatre, Mr. D. Hart.

GRAVESEND—Elementary school, Cecil-road, Local Education Committee.

GREAT CROSBY—Council school (£7,876), Lancashire Education Committee.

GREENWICH—Six houses, Barling-street, Mr. Shorter.

GRIMSBY—Chapel, Weelsby-road (£3,900), Trustees.

GUILDFORD—Porter's lodge and receiving block at workhouse (£3,200), Joint Hospital Board.

HACKNEY, N.E.—Additions, union infirmary; workshops, etc., Messrs. H. Dearsby and Son.

HADDINGTON—Post office, Court-street; architects, Messrs. W. Black and Sons.

HALIFAX—Extensions to shops, etc., in the Piece Hall, Mr. J. Lord.

HALTWHISTLE—Church hall (£2,000), Vicar.

HALWIN—Improvements at Council School, Cornwall Education Committee.

HANWELL—Extensions to the superintendent's lodge, Kensington Royal Borough Council.

HARWICH—County high school (£9,000), Essex Education Committee.

HASLINGDEN—Additions to infirmary, Board of Guardians.

HASTINGS—Building for the nursing staff (£3,000), Guardians.

HEBDEN BRIDGE—Semi-detached villas, Saville Estate; architect, Mr. W. Wrigley.

HENDON—Eighteen houses, The Drive; 91 houses, Hamilton-road, Messrs. Hamiltons, Limited; 16 houses, The Drive, Messrs. Tucker and Huntly; two houses, Ravenscroft-avenue, Mr. R. V. Hart; 14 shops, The Parade, Golder's Green, Mr. W. J. King; three houses, Hampstead-way, Mr. R. Unwin; 10 houses, Wentworth-road, Mr. W. J. Matthieson; two houses, Temple Fortune-lane, Messrs W. Moss and Sons; three houses, Mr. A. J. Reynolds; 20 houses, Woodstock-avenue, Mr. H. Bernstein.

HOELYCYW—Public hall, Electors of Coychurch Higher.

HOLBORN, W.C.—Alteration to town hall, Mr. W. P. Hartley.

HOPWAS—Temporary accommodation, Council School, Staffs Education Committee.

HORDEN—House and shop, Mr. F. Watt.

HOWICK—Chapel and school (£800), Primitive Methodists.

HOYLAND NETHER—Elementary school, West Riding Education Committee.

HULL—Almshouses in Southwater-lane, Trustees of Eleanor Scott's Charity.

ILFORD—Library and public hall, High-road, Urban District Council.

INTAKE—Elementary school (£2,340), West Riding Education Committee.

INVERKEILOR—Additions, public school. Mr. J. Sim, architect.

INVERURIE—Higher-grade school (£5,000), Education Authority.

IRCHESTER—Free library, Library Committee.

JARROW—Bakery, Jarrow and Hebburn Co-operative Society.

KEA—Additions to dwelling, etc., Higher Lanner, Mr. W. J. Jennings.

KENDAL—Additions, Castle Villa, Mr. H. B. Armistead.

KEYNSHAM—Alterations and improvements, laundry (£200), Guardians.

KIDDERMINSTER—Alterations to the old chapel at the cemetery, Joint Burial Committee.

KINGTON—Public hall (£900), Urban District Council.

LANCHESTER—Council school, Malton Colliery, Parish Council.

LEICESTER—Extensions, technical institute (£14,000), Town Council.

LEIGH—Elementary school, Rochford Hundred Education Sub-Committee.

LEYTON (ESSEX)—Vicarage, Grove Green-road, Rev. J. Kennedy.

LEYTON—Extension to municipal accommodation by erecting extra building (£18,000), District Council.

LEYTONSTONE—Vicarage adjoining St. Catherine's Church, Rev. J. Kennedy.

LINCOLN—Restoration of St. Mary-le-Wigford's Church (£700), Ecclesiastical Commissioners.

LITTLE COATES—Chapel, Stortford-street (£1,300), Primitive Methodists.

LLANDUDNO—Library, Urban District Council.

LLANELLY—House, Bigyn-road, Mr. T. Rosser; workshops, Marble Hall-road, Mr. J. Charles.

LONDON, N.—Additions to Great Northern Hospital, Holloway-road, Sir J. Dickson Poynder.

LONDON, N.W.—Twenty-four houses, Staverton-road, Brondesbury Park, N.W., Messrs. Callow and Wright; alterations, etc., 10, Bank-buildings, High-street, Harlesden, Messrs. Liptons, Limited.

LONGFORD—Alterations to stores, Lockhurst-lane, Foleshill Co-operative Society.

LOSSIEMOUTH—Laboratory and classrooms at schools. Mr. R. B. Pratt, architect.

LOWER BENTHAM—Elementary school to accommodate 100 scholars, West Riding Education Committee.

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LOWESTOFT—Electric lighting, Town Council.

LUTON — House, Hitchin-road, Mr. C. Abrahams; two houses, Naseby-road, Mr. T. Day; six houses, Hartley-road, Mr. J. Tomkins; four houses, Ridgeway-road, Mr. A. Cole; six houses, Clipstone-road. Mr. J. Frost; two houses, New Bedford-road, Mr. W. Davis; two houses, West Hill-road, Mr. W. Smith; two houses, Reginald-street, Mr. G. Kingham; Baptist chapel, school-room, etc., off Adelaide-road, Trustees; 10 villas, Cromwell-road, Mr. W. G. Dunham.

MAESTEG—Public hall and institute, Garth-road, Colliery Workmen.

MAESTEG—Alterations and additions Glanllynfi, Mr. J. P. Gibbon; six houses, Tubervil-street, Messrs. Bowen and Davies; two houses, Garnwen-terrace, Messrs. Jones and Morris.

MALDON—School, Education Committee.

MANCHESTER—Additions, Education Offices, Education Committee.

MEATH—Workmen's dwellings (£30,028), Rural District Council.

MARCH—High school, Isle of Ely Education Committee.

MERTHYR—Free library, swimming bath, police court, and museum, General Purposes Committee.

MERTHYR TYDFIL—Seven additional classrooms, cookery-room, cloak-rooms, etc. Mr. J. Llew llin Smith, architect.

MEXBOROUGH—Elementary school, Alwick-road, Education Committee.

MIDDLESBROUGH—Alterations and additions 17 houses, Linthorpe-road, and conversion into shops. Mr. Wiggen, architect, Abinger road, Bedford Park London.

MIDDLESBROUGH—Public library (£1,500), Free Library Committee.

MIDHOPE—Elementary school at Midhope, Education Committee.

MILLSTREET—Workmen's dwellings (£33,130), Rural District Council.

MOIRA—Fifty-one labourers' dwellings (£12,217), Rural District Council.

MORESBY—Two semi-detached houses, Millgrove, Mr. Burnyeate.

MORLEY—Alterations and additions, residence, Wide-lane, Mr. W. Scarth.

MOULTON—Alterations to premises, Moulton Branch, Windsford Industrial Co-operative Society.

NEWBURY—Private residence, Speen, Trustees of the late Sir Richard Sutton.

NEWBURY—Removal of old town hall, construction of offices, Town Council.

NESTON—Elementary school, Bebington and Neston Education Committee.

NEWCASTLE—Post office, Council.

NEWCASTLE (CO. DOWN).—Presbyterian Church, Rev. J. Keers.

NORTHLEACH Elementary school, Gloucester Education Committee.

NORTON—Two houses, Ragworth Estate, Mr. J. Coxon.

NORWICH—Electricity extensions (£1,450), Council.

NORWICH—Wiring supplies, etc., Electricity Committee.

NORWICH—Reconstruction of the sanitary offices, Norfolk and Norwich Hospital (£425), Board of Governors.

OKEHAMPTON—Alterations, Freemasons' Hall, Town Council.

PEMBURY—Four houses, Mr. J. Seymour.

PETERBOROUGH—Shops and offices, Park-road, Co-operative Society.

POCKLINGTON—Alterations to workhouse, Board of Guardians.

PORTSMOUTH—Police and fire-escape station (£1,400), Town Council.

PORT TALBOT — Corrugated iron building for public library and reading-room, Bryn. Mr. R. Evans, architect.

RAYLEIGH—Elementary boys' school (£2,705), Rochford Hundred Education Sub-Committee.

READING—Council School, Northumberland-avenue, Whitley, Local Education Authority.

REDDITCH—Transfer County Council buildings for educational purposes (£2,000), County Council.

REDDITCH—Extension of secondary school, Higher Education Committee.

RHYL—Pavilion (£13,683), Urban District Council.

RINGWOOD—School (£3,962), Hants County Council.

ROEHAMPTON—Houses, Mr. Pennington.

ROTHBURY—Parish hall on ground between church house and parish church, Ecclesiastical Commissioners.

ROTHERHAM—Electricity and generating station, Town Council.

ROTHERHAM—Cookery centre, etc.; extensions to Alma-road Council School; alterations, Thornhill Council Schools.

ROWLEY—Improvements, Black Heath Council Schools (£783), Education Committee.

RUGBY—Motor and house, new speech-room, Governing Body, Rugby School; alterations and additions, premises, Railway-terrace, Mr. C. H. Patchett.

SACRISTON (DURHAM)—Shops, warehouses, etc., Mr. D. M. Spence.

SAFFRON WALDEN—House, etc., Borough-road, Mr. J. Mumford; workshop, King-street, Mr. J. Dominick; villa, Ashdon-road, Mr. G. H. Archer; two houses, Seward's End, Mr. R. Waraker.

SEAHAM COLLIERY—Residence, Mr. W. C. Mason; houses, Messrs. Clark and Son.

SEDBERGH—Alterations, Sedbergh Club, Managers.

SHILDON (YORKS)—Workmen's institute, Directors, North-Eastern Railway Co.

SHIPSTON-ON-STOUR—Improvements, St. Edmund's Church, Churchwarden.

SLOUGH—Roman Catholic church, Curzon-street,

SIDLESHAM—Alterations and additions to Council School, West Sussex and Chichester Local Education Committee.

SOMERSET BRIDGE—Elementary school (£2,300), County Education Committee.

SOUTHALL—Elementary school, Western-road, Middlesex County Council.

SOUTH ELMSALL—Elementary school (£6,210), Education Committee.

SOUTH HETTON—House, Dr. Henegan.

SOUTH MEDOMSLEY—Five houses near Dipton, Mr. Gillies.

SOUTH WALES—Twenty miners' rescue stations (£40,000), South Wales Coalowners' Association.

SPEYMOUTH—Additions and alterations to public school; architect, Mr. Willet.

ST. AUSTELL—House, Foxhole, Mr. T. Bassett; two houses, Station-road, St. Blazey; three houses, Ranleigh-road, Mount Charles.

ST. PANCRAS, N.W.—Free public library, Borough Council.

STAFFORD—Additional accommodation, Council School, Wood-lane, Education Committee.

STANLEY—Two houses, North Thorn-terrace, Messrs. Bell and Curry; two houses, Ernest-terrace, Mr. P. Duffy.

STANNINGLEY—Alterations to chapel; architect, Mr. W. G. Smithson.

STALYBRIDGE—Electricity undertaking (£25,223), Stalybridge Joint Tramway and Electricity Board.

STAINES—Enlargement, Kingston-road Council School (£583), Middlesex County Education Committee.

STANTON HILL—Schools and classrooms, rear of Primitive Methodist Chapel (£1,000), Trustees.

STOW BRIDGE—Mission church, Trustees.

STRANORLAR—Alterations at the National Robertson School.

STRATFORD—Additions and alterations, Messrs. Rice and Sons' premises, Wharton-road.

STROUD—Craft school, Gloucester Education Committee.

SUTTON COLDFIELD—Elementary school, Green-lanes, Education Committee.

SWANSEA—Operating theatre, workhouse, Guardians.

TEESDALE—Post office, Middleton, H.M. Commissioners of Works.

TINGLEY—Sunday school, Wesleyan church (£1,315), Trustees.

TON—Alterations, Industrial Co-operative Society, Church-road, Mr. W. D. Morgan.

TREHERBERT—Enlarging chapel, Trustees of Libanus Chapel.

TUNSTALL—Enlargement, school, Staffs Education Committee.

TURRIFF—Burgh Council Chambers (£250), Council.

TWERTON—Engineering works, Midland-road, Messrs. Aldridge and Ranklin

WALSALL—Manual instruction cookery and laundry work centres, Elmore-green School, Education Committee.

WARFORD—Special school for epileptic children, Manchester Education Committee.

WASHINGTON—Fifty houses (£14,000), Durham County Council.

WATFORD—Transformer station in Milton-street, Messrs. Bemrose Dalziel, Limited; additions to Railway Tavern, Pinner-road, Messrs. Clutterbuck and Co.; 30 houses, Kensington-avenue, Messrs. W. and D. Wilkins; three houses, King's-avenue, Mr. T. Rolfe.

WAVENDON—House, Newport-road, Mr. Wilson; alterations and additions, house, Bow, Brickhill, Mr. Stilton.

WELLINGBOROUGH—Alterations, shop, Oxford-street, Mr. Woolston.

WEST COATS—Elementary school (£3,000), Education Committee.

WESTMINSTER, S.W.—Alterations, Roman Catholic schools (£118,000), London County Council.

WESTON-SUPER-MARE—Primitive Methodist school-chapel, Brighton-road (£1,500), Trustees.

WHITBY—Elementary school (£2,750), North Riding Education Committee.

WHITTINGTON—Enlargement, school, Staffs Education Committee.

WIGAN—Public house, Albion Brewery Co.

WILLESDEN, N.W.—Dairy and offices, Kilburn-road; laundry premises, Acton-lane—Mr. G. A. Sexton, architect; 58 houses, Dudden Hill Estate, Mr. J. C. Hill; two motor garages, Aylestone-avenue, Messrs. Trant, Brown, and Humphries; alterations, Falcon public-house, Salisbury-road, Messrs. Dove Bros.; additions, R.C. schools, Manor Park-road, Mr. W. J. Maddison; additions, St. George's Presbyterian Mission Hall—Messrs. Hukins and Mayell; shop and house, High-road; two shops, Cricklewood-broadway, Mr. J. D. Hunter; seven houses, Stonebridge Park, Mr. H. Enderby; 12 houses, Melrose-avenue, Mr. J. Catton.

WINGATE—House, Mr. A. Cook; house, Mr. R. J. Hays.

WIRKSWORTH—Extensions, town hall (£300), Urban District Council.

WIRRAL—Additions to administrative block, Joint Hospital Board.

WOBURN SANDS—House, Brickhill-road, Mr. F. Wingrave; house, Brickhill-road, Mr. C. H. Wynn.

WOMBWELL—Elementary school, John-street, Education Committee.

WOOLER—Auction mart, Wooler Auction Mart Co.

WORSBOROUGH—Elementary school (£5,000), Education Committee.

WORSBOROUGH DALE—Church, Trustees of the Worsborough Dale Wesleyan Chapel.

YORK—Farm buildings, City Asylum, Naburn, City Council.

YSTRAD—English Baptist Tabernacle (£1,300), Trustees.

YSTRAD—House, Ystrad Mynach, Mr. G. Davies.

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PROVISIONAL PATENTS, 1908.

MAY 21.

10997. Improvements in apparatus for electrically lighting the mouth and cavities beyond during dental or other surgical operations. Charles Garfitt and James Baxter, 12, Mulberry-street, Sheffield.

11029. Improvements in or relating to electric automatic call boards and apparatus connected therewith. James Appleby and Albert Edward Drew, 8, Quality court, Chancery-lane, London.

11030. Improvements in switches for electric lighting and purposes therefor. Frederick Hodgson, 24, Queen Victoria street, London.

11035. Improvements in electric batteries. The New Ignition Syndicate, Limited, and Wallace James Lambert Sandy, 24, Southampton-buildings, London.

11061. Improved form of electric break or interrupter. Ernest Elias Tidboald Badcock Greville, 228, Gray's-inn-road, London.

11064. Improvements in and relating to starting switches for electric motors. Dagobert Timar and Karl von Dreger, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, June 5, 1907, being date of application in Germany.) (Complete specification.)

11068. Improvements in electro-mechanical regulators or governors for electric generators, electric furnaces, and the like. Joseph Louis Routin, 31, Bedford-street, Strand, London. (Date applied for under Section 91 of the Act, May 24, 1907, being date of application in France.) (Complete specification.)

MAY 22.

11099. Improvements in apparatus for transmitting telegraphic signals. William Hamilton, 6, Bank-street, Manchester. (Complete specification.)

11105. Improved process for treating electrolytic copper during melting in a reverberatory furnace. Henry Davies, 33, Chancery-lane, London.

11106. Improvements in portable electric lamps. Henry Francis Joel, 74, Windsor-road, Forest Gate, Essex.

11119. Improved dynamo for motorcars and other vehicles. Louis Bachten and Jean Gallay, 52, Chancery-lane, London. (Complete specification.)

11128. Improvements in electric heating apparatus. Max Hankin, 18, Southampton-buildings, London. (Date applied for under Section 91 of the Act, May 27, 1907, being date of application in Belgium.) (Complete specification.)

11134. Improvements in electrical induction clutches. Abram Peters Steckel and Francis du Pont Thompson, 7, Southampton-buildings, London. (Complete specification.)

11135. Improvements in or relating to telephony and telegraphy. Sidney George Brown, 7, Southampton-buildings, London.

11136. Improvements in electrical induction clutches. Abram Peters Steckel, 7, Southampton-buildings, London. (Complete specification.)

11153. Improvements in or connected with electric cables. Sydney Paterson and Dundas Alexander Smith Porteous, Norfolk House, Norfolk-street, Strand, London.

11158. Improvements in appliances for notifying the extinction of a lamp or other flame, and/or automatically replacing it by an electric light. William Arthur Jones and George Spencer Bowler, 6, Lord-street, Liverpool.

11161. Improvements in and relating to dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Allgemeine Elektricitäts-Ges., Germany.) (Complete specification.)

11163. Improvements in submarine signalling cable. Theodor Petersen and Callender's Cable and Construction Company, Limited, Hamilton House, Victoria-embankment, London.

11170. Improvements in and relating to induction coils. John Boultbee Brooks and Frank Herbert Alston, 24, Temple-row, Birmingham.

11175. Improved electromagnetic switch for tramway lines. Albert Köhler and Fritz Köhler, 345, St. John-street, London. (Complete specification.)

MAY 23.

11183. Electrical circuit breakers. Bertram Thomas and Eustace Thomas, Worsley-street, Hulme, Manchester.

11191. Improved means of making electric light or power. John Mabbett, White House, Canonbury-street, Berkeley, Gloucestershire.

11193. Electric ring game. Ernest McKaig, 12, Raglan-circus, Weston-super-Mare. (Complete specification.)

11224. Improvements in electric bell systems and means for operating same. John Matthew Young, 44, West George-street, Glasgow.

MAY 25.

11288. Improvements relating to mercury interrupters for alternating electric currents. Frederick William Watson Baker and Arthur Charles Gunstone, 313, High Holborn, London.

11299. Improvements in or relating to the measurement of intensity and tension of electric currents delivered by an induction coil. Friedrich Klingelfuss, 111, Hatton-garden, London. (Complete specification.)

11336. Improvements in connection with dynamo-electrical machinery subject to fluctuation of load. The Electric Construction Company, Limited, and William Buchanan, 47, Lincoln's-inn-fields, London.

11399 Improved method of firing mines and the like by electricity. Julius Pichler, 173, Fleet-street, London.

11344. Improvements in and relating to electrical power transmission systems. The British Thomson-Houston Company, Limited, and William Francis Dawson, 83, Cannon-street, London.

11345. Improvements in and relating to the control of electric circuits and apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

11346. Improvements in insulators for overhead systems of electric railways and the like. Frank Guillot, 83, Cannon-street, London. (Date applied for under Section 91 of the Act, Oct. 10, 1907, being date of application in United States.) (Complete specification.)

11347. Improvements in and/or connected with conductor rails for electric railways and the like. Charles Hesterman Merz and Sydney George Redman, Norfolk House, Norfolk-street, Strand, London.

MAY 26.

11394. Improvements relating to electrical relay applications. Axel Orling, 22, Southampton-buildings, London.

11404. Improvements in protective devices for electric circuits. Kenelm Edgcumbe and Edgar Isaac Everitt, Collindale Works, Hendon, London.

11432. Improved magneto-electric ignition apparatus. Gustav Adolf Unterberg and Friedrich Helmle, trading as Unterberg and Helmle, 322, High Holborn, London. (Date applied for under Section 91 of the Act, Dec. 6, 1907, being date of application in Germany.) (Complete specification.)

11460. Improvements in and relating to incandescent electric lamps. The British Thomson-Houston Company, Limited, and Thomas Edward Robertson, 83, Cannon-street, London.

MAY 27.

11490. Improvements in electrically heated laundry irons. Harry George Barrett and James Ferguson, 182, West George-street, Glasgow.

11511. Improvements in electrical contacts. Siemens Bros. and Co., Limited, Queen Anne's chambers, Broadway, Westminster. (Siemens und Halske Akt.-Ges., Germany.) (Complete specification.)

11512. Improvements in or relating to switch arrangements for starting electric motors. Siemens Bros. Dynamo Works, Limited, Bertie George Payne, and Ernest Schupp, 139, Queen Victoria-street, London. (Complete specification.)

11517. Improvements in continuous-current machines. Siemens-Schuckertwerke G. m. b. H., 231, Strand, London. (Date applied for under Section 91 of the Act, July 27, 1907, being date of application in Germany.) (Complete specification.)

11521. Improved manufacture of metal incandescence filaments free from carbon. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, June 8, 1907, being date of application in Germany.) (Complete specification.)

MAY 28.

11534. Improvements in high-tension distributors for electric ignition in internal-combustion motors. George Jack and Edward Frederick Robertson, 121, West George-street, Glasgow.

11584. Carbon steadier for arc lamps. Edward Cunningham, jun., 31, North terrace, Tarbrax, Cobbinshaw, Scotland.

11594. Improvements in or relating to apparatus for electrically igniting miners' safety lamps in mines. Albert Edward Best, Robert Octavius Best, and Maxwell Best, 33, Chancery-lane, London.

11593. Improvements in dynamo-electric generators and motors. Edward Bentall Gray, 23, Southampton-buildings, London.

11595. Improvement in magnetic clutches. Bernard Mervyn Drake and Robert Wilson Smith, 66, Victoria street, London.

11596. Improvement in magnetic clutches. Bernard Mervyn Drake and Robert Wilson Smith, 66, Victoria-street, London.

11599. Process of producing filaments for electric incandescent lamps of vegetable oils and resins. Karl Rittersberg and Hermann Rubert, 67, Knesebeckstrasse, Charlottenburg, Germany. (Date applied for under Section 91 of the Act, Sept. 6, 1907, being date of application in Germany.) (Complete specification.)

11600. Process of producing filaments of Chinese ink for electric incandescent lamps. Karl Rittersberg and Hermann Rubert, 67, Knesebeckstrasse, Charlottenburg, Germany. (Date applied for under Section 91 of the Act, Oct. 30, 1907, being date of application in Germany.) (Complete specification.)

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11603. Improved manufacture of tungsten incandescence filaments. Siemens und Halske Akt.-Ges., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, June 8, 1907, being date of application in Germany.) (Application for patent of addition to No. 16489/07.) (Complete specification.)

11607. Illuminating canopy electrically lighted underneath for billiard and operating tables and the like. Edward Ranier Crook, 5, Carnaby-street, Regent-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on June 11.)

1907.

3842. Electric motor controllers. Schattner.

11288. Alternate-current motors. Fynn.

11347. Telephonic dictating system and devices. Heys. (General Acoustic Company.)

11352. Electrically operated or controlled whistles or sound signalling apparatus. Bruce.

11459. Electric switches. Tucker.

11471. Electrodeposition of metals Cowper-Coles.

11520. Electric switches. Tucker.

11695. Radio-telephony. Amalgamated Radio-Telegraph Company. (Seibt.)

11794. Control of electric motors. Lang.

11808. Telephonic apparatus. Graham.

11874. Combined electrical and mechanical systems for the storage of power. Siemens Bros. Dynamo Works and Poynder.

12238. Systems for electrically operating railway signals, points, and the like. British Thomson-Houston Company. (Allgemeine Elektricitäts-Ges.)

12368. Electric ampere-meters, voltmeters, and the like. Lehmann.

12633. Methods of producing electric oscillations. Galletti. (Date applied for under International Convention, Jan. 29, 1907.)

12634. Methods of producing electric oscillations. Galletti. (Date applied for under International Convention, March 9, 1907.)

12635. Wireless telegraphy. Galletti. (Date applied for under International Convention, Dec. 29, 1906.)

12636. Wireless telegraphy. Galletti. (Date applied for under International Convention, Jan. 24, 1907.)

15298. Apparatus or devices for use in submarine signalling. Gardner.

15412. Receivers for wireless telegraphy. Walter.

18342. Means for receiving intelligence communicated by electric waves. Pickard. (Date applied for under International Convention, Aug. 30, 1906.)

20229. Electric motor starters and regulating rheostats. Allgemeine-Elektricitäts Ges. (Date applied for under International Convention, Sept. 12, 1906.)

21860. Method of insulating transformers and other electric apparatus. Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.)

23585. Method of producing electric illuminating bodies by causing raw metallic threads to become incandescent by means of the electric current. Fairweather. (Gluhlampenwerk Anker Ges.) (Rights under Section 91, Patents, etc., Act, 1907, not granted.)

23778. Manufacture of electric resistances. Day. (Fabrik Elektrischer Zünder Ges.)

24017. Measurement of electrical power. Arcioni.

24074. Measurement of electrical power. Arcioni.

1908.

268. Production of high-frequency electric oscillations. Eisenstein.

290. Multiple switches, particularly applicable to automatic telephone exchange selectors. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

608. Electric switch boxes or cases. Garforth and Bousfield.

1613. Apparatus for noting down telephone conversations and the like. Schmid.

2308. Electrically selecting one of several receivers connected with a common conductor. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, Feb. 11, 1907.)

2481. Holders for electric incandescent lamps. Siemens Bros. Dynamo Works, Limited, and Wheat.

3505. Current collector for electrically-propelled vehicles. Mertens. (Date applied for under International Convention, Feb. 16, 1907.)

3889. System of push-button apparatus for operating or controlling electric lifts Mair. (Application for Patent of addition to No. 5958/07.)

4139. Lifting magnets for cranes. Bloxam. (Markische Maschinenbauanstalt Ludwig Stuckenholz Akt.-Ges.)

4166. Multiple-rate electricity meters. Evans.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £	Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
—— Ord., 1,125,000	1 ..	⅛-¼
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125 000	1 ..	23/32-27/32
—— Ordinary, Nos. 1 125,000	1 ..	3/16 5/16
British Aluminium Co., Ordinary, 2 001-40,000	5 ..	3⅛-3⅜
—— 7 per cent. Cum. Pref., 1-40,000	5 ..	4-4½
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	4⅞-5⅛
—— 4 per cent. Funding Certificates, 1-20,000	5 ..	3⅜-4⅛
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	104-108
—— 5½ per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5 ..	5⅛-6⅛
—— 6 per cent. Cum. Pref., 1-100,000	5 ..	5⅞-6⅛
—— 4½ per cent. Mortgage Debentures	100 ..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	93 98
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275,001-475,000	3 ..	7/16-11/16
—— 4 per cent. Mortgage Debenture Stock	100 ..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105,721	2 ..	0-⅛
—— Non. Cum., 6 per cent., Pref.	8 ..	3/16-7/16
—— 4½ per cent 1st Debenture Stock	100 ..	70-75
—— 4½ per cent. 2nd Debenture Stock	100 ..	55-60
Callender's Cable, Debentures	100 ..	107-109
—— Ordinary	5 ..	9⅛ 10⅛
—— 5 per cent. Pref.	5 ..	5⅛-5⅜
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	⅜-½
Crompton and Co.	3 ..	1⅛-1
—— 5 per cent. Debentures	— ..	92-96
Dick, Kerr and Co., Ordinary, 1,250 000	1 ..	1 1/16-1 5/1
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	101-104
Edison and Swan United, "A" Shares, 1-99,261	5 ..	⅛-¼
—— "A" Shares, 01-017,139	5 ..	1⅛-2⅛
—— 5 per cent. Debentures	100 ..	85-87
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112,100	2 ..	¼-⅜
—— 7 per cent. Cumulative Pref.	2 ..	1⅛-1⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red	100 ..	75 80
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅛-8⅛
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	87-90
W. T. Henley's Telegraph Works, Ordinary	5 ..	10⅛-11⅛
—— 4½ per cent. Preference	5 ..	5-5⅛
—— 4½ per cent. Debentures	100 ..	104-106 xd
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15⅛-16⅛
—— 4 per cent. Debentures	100 ..	98-100
National Electric Construction Co., 1-170,000	1 ..	⅜-½
Parker, Thos., Limited, Ordinary	10 ..	10-10⅛
Peebles (Bruce) and Co., 6 per cent. Cum. Pref, 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	29-31
—— 4 per cent. Bonds	100 ..	101-103
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	7⅛-8⅛

Electric Lighting and Supply.—

Name.	Amount paid. £	Last price. £
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4⅝-5⅛
Bournemouth and Poole, Ordinary	10 ..	10⅛-11
—— 4½ per cent. Cum Pref., 7 501-15 000	10 ..	9⅛-10⅜
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	10⅛-10⅝
—— 4½ per cent. Debenture Stock, Red.	100 ..	102-105
Bromley (Kent) Electric Light and Power Co.	5 ..	4⅛-5
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	94-97
Brompton and Kensington, Ordinary	5 ..	6⅛-7⅛
—— 7 per cent. Preference	5 ..	6⅞-7⅜
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5 ..	5⅛ 5⅜ xd
Cambridge Electric Supply Company, £10 Ord.	8 ..	12⅛-13⅛
Canadian General Electric Co., Common Shares	$100 ..	86-90
—— 7 per cent. Cum. Pref. Stock	$100 ..	108-110
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	97-100 xd
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅛-3⅜
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	4⅛-4⅜
—— 4 per cent. Debenture Stock, Red.	100 ..	96-99
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	3⅞-4⅛
—— ditto (903) 40,001-80,000	5 ..	4⅜-4⅝
Chelsea Electricity Supply	5 ..	3-3⅛
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 4½ per cent. Debenture Stock	100 ..	124-127
—— 4½ per cent 2nd Deb. Stk., Red.	100 ..	102-105
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,630	50 ..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2⅛-3
—— 5 per cent Preference, 1-50,000	5 ..	3⅜-4⅛
County of London Elec. Supply, Ordinary	10 ..	7⅜-8⅛
—— 6 per cent. Cum Pref.	10 ..	10⅜-1 ⅛
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	97-100
Edmundson's Electricity Corporation, Ordinary, 1-50,000	5 ..	⅛-⅜
—— 6 per cent. Cum Pref.	5 ..	⅜-1
—— 4½ per cent. First Mort. Deb	100 ..	65-75
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	83-86 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2⅜-2⅝
—— 5 per cent Debenture Stock, Red	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	90-93
Folkestone Electric Supply, Ord., Nos. 1-10 000	5 ..	4⅜-4⅝
—— 5 per cent. Cum Pref., Nos. 1-10,000	5 ..	5-5⅛
—— 4½ per cent. First Deb Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	5-5⅛
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	95-98
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	90-93
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 ..	⅝-¾
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5 ..	7-8
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	97-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	5 ..	7-7⅛
—— 6 per cent. Pref.	5 ..	4¼-4⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100 ..	85-90
Metropolitan Ordinary, 100,001-200,000	5 ..	4⅜-4⅞
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	107-111
—— 4½ per cent. Cum. Pref.	5 ..	4⅜-4⅞
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000	— ..	80-82 p.c.
Mexican Light and Power Co., Capital Stock	$100 ..	54-56
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	— ..	85⅛-87½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	— ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009 ..	5 ..	5⅛-6
—— do., 57,010-75,000	5 ..	5⅛-6
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5 ..	6⅛-5⅛
—— 5 per cent., Pref., 1-57,009	5 ..	5⅛-5⅛
Notting Hill Electric Lighting	10 ..	11⅛-12⅛
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100 ..	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5 ..	5⅜-6⅛
—— 4 per cent. Debenture Stock	100 ..	94-98
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1 ..	27/32 31/32
—— 6 per cent. Non-Cum. Pref., 1-100,000	1 ..	⅛-1
—— 5 per cent. Debenture Stock, Red	100 ..	96-99
Rosario Electric Co., 6 per cent. Cum Pref., 1-20 000	5 ..	4⅜-5⅛
—— 6 per cent. Cum. 2nd Pref., 1-15 000	5 ..	4⅜-5⅛
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	96-98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	— ..	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5 ..	⅛-¼
—— 4 per cent. Debenture Stock	100 ..	70-74
South London Ordinary	4 ..	2⅛-2⅜
South Metropolitan Electric Light and Power, Ord.	1 ..	⅜-⅝
—— 7 per cent. Cum Pref.	1 ..	1 1/16-1 5/16
—— 4½ per cent 1st Mort. Deb.	100 ..	98-102
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	7⅛-8⅛
—— 7 per cent. Pref.	5 ..	6⅛-7⅛
—— 3½ per cent. Deb.	100 ..	85-90
Urban Electric Supply Co., Ordinary, 8-30 007	5 ..	1-2
—— 5 per cent. Cumulative Preference, 50 001 80,000	5 ..	1⅝-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100 ..	87-90
Westminster, Ordinary	5 ..	7⅛-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5 ..	4⅜-5⅛

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-260,007	5 ..	6⅛-6⅜
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007 ..	5 ..	8 3 16-8 7/16
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	140-145
Auckland Elec Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100 ..	104-107
Barcelona Tramways, Ord., 1-20,000	10 ..	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10 ..	—
—— 6 per cent Deb., Red., 1-600	100 ..	—
—— 4½ per cent. Red. Deb. Stock	100 ..	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1 ..	⅜-⅝
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1 ..	⅜-⅝
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100 ..	93-96
Blackpool and Fleetwood Tramroad	10 ..	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10 ..	10⅛-10⅝
—— 4½ per cent. Deb. Stock, Red.	100 ..	93½-95½
Brisbane Tramway Invest., Ord., 1-75,000	5	3 15/16-4 3/16
—— 5 per cent. Cum Pref., Nos. 1-75,000	5	4 13/16-5 1/16
—— 4½ per cent Deb. Stk., Red., Prov. Certs. all pd. ..	100 ..	98-102
British Columbia Electric Railway Co., Ord Def.	100 ..	128-132
—— Ord Pref.	100 ..	112-115
—— 5 per cent. Cum. Perpetual Pref. Stock	100 ..	107-111
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	99-102
—— 4½ per cent. Vancouver Power Deb.	100 ..	101-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10 ..	1⅛-1⅜
—— 6 per cent. Cm Pf., 300,001-60 000	10 ..	3⅜ 4⅛
—— 5 per cent. Perpetual Debenture Stock	100 ..	90-95
—— 4½ per cent 2nd Deb. Stock	100 ..	71-75
Bueno Ayres and Belgrano Trams.	5 ..	4⅜-4⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅝ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27 500	5 ..	4⅝ 5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	110-116
—— Prov. Cert., all paid	100 ..	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100 ..	95-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100 ..	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100 ..	98-102
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	9 95
Calcutta Tramways, Ord., Nos. 1-137,610	5 ..	[illegible]
—— 5 per cent. Cum. Pref., Nos. 1 50,000	5 ..	[illegible]
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	103 10[illegible]
Cape Electric Tramways, Nos. 1-480,000	1 ..	3 16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5 ..	4⅛-4⅜ xd
—— 4 per cent 1st Mortgage Deb., 1-3,000 (1917)	100 ..	97-100
City of Buenos Ayres Trams. Co. (1904), 1-248,000	5 ..	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100 ..	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	88-91 xd
Cork Electric Tramway and Lighting Co., Ordinary	10 ..	13-14
—— 6 per cent. Cum. Pref.	10 ..	12⅜-13⅜
—— 4 per cent. Debentures	100 ..	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12⅛-13⅛
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	12⅛-13⅛
—— 5 per cent. Mort. Debs., 1-3,000 Red.	100 ..	90-95
Hastings and Dist. Elec. Tram Co., 4½ p.c. Deb. Stk., Red.	100 ..	94-97
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000 ..	80-85
Imperial Tramways, Ordinary	all ..	18-19
—— 6 per cent. Cum. Pref.	all ..	14-14½
—— 4½ per cent. Deb. Stock	100 ..	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	⅞-1⅛
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100 ..	58-63
Kalgoorlie Electric Tramways, 1-250,000	1 ..	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100 ..	87-91
—— 6 per cent. "B" Deb. Stock	100 ..	71-75
Kidderminster and District Lighting and Traction, Pref.	5 ..	10-10½
Lancashire United Tramways, Limited, 5 per cent Prior Lien Deb. Stock, Red.	100	91-94
—— £296,500 2nd Mort. Deb. Stock	— ..	—
—— £83,330 Deferred Deb. Stock (all fully paid)	— ..	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1 ..	1-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1 ..	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100 ..	90-95

Name.	Amount paid.	Last price.
	£	£
London United Trys. (1901), 5 per cent. Cum. Pref.	10 ..	7-8
—— 4 per cent. 1st. Mt. Db. Stock, Red	100	80-85
Madras Elec Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000 ..	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,535 and 436-25 000	5 ..	4⅛-5
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1 ..	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	11/16-13/ 6
—— ½ per cent. Deb. Stock, Red.	100 ..	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	— ..	88½-89½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000 ..	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100 ..	101-103
New General Traction, 6 per cent. Cum Pref., 1-10 000 and 34,001-74,000	5 ..	⅛-1
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	2
—— 5 per cent. Cum. Pref.	10 ..	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100 ..	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1 ..	⅛-⅜
—— per cent. Cum Pref., 300,001-545 000	1 ..	⅛-⅜
—— per cent. Debenture Stock	100 ..	91-94
Provincial Tramways Co., Ordinary, 1-24,912	10 ..	4⅛-5⅛
—— per cent. Cum. Pref., 1-10,000	10 ..	9½-10⅛
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5 ..	5⅛-5⅜
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100 ..	97-99
Sao Paulo Tramway, Light, and Power Co.	$100 ..	129-134
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-12,000	$500 ..	96½-97½ p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1 ..	⅜-1
—— 4 per cent. Deb Stock, Red. 1940	100 ..	77-81
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100 ..	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5 ..	1-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5 ..	3⅛-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100 ..	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100 ..	81-84
—— 4 per cent. Pref.	100 ..	90-93
—— " " deferred	100 ..	64-67
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid) ..	100 ..	101-104
City and South London, Consolidated Ordinary	100 ..	40-42
—— 4 per cent Debenture Stock	100 ..	100-103
—— 5 per cent. Pref. Stock '91	100 ..	113-116
—— " " " '96	100 ..	112-115
—— " " " '01	100 ..	110-113
—— " " " '03	100 ..	105-108
Liverpool Overhead, 5 per cent. Pref.	10 ..	10-10½
—— Ordinary, 1-50,000	10 ..	3⅜-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	94-96
Underground Electric Railways of London, 5 per cent Profit-sharing Secured Notes	— ..	39-43
—— Deposit Receipts	— ..	39-43

Telegraphs and Telephones.—

Name.	Amount paid.	Last price
	£	£
Amazon Telegraph Co., 1-25,000	10 ..	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100 ..	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000 ..	87-90
Anglo-American Telegraph Co., Ordinary	100 ..	59-62
—— 6 per cent. Preferred Ordinary	100 ..	104-106
—— Deferred Ordinary	100 ..	17⅛-17⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	99-102
Chili Telephone Co., 1-44,000	5 ..	7-7⅛
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100 ..	84-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10 ..	7⅛-8⅛ xd
—— 10 per cent Preference, 1-6 000	10 ..	15⅜-16⅜ xd
Direct Spanish Telegraph Co., Ordinary	5 ..	3⅛-3⅜
—— 10 per cent. Cum. Preference	5 ..	8-9
—— 4½ per cent. Debs., 1-600	50 ..	100-103
Direct United States Cable Co.	20 ..	13½-14
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100 ..	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100 ..	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000, 1913	25 ..	100½-102½
Eastern Extension, Australasia and China, 1-300,000	10 ..	12⅜-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100 ..	100½-102½
Eastern Telegraph Co., Ordinary Stock	100 ..	1[illegible]-135
—— 3½ per cent. Preference Stock	100 ..	83½-86½
—— 4 per cent. Mortgage Debenture Stock	100 ..	100½-102½
Great Northern Telegraph Co. (of Copenhagen)	10 ..	29-29
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100 ..	100-102
Indo-European Telegraph Co.	25 ..	52-55
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1 ..	⅛-⅜
Monte Video Telephone Co., Ordinary, 1-72,680	1 ..	29/32-1 1/32
—— 5 per cent. Preference, 1-86,492	1 ..	15/16-15/16
National Telephone, Preferred	100 ..	108-110
—— Deferred Stock	100 ..	110-112
—— 6 per cent. Cum. First Pref.	10 ..	10⅛-12⅛
—— 6 per cent. Cum. Second Pref.	10 ..	10⅛-12⅛
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	98-101
—— 4 per cent. Deb. Stock, Red.	100 ..	101½-103½
Oriental Telephone and Electric Company	1 ..	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1 ..	1⅛-1⅛
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100 ..	98½-101½
United River Plate Tele. Co., Ordinary, 1-100,000	5 ..	6⅜-6⅞
—— 5 per cent. Cum. Pref., 1-40,000	5 ..	5-5⅛
—— 4½ per cent. Debenture Stock, Red.	100 ..	100½-102½
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100 ..	99-102
West African Telegraph Co.	10 ..	10-10⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½ ..	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph ..	100 ..	99-102
West India and Panama Telegraph Co., Ordinary	10 ..	19 3/32-28/32
—— 6 per cent. Cum. 1st Preference	10 ..	8⅛-9
—— 6 per cent. Cum 2nd Preference	10 ..	9⅛-10⅛
—— 5 per cent. Deb., Red., 1-800	100 ..	101-104
Western Telegraph Co., 1-207,930	10 ..	13⅛-13⅞
—— 4 per cent. Debenture Stock, Red.	100 ..	100½-102½

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	May 20	1,390	1,305	+ 85	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·54
Ayr Corporation	,, 30	266	277	- 10	—	8	8	,, 15	15,283	3,603,789	378,834	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 30	2,910	2,415	+ 595	+15,329	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 31	1,100	1,035	+ 95	+ 370	23·53	23·53	March 31	55,408	11,686,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 23	6,445	6,976	- 531	—	56½	56½	,, 31	18,557	5,552,088	215,345	·87	16·2	9,238	—
Blackburn Corporation	,, 20	1,123	1,349	- 226	+ 97	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·08
Blackpool Corporation	,, 28	606	1,733	1,127	- 1,488	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·790
Bolton Corporation	,, 31	2,427	2,309	+ 118	+ 671	42	42	March 31	111,294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 27	1,474	1,565	- 91	- 1,206	29¼	24½	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 23	4,839	5 464	- 625	+ 1,496	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 31	875	816	+ 57	- 350	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 27	5 014	5,018	- 4	—	53½	51½	,, 31	266,769	46,902,257	6,178,826	—	—	—	—
Burnley Corporation	,, 30	1,260	1,216	+ 44	—	19½	19½	,, 31	62,699	11,967,488	1,205,83	1·31	12·48	5,825	8·21
Burton Corporation	,, 31	265	278	- 13	- 233	9½	8½	,, 31	15,676	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	May 20	181	176	+ 5	—	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 30	7,077	5,780	+1,297	- 657	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,367	55·22a
Charing X, Euston, & Hamp. Ry	,, 30	3,345	—	—	—	7¾	6½	—	—	—	—	—	—	—	—
City and South London Railway	,, 31	2 825	3 000	- 175	+ 6,125	9	6½	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 6	181	195	- 14	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 28	543	521	+ 21	- 458	15½	15½	Dec. 31	25,032	5,966,364	891,9 8	—	6·74	—	4·78
Croydon Corporation	,, 29	1,522	—	—	—	12 c	12 c	March 31	62,065	13,514,918	1,502,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 29	2 7	257	—	—	7 23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	,, 23	188	280	- 92	- 326	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	,, 29	130	116	+ 14	+ 60h	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 29	5,550	5,926	- 374	- 1,9.0	54½	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	April 8	1,144	1 195	- 51	—	22	22	May 15	57,672	15 554,905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	May 30	963	874	- 11	- 628	14	14	March 31	47,140	15,049,240	1,062,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 30	18, 89	18,125	+ 163	+14,229h	177½	169	May 31	887,381	224,063,098	20,350,367	95	10·47	5,035	5·21
Gloucester Corporation	,, 27	262	259	+ 3	—	15	15	March 31	15,033	3,182,111	579,996	1 06	6·94	1,002	5·1
G.N., Piccadilly and Brompton	,, 30	5 500	4,500	+1,300	+24,001	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	,, 5	1,490	1,515	— 25	—	52·574	37	,, 31	77,996	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	,, 30	1,587	1,439	+ 148	- 146	35½	35	,, 31	81,196	15 252,150	1,804,745	1 22	10·79	2,770	5 9a
Hull Corporation	,, 20	2 380	2,340	+ 39	- 220	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	,, 2	410	449	- 39	—	10½	10½	,, 31	26,499	6,586,754	645,117	89	9 58	2,225	6 5
Ilkeston Corporation	,, 27	142	124	+ 18	+ 16	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	,, 6	249	256	- 7	—	7½	7½	May 15	13,702	4,640,618	466,919	6·92	7 55	1,73	4 95
Lancashire United Tramways	,, 27	1,460	1 885	- 425	+ 716	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 23	6 609	7,212	- 633	+ 822	96½	96½	March 31	327,794	73,024,853	7,358,185	1 06	10·69	3,352	5 58
Leicester Corporation	,, 30	2,297	2,118	+ 59	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 23	10,976	11,562	- 586	- 2,692	104	104	Dec. 31	563,793	122,094,528	12,115,934	1 108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 31	1,452	1,480	- 28	- 778h	9·25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 16	34 285	31,764	+2 524	+ 18,478	98	98	March 31	1378,014	314,227,090	30,130 297	1·05	10 98	—	8·56
Lowestoft Corporation	,, 23	174	219	- 45	—	3½	—	Sept. 30	11,009	2,622,922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 28	189	78	+ 111	—	3½	2	March 31	5,913	1.186,566	157,050	1·14	8 6	2,956	6·2
Manchester Corporation	,, 23	15,519	17,269	- 2,320	+ 4,837	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·05
Metropolitan District Railway	,, 30	9,203	8 289	+1,014	+21,285	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 31	15,695	15,484	+ 211	+ 2,554	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 30	148	139	+ 9	- 139	2¾	2¾	March 31	7,709	2,035,300	203,203	86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 20	3,685	3,905	- 222	- 3,658	59½	57½	,, 31	210,491	45,596,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 30	655	659	- 4	- 213	14½	14½	,, 31	32,421	7,760,403	772 753	1 03	10 01	1,525	6·67
Oldham Corporation	,, 3	1,894	1,871	+ 23	- 321	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·259
Portsmouth Corporation	,, 23	1,905	2 330	- 425	—	28½	28½	,, 31	98,911	20.668 825	2,199,823	1·15	10 79	—	—
Reading Corporation	—	—	—	—	—	13½	13½	,, 31	32,661	8,130 179	918,825	·95	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	,, 25	4,619	6,261	-1,642	- 2,186	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	
Sheffield Corporation	,, 24	5,694	5,961	- 267	- 1,753	65½	65¾	March 25	276,807	73,966,299	6,804,656	898	9 767	4,174	
Southampton Corporation	,, 6	1,079	932	+ 147	+ 202	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	,, 27	361	362	— 1	—	9	9	,, 31	20,076	4,431,728	390,538	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 31	1,196	1,3 2	- 116	- 2,414	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,958	7·79
Torquay Tramways	,, 28	278	145	+ 133	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 30	900	828	+ 72	+ 79	12 68	12·43	‡ ,, 31	42,810	8,312,592	890,906	1·23	11·53	3,376	—
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965,296	429,785	—	10 724	1,989	6·95
West Ham Corporation	,, 28	2,200	2,274	- 74	- 2,051	14·7	14 7	,, 31	122,881	35,802,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 27	793	792	- 7	- 558	20	20	,, 31	43,823	9,276,023	966,133	—	10·896	2,159	6·095

* 1905-6 figures. ‡ 1907-8 figures. † And 98 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures

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THE

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SUPEREROGATION—WEST BROMWICH.

It is a work of supererogation to attempt to get at the truth. Very few want to know the real truth. What they want to know is of something that will serve their own interests. In the *Times* of Tuesday Mr. Cave laboriously points out factors conveniently forgotten by controversialists when discussing municipal and private enterprise. Some years ago we made an earnest effort to define what enterprises came naturally and logically within the scope of municipal—that is, of collective—activity. Nine-tenths of the viciousness of the socialistic doctrines of the day would go if we could determine, even within wide limits, what should be done collectively and what individually. Why is there a constant desire to compare the incomparable? Municipal enterprise neither starts from the same point nor has the same goal as private enterprise, yet without explanation or qualification men are found constantly arguing as if the results obtained might be compared without question. We have stated this so many times, and to most of our readers it is so obvious that it seems a work of supererogation to say it again. Yet what is to be done when these silly comparisons are so frequently made? It is compulsory to continue to call attention to the fact. Coming now to the report of Mr. Jackson on the year's working at West Bromwich. It shows just what we should expect, that attention is paid to every detail to ensure that efficiency should be maintained and costs kept as low as possible. Mr. Jackson is to be congratulated upon coming out so well under the most disheartening circumstances, not the least of which is the loss on units sold for traction to two sections of the South Staffordshire Tramways, one outside the borough, having their supply elsewhere. But this report will be used for the moment only for a text to hang a sermon upon. The text is this: can we accept and adopt a common method of charging for public lighting? It seems to us this is important, and the time ripe for settlement. Assume that, so far as the public supply of anything is concerned, if carried out by the authority it is not for the purpose of gain, but for the purpose of economy and convenience. The provision of pure water for every inhabitant costs so many pounds. If more pounds are charged for that provision it is wrong, as although the surplus may be returned it is seldom returned in the proportion in which it is contributed. Oh! but, of course, say the critics, water is different; you ought not to make a profit on that, but provide it at cost. Just so. But we incline to the opinion that public lighting is also a necessity—a necessity for every citizen. Hence the standard of cost for public lighting is simply the cost of production. So far as Mr. Jackson and West Bromwich are concerned, this matter seems to be on the right side, for the average price charged for public lighting for the year ending 1908 is 0·55d., as against 1·69d. for traction, 2·81d. for lighting, and 1d. for power, the average price per unit for lighting and power being 1·73d. Of course, the costs must differ in different places because of prevailing conditions, and this from year to year; thus during the past year at West Bromwich coal has cost ·004d. per unit more, as have wages, while repairs are ·054d. and distribution costs ·019d. more. On the other hand, showing the care and supervision exercised, oil, waste, etc., rents, rates, etc., and legal expenses have cost less. There is one sentence in Mr. Jackson's report of the highest interest: "Your committee is now providing *out of revenue for the full depreciation* on the battery, and at the completion of the maintenance period of ten years the battery will be equal to new." The italics are ours. What have the critics to say on this? They so constantly and consistently state that munici-

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palities do not depreciate enough, and here is one, at any rate, that is depreciating, or renewing, or maintaining out of revenue in a manner which it is stated should at the end of the repayment period give them a piece of apparatus as good as new, and which would naturally be an asset although standing in the capital account at no outlay.

PATENTS.

The report of the Comptroller-General of Patents, etc., for 1907, which appeared this week, is probably the last that will appear under the old conditions of the patent law, and when the report for this year appears we hope to see in it some of the effects of the new Patents Act. We do not suppose that anyone who studies the abstract of the 1907 report, which appears in another part of this journal, will overlook the fact that the report in question deals with a period anterior to the operation of the Act passed last year, otherwise it might be erroneously concluded from the figures, which show that the applications for patents from abroad last year exceeded in number those made during 1906, that the critics of the Act proved to be right. We have already expressed our views on the amended state of the statute law relating to patents, and need only reiterate our belief that the comprehensive measure passed last year will effectively check the system under which patentees have in the past been enabled to take out patents in this country without any intention of working them here, but merely to prevent British manufacturers from producing articles which might compete with them in their own or other markets. Indeed, short as is the time since the Act commenced to take effect, there are already ample evidences to show that the injustices and abuses which were possible under the old state of the law are now being abolished, and that a heavy restraint is being removed from British manufacturers and trade in the way anticipated by the framers of the Act. To return to the report, however. It will be noticed that last year's applications for patents for electrical machinery, regulating apparatus, methods of distribution, electric lamps, telegraphic systems, and for patents relating to various sections of electrical science and industry show noteworthy increases on the previous year. But there is nothing very striking to record except the wonderful development of metallic-filament lamps as evidenced in numerous patents, and the development, to not so great an extent, of wireless telegraphy, and of automatic electrical systems of signalling. An interesting point which arises out of the report is the fact that legislative activity in industrial matters gives a fillip to invention, particularly to the invention of devices for minimising the dangers to which workpeople and others employed in factories and workshops are liable. That is plainly evident in the increase in the inventions of automatic apparatus and safety devices relating to the prevention of accidents in and about electricity works. In these days of compensation and insurance, when whole or partial disablement or loss of life invariably means that large sums have to be paid out by employers, the application of inventive genius to the desigu of safety apparatus is to be encouraged on economical, if not on humanitarian grounds. But there is another side to the question. A meddlesome Government, or, strictly speaking, a State department, not possessing any expert knowledge of the intricacies daily encountered in a particular industry, in its desire to secure the safety of workpeople might endeavour to enforce the adoption of ome patented apparatus by that industry, however inconvenient, or expensive and uneconomical might be its use. There is thus the risk of industrial legislation unwittingly encouraging cranks and faddists to foist their inventions upon manufacturers to the detriment of the latter.

ORGANISATION v. RED-TAPE.

We hear a great deal of systems of managing engineering businesses which are warranted by their advocates to make any business successful. Again, it is often charged against Government undertakings and large business corporations that their organisation has degenerated into red-tape, which hampers business and prevents the individuality of the staff being properly used. We remember one large electrical firm which a new manager proposed to improve by a perfect scheme of organisation. This was warranted to work with the minimum amount of attention, and to secure the delivery by the promised date of every order received. When once started no engineers were to be required to work the system, as an unskilled clerk could send out at the proper time the various letters of complaint to sub-contractors who were getting behind in their supplies. After two years it was found that this red-tape system, which called for no discrimination on the part of the staff, was an utter failure, and the last state of the firm was worse than the first. This subject of red-tape was dealt with by Mr. Paul Lupke at the recent Chicago convention of the National Electric Light Association. He pointed out that rules "must be designed to assist individual judgment, not to stifle it. Use sober reason persistently. Thoroughness does not mean indiscriminate attention to an agglomeration of petty details; it means the intelligent elimination of unessentials and a firm grasp on matters of vital importance. The company man needed is he who can stoutly and with ability defend his own opinion while a matter is under discussion and open to argument, and who, if overruled, is broad enough to bring his best efforts, with true loyalty, to bear upon making an unqualified success of the opinion that prevailed; in short, a company man must be able to abide by the decision of the court and go to work. Concerted action of men who have minds of their own must always be based on a compromise. Though we cannot all get what we think is best, we must nevertheless all do the best we can with what we get."

THE MANUFACTURE OF ELECTRICAL CONDENSERS.*

BY G. F. MANSBRIDGE, MEMBER.

(*Continued from page 808.*)

The condenser plates having been wound then pass to the drying oven, and subsequently to the vacuum pans and screw presses. The desiccation of the plates prior to waxing must be very complete and thorough if the highest insulation is required. Ovens heated by gas, steam, and electricity are in use for this purpose, but the last-named is infinitely preferable. The ease with which the tempera ture can be controlled, and particularly the facility with which the heat can be kept to its legitimate purpose instead of being dissipated throughout the shop, and the absence of objectionable fumes and of steam joints, which always give trouble sooner or later, are advantages sufficient to place this form of oven easily first. For an oven of about 25 cubic feet capacity which will accommodate 500 two-microfarad plates, a power consumption of 2 kw. suffices. The length of time necessary to produce thorough desiccation depends upon the temperature of drying, the relative dryness of the air, and the degree of contact between the hot air and the paper. The temperature permissible is limited by the necessity to avoid scorching the paper, since cellulose suffers adverse physical changes if heated much

* Paper read before the Institution of Electrical Engineers.

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above 212deg. F. for any considerable time. Consequently the practice at one time was to dry the condensers at a temperature of 212-220deg. F., but this involved from three to four days stoving unless the plates were composed of only a very few sheets or layers, and were disposed in such a way that the heat could readily permeate, and the moisture readily leave, the innermost layers. This in commercial work is impracticable, since some condensers of ordinary size have over 100 convolutions—that is, 800 layers of papers in the flat roll—and a great many have to be accommodated in the oven at the oven at the same time. In seeking for means to introduce heat into the interior of the condenser, and thereby to expedite the drying process, the author tried the plan of utilising the resistance of the strip of foiled paper to generate heat in the interior of the condenser when a current of suitable strength was passed along it. To this end all that was necessary was temporarily to short-circuit the plate by means of the connecting lugs at the commencement of the roll, and to pass the current in at another pair of lugs at the end of the roll. It was found in this way that with an oven temperature of 212deg. F., and an additional

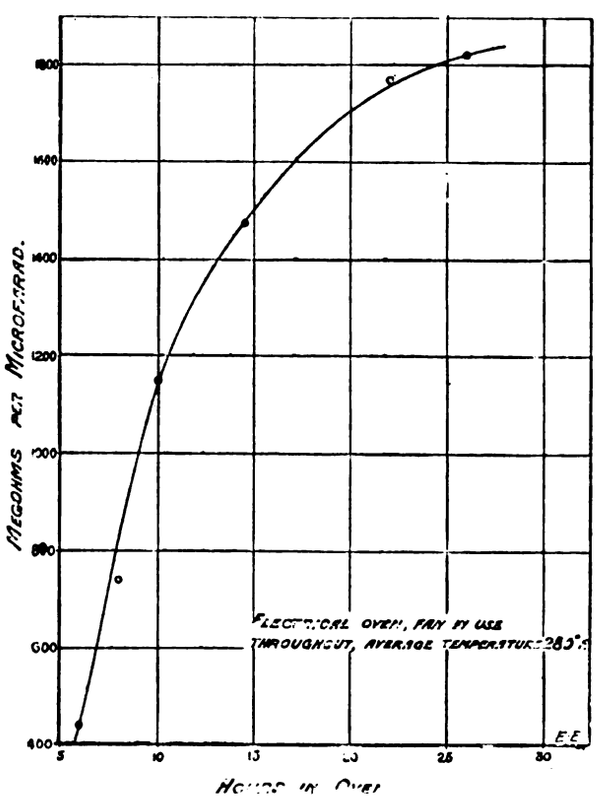

FIG. 3.—Foiled Paper Condensers. Average Insulation (300 volts, 60 seconds, 60deg. F.) after Various Periods of Drying.

expenditure of four watts per two-microfarad plate, thorough desiccation could be effected in eight to twelve hours, without any scorching of the paper, although the temperature inside the rolled condenser reached 270deg. F. Although fairly simple in manipulation, this method did not lend itself very readily to commercial manufacture on the large scale, but it served to point the way to the possibility of using higher temperatures without scorching, and it eventually led to the use of a simple process which has been found most satisfactory and efficient—namely, the vigorous churning of the heated air inside the oven by means of a fan. This rapid circulation results in a great number of particles of heated air being brought into contact with the paper in a given time, and as a result of numerous trials it is found that the use of a fan in this way permits of temperatures as high as 290deg. or 300deg. F. being employed without scorching the paper. It will be understood that the fan does not create a circulation of air from outside, but merely churns the hot air in the oven, and although after a time this air becomes more or less moisture laden, the high temperature enables it to absorb an enormous weight of water before reaching saturation point. By running up the temperature in this way satisfactory desiccation can be obtained in as short a time as eight hours, and this quick drying is of very great advantage where a large output has to be maintained.

Fig. 3 is a graph of the insulation of various batches of foiled-paper condensers which were subjected to different periods of drying under the conditions indicated above. One point calling for attention as regards the drying of condensers is the shrinkage in length which takes place with many papers during desiccation. In the case of plain paper newly come from the mill, this may amount to $\frac{1}{2}$ per cent. after 24 hours' drying at 212deg. F., and there is a further shrinkage on waxing. In the case of foiled paper the shrinkage on drying is much less, and the whole of this occurs prior to waxing. If perfectly fresh and undried interleaving paper is wound up tightly with foiled paper and the compound roll is then dried and waxed, there will be a tendency for the great shrinkage of the interleaving paper to cause the foiled paper to crinkle or crease when pressed. To guard against this, the plain paper should either be matured for a few months in stock, by which time it will have shrunk considerably, or it should be oven-dried for some hours before use. After being effectively desiccated the plates have to be impregnated with paraffin wax. The function of the paraffin is threefold: (1) to increase the inductive capacity of the dielectric; (2) to prevent moisture from again reaching the highly hygroscopic paper; (3) to retain the condenser in the closely compacted form into which it is compressed while the wax is hot.

The inductive capacity of the layers of paper and air which separate the electrodes before the plate is impregnated is approximately 1·2, and on the air being replaced by paraffin this increases to approximately 3·2. Obviously the more thoroughly the air is replaced by the paraffin the greater will be the gain, and to facilitate this it is advantageous to impregnate the condensers *in vacuo*. Hot wax very readily penetrates paper, and it might be thought that soaking for several hours in paraffin at 212deg. F. would suffice thoroughly to impregnate the paper, but as the result of tests of some batches aggregating a thousand plates it was found that the gain in capacity due to impregnation under vacuum averaged 11 per cent. This means that by using the vacuum process 11 per cent. less material is required for a given capacity, while in addition the condenser produced is more reliable, since every isolated air-bubble entangled in the interior tends to reduce the dielectric strength by causing unequal distribution of strain, and also tends by expansion and contraction to cause in time a drop in capacity by separating the layers, and a drop in insulation by affording an opportunity for moisture to enter the interior of the plate. An obvious way of impregnating *in vacuo* is to exhaust the air from the pan containing the condensers, and then after complete evacuation to run in the hot paraffin; but equally good results can be obtained by simple exhaustion over the wax, that is to say, by plunging the plates into a pan of hot wax, fastening the lid, and then maintaining a vacuum in the upper portion of the pan. The advantage of the latter plan is as follows. In order to facilitate the exhaustion it is necessary to heat the paper; this heat can most conveniently be conveyed into the inside layers of paper by means of the hot wax. If the exhaustion is carried out with the paper dry, there is no vehicle to carry the heat into the interior of the condensers, and only radiated heat from the sides of the pan is effective since the air has been withdrawn; for other reasons also the plan of evacuating over the wax is found to have the balance of advantage. A photograph of a convenient form of vacuum pan is shown on the screen. This pan is gas-heated and will accommodate 150 two-microfarad plates per charge. To prevent deterioration of the paraffin by scorching, the bottom of the pan is made exceptionally thick and several rows of minute gas jets are provided so as to distribute the heat uniformly over the bottom. To facilitate the circulation of the hot wax the plates are not allowed to rest upon the pan itself, but are laid upon a loose metal grid which stands up an inch or so from the bottom of the pan. Two hours impregnation at 212deg F. is sufficient if a thoroughly good vacuum is obtained. After full impregnation the vacuum is broken and the condensers are left subjected to atmospheric pressure for 10 minutes, and are then removed from the hot wax and

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at once pressed. No advantage can be traced from the employment of more than atmospheric pressure in the pan after evacuation is complete. The method of pressing and the manipulation at this stage are of considerable importance, and it may therefore be well to describe this operation in detail. In the first place, it will be obvious that the greater the pressure the greater, within limits, will be the capacity obtained, and with this object it is the practice in certain factories to employ hydraulic machinery, and to compress the plates to the utmost limit. The objections to this course are, however, considerable. First, there is a great tendency to drive the paraffin out of the pores of the paper, and so to leave the paper readily penetrable by moisture unless the plates are at once hermetically sealed. Secondly, the enormous pressure greatly increases the liability to short-circuits, and although this is of little importance with foiled-paper condensers owing to the automatic sealing, it is better to avoid it since such breakdowns after the paper has been waxed are always accompanied by a fall in insulation. Thirdly, the excessive pressure results in lowering the insulation to an extent which is out of proportion to the increased capacity. This effect, which is shown graphically in Fig. 4, necessarily

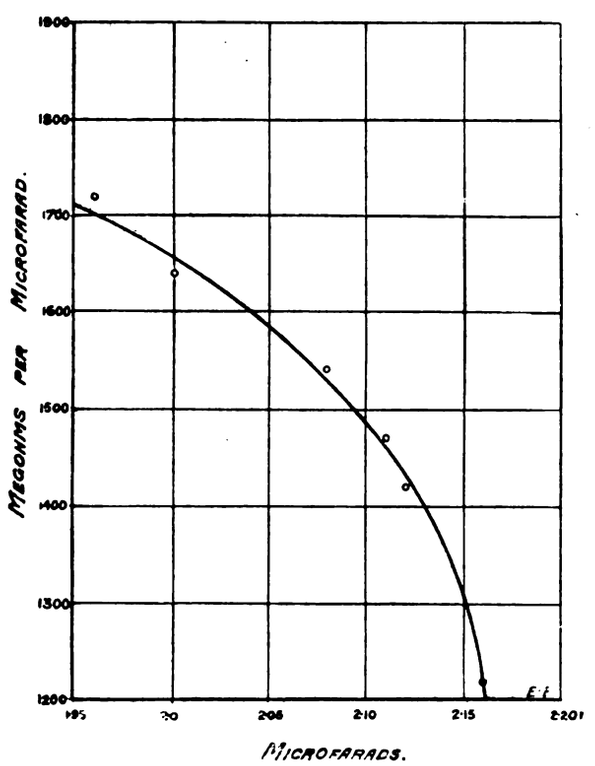

FIG 4.—Folled Paper Condensers Relation between Capacity and Insulation of similar Condensers subjected to Differing Degrees of Mechanical Pressure.

follows from the reduction in the proportion of paraffin to paper, since the wax has much the higher specific insulation. A further objection to hydraulic pressing is that for commercial reasons it involves the simultaneous pressing of a vertical pile of plates, and this procedure is to be deprecated since the cooling of such a pile is necessarily slow, and the wax continues to drain out of the inner condensers to such an extent that when cold there is comparatively little left in them. As the result of experience, it can be said that for a condenser which is required to maintain its insulation and capacity for many years it is of first importance that a good body of wax be left in the plate. For this reason the pressing of even two plates one above the other is not permitted at the Post Office factory. The same objections do not, of course, apply to the pressing of a number of plates side by side; indeed, this is the current practice, and it is found to give satisfactory results. With the same object—namely, that of retaining a sufficiency of wax in the plate, the presses are water-cooled both on the top and on the bottom. This water-cooling, in addition to the technical advantage referred to, has also the commercial advantage of increasing the output of the presses, which is of importance now that condenser manufacture is carried out on such a large scale. With cooling water at a temperature not exceeding 60deg. F. five minutes' cooling in the press suffices for a condenser ¼in. thick; for plates of greater thickness a correspondingly longer time is necessary. The presses are of the screw type, and the question naturally arises as to why this form is adopted in preference to the apparently more scientific method of a lever and dead weights. Contrary to what might be expected, experience shows that more uniform results can be obtained with screw presses than with levers and dead weights, and the latter form has consequently been altogether abandoned at the Post Office factory. Even the use of gauge blocks for the screw presses, by means of which the condensers are pressed to a certain definite thickness, seems to give less uniform results than can be obtained by a careful workman with a little practice without any guide other than the "feel" of the press, and an occasional capacity test of the plates as they come from the presses. One objection to the gauge blocks is that they do not allow for the small commercial variations which are constantly met with in condenser manufacture, and another is that they tend to reduce the operation of pressing, which is one that really requires some little skill and care to the mere manipulation of a machine. As soon as the plates are fairly cold they should be placed aside to settle down in temperature before being tested, and in the

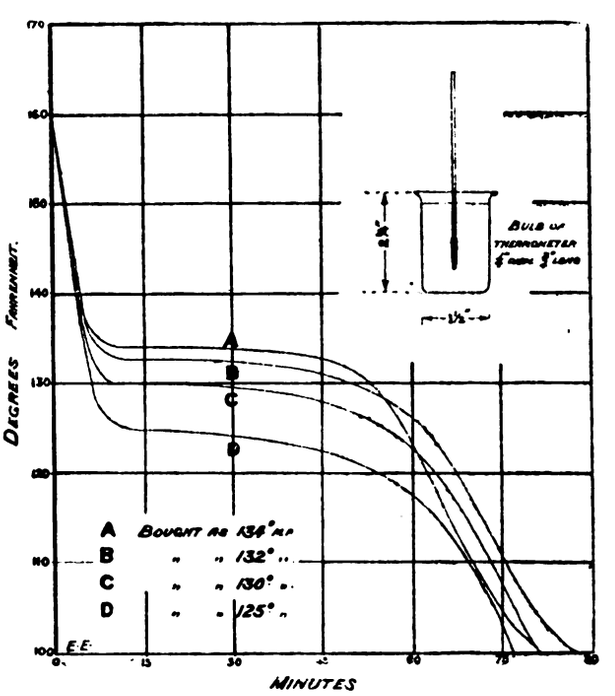

Fig. 5.—Cooling Curves for Paraffin Wax.

meantime they should be protected from atmospheric moisture. Paraffin, contrary to the opinion of the layman, is markedly hygroscopic, and it important that the outer layer of wax should not be allowed to absorb moisture before the conderser is hermetically sealed; otherwise the insulation will steadily fall as the moisture diffuses throughout the mass.

In addition to or in substitution of paraffin, various waxes and mixtures have from time to time been proposed for condenser work. Beeswax, resin, shellac, ceresine, stearine, lead stearate, etc., have all been suggested, and for each some special advantage has been claimed in the way of higher inductive capacity, greater dielectric strength or less affinity for moisture as compared with paraffin. The author has, however, been unable to find that any one of these substitutes possesses the all-round advantages of good paraffin; this material, plain and unadulterated, is therefore, recommended save for special cases where a peculiar property of one or other of the substitutes may justify its use to meet the peculiar conditions. For condenser work a high quality of wax is necessary, but this does not necessarily imply a high price or a high melting point. For use in tropical countries paraffin of a specially high melting point is desirable, but for use in the temperate zones wax with a melting point of about 130deg. F answers most requirements. The melting point, or, more

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correctly, the "setting point," may be determined in a very simple way, although various methods of a more elaborate character find favour in some chemical laboratories. The plan adopted by the author is to insert a calibrated thermometer with a small bulb into a vessel of hot wax, and as the wax cools to observe the fall of temperature with respect to time. If the thermometer and the quantity of wax are suitably chosen, there will be a well-defined period during which the temperature becomes stationary; this temperature represents the setting point. The observation can be repeated by different unskilled observers with identical results, provided that the local conditions are approximately the same for each observation. Some typical curves showing the result of this method are reproduced in Fig. 5. A convenient quantity of paraffin is about 2oz. contained in a test tube or beaker 1½in. in diameter; the thermometer generally used has a bulb of ¼in. diameter by ¾in. long. If a thermometer with a very large bulb is used, the effect may be partially masked, since the quantity of latent heat given out by the paraffin on solidifying is not great, but even under these conditions the setting point may be estimated very closely.

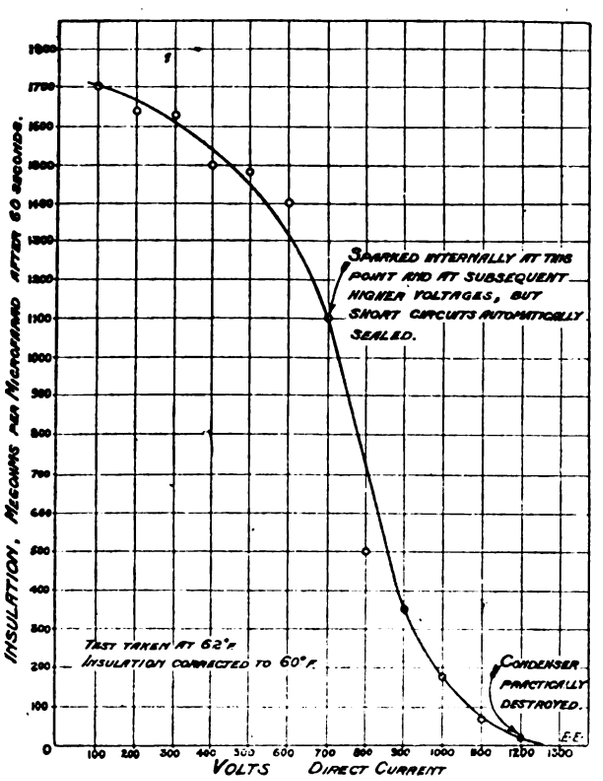
INSULATION, MEGOHMS PER MICROFARAD AFTER 60 SECONDS.
SPARKED INTERNALLY AT THIS POINT AND AT SUBSEQUENT HIGHER VOLTAGES, BUT SHORT CIRCUITS AUTOMATICALLY SEALED.
TEST TAKEN AT 62°F.
INSULATION CORRECTED TO 60°F.
CONDENSER PRACTICALLY DESTROYED.
E.E.
VOLTS DIRECT CURRENT

FIG. 6.—Folie1 Paper Cordensers. Curve showing Relation between Testing Voltage and Observed Insulation.

For condenser work the wax cannot be considered satisfactory unless it is chemically neutral and free from unsaturated hydrocarbons. Its suitability in this respect can readily be ascertained by the usual chemical tests. Before being run into the vacuum pan the wax should be strained through sieves of the finest mesh (a few thicknesses of muslin will answer very well) to remove mechanical impurities. In all stages of condenser manufacture handling by the workmen should be restricted to a minimum, and no operative who is inclined to perspire freely should on any account be permitted to handle the plates prior to boxing. Paraffin readily absorbs the moisture and salts of the body, and a condenser plate once contaminated in this way will have a short life so far as insulation is concerned. From this point of view the ideal method of manufacture is to place the dried plates in metallic cases, to plunge the whole into the hot wax, then to exhaust the air, and, finally, to take out the condenser complete in its case so that the plate after impregnation suffers no handling whatever. The objections to this plan are that there is so little control over the capacity, and that there is such great waste of material since the pressure which can be brought to bear is so small; the method can, however, be recommended where long life is of more importance than first cost.

In default of reaching the ideal, the best that can be done commercially is to handle the plates as little as possible and to seal them hermetically in metal cases as soon possible after manufacture, and this is the course adopted at the Post Office factory. Reference has already been made to the question of dielectric strength. As is well known, this with paraffined paper is apt to be a very variable quantity particularly, when—as with most commercial condensers—the electrodes are separated by only two thicknesses of paper, since a weak spot in one of them so largely reduces the resistance to disruptive discharge. As a rough approximation it may be said that with ordinary paraffined paper at 60deg. F. the breakdown point is approached when the pressure reaches the equivalent of 150,000 volts per centimetre. With foiled paper, however, the result of the automatic sealing is practically to double the effective dielectric strength. Fig. 6 shows graphically the results obtained on subjecting an ordinary telephone condenser made from foiled paper to steadily increased pressure. As the voltage rose above the normal point of dielectric strength the paper broke down, possibly at several places, but each short-circuit sealed up as fast as it was formed, and not until the pressure reached 1,200 volts was the condenser rendered useless.

For telegraph condensers, which are generally required to be adjustable, an outer wooden case carrying a peg switch is provided. The internal construction is as follows. Separate condensers of suitable capacity are selected, and after a preliminary test are assembled between a pair of sheet-iron plates, which are then bolted together. The object of these clamping plates is two-fold: first, to build up the separate condensers into a substantial mechanical structure, and, secondly, to keep upon them a certain degree of pressure so as to counteract the natural tendency towards a drop in capacity. The batch of plates so assembled is built up into a solid mass with plastic paraffin, and is then hermetically sealed in a tinned iron case, the opening where the wires are brought out being sealed with a non-contracting mixture of guttapercha, resin, stearine pitch, and Stockholm tar. The mixture consists of guttapercha scrap, 20 parts; resin, 14 parts; stearine pitch, six parts; Stockholm tar, 14 parts. Commercial stearine pitch varies considerably in hardness, and if the mixture so made proves too hard it may be tempered by the addition of a little boiled linseed oil. This compound does not flow at high temperatures, does not get brittle when frozen, adheres firmly to metal surfaces, and contracts very little on cooling. The same mixture is used for sealing the top of the tin cases of telephone condensers, the metal cap which is subsequently soldered in position being merely a mechanical protection. For telephone work nothing more is necessary than a hermetically sealed metal case, since the condenser is usually covered up and protected by the telephone apparatus. On the Continent papier-mâché cases have been adopted to some extent, but their use cannot be recommended, since papier-mâché readily absorbs moisture, and in consequence the insulation of a condenser contained in a case of such material cannot be relied upon for any length of time. Such cases are cheaper to make than metal ones, and they obviate any risk of contact between two circuits *vi2* the cases of two contiguous condensers, each of which has developed contact with one of the contained electrodes; but inasmuch as satisfactory and lasting insulation between the electrodes and the case is obtainable with ordinary care, there would seem to be no sufficient reason for the employment of such an untrustworthy material as papier-mâché.

In speaking of the insulation resistance of a condenser it is necessary to be most precise as to exactly what is meant. The insulation is usually expressed either in terms of the percentage loss of charge after the charged condenser has been insulated for a certain time or as so many megohms per microfarad. The "percentage-loss-of-charge" method is used chiefly for standards and for submarine cable condensers; for ordinary telegraph and telephone condensers the insulation is more often reckoned as "megohms-per-microfarads." Neither expression is a precise specification of the insulation value unless certain datum lines are assumed or stated. The first of these necessary data is the temperature at which the test is taken, the second is the

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value of the voltage applied, and the third is the time which is allowed to elapse between the first application of the voltage and the moment at which the leakage is measured. For the loss-of-charge method the periods of charge and of insulation have to be stipulated. The latter period is commonly taken as one minute, but the period of charge is not so well standardised, 15 seconds being taken by some observers and 60 seconds by others. The pressure often employed for this test is 100 volts. Of the scanty literature on this subject the most noteworthy seems to be that contained in an article by Messrs. Dearlove and Sayers, who have given the results of some interesting experiments made by them on tinfoil and paper condensers as made for submarine telegraph work.

With respect to temperature, 60deg. F. is in this country the standard generally accepted for tests made by both methods. The voltage adopted for the "direct deflection" or megohms-per-microfarad method varies according to the nature of the duty demanded of the condenser. The period of application of the pressure in this case is usually two minutes; the leakage is measured at the sixtieth second after the moment of application, and the insulation is calculated on the basis of that moment's reading. During the whole period of the test the leakage should steadily

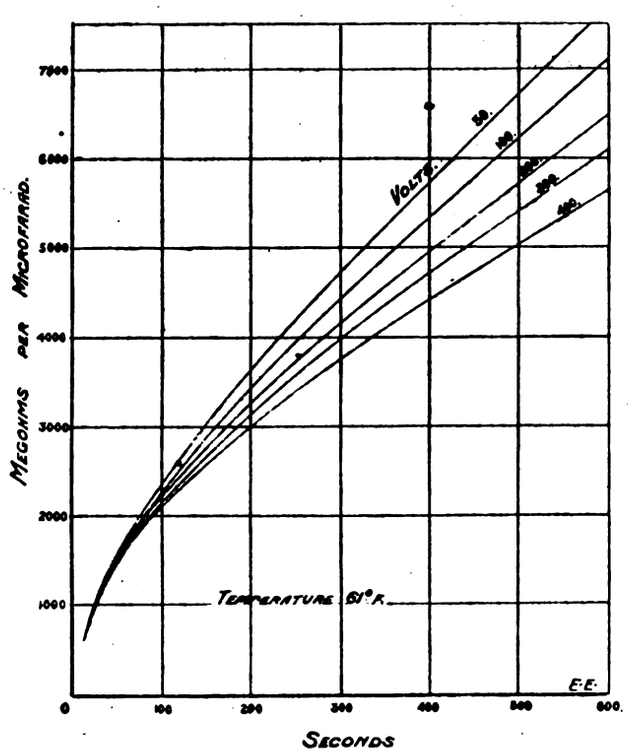

FIG. 7.—Foiled Paper Condensers. Insulation and Electrification with Various Voltages.

decrease; and as a measure of this absorption or "electrification," it is usual to take the difference between the readings at the end of the sixtieth and the one hundred and twentieth second respectively, and to express this difference as a percentage of the reading at the sixtieth second. With a good condenser this percentage will usually fall between 25 and 35 if the test is taken at 60deg. F. The degree of electrification falls markedly with a rise in temperature. The behaviour of a condenser in respect to electrification is an important indication of its quality, as incipient defects give the first indication of their existence by producing unsteady or "negative" electrification. Fig. 7 shows typical insulation and electrification curves of foiled-paper condensers when tested with various voltages. The relation between time and insulation, and also between voltage and insulation, is clearly shown by these curves, and it needs only a glance at them to see how necessary it is closely to specify the precise data of any test. Fig. 8 shows similarly the variation of insulation with constant voltage and varying temperature, the tests being taken after one minute's application of the voltage, the temperature in each case being maintained for a period long enough to allow the condenser thoroughly to take up the new temperature. As may be deduced from the curve, the correcting coefficient for foiled-paper condensers is as nearly as possible 3·50 per cent. per degree F. or $Y_{60} = Y_t\ 1{\cdot}035^{\,t-60}$, where Y_t and Y_{60} are respectively the observed insulation resistance at t degrees F. and the corrected insulation resistance at the standard temperature of 60deg. F This assumes that the insulation is measured after 60 seconds application of a pressure of several hundred volts. It is not suggested that this formula has an accuracy which is comparable with that of a copper resistance temperature coefficient, since the difficulties of measurement are so much greater in the former case, but it is thought that the formula will be found generally to give, over a considerable range of temperature on both sides of 60deg. F., results sufficiently accurate for commercial purposes. From general considerations one may state the relation:

$$\Omega \propto \frac{s}{vt},$$

where Ω = megohms per microfarad;
s = seconds after application of voltage;
t = temperature in degrees F.;
v = applied voltage.

Analysis of a number of insulation and electrification curves shows that this expression may be thrown into a

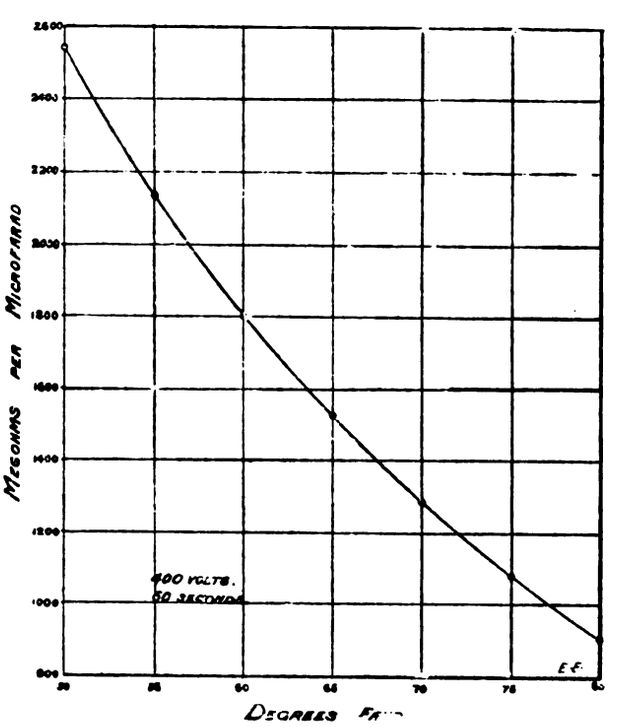

FIG. 8.—Foiled Paper Condensers. Variation of Insulation with Temperature. (Curve plotted from calculated figures.)

simple numerical form, and for foiled-paper condensers the following approximate empirical formula is obtained:

$$\Omega = 200\ \frac{s^{\cdot 5}}{v^{\cdot 1} \times 1{\cdot}035^{\,t-60}}.$$

For metallic-foil condensers the expression becomes—

$$\Omega = 2{,}000\ \frac{s^{\cdot 5}}{v^{\cdot 1} \times 1{\cdot}035^{\,t-60}}.$$

These empirical formulæ are, of course, only applicable to thoroughly desiccated condensers properly constructed of good material.

A special development of the paper condenser is the "inductive resistance" form introduced by Dr. Alexander Muirhead for the balancing of long submarine cables. The onerous conditions of duplex working on a long cable call for an artificial line whose electrical constants in all respects approximate closely to those of the real cable. The difficulty in constructing such artificial cables lies in the fact that the constants to be matched are so many; the artificial line must match the real line in resistance and capacity, both in the aggregate and as regards distribution, and at the same time the insulation resistance and electrification must be similar in the two lines. These

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conditions are closely met by the Muirhead grid type of condenser. This, as is well known, differs only from the tinfoil condenser in that one set of electrodes consists of plain sheets bunched together, while the other set consists of sheets of foil cut into the form of a grid. The strips forming the grid are joined in series and serve as a resistance. The width of the strips may be chosen so as to give within a considerable range any desired ratio between resistance and capacity. The insulation and electrification constants are not so easily matched with accuracy, but fortunately the insulation and electrification of high-class condensers made from thoroughly desiccated paper impregnated with paraffin are of the same order as those of a guttapercha submarine cable, and an exact match of these constants is not essential. To adjust the capacity and resistance of such an artificial line to a definite value at standard temperature is not difficult, since, for commercial reasons, such condensers are invariably made up from a number of separate plates, and although each of these may be expected to have some variation from the precise figure aimed at, yet by combining high and low plates together the aggregate may be made to agree very closely with the desired figure, and the final adjustment may then be made as with a resistance coil.

The question of maintaining the conductor resistance of such a condenser constant under varying temperatures is a more difficult problem, and is one which, so far as the author is aware, has not been successfully solved. The usual method is to get round the difficulty rather than over it by choosing a situation for the artificial cable where the temperature variations are reduced to a minimum. The manufacture of such artificial cables is very expensive, owing to the difficulty in handling the thin grid of tinfoil. This may, however, be overcome by the use of foiled paper, since, owing to the thinness of the conducting film, the strips are much wider than if made of metal, and they are consequently more easily handled. In illustration of this it may be said that artificial cables of very high $\frac{\text{resistance}}{\text{capacity}}$ ratio have been constructed of foiled-paper strip without difficulty. For example, some have been made to match 20lb. conductor paper-insulated telephone cable, which has a resistance of 44 ohms per mile and a distributed capacity of 0 054 microfarad per mile. Such a proportion with solid metal strip would offer great manufacturing difficulty, particularly as for artificial telephone cables it is necessary that both electrodes be of the strip form; for submarine cables with single conductors the plates are alternately strip and sheet. It should, however, be observed that the insulation obtainable from metallic strip and plain paper is higher than is obtainable from ordinary foiled paper, but by specially preparing the foiled paper this difficulty could probably be overcome.

The workshop apparatus required for testing condensers during and after manufacture depends, to a certain extent, upon the conditions of service. Assuming that the condensers are required to comply with the requirements of the Post Office specification, the most satisfactory testing set will be found to be a good strained-suspension reflecting galvanometer, carefully calibrated for proportional throws and deflections, together with the usual universal shunt-box, short-circuit, and reversing keys, and a primary or secondary battery giving at least 400 volts. Dry cells of modern types and of not too small capacity give satisfactory service for two years or more, but care must be taken to insulate them satisfactorily. The galvanometer and other testing instruments must be carefully "guard-wired," otherwise the tests will be more or less vitiated by leakage. No difficulty has been found in training ordinary workmen to use reflecting galvanometers intelligently and without damage. The strained suspension is of great value in overcoming difficulties due to vibration of the building.

The specification of the National Telephone Company provides for tests of a less simple character. These tests involve the use of sinusoidal alternating currents of speaking and ringing frequencies, and require apparatus of special construction. By the courtesy of the National Telephone Company, Limited, the author is able to quote in the appendix the technical details of this specification.

4. *Electrolytic Cells.*—These have not been received with much favour in this country, but they were at one time used to a considerable extent in Germany for common-battery telephone work. They have, however, been almost entirely discarded in favour of paraffined-paper condensers. The only advantage which these "polarisation cells" possess over condensers is with respect to size, a cell or a set of cells capable of stemming back a direct current of 25 volts having a volume of only about five cubic inches. On the other hand, the cost of such a set of cells is from three to four times that of a condenser of equal effectiveness. The cells used appear to be of three classes—viz., "acid cells," consisting of two small electrodes of platinum dipping into an acid solution; "sodium cells" (natronzellen), in which the electrolyte is a solution of a sodium salt; and aluminium cells, in which the electrodes consist of aluminium, and the electrolyte is some kind of basic solution. The acid cells have a damming effect of about 1 8 volts each, the sodium cells about 2·7 volts, and the aluminium cells as much as 30 or more volts. It is probable that the polarisation cell would never have been developed as a practical device if the modern condenser had been available at a reasonable price in the early stages of telephone development. The disadvantage of the polarisation cell is that it is more or less leaky, both electrically and mechanically. The permanent polarisation current passing through each cell is small, but on a system of many thousand subscribers the aggregate leakage becomes considerable. The mechanical difficulty is, however, the more serious one. If the cells are hermetically sealed they are liable to burst owing to the gradual accumulation of gas, which has been known to cause pressures up to 20 atmospheres. To avoid this difficulty, some forms are provided with a simple release valve. This is particularly necessary with aluminium cells, as these are of larger size and evolve a greater quantity of gas. It is, however, almost impracticable to prevent some leakage of the solution, and in all the circumstances it is not surprising that the chemical cell has been ousted by the static condenser. Specimen polarisation cells are laid upon the table for examination.

Appendix.

Post Office Specification for Condensers (Wooden Cased) for Telegraph Purposes.

The plates to be secured between substantial iron clamps and to be boxed up solid and airtight with an approved insulating compound, the clamp being secured to the side of the case by means of suitable lugs and screws. The capacity of each section to be not more than 5 per cent. higher or lower than the nominal value in the case of plates of one microfarad and above, and not more than 10 per cent. higher or lower in the case of capacities of less than one microfarad, and in the case of signalling condensers the difference between the two halves of the condenser to be not more than 0·25 microfarad. The capacity of each section to be measured by taking the instantaneous discharge after the section has been charged for a period of 10 seconds with an E.M.F. of 30 volts. Each condenser will be tested for insulation and electrification, but these tests will be taken on the condenser as a whole and not on the separate sections, and the tests will be taken with an E.M.F. of 400 volts as follows: The condenser being at a temperature of approximately 60deg. F., apply the battery for a period of two minutes. The deflection shown after one minute must indicate such an insulation resistance in megohms that when multiplied by the capacity in microfarads the product shall be not less than 1,000. The deflection shall steadily decrease during the second minute, and the difference between the readings at the beginning and end of the second minute shall not be less than 20 per cent. of the first minute reading for one microfarad and the larger sized condensers, and 10 per cent. of the first minute reading for condensers less than one microfarad, but including 0 5 + 0 5. The case to be of best well-seasoned Spanish mahogany, and to be thoroughly French polished.

Post Office Specification for Condensers (Metal Cased) for Telephone Purposes.

The over-all length, width, and thickness of the complete condenser, including the outside soldering tags, not to exceed the following dimensions—viz.:

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For condensers	0·5 mfd.	4¾in. × 2⅝in. × $\frac{7}{16}$in.
,,	1·0 ,,	4¾in. × 4⅛in. × $\frac{7}{16}$in.
,,	2·0 ,,	4¾in. × 4⅛in. × $\frac{9}{16}$in.
,,	2·0 ,,	(square) 4¾in. × 1⅝in. × 1⅝in.
,,	4·0 ,,	4¾in. × 4⅛in. × 1⅝in.
,,	10·0 ,,	4¾in. × 4⅛in. × 2$\frac{11}{16}$in.

The maximum total weight allowed for each type of condenser, complete with case, is as follows:

0·5 mfd.		4oz.
1·0 ,,		8oz.
2·0 ,,		12oz
2·0 ,,	(square)	10oz.
4·0 ,,		1lb. 4oz.
10·0 ,,		2lb. 14oz.

The letters "G.P.O.," the manufacturer's approved code letter, the year of manufacture, and the nominal capacity of the condenser, to be plainly stamped on the metal case as on pattern. The stamping to be done before the condenser is inserted in the case. The actual capacity to be not more than 10 per cent. higher or lower than the marked value. The capacity to be measured by taking the instantaneous discharge after the condenser has been charged for a period of 10 seconds with an E.M.F. of 30 volts. Each condenser will be tested for insulation and electrification, but these tests will be taken on the condenser as a whole after fitting in the case and not on separate sections. The tests will be taken with an E.M.F. of 30 volts as follows: The condenser being at a temperature of approximately 60deg. F., apply the battery for a period of two minutes. The deflection shown after one minute must indicate such an insulation resistance in megohms that when multiplied by the capacity in microfarads the products shall be not less than 200. The deflection shall steadily decrease during the second minute, and the difference between the readings at the beginning and the end of the second minute shall be not less than 20 per cent. of the first minute reading. The insulation resistance between either of the outside soldering tags and the metal case to be not less than 300 megohms. The condenser plates to be tightly fitted in the metal case and the top to be hermetically sealed before the metal top is put on. The sealing composition must not be brittle or so soft that it will flow at a temperature of 75deg. F., and it must adhere firmly to the tinned iron case. The ebonite strip carrying the tags to be securely riveted to the metal cap, and the latter to fit well and to be firmly soldered to the body of the case at both ends. The condensers to be fully equal to pattern as regards workmanship and finish. The case to be stove-enamelled with a finish equal to that of the pattern. The enamel to be hard but non-chipping.

National Telephone Company's Specification for Condensers (Technical Details only).

1. The capacity to be not less than 1·8 nor more than 2·2 microfarads when tested with direct current at four to five volts, and with an alternating current (sinusoidal wave) at four to five volts and 800 periods per second.

FOILED-PAPER CONDENSERS.

Temperature Coefficients for Correcting Insulation Resistance to Standard Temperature (60deg. F.). (400 volts, 60 seconds.)

Testing temperature. Deg. Fahr.	To correct to 60deg., multiply by	Testing temperature. Deg. Fahr.	To correct to 60deg., multiply by
50	0·710	71	1·457
51	0·734	72	1·508
52	0·759	73	1·561
53	0·785	74	1·616
54	0·812	75	1·673
55	0·840	76	1·732
56	0·870	77	1·793
57	0·901	78	1·855
58	0·933	79	1·919
59	0·966	80	1·986
60	1·000	81	2·055
61	1·035	82	2·127
62	1·071	83	2·202
63	1·109	84	2·279
64	1·148	85	2·358
65	1·188	86	2·440
66	1·229	87	2·525
67	1·272	88	2·613
68	1·316	89	2·704
69	1·361	90	2·799
70	1·408		

2. The insulation resistance to be not less than 100 megohms between the two plates and between the plates and the case when tested with an E.M.F. of 100 to 200 volts.

3. The condensers to withstand an E.M.F. of 400 volts maximum (not R.M.S. value), alternating at 20 to 25 ~ per second, applied at the terminals for a period of half a minute.

STEAM-TURBINE POWER AND TRANSMISSION PLANT OF THE MOCTEZUMA COPPER COMPANY AT NACOZARI, SONORA, MEXICO.*

BY JOHN LANGTON, M.CAN SOC.C.E, AND CHARLES LEGRAND.

This power plant was erected to provide for a large extension in the operations of the Moctezuma Copper Company, both at its works, situated at Nacozari, and at its mines, six miles distant. The plant was planned with the aim of providing comprehensively, not merely for present needs, but for all probable contingencies, and for possible further extensions. The duty on crude petroleum into Mexico being prohibitive, and the wood supply in the neighbourhood being inadequate to furnish fuel for a steam plant of the requisite capacity, coal is the only available fuel, and bituminous coal from northern New Mexico is the nearest and cheapest to be had. Since this coal has to be hauled 750 miles by rail to Nacozari, its excessive cost required that the plant should be planned for the greatest fuel economy consistent with that simplicity in operation which is essential in a plant which must run continuously in an isolated situation such as Nacozari, where skilled labour is frequently scarce. The cost of fuel dictated the addition of economisers to the boilers, and also superheaters to give a moderate degree of superheat. After careful investigation and consideration of all the conditions, both local and general, it was decided to use steam-turbines.

The water at Nacozari is saturated with lime salts, and deposits hard scale in large quantities in the boilers, unless it is chemically treated to replace the lime salts by sodium sulphate. In the latter case great waste is involved in blowing-off the boilers to keep down the degree of concentration of the sodium sulphate in solution, which would otherwise cause foaming. The use of steam-turbines, and the consequent absence of oil in the exhaust steam, makes it easily possible to get pure feed water for the boilers by using surface condensers, thus transferring scale deposit from the economiser and boiler tubes to those of the condenser, where it is more easily dealt with, and where at the lower temperature the deposit will possibly be lessened. In addition to the water being hard, it is also scarce in the dry season, and very turbid and full of sediment during the rains. Of necessity, in times of scarcity, and for the sake of clear water in times of plenty, the condensing water is passed over a cooling tower, the new water supplied being only that quantity needed to make up for the evaporation in the cooling tower. Whether it will be cheaper to treat this water supply chemically, or to expend labour in scaling the condenser tubes, remains to be determined by experience.

The near-by load on the power plant is about 1,000 kw. This is consumed by the concentrating mill, the town lighting, and a few general service motors, and is approximately fixed in amount. The transmission load is about 500 kw., and this is the portion of the load which is most likely to require extension, possibly in several directions; since the broken and mountainous character of the country, the scarcity of cheap fuel, and of water of any kind, make any but transmitted power for mining operations very costly. It was, therefore, decided to generate power at a voltage suitable for direct transmission to the mine, having in mind also that step-down transformers would in any case be needed for the bulk of the near-by load, since no good site for the power plant could be found sufficiently near the concentrating mill to permit transmission of the mill power at motor voltage.

DESCRIPTION OF POWER PLANT.

The plan and sectional elevation of the plant are shown

* Paper read before the electrical section of the Canadian Society of Civil Engineers, March 5, 1908.

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by Figs. 1 and 2. The framework of the building is steel. The roofs are corrugated steel. The walls of the boiler-room are also corrugated steel. The outside wall of the turbine-room is concrete, and the partition between the turbine-room and the boiler-room is reinforced concrete. The coal has to be hauled through that section of the semi-arid western country where railroad traffic is subject to severe interruptions when it rains, either due to track washouts caused by cloudbursts, or to the loss of bridges torn away by the debris carried along by floods in the usually dry beds of streams. To ensure continuous operation of the plant it is, therefore, necessary to carry a large stock of coal at all times. It was considered desirable to provide storage for one month's fuel consumption. Storage by reserve stock pile entails the expense of double handling, and with bituminous coal involves deterioration, both in heat value and in physical character. Some form of bin storage, by which the whole stock is carried in the bins, and is continually moving through them, is, therefore, very desirable.

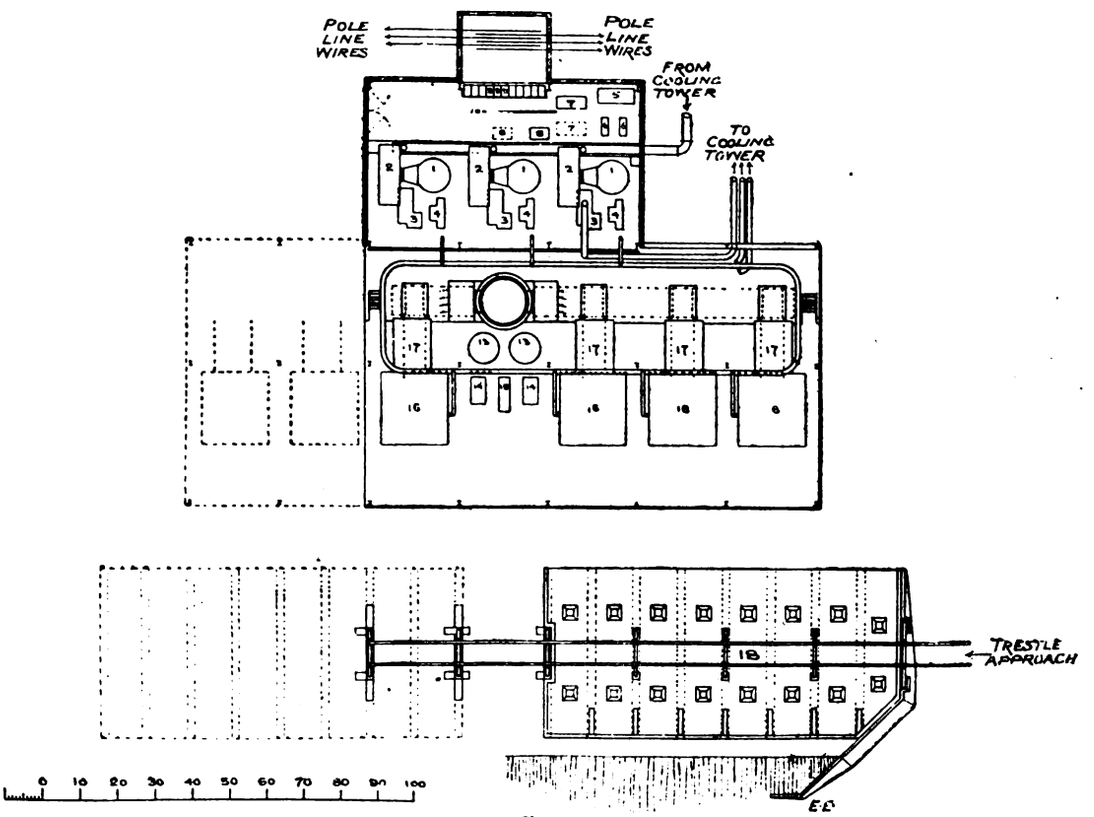

FIG. 1.

The form of storage adopted for this plant is that shown by the coal dock, numbered 18 in Figs. 1 and 2. The site selected afforded the opportunity of getting a trestle for main-line cars 33ft. above the boiler-room floor, at the cost of a spur of moderate length from the main line, and a short trestle approach, both on a 4 per cent. grade. The

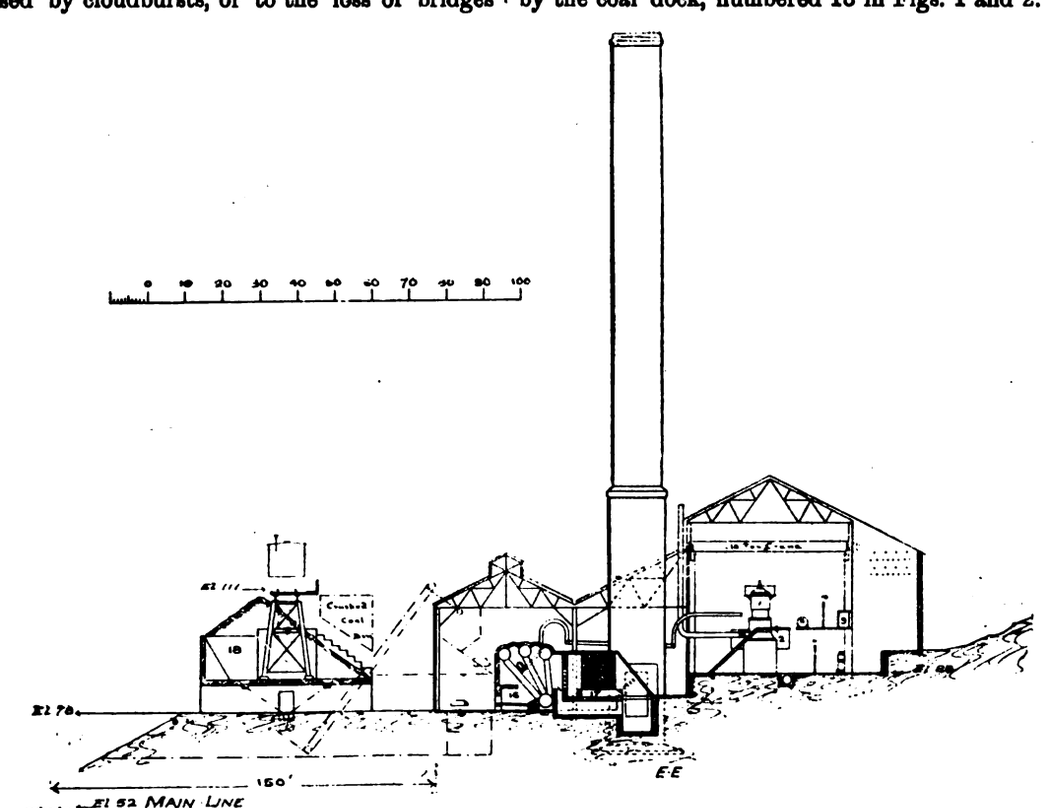

FIG. 2.

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trestle continues over the coal dock on a level, and 24ft. above the floor of the dock. This floor is of reinforced concrete, resting on a series of transverse walls. The two ends and one side of the dock have reinforced concrete walls 12ft. high. For the present the wall on the side next the boiler-house is omitted, though anchorages are provided by which it may be added in the future if desired. The transverse foundation walls form a series of tunnels under the dock, in each of which coal may be drawn from the bottom of the pile through the hoppers and coal valves shown, fresh coal being unloaded on top of the pile direct from the main-line cars. The dock constructed holds 1,200 tons. An extension to double this capacity is shown on the plan in dotted lines. With the fuel consumption in immediate prospect, and with the labour conditions which obtain at Nacozari, it was considered that hand firing would at present be most economical. The coal is brought to the boilers in charge cars holding one ton of coal each, and ashes loaded by hand into small dump cars which are then pushed to a point where they are discharged into main-line cars on a spur from the main line, the latter being parallel to the boiler-house, 150ft. distant from it, and 26ft. below the level of the boiler-room floor. All charge-car and ash-car tracks are on the boiler-room floor level, and are without grade.

In case future extension and other developments make it profitable to use automatic stokers, provision is made for delivering coal to them from the cold storage dock, by means of the apparatus indicated by broken lines in Fig. 2. Coal, fed by gravity from the present hoppers to a spiral conveyor for which openings (shown in Fig. 2) are provided in the transverse walls, will be carried by the conveyor to the central transverse passage between the two coal docks. This passage will be excavated to a depth of about 12ft. below the boiler-room floor, giving space for crushing rolls, and drop enough to feed the lump coal by gravity through the rolls to the boot of an elevator. This elevator will either deliver the crushed coal to a pocket running the length of the boiler-house, suspended from the roof truss; or, if it is preferred to deliver coal to the stokers by charge cars, the elevator will deliver to a small crushed-coal bin In the first case, spiral conveyors will distribute the coal along the length of the pocket, from which it will be drawn through weighing chutes to the hoppers of the automatic stokers. In the second case, charge cars filled from the crushed-coal bin and weighed, will run on a platform placed at a convenient height for the cars to discharge into the hoppers of the stokers. If desirable and profitable in the future, the excavated central transverse passage may be continued into the boiler-room, and carried along the front of the boilers, under the boiler-room floor, forming a basement about 12ft. high, which will allow the use of hopper-bottomed ashpits, discharging their contents either into cars or to a suitable ash conveyor.

Stirling boilers, Class A, are used, 435 h.p. each, with safety valves set to pop at 160lb. gauge pressure. Each boiler is equipped with a Foster superheater to give 75deg. F. superheat. Directly back of and in continuation of each boiler is a 160-tube Green fuel economiser, 16 rows of 10 tubes wide. The gases from the economiser, or from the by-pass flue beneath the economiser, pass into the main flue, 8ft. wide by 9ft. high, and thence to the central stack, 12ft. inside diameter and 184ft. in height above the boiler-room floor. In addition to dampers at each economiser and at each by-pass flue, main flue dampers are provided, one at each side of the stack, to be operated by automatic damper regulators. The boilers and economisers are set in brickwork, but all flues are of concrete, with reinforced concrete roof. The stack is entirely reinforced concrete construction. The boiler feed pumps are placed in the central space opposite the stack. They draw from two small tanks adjacent to them, and placed to give a suction head to the pumps. Condenser water, live-steam drips, and any fresh water needed to make up feed, are delivered to these suction tanks. There are two geared triplex pumps driven by variable-speed induction motors, one in operation and one in reserve, and a duplex steam-pump for emergencies. The latter is also piped to give high-pressure cold water to the turbine scale borers, for scaling boiler and condenser tubes. The main steam-pipe is 8in. in diameter, and is a ring system, divided into sections by gate valves to allow repairs to piping or branch valves without a general shut down. All piping is overhead.

The turbine-room contains three 1,000-kw. Curtis turbo-generators. They run at 1,800 r.p.m., and are three-phase, 60-cycle, 6,600 volt machines. One turbine is always in reserve. Each turbine has its own condenser, air-pump, and circulating pump. The condensers are counter-current Alberger surface condensers, with a motor-driven dry vacuum pump. By carrying the condensed-water drain pipes a short distance outside the building to a seal tank, a sufficient difference of elevation is obtained to give a barometric column. This obviates the necessity of a condensed water pump at each condenser. Two simple low-lift centrifugal pumps, motor-driven, are provided at the seal tank to return the condensed water to the feed-pump suction tanks in the boiler-room. One centrifugal pump is in operation and one always in reserve. The circulating pumps are of the Root or Connersville impeller type. They are motor-driven, and handle 3,000 gallons per minute each. The cooling tower is placed on a table-land, which begins about 100ft. back of the power plant, and which is 55ft. higher than the boiler-room floor level. It is of the open atmospheric type, which is found very satisfactory in the dry western climate, where for the greater portion of the year the relative humidity is about 30 per cent. A 24in. cast-iron pipe, 150ft. long, carries the circulating water from the cooling-tower sump to the turbine-room, along which it runs with a branch to each condenser. The valves in these branches are the only ones in the circulating-water system. The elevation of the cooling-tower sump gives a static head of 35ft. at the condensers; the circulating pumps draw from the condensers, and each pump delivers through its own 16in. pipe, opened at the top of the cooling tower, 14ft. above the level of the water in the cooling-tower sump.

The turbines and condensers are set high enough above the floor to give headroom under the pipes, draining water from the condenser, and oil from the footstep bearings of the vertical turbines. This sets the operating gallery for the turbines at 12ft. above the floor. In the middle section of the turbine-room this gallery is continued to the back wall of the room, and carries the main switchboard and a 50-kw. motor-driven exciter, with space for a second identical exciter. A feeder from the main high-tension switchboard supplies three 75-kw. station transformers placed under the gallery, which furnish 230-volt current to an adjacent distributing switchboard, whence wires, run on the underside of the gallery floor, supply all the motor-driven station apparatus and auxiliaries. The circulating pumps and air-pumps are on the main floor, as are also the oil filter and the two steam-driven oil-pumps which supply the turbines, and a steam turbine-driven 50-kw. exciter; space is provided for a second steam-driven exciter. The overhead crane will reach all machines, and carry them to or from a truck or car which may be run into the building in the vacant floor space left for that purpose. The station transformers under the gallery are alone out of reach of the crane, and they, therefore, stand on small trucks, that they may be wheeled out into a space accessible to the crane. The pole line wires pass out from the lean-to behind the switchboard, which contains the arrangement of wires for connecting any pole line wire to any feeder panel, and also the lightning arrester and choke-coil system.

Normally, the plant is run with motor-driven auxiliaries throughout, but in starting up, or in case of accident to the station feeder or the transformers, the steam-driven boiler feed pump and the steam-driven exciter enable the plant to operate with the turbine on open-air exhaust, each turbine having its own atmospheric relief valve and open-air exhaust pipe. The turbine-room exemplifies the concentration of power which is possible with steam-turbines; the three 1,000-kw. machines with condensers and auxiliaries, and with switchboards and exciters, being comfortably housed in a floor space 45ft. by 72ft., practically 1 kw. per square foot. The four boilers at present installed are for the immediate load of 1,500 kw.—three boilers under steam and the fourth a spare, for cleaning and repairs. One or two more boilers, depending on what the load factor and the peak loads of the increased consumption

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may prove to be, will be needed to bring the boiler plant up to the full capacity of two turbines. An extension for two or more boilers is shown by dotted lines in Fig. 1.

Electrical Distribution.

As stated previously, the load consists of a few scattered motors, the town lighting, the concentrator, and the mine motors and lights. The feeders are all of bare half hard-drawn copper wires, spaced 24in. apart, except between the transmission line and the mine. Where transformers are operated in parallel, or are likely to be operated in parallel in the near future, they are provided with a primary oil switch and a secondary knife switch. These switches are located near each other, so that a simple mechanical interlocking arrangement is used to prevent secondary switch being left closed when primary switch is open. This locking device permits the opening of secondary switch with primary switch closed, but secondary switch cannot be closed if primary switch is open, or primary switch opened without first opening secondary switch. This device is used to prevent a man working on transformer from forgetting to open secondary switch.

Concentrator.

The house which contains the transformers for furnishing current to the concentrator motors and lights is a two-storey fireproof building, 20ft. by 32ft., with concrete walls, steel trusses and corrugated iron roof. The floor, made to stand a load of 1,000lb. per square foot, is the so called multiplex plate (a corrugated steel plate with a special form of corrugation), filled with concrete. The building is provided with two 48in. adjustable ventilators and the necessary openings in the floor and lower walls to ensure a good circulation of fresh air in both storeys. The ten 125-kw. transformers are located in the upper storey, and are connected in groups of three on each phase; the tenth transformer is a spare one, which can be connected to any of the three phases. The high-tension wires, after passing through choking coils, are run on insulators on the bottom chord of roof trusses. Low equivalent lightning arresters are connected to each wire where it enters the building. The primary of each transformer is connected to its proper phase through an automatic two-pole oil switch and two single-pole disconnecting switches. The secondary of each transformer is connected to the distributing switchboard 'bus bars through a two-pole knife switch with enclosed fuses. The primary and secondary switches are interlocked as explained above. The secondary wiring between transformers and switchboard 'bus bars is arranged to give as nearly as possible an equal load on each transformer connected to the same phase.

The distributing switchboard is located in the lower storey, where there are no high-tension wires, and consists of eight panels of black enamelled slate, on which are mounted 16 three-pole feeder switches with fuses. Three transformers in parallel were used on each phase, instead of a single one, for several reasons: (1) the transformers had to be self-cooling to reduce attention to a minimum; (2) in case of trouble with one transformer, the operation of the concentrator would hardly be interfered with; (3) greater ease of handling; (4) figuring on having a spare unit, which is necessary when plant is so far from manufacturers and continuous operation is of the utmost importance, the total cost is smaller. These advantages more than balance the slightly decreased efficiency and difficulty of maintaining an equal load on transformers connected in parallel. The transformer house is situated as nearly as possible at the centre of the load, and over half of the load is within a 300ft. radius. The motors connected to these transformers consist of four 150-h.p., one 75-h.p., five 50-h.p., one 30-h.p., eight 20-h.p., five 10-h.p., and nine 5-h.p., also the equivalent of about a thousand 16-c.p. lamps. Two 50-h.p. and the 75-h.p. and 30-h.p. motors are to run for 10 hours a day; the other motors run continuously. Inside of the building, where it would not necessitate too large a cable, three-conductor cables were used instead of three single wires. The secondary distribution was made at 220 volts instead of 440 volts, to permit the use of incandescent lamps on the same feeders as the motors, and also to reduce the trouble with insulation, a concentrating mill for copper ore being a very wet building.

Mine.

The power is transmitted to the mine at Pilares, 5½ miles from Nacozari, by a line consisting of three No. 2 wires spaced 32in. apart, mounted on porcelain insulators suitable for 20,000 volts. The poles are of Michigan cedar with 6in. tops, spaced at an average distance of 130ft. The transmission line has been operated at 6,600 volts and 25 cycles from another power plant, and in three years' operation has not given any trouble from lightning or other other causes, although a great many insulators are broken by being used as targets for revolver shooting. At Rosario, 3½ miles from Nacozari, are located three 10-kw. transformers, with necessary switches and lightning arresters. They are used to operate a motor-driven pump delivering water against 600ft. head to a tank at Porvenir. A part of this water is used for steam locomotives operating on the railroad between the mine and the concentrator; the rest is pumped 700ft. higher to Pilares for domestic use. At a point five miles from Nacozari the line divides in two branches, one going to the Pilares shaft, the other to the Y shaft. At Pilares are located three 15-kw. transformers for lighting and power circuits on the surface and in the mine. At the Y shaft are located two 300-kw, six-phase, 260-volt rotary converters, one 150-h.p., 220-volt induction motor driving a compound air-compressor, and three 15-kw. transformers for lighting and power circuits on the surface and in the mine; these transformers operate in parallel with those at Pilares, their circuits being connected through the mine workings, and both sets are provided with primary and secondary interlocking switches. The air-compressor is belt-driven, and delivers air at 100lb pressure for the operation of air drills in the mine. The direct current from the rotary converters is used to operate electric locomotives in the mine and on the surface, two electric hoists, one at the Y shaft, the other at Pilares shaft, and one stationary motor at Porvenir driving pump mentioned previously.

The electric locomotives in the mine consist of three 10-ton locomotives for 36in. gauge, of which any two are operated in tandem from one controller by means of cable connections; they are equipped with air brakes. This tandem arrangement was used in preference to a 20-ton locomotive, because when the use of a 20-ton locomotive became necessary, a 10-ton locomotive was already in service. It was also difficult to get a 20-ton locomotive for the narrow gauge and with the necessary clearances to operate in mine tunnel. It also gave a spare half unit corresponding practically to a whole spare unit. The trolley pole is of the "scissors" type, with a roller 2ft. long instead of a wheel, capable of 8ft. vertical motion, as the locomotives have to operate outside of the mine in the same yard with the steam locomotives. This trolley pole has no lateral motion. The trolley wire in the mine is 8ft. from the rails, the tunnel in which locomotives run being large enough to give clearance to 30-ton double-truck steel ore cars. These cars are loaded at bins in the mine, and after loading are passed under a timber gauge which limits the height of the ore so as not to interfere with the trolley wire. The hoists at the Y and Pilares shafts are duplicate as far as the electrical equipment is concerned. They are designed to lift an unbalanced load of 5,500lb. at a speed of 525ft per minute with 250 volts at the motors; with an unbalanced load of 3,000lb., the hoisting speed to be 600ft. per minute. The hoists are double-drum geared hoists, which can be operated balanced or unbalanced, each drum being driven independently of the other by means of clutches. The Y shaft hoist is a new one, with motors mounted on same bed-plate as the drums. The Pilares hoist is an old steam hoist which has been operated electrically for the past three years. The motors in this case are set outside the hoist frame on independent foundations and geared to the crank discs of the steam-engine, crown gears having been shrunk and keyed on the discs. The connecting rods and eccentric straps of the steam-engine are disconnected, but can be reconnected again in a very short time to run the hoist with steam. This has been done only once, not because of trouble with the electrical equipment, but through the lack of power at the generating station.

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The motors are two compound-wound street railway motors, rated at 68 h.p. for one hour run, geared directly to the secondary shaft of the hoist. They are operated in series parallel by means of a drum controller, giving five positions with the motors in series and four positions with the motors in parallel. The change from the series to the parallel connections of motors is done by the bridge method, which does not open the circuit, and gives a practically constant torque during the change. This prevents jars on the hoist cables. The rheostats are of ample carrying capacity, and their resistance is so proportioned that with a light load—such as two or three men—the acceleration is not unpleasantly fast; with the maximum load the hoist does not start until the second step of controller is reached. Compound instead of series motors were employed, to allow the motors to be used as generators, and act as brakes when lowering men into the mine. Although series motors would also act as generators under the same conditions, they would have to attain too great a speed before "picking up," and then would give a too quick retardation. When used as generators, the shunt winding of the motors is excited from the outside circuit, and the current generated by the motors is passed through their series winding to excite the field in the same direction as the shunt winding. This is done so that if the outside current fails while lowering, the cage accelerates a little but is not completely deprived of electric brake. The current generated by the motors is passed through the starting rheostats There are seven steps on the controller; on the first one the motors are short-circuited without rheostat, then the resistance is gradually increased to a maximum, the increased resistance corresponding to an increased speed. The maximum resistance is such as to limit the lowering speed of a full cage of men to a set maximum speed which cannot then be exceeded. The first step of the controller gives a speed of about 60ft. per minute with a cage full of men.

The lowering of men into the mine is the most important work of this hoist. Its operation is the reverse of the ordinary steam hoist. With a steam hoist the men are lowered "on the brake," and the steam kept as a reverse to stop the hoist in case of accident to the brake, while with the electric hoist the hand brake is kept in reserve When changing the hoist from steam to electricity all but one of the operating levers were kept the same as before, even the reversing lever of the engine being used to operate the reversing switch of the controller. The lever operating the controller was the only one changed from the one operating the throttle, but the controller was made to operate with a regular lever as nearly as possible the same as the throttle valve instead of the regular controller handle. This was done to prevent as much as possible false motions on the part of hoisting engineers. This hoist has been in operation for three years, and has worked very successfully. Outside of a set of new pinions, armature bearings, and controller contact fingers, there have been no repairs to the electrical equipment, the commutators not even having been turned once. The acceleration is very smooth, and the electrical braking is a marked improvement over the hand braking. These results are, to a great extent, due to the use of motors and controlling apparatus of generous size for the work to be done.

It may be interesting to give some tests of running efficiency of this hoist, obtained from the electric input of motors to total load lifted. The gears on the hoist itself are cast gears uncut, but worn smooth by several years of service. The weights given are only approximately correct, but error is not over 3 per cent. The tests were taken when running unbalanced; the efficiency would be somewhat lower when running balanced, the friction being greater for the same total load lifted.

Total load. Lb.	Hoisting speed. Feet per minute.	Electrical input. E.H.P.	Efficiency. Per cent.
1,300	656	46·6	55·3
1,450	653	48·3	59·4
1,900	634	60·0	60·8
2,100	622	66·6	59·4
4,100	586	107·0	68·0

With average care in starting, such as given by the Mexican hoisting engineers, the starting current does not exceed the running current by more than 25 per cent.

EXPERIENCES WITH STEAM-TURBINE PLANTS.

Herr Müller-Köhler recently sent out an inquiry sheet to over 200 stations containing steam-turbines asking for particulars of their behaviour in practice. Sixty-three replies were received, all dealing with turbines driving electrical machinery, and covering the following five groups: (I.) machines up to 290 kw. output; (II.) machines between 300 kw. and 590 kw. output; (III.) machines between 600 kw. and 900 kw. output; (IV.) machines between 1,000 kw. and 2,400 kw. output; (V.) machines of over 3,000 kw. output.

Group I. contained 13 machines, mostly of the Parsons (Brown-Boveri) type, of which seven are direct-current and the remainder three-phase generators, the speeds lying between 2,500 r.p.m. and 3.500 r.p.m. The steam pressure is generally 120lb. per square inch. Eight of the turbines work with steam superheated from 65deg. to 130deg. C. The condensing plants are about equally divided between the surface and the jet type. The steam consumption averaged something below the specified figure, being 25½lb. per kilowatt-hour with superheated steam and 27·4lb. with saturated steam. In one case the consumption was as low as 19·6lb. per kilowatt-hour. The consumption of lubricating oil amounted to from 145lb. to 440lb. annually for the turbine alone, and to from 770lb. to 1,000lb. annually for the complete set. Overloads exceeding 30 per cent. were not common. The returns show that very few repairs were required amongst these 13 turbines, in spite of continuous day and night work. In only two cases did breakage of blades occur, and these involved little expenditure for repair. The cost of the plant for the 100-kw. size averaged £12. 10s. per kilowatt, exclusive of the condenser plant, or £16. 10s. including the latter. For the 250-kw. size the cost was £7 to £8. 10s. per kilowatt without condenser and £10. 10s. to £12 with condenser.

Group II. contained 22 machines, of which six were direct-current ones, 14 were three-phase, and two were high tension single-phase ones. The Parsons turbine is used in 19 cases. The speed was generally 3,000 r.p.m. More than half (13) work with superheated steam (41deg. to 150deg. C.). Two use the exhaust steam from reciprocating engines at an initial pressure of ·2 atmosphere. The remainder work at steam pressures between 110lb. and 190lb. Twelve of the turbines have surface condensers, nine have jet condensers, and one exhausts into the atmosphere, the steam being used for cooking purposes. The guaranteed steam consumption for sizes between 300 kw. and 385 kw. lay between 22lb. and 25lb. per kilowatt-hour with superheating and between 24½lb. and 25lb. with saturated steam. For sizes between 400 kw. and 550 kw. the figures were 19 8lb. to 22lb. and 23lb. to 27 7lb. The tests showed a considerable improvement on these figures (the lowest consumption being 18·5lb. per kilowatt-hour with superheated steam). The two turbines working with exhaust steam showed a consumption of 39½lb. and 38½lb. The turbine exhausting into the atmosphere consumed 113lb. per kilowatt-hour at full load, working with 50deg. C. superheat and a steam pressure of 200lb. The annual cost of lubrication varied between £3 and £36; for cleaning and packing material between 5s. and £5. 7s. per turbine. Overloads of 6 to 10 per cent. were common, and one turbine ran for months with an overload of 34 per cent. (740 kw.) without trouble. Practically no turbine breakdowns occurred, although most of the machines had been in use for five years. Only three turbines developed minor blade faults, necessitating delays of 24 and 72 hours as a maximum. The maximum cost for repairs (replacement of inlet valve and steam relay) amounted to £25. Dynamo faults occurred in eight cases—generally in the commutators or brushes. In a single case, owing to leakage at the stop valve, the turbine ran away, causing an explosion of the dynamo rotor, but not affecting the turbine itself. The prime cost in this group varied between £5. 15s. and £10 per kilowatt for direct-coupled turbo-generator sets with exciter, not including the cost of condensing plant. Including the latter the cost was £6. 4s. to £12 per kilowatt. The low-pressure turbines cost £8 to £10 per kilowatt. Groups III., IV., and V. are to be dealt with later.—*Elektrotechnik und Maschinenbau.*

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THE USE OF MOTORCARS ON RAILWAY LINES.

Herr A. Sármezey in a paper recently read before the Hungarian Engineers' and Architects' Society gives some interesting particulars of the experience gained on the Arad-Csanáder railway line with steam and benzine motorcars for passenger and goods traffic. Some particulars of these motorcars, together with similar data referring to the Hungarian State Railways, are reproduced in Table I.

TABLE I.

—	Hungarian State Railways.						Arad-Csanáder Railway.				
	Various motorcars by Ganz and Co.				Motorcar by Raaber.	Small locomotive.	Various benzine-electric motorcars by Weitzer.				Ganz steam motorcar.
Weight of car, tons	18	22	21·2	31·5	24·4	18·4	18	13	16·3	13	13·5
Rating of motor, horse-power	50	80	150	80	80	150	70	30	70	40	36
No. of axles	2	2	2	4	3	2	2	2	2	2	2
Speed, miles per hour	28	37·5	25	31·5	31·5	25	31·5	19-22	35-38	22-25	19-22
No. of seats 1st class	—	—	—	20	—	—	—	17	15	17	9
No. of seats 3rd class	40	38	35	76	40	—	40	25	24	25	25
Weight of trailer, tons	11·6	11·6	11·6	11 6	11·6	11·6	11·6	6·3	6·3	6·3	6·3
No. of seats in trailer 1st class	20	20	20	—	20	20	20	16	16	16	16
No. of seats in trailer 3rd class	40	40	40	—	40	40	40	32	32	32	32
Weight of normal train with 90-100 seats, tons	29·6	33·6	32·8	31·5	36	46	29·6	19·3	22·6	19·3	19·8
Weight per seat, tons	·296	·336	·328	·315	·36	·46	·296	·214	·257	·214	·27

TABLE II.

Motorcar.	H.P. of motor.	Total car miles run up to end of 1906.	Weight of fuel per car mile.	Cost of fuel, lubrication, attendance, and sundries. Pence per car mile.	Cost of maintenance and interest per car mile. Pence.	Total cost per car mile. Pence.
Daimler benzine motor with direct drive, 1903-6	40	78,000	154lb. benzine.	2·24	·79	3·03
Ganz steam motorcar, 1903-6	35	412,000	8·6lb. charcoal.	2·28	·66	2·94
Weitzer benzine-electric motorcar, 1903-6	30	445,000	1·42lb. benzine.	2·22	·7	2·92
Weitzer benzine-electric motorcar, 1906	70	178,000	2·1lb. benzine.	2·98 (high-speed traffic).	·78	3·76 (high-speed traffic).

In Table II. is given an analysis of the running cost of the motorcars. Table III. shows the greatly improved profit resulting from the use of the motorcars. Before the introduction of the motorcars (in the year 1902) 1,053,092 passengers were carried, and the gross receipts were £35,500, whilst in 1906, after the motorcars had been in use for about three years, the number of passengers had increased to 2,238,740, and the receipts to £54,000.

TABLE III.

—	Receipts per ton-mile. Pence.	Expenses per ton-mile. Pence.	Profit or loss. Pence.
Locomotive passenger traffic, 1900-1907	·15	·178	·028 loss.
Locomotive goods traffic, 1900-1907	·26	·126	·134 gain.
Motorcar traffic, 1904-1907	·48	·235	·245 gain.

It is clear from the above figures that under the particular conditions existing on the Arad-Csanáder line, motorcar traction is considerably superior to locomotive traction.—*E. K. und B.*

LIGHTNING ARRESTER PERFORMANCE.

Two papers dealing with lightning arresters were presented at the meeting of the American Institute of Electrical Engineers held on May 19. Mr. J. F. Vaughan related the results of comparative tests of lightning protective devices on the 50,000-volt Taylors Falls transmission system. Mr. N. J. Neall discussed the data gained from the above tests and from tests made on the system of the Presumpscot Electric Company, which supplies energy at 11,000 volts to the Cumberland Mills, near Portland, Maine. The results of the Taylors Falls experiments indicate that the principal trouble is from temporary or permanent breakdown of line insulation by static charges induced in the line by passing storms. The induced charges are highly concentrated, and often of immense volume and intensity, discharging to ground over insulators with a disruptive effect that tends to shatter, but rarely to puncture, them. The disturbances may occur anywhere on the line, but the preference is for exposed heights and to a less degree for wet low lands. There was no evidence of surges other than the direct effects of grounds or short-circuits nor of stress at any definite points on the line, such as from reflected or standing waves. Overhead grounded wires are of decided value in shielding the line from induced static charges and in preventing insulator breakdowns. A grounded conductor running down the pole is of decided value in preventing splintering of the pole. The shunted resistance multigap type of arrester is effective in disposing of ordinary disturbances. The aluminium-cell type of arrester is, in general, more sensitive and freer in discharge; it gives great promise for station protection. Horn arresters of the series-gap and selective-resistance type are of special value as emergency devices to relieve the station arresters in case of abnormal discharge. They may be adjusted to be fairly sensitive without causing interruption to the service.

Mr. N. J. Neall, after reviewing the experiences on the Taylors Falls and Presumpscot systems, expressed the opinion that a grounded wire suspended along a line will tend to absorb an electric charge. It is desirable to place one, two, or more wires above the line wires, the former wires being grounded at each pole near stations and important places. When an overhead grounded wire is used exclusively for station protection, it should be not less than two miles in length and be grounded at each pole. Lightning rods added to the overhead grounded system probably add to the protection. The shattering of insulators is liable to occur in every severe lightning storm, but not in mild ones. Insulators should be so designed as to withstand at least twice normal voltage

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between line and pin; the equivalent spark-gap of the insulator should be higher than that of any arrester path to ground on the line. Horn-type arresters should be employed for extraordinary service only. A wood pole may be effectively protected against splintering from lightning discharge by providing it with a small metallic conductor connected to ground.

For station protection electrolytic lightning arresters have operated creditably, but they have not shown complete superiority over other types. When the external lines are fully protected, as by the use of overhead grounded wires, the station apparatus is also protected thereby.—*Electrical World.*

THE CONTINUOUS CAPACITY OF RAILWAY MOTORS.

BY E. V. PANNELL.

When the one-hour rating for railway motors was established, practically the only service conditions to be fulfilled were those which obtain in suburban operation with frequent

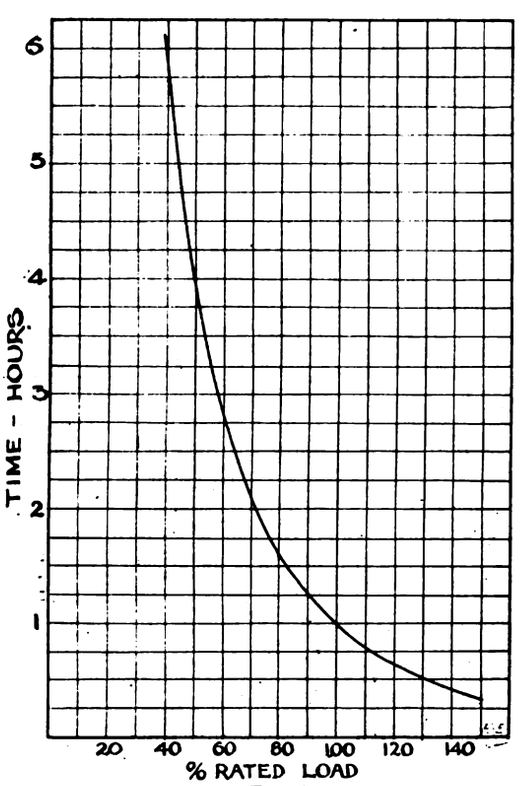

FIG. 1.

stops. High rates of acceleration (accompanied of necessity by heavy current inputs) and comparatively long coasting periods form the chief characteristics of the service. The normal accelerating current has usually been taken at or about the current maintained in the one-hour rating test, hence the latter affords some criterion of the motor performance under service conditions. As the field of electric railway working has become extended, the need for some basis of comparison for continuous service has been felt. The service conditions of a train motor used for long-distance operation are far more clearly defined than where acceleration problems come into play, but, on the other hand, conservatism is necessary from the absence of lay-overs to compensate for overheating. Several traction engineers, both in this country and the United States, have joined issue in taking the continuous rating as being one-quarter the one-hour rating for a normal temperature rise. This would seem to the writer to be unduly conservative, more especially as one particular firm advertise their motors as having a continuous capacity of the order of 40 to 50 per cent. of the one-hour output. The curve showing relation between time to rise 75deg. C. and percentage of full-load current (Fig. 1) is averaged from a large number of published tests, and seems to point to 40 per cent. of the one-hour rating as being a safe value for continuous service.

Another consideration comes in to accentuate the advisability of not taking too low a value for the continuous rating. Fig. 2 reproduces the efficiency curve and losses for a typical large railway motor. Below about 40 per cent. of full load it will be seen that the efficiency curve droops considerably, mainly due to friction losses occasioned by the higher rotational speeds. If, therefore, the continuous rating be taken at 25 per cent. of the one-hour rating, the efficiency will be only about 81 per cent., whilst at 40 per cent. of the rated load the efficiency is 89 per cent. Hence, if the efficiency of the motor can be raised by 8 per cent., it is certainly advantageous to run at the higher load, even though more strict attention have to be given to ventilation.

With totally enclosed motors of the railway type, it has been recognised by designers that the temperature rise is determined more by the conductive heat capacity than by the emissive capacity of the motor. In other words, the heating is some inverse function of the cubical content and not of the surface. Mr. Hobart takes a definite number of watts per ton as corresponding to the 75deg. rise. Where the rotational speeds vary, however, it is certain that they will, by inducing a better circulation in the motor carcase, influence the heating. Herr Reichel has shown that for a given weight of motor and a given temperature rise the continuous capacity is a function of the armature peripheral speed. The motor from which the curves in Fig. 2 are plotted rates at 240 h.p., and has a weight of 2·5 tons. The watts per ton on the 40 per cent. basis are, therefore, 1,900 for continuous dissipation. For continuous service the motor should be so designed and ventilated as to be capable of dissipating this loss.

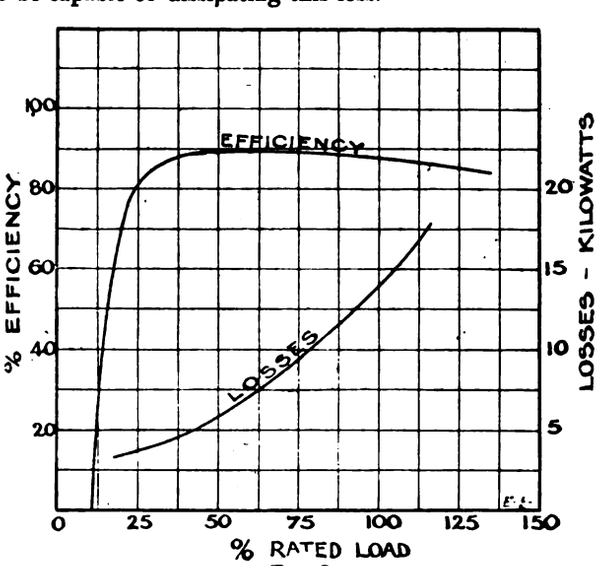

FIG. 2.

The design of railway motors to-day tends more and more towards the maximum specific utilisation in order to get the utmost capacity on the one-hour rating. It is the writer's opinion that for certain classes of service the continuous capacity can, and should be, increased at the expense of the one-hour capacity. The light load, core, and friction losses are not likely to be reduced, but the provision of more effective ventilation would have a great effect on the ultimate temperature rise while little affecting the one-hour rise. The use of gauze-covered ducts through the field structure so as to ensure renewal as well as circulation of the air should be standardised, and some of the effective material sacrificed to provide air passages. The trend of present-day design seems to point to the railway motor of the future being run at exceedingly high current and magnetic densities, and having its structure honeycombed with passages to provide for forced draught ventilation.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.

The fourth annual dinner of this association will be held at the Queen's Hotel, Leicester-square, W., on Thursday, June 18, at 7 for 7.30 p.m., Mr. Gerald W. Partridge, M.I.E.E., M.I.C.E., president, in the chair.

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THE ELECTRICAL INDUSTRY IN GERMANY.

The subjoined extracts from the report of Mr. Consul-General Schwabach on the trade of the consular district of Berlin for the year 1907 present a comprehensive survey of the condition of the electrical industry in Germany. Although our Consul-General confines himself nominally to the trade of the Berlin district, his report practically covers the whole of Germany, and contains a bird's-eye view of the industrial, commercial, and economic conditions of the Fatherland as they present themselves to a very shrewd and capable observer.

The year 1907 witnessed a considerable growth in the business of the electro-technical industry; the financial results of the electric companies proved very satisfactory too. The continued rise in the scale of wages and the price of raw and auxiliary materials was, indeed, unpleasantly noticeable; but cautious purchasing prevented the increase in price from being too keenly felt and also weakened the effect of the sudden fall in the price of copper. The concerns sought to check the growing demands of the workmen by replacing manual labour as far as possible by automatic machines. This endeavour accounts for the remarkable circumstance that the General Electric Company in Berlin, Germany's greatest electric concern, in spite of an increased business, reduced the number of their employés in the year 1907 from 33,906 to 30,667 (about 10 per cent. The scarcity in the money market did not affect the electric companies to any appreciable extent. A useful lesson had been learnt from the crisis of 1900-2, and hence the financial power was strengthened as far as possible, and, above all, funds were kept available. Bank credit was, therefore, not requisitioned to the same extent as by other branches of industry. In one respect, indeed, if only indirectly, they felt the difficulties of the money market—viz., through many of their customers delaying the fulfilment of obligations as regards extensive orders. However, since the difficulties on the money market did not grow too heavy and there were not numerous failures, the electrical industry cannot be said to have experienced any noticeable decline in business. It is a peculiarity of this branch of industry that it is also required in cases of declining commercial prosperity, for at such times many industrial concerns seek to improve and cheapen their business by introducing and making extensive use of electric current.

In the construction of electric engines special progress was made. It has at last been proved that the turbine is decidedly superior to reciprocating engines for all heavy work, and the great economy of expense and labour obtained by the work of turbines has opened up ever-increasing fields of operation for the German industries. Smelting and coal works as well as lignite and textile concerns make use of turbines in their workshops. Alternating-current turbo-dynamos were mostly in demand, more especially the 1,000-kw. type. Even should machine engineering succeed in the attempt to construct a steam-driven hauling engine, the proved safety of working of the electric motor, particularly where haulage of men is concerned, will still carry the day. Turbines are almost exclusively used in power stations for supplying electric energy. There was likewise an increased application of electrically-driven reversible rolling-mills. Although these machines have only been in use for a short period, German works have already been able to construct 12 electric rolling-mills. This capacity can, according to the class of machine, be exceeded by 50 to 60 per cent., so that, strictly speaking, the maximum capacity is about 12,000 h.p. to 15,000 h.p. Of the 12 above-mentioned rolling-mills, three are for Austria-Hungary, one for England (wireworks in Middlesbrough), one for Switzerland, and one for Belgium, the others being erected in Germany.

In the electric railway department the German electric works were very active. In the first place, Berlin and Hamburg gave them continuous occupation in the further extension of their elevated and underground railways. The Prussian State, which introduced electricity for the Hamburg suburban traffic, also became a customer. Bavaria, too, decided to apply electricity as a motive power for railroad traction on the Berchtesgarden-Salzburg line. Undoubtedly electric railways will be extensively used in the near future, and a great field of work lies open to the electric companies. The next undertaking will probably be the electrification of the Berlin Metropolitan Railway. But it may safely be predicted that the next advance will be the impressing of Germany's water power into the service of the electric industry. The number of power stations for supplying electric energy over large distances will be increased by this means. The different States are evidently alive to the advantage of utilising streams and waterfalls, and are determined to secure these for the public benefit, so as to prevent their monopolisation by private concerns. Considering the great and steadily increasing influence of the electric industry on economic life in Germany, it is no wonder that there has been some talk of monopolising the production of electric energy for the Empire; hitherto, however, no definite scheme has been formulated. In conclusion, it should be remarked that the German electric industry has succeeded in introducing a new insulating material called "Tenacite," an approved and cheap substitute for indiarubber.

The increased use of electric current is instructively shown in the following tables. Only the figures for Berlin are given, but those for all the large towns of Germany have increased in like manner:

CONSUMPTION OF ELECTRIC CURRENT IN BERLIN (IN KILOWATT-HOURS) DURING THE YEARS 1907-1905.

	1907.	1906.	1905.
Private lighting	28,524,790	24,816,983	20,139,869
Public lighting	3,376,513	2,808,339	2,318,525
Manufactories	48,902,247	43,049,036	36,687,516
Accumulators	5,088,784	4,522,829	3,798,969
Tramways	53,196,218	50,952,760	47,287,808
Own consumption of electric power stations	3,833,264	1,952,901	1,340,095
Total	142,921,816	128,103,848	111,572,782

The employment of electromotors in the various branches of the Berlin industry will be seen from the following table:

NUMBER AND CAPACITY OF ELECTROMOTORS IN BERLIN.

—	1907		1906		1905	
	Electro-motors.	Horse-power.	Electro-motors.	Horse-power.	Electro-motors.	Horse-power.
Lifts	2,342	14,137	1,985	11,611	1,698	9,704
Ventilators	2,312	737	2,097	659	1,868	601
Machines for working metal	2,293	9,768	2,156	9,216	1,775	7,551
Printing machines..	2,228	6,512	2,033	5,904	1,730	5,005
Machines for working wood	1,998	7,044	1,520	5,762	1,241	4,751
Butchers'machinery	997	3,585	850	3,064	678	2,394
Grinding and polishing machines	434	1,535	418	1,499	376	1,390
Machines for working paper	425	1,272	413	1,246	369	1,149
Laundry machines	365	1,019	296	849	230	672
Sewing machines...	362	286	303	277	229	201
Pumps	330	1,323	302	1,197	252	906
Cutting machines...	271	174	241	163	194	140
Winding machines	165	388	142	344	96	274
Machines for working leather	151	561	129	465	111	417
Dynamos	129	1,338	81	1,271	76	809
Roasting machine...	93	196	90	194	78	153
Galvanoplastic art..	73	175	91	237	75	239
Ironing machines...	28	79	29	82	27	74
Miscellaneous	1,970	5,324	1,744	4,379	1,446	3,491

The improvement in wireless telegraphy during the year under review showed itself in the greater distance compassed—for instance, the German cruiser "München" successfully communicated with the Norddeich transmitting station (situate in the Grand Duchy of Oldenburg) from Bergen (Norway), a distance of 750 miles, while the North German-Lloyd steamer "Bremen" effected a connection with the Nauen station (22½ miles from Berlin) from a distance of 1,500 miles.

In the year under review the "Wolfram," the "Osram," and the "Helion" lamps were brought into the market, all of which are said to be great improvements on similar lamps hitherto in use.

The extent of Germany's foreign trade in electro-

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TABLE A.—GERMANY'S FOREIGN TRADE IN ELECTRO-TECHNICAL PRODUCTS DURING THE YEAR 1907.

Articles.	Imports.		Exports.		Imports from United Kingdom.	Exports to United Kingdom.
	Metric tons.	£	Metric tons.	£	Metric tons.	Metric tons.
Dynamos, electric motors, continuous-current transformers, converters, and reaction coils	1,326·6	94,450	22,350 2	1,716,400	—	2,308·1
Electric cables	1,462·7	76,050	32,289 5	2,260,250	926·1	3,630
Arc lamps	19·7	4,200	682 9	145,100	5·3	90·7
Complete cases for arc lamps	1·3	200	150·5	20,700	—	18 7
Reflectors, searchlights	4·1	2,450	224·1	134,450	—	41·9
Electric incandescent lamps	88·6	53,150	698 5	419,100	—	150·9
,, telegraph appliances, telephones	92·8	58,450	1,530·5	765,250	—	195·8
,, appliances for illumination, transmission of power	262·7	43,200	5,593·7	922,950	40	514
,, ,, for surgical and dental purposes	9·3	3,700	168·1	67,250	1·2	19·8
,, measuring, counting, and registering apparatus	69·3	27,700	980·2	392,100	—	55·6
Galvanic and dry batteries and thermo-electric couples	10 3	1,050	386·5	38,650	—	92·8
Insulating appliances of earthenware, porcelain, and glass	232 1	8,700	539·1	20,200	40	171

technical products during the year under review is shown in Table A.

As regards this class of manufactures Germany is to be considered chiefly as an exporting country. Her principal customers are Belgium, the United Kingdom, the Netherlands, Russia, and Austria-Hungary, but it may also be remarked that the increased use of water power for producing electric energy led to enlarged exports of dynamos and electric generators from Germany to Spain and Italy. Imports of electro-technical products are derived principally from France, the United Kingdom, and Switzerland.

The following table gives particulars of the steam-engines in use for the production of electric current :

Year (April 1)	Number of steam-engines.	Total horse-power.	Average H.P. per steam-engine.
1907	6,191	954,945	154·25
1906	5,955	883,364	148·44
1905	5,679	788,981	138·93
1904	5,447	708,274	130·03
1903	5,160	623,334	120·80
1902	4,928	573,405	116·36
1901	4,638	490,961	105·86
1900	4,269	403,314	94·48
1899	3,776	333,342	88·28
1898	3,305	258,726	78·28

It must, however, be noted that the figures represent the minimum, and that, in addition to those known, probably other machines are also used in the production of electric current. Of the big machines, 158 are possessed of a capacity of 1,000 h.p. and more. The largest has a capacity of 6,500 h.p.

The efforts of German manufacturers to concentrate atmospheric nitrogen in a practically utilisable form were continued energetically during the year 1907. Factories were erected in Norway, Switzerland, and Bavaria, more especially for the utilisation of the water power in these countries. To render themselves as far as possible independent of the coal trade, and in order to supply their requirements of fuel in their own collieries, three big combined chemical concerns—viz., the Farbenfabriken vorm. Bayer in Elberfeld (so-called Elberfeld Dye Manufactory), the Bayerische Anilin-und Sodafabriken in Ludwigshafen, Bavaria, and the Actien-Gesellschaft fuer Anilinfabrikation in Berlin—together purchased a colliery for their mutual use, and for this purpose, and also in order to build the atmospheric nitrogen factories mentioned above, increased their capital by £1,750,000.

Our Consul-General's remarks on the state of the labour market illustrate how strikes and threats of strikes were successfully frustrated by the employers' associations, which have become necessary in order to stem the growing power of the trade unions. The following extract is of special interest as showing the rise of a new element into the labour market: "Besides the workmen's disputes mentioned above, a further evil now appeared in big industrial concerns—viz., the want of experienced and capable workmen. The efficient training of workmen in the different departments of the factories is one of the unsolved problems of modern industrial development. Young people of both sexes object to the trouble and the small sum they earn at first whilst they are being properly trained; the elder workmen object to the trouble and loss of time which such teaching would occasion, and now and then, under the influence of the trade unions, even desire to keep down the number of trained and efficient hands. Finally, the employers themselves shun the trouble and expense which systematic teaching would involve. They doubt whether it would be of profit to themselves, whether they would reap the fruits of their labour, or whether those whom they trained would not later on go over to some trade rival. Though the special training schools opened by the civic authorities of many towns show some good results, they have not yet been successful in remedying the deficiency which is clearly felt. These manifold labour difficulties, matters of grave anxiety for German manufacturers, have accelerated the development of the substitution of machinery for human manual labour. In the glass, cement, and electrical industries this course has been productive of visible progress."

REPORT OF THE COMPTROLLER-GENERAL OF PATENTS, ETC.

The past year does not seem to have been appreciably affected by the operation of the new Patents Act, if we may judge by the annual report of the Comptroller-General of Patents, Trade Marks, and Designs. The number of patents issued to foreigners during 1907 shows no diminution in comparison with the number issued during previous years. The total number of applications received in 1907 numbered 29,040, as compared with 30,030 in 1906, a decrease of 990, or 3·3 per cent. Of these applications 19,630 were accompanied by a provisional specification, and 9,410 by a complete specification. The applications accompanied by complete specifications continue to increase at a more rapid rate than those accompanied by provisional specifications. The proportion of the latter to the former was in 1885, 87 to 13; in 1895, 83 to 17; in 1905, 72 to 28; and in 1907, 68 to 32. The number of complete specifications filed after provisional specifications was 9,483. The total number of specifications received was 38,523, as compared with 39,268 in 1906, a decrease of 745, or 1·9 per cent. In all, 16,272 patents were granted, compared with 14,707 in the preceding year. There were 1,646 applications made by way of communication from abroad, of which 828 came from the United States of America, 453 from Germany, 70 from France, 38 from Switzerland, 30 from India, 29 from Canada, 27 from Austria-Hungary, 22 from Italy, and 22 from the Transvaal. The applications made in this country under the provisions of the International Convention of 1883 by inventors living in other States of the Union numbered 2,286, as against 2,044 in 1906. Of these, 819 were received from Germany, 587 from the United States, 548 from France, 91 from Sweden, 79 from Belgium, 56 from Italy, 47 from Switzerland, 26 from Norway, 17 from Denmark, 6 from New Zealand, 5 from Spain, 2 from Portugal, 2 from Australia, and 1 from Japan.

The receipts from patent fees were £265,012, an increase of £9,366 on the year 1906.

The following table shows the progress of patented inventions during the past three years in each of the engineering classes, and the total number of complete

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specifications abridged in each of these classes, together with the yearly average over each period.

	1904.	1905.	1906.	Total 1855-1906.	Average per year, 1855-1906.
Number of specifications	16,185	15,459	17,073	366,241	7,043
Air and gas engines	511	465	612	6,093	117
Dynamo-electric generators, etc.	409	355	385	5,041	97
Electricity, conducting, etc....	151	145	161	3,265	63
Electricity, measuring, etc. ...	139	133	133	2,016	39
Electricity, regulating, etc. ...	746	670	703	8,287	159
Electric lamps, etc.....	829	292	370	4,793	92
Electric telegraphs, etc.....	292	293	294	4,388	84
Electrolysis	77	80	108	1,767	34
Pumps, etc.....	185	193	195	4,472	86
Railway, etc., vehicles	528	428	512	11,208	216
Railways, etc.....	345	278	260	6,407	123
Railway signals, etc.....	126	139	155	3,016	60
Road vehicles	290	257	337	6,810	131
Rotary engines, etc.	278	282	320	3,721	72
Signalling, etc.	113	112	153	2,917	56
Steam-engines.....	458	409	411	11,165	205
Steam generators	341	339	259	9,021	173

Although the total number of applications for 1906 was slightly less than in 1896 and 1897, the number of complete specifications for that year is the largest yet recorded, being an increase of nearly 11 per cent on the previous year. Among the 24 classes which contained a larger number of complete specifications for 1905 than for any previous year, those which have advanced still higher include electric telegraphs, etc.; indiarubber, etc.; mechanism, etc.; metals and alloys; philosophical instruments; railway signals, etc.; rotary engines, etc.; valves, etc. Other classes which have attained a maximum, and, therefore, show generally a still larger increase on the previous year, include air and gas engines; bearings, etc.; electricity, conducting, etc.; electric lamps, etc.; electrolysis; grinding, crushing, etc.; pumps, etc.; signalling, etc. Noteworthy increases are shown also in classes: dynamo-electric generators, etc.; electricity, regulating, etc.; galvanic batteries; railway, etc, vehicles; road vehicles. Steam generators show a considerable falling off.

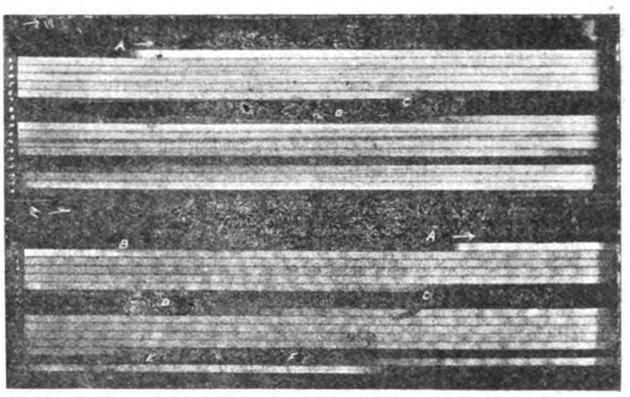
The Comptroller-General furnishes an interesting paragraph on the trend of invention in 1907. He remarks that the great inventive activity in connection with the motorcar industry now shows signs of falling off. Judging from the titles only, the number of inventions relating to motor road vehicles during the year 1907, although still large, has decreased nearly 35 per cent. from that of the previous year. The occurrence during the year of several serious railway accidents owing to the failure of signals has caused much attention to be given to automatic electrical systems of signalling, in which the services of signalmen are entirely dispensed with and the signals are given on the engine itself instead of by means of the usual wayside devices. Several applications have also been made for stopping trains automatically when the signals are against them. The occurrence of accidents in lifts has directed the attention of inventors towards the improvement of devices for preventing a mine or lift cage from falling down the shaft in the event of its hoisting cable breaking. A large increase is also observable in the subject of wireless telegraphy, and some attention was given to the transmission of portraits and designs by telegraphic means.

"OVER-SHOOTING" OF TUNGSTEN INCANDESCENT LAMPS.

BY JOHN B. TAYLOR.

A short article in the issue of the *Electrical World* for April 25* described what has been termed an "over-shooting effect" in the light from the tungsten incandescent lamp for a brief fraction of a second after the circuit is closed. The accompanying illustrations (Figs. 1 and 2) present the photographic evidence to show that this "over-shooting effect" is a real physical action as distinguished from a physiological effect or mental impression. These records were made on a photographic film 4in. wide and a little over 12in. long, placed in a G.E. oscillograph film-holder with a slit opening. For making these records the film drum was placed in a screw-cutting lathe and driven at a uniform speed of approximately 266 r.p.m. The screw-cutting gears were arranged for six threads per inch, while the tool post carried a piece of cardboard covering the slit in the oscillograph film-holder. An opening $\frac{1}{8}$in. wide in the cardboard exposed a small portion of the film (about $\frac{1}{8}$in. by $\frac{1}{16}$in.) to the light of an incandescent lamp under test. For these records a 20-watt, 22-volt tungsten lamp was placed about 24in. from the photographic film. It will be readily seen that the arrangement permitted of obtaining a photographic trace more than 20ft. long.

In Fig. 1, with the drum rotating continuously, the lamp circuit was closed at A, opened at C, closed again at D, etc. It is plainly evident that the trace between A and B is appreciably lighter than the remainder of the record, and the known velocity of the film gives the time between A and B as very nearly one-tenth of a second. Particular attention is called to the fact that this "over-shooting effect" is not seen at D, the lamp being still warm, as the interval between C and D is only about two-thirds second. In making this record the source of supply was a 25-volt storage battery from 15ft. to 20ft. from the lamp with no inductive apparatus in the circuit. The source of energy supply for the record at the bottom of Fig. 1 was the commercial 60-cycle lighting circuit with a small auto-transformer to reduce the E.M.F. from 110 to 22 volts. The same lamp was used as for the record of Fig. 1. This



FIGS. 1 AND 2.—Oscillograph Records of "Over-Shooting Effect."

record is lettered similarly to Fig. 1, the greater initial brilliancy being shown by the trace between A and B. In this record the alternate heating and cooling of the filament, corresponding to the peaks and zero values of the current wave, is readily seen. The photographs have not been retouched. It is not claimed that the photographic trace as presented shows the proper relative values of light at the different times, as exposure and chemical development have been chosen with a view to bringing out the contrast for illustrating the phenomenon.

From the records which the writer has made, these two have been selected as best presenting the effect for reproduction. As the cause of this effect has not yet been definitely demonstrated, it seems only fair to add that a higher voltage tungsten lamp of different manufacture showed this same effect, but not in so great a degree, which might indicate that the thicker filament is in some way responsible for the effect. On the other hand, the relative exhaustion of the two lamps is not known, and the relative proportions of lamp volume, surface of glass, and watts dissipated may be factors of more importance than the size and structure of the filament.

* Abstracted in *Electrical Engineer* for May,

AUSTRALIA.

Proposed Extensions at Sydney Electricity Works.

Mr. H. R. Forbes Mackay has now taken up his duties as chief electrical engineer of Sydney, and one of his first duties has been the preparation of a report as to the position of the electricity undertaking. Mr. Mackay has carefully gone into the question of the demand that may reasonably be made on the plant in the winter of 1909. He estimated the peak load to be 7,100 kw. The total capacity of the existing generating

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plant at Pyrmont was: engines and generators, 6,700 kw.; boilers, 5,609 kw., excluding their overload capacity of 20 per cent., and he considered that it was essential for the safe working of the system that one of the turbine sets and one Stirling boiler should be held in reserve. This reduced the generating plant to: engines and generators, 4,700 kw.; boilers, 4,800 kw.; which represented the plant available, with the required standing to deal with an estimated load of 7,100 kw. In addition to this the transforming plant at the town hall sub-station, which has a capacity of 2,100 kw., would be unable to cope with the demand made upon it. It was impossible to procure new generating plant in time to be available for the winter of 1909. This contingency could be met by the installation of a storage battery at the rear of the town hall sub-station with as little delay as possible. This would assist the generating plant at the power-house and the trunk mains from the power-house to the town hall sub-station by supplying a portion of the peak load. It could be charged at times of light load and discharged at times of heavy load, and in so doing it would improve uniformity of load on the generating machinery, and in consequence secure a higher economy in operation. It would also be of value in reducing the risk of a temporary failure of the supply in the centre of the city, which is the most important part of the system, for should any accident happen to the machinery in the power-house or the town hall and Lang Park sub-stations the storage battery would automatically take charge of a large portion of the load. Apart from the anticipated overload to the generating plant, the existing high-pressure trunk mains from the power-house and the low-pressure feeders from the town hall sub-station would have to be increased. The total capacity of the trunk mains leaving the power-house was 5,000 kw., and he considered that two additional high-pressure cables should be run, one from the power-house to the town hall sub-station and one from the power-house to Lang Park sub-station. There were no spare conduits laid to draw these cables in, and new conduits would have to be installed. Additional low-pressure feeders would also be required from the town hall sub-station to various centres of the city in the districts south of King-street.

Mr. Forbes Mackay reports that he has not had time to consider the extensions that would be necessary to the power-house building and generating plant for the winter of 1910, but he proposed to do so immediately. The matters mentioned were of great urgency, and he requested permission to (1) prepare specification and call for tenders for storage battery, with necessary boosters and switchgear; (2) make provision for temporary accommodation of storage battery; and (3) prepare a specification and call for tenders for the supply of high and low tension feeders, with necessary switchgear and conduit. The expenditure involved in carrying out the recommendations is estimated at between £40,000 and £50,000.

INSTITUTION AND SOCIETY NOTES.

Leeds Local Section.

The committee of the Leeds Local Section of the Institution of Electrical Engineers has arranged an excursion to Middlesmoor and Angram, in Nidderdale, for Saturday, June 20. The price of each ticket, which includes return fare from Leeds to Pateley Bridge, and from Pateley to Lofthouse, with luncheon at Middlesmoor and tea at Pateley Bridge, is 7s. 6d. By the kindness of Mr. W. A. Best (of the firm of Best and Sons, the contractors for the waterworks for the Bradford Corporation), the party will be enabled to visit the interesting waterworks at Angram, in which is in course of construction a dam which will make one of the largest reservoirs in existence, the depth being about 150ft. There is a high-tension three-phase plant driven by water power (and steam as reserve), an aerial ropeway (over 400 yards long and 150ft. in height), and other interesting details, to which the party will be shown by Mr. W. Thomson, the electrical engineer in charge. The stewards are Mr. T. Harding Churton, Mr. S. W. Cuttriss, and Mr. H. Dickinson (hon. secretary).

CITY AND GUILDS OF LONDON INSTITUTE.

The annual report of the council of the City and Guilds of London Institute for the year 1907 opens with a reference to the loss which the institute has sustained by the death of three members who had rendered valuable services towards the fuller development of its work—Lord Kelvin, Mr. T. F. Blackwell, and Sir W. H. Perkin.

Dealing first with the Central Technical College, the report, after mentioning that the number of students during the last complete session was 457, as against 435 in the previous session, draws attention to a fact to which reference was also made in the report of the previous year. The unequal distribution of engineering students between the civil and mechanical course and the electrical course has become even more marked, and it is thought that the depression in the electrical industries may affect the choice of candidates in their branch of study. During the session 1906-7 there were 126 students taking the electrical engineering course. In the previous session the number was 135, against 160 in the session 1904-5. Nor is this decrease in the number of electrical students peculiar to this college. A similar decrease has taken place at most of the technical institutions all over the country. Turning to another part of the report, we find that the sister college of the Central Technical College has not escaped this diminution. In 1904-5 there were 107 students taking the electrical engineering course. In the following year this number had dropped to 97, and again to 87 last year. The evening classes at the Finsbury Technical College were last year attended by 302 students, as against 328 in the preceding session, 15 students entering for the complete course in electrical engineering and 131 attending special lectures in the same department.

CALLENDER'S LONDON OFFICE STAFF ANNUAL OUTING.

This function was celebrated on May 30 at Brighton. An excellent luncheon was served at the Royal York Hotel, at which Mr. James O. Callender took the chair. Sixty members of the staff sat down, including several visitors from the works offices. After the luncheon Mr. James O. Callender rose to

propose the toast of "The Callender Company," at the same time regretting that Mr. T. O. Callender, the managing director, had been unavoidably called to Hamburg upon important business in connection with the German Callender Company. In a brief and witty speech he expressed his pleasure at being present, and also thanked the visitors for attending. He complimented the hon. secretary (Mr. J. M. Dunkley) and the committee on the way the outing had been arranged, and, on behalf of the staff, presented Mr. Dunkley with a smoker's companion. Mr. Allnutt proposed a vote of thanks to Mr. James O. Callender for occupying the chair, which was seconded by Mr. Macmaster, and accorded musical honours. Mr. Goodman, of the works, replied for the members of the works staff. The health of Mr. T. O. Callender was drunk, also with musical honours. During the afternoon the whole of the members took a sea trip to Newhaven, returning to the Royal York Hotel for tea. They returned from Brighton by the 8.30 train after a really enjoyable day.

APPOINTMENTS VACANT.

Senior Draughtsman. Well versed in design and manufacture of high-lift turbine pumps. Applications to No. 858, *Electrical Engineer* Office. See advertisement.

Station Superintendent, Carlisle Electricity Works. Salary, £130 per annum. Applications to Mr. S. Allen, city electrical engineer, by June 15. See advertisement in last issue.

Head of the Physics and Electrical Engineering Department, Northern Polytechnic Institute, Holloway, London, N. Salary, £300 per annum. Applications by June 29. See advertisement.

Professor of Mechanical Engineering, Poona College of Science. Salary, Rs 500 per month, rising by annual increments of Rs.50 to Rs.1,0.0, with a pension. Applications to the Secretary, Public Department, India Office, London, S.W., by June 15.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal*

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HULL TELEPHONES.

SIR,—At the end of your editorial article (on p. 794) on the Hull municipal telephone undertaking you very naturally express doubt as to the reality of the alleged results. The explanation of the apparent prosperity of the Hull municipal telephone system is very simple. The Hull Corporation, by legal means, obtained free intercommunication between their telephone system and that of the National Telephone Company in the Hull area. The National Hull system outnumbers that of the Corporation by about four to one. The Hull municipal system, therefore, exists mainly by the use of the National Company's plant, and the Hull Corporation are really selling the National Company's service—at their own prices. As an illustration of the practicability of municipal telephone estimates, methods, and practice the Hull example is, as you suggest, absolutely unreal.—Yours, etc.,

HERBERT LAWS WEBB.

THE HART SECONDARY BATTERY SYNDICATE.

SIR,—Some misunderstanding having arisen through the notice published relative to the winding up of the Hart Secondary Battery Syndicate, Limited, I should like to state that this liquidation in no way affects the Hart Accumulator Company, Limited, beyond the fact that the Hart Accumulator Company, Limited, have purchased the foreign patents of the syndicate with the intention of further developing their foreign and Colonial trade in accumulators. The similarity of name has evidently caused some confusion, and I should be very glad if you will give me the opportunity of making this explanation.—Yours, etc.,

J. H. POULTON, Secretary.
(Hart Accumulator Company, Limited.)

ALTERNATING CURRENTS FOR TELEPHONIC AND OTHER MEASUREMENTS.

At a recent meeting of the Physical Society, Mr. B. S. COHEN read a paper on "The Production of Small Variable Frequency Alternating Currents suitable for Telephonic and other Measurements." As an introduction a summary of the methods used by the author for such currents is given A new method for producing these currents is then described; this consists of a form of vibrating wire interrupter which operates a make-and-break contact. This is used to put a source of potential on and off a resonating circuit tuned to any desired frequency. The alternating current is taken from a small transformer in the resonating circuit. A series of damped wave-trains of any frequency can be produced by this means, the trains following each other with the frequency of the wire vibrations. Several forms of circuit are described, one of which gives a train of oscillations at each break of the supply circuit. Other circuits give damped waves both on the break and on the make contact, and by a suitable conbination of two oscillating circuits worked from one mercury cup and contact it is shown that continuous and fairly uniform oscillations can be produced. The theory of action of the various circuits is briefly entered into, and the paper concludes with some applications of the waves produced to both telephonic and general electrical measurements. The wave-forms given by the various circuits were shown at the meeting by means of a Duddell oscillograph.

Mr. A. CAMPBELL mentioned that with his vibrating-bar microphone hummer he had found it easy to obtain more than one frequency from the same bar by altering the supports to suitable nodal points and tuning the magnet circuit with a condenser. Harmonics of the fundamental frequency are thus produced. He asked if any of the composite wave-forms shown gave vowel sounds in the telephone.

Dr. RUSSELL congratulated the author on his interesting and valuable paper, and thanked him for the instructive demonstration he had given of methods of producing high-frequency currents suitable for telephonic and other measurements. He understood that the author's main object was not the obtaining of currents of excessively high frequency, but obtaining currents having frequencies varying between 100 and 5,000 which followed the harmonic law. Some of the methods described, in particular the author's "double action circuit" method, seemed well adapted for this end. In some of these circuits there are two free periods of vibration, and it was exceedingly interesting to see the accuracy with which the oscillograph gave the resultant of two slightly damped trains of high-frequeucy waves of different periods. Tuning for resonance the author obtains a very perfect sine wave. He thought that the thanks of the meeting were also due to the National Telephone Company for the facilities they had afforded Mr. Cohen.

Mr. COHEN expressed his interest in Mr. Campbell's statement that it was easy to get more than one frequency from his vibrating-bar hummer. The currents shown, when passed through a telephone receiver, did not produce vowel sounds.

ILLUMINATION AT THE ROYAL OBSERVATORY, GREENWICH.

The annual report of the Astronomer Royal dealing with the work of the observatory during the past year contains an interesting paragraph on the method of illuminating the field of the transit circle. Sir W. H. M. Christie records the fact that it was discovered last year that the method of illuminating this field by means of an elliptical annular reflector, lit by an axis lamp, was open to objection, as the tilting of the reflector to different points to produce various degrees of illumination caused a shift in the centre of light, and an apparent shift in the wires. A uniform central illumination has now been substituted, a small elliptical reflector with a matt white surface being cemented to the centre of the object glass, reflecting the light of a small electric lamp: change in the degree of light is produced by altering the current through the lamp by a rheostat. This plan, says the report, has been in use in the Altazimuth

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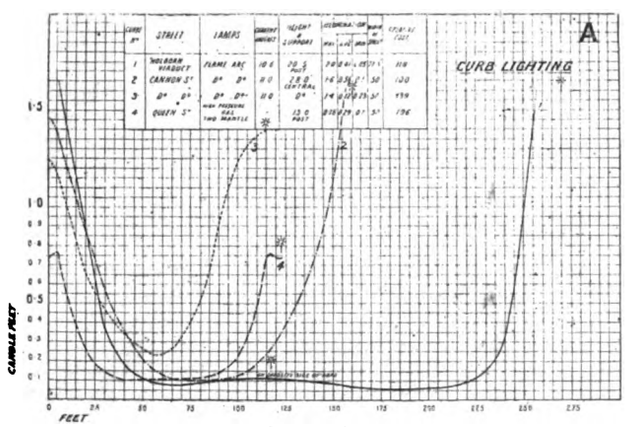
for a year with very satisfactory reaults. Arrangements have been made on each instrument to take a few transits by the old method for the purpose of comparison. A new arrangement of wires has also been inserted in the collimators of the transit circle, thin parallel wires replacing the thick oblique wires in former use.

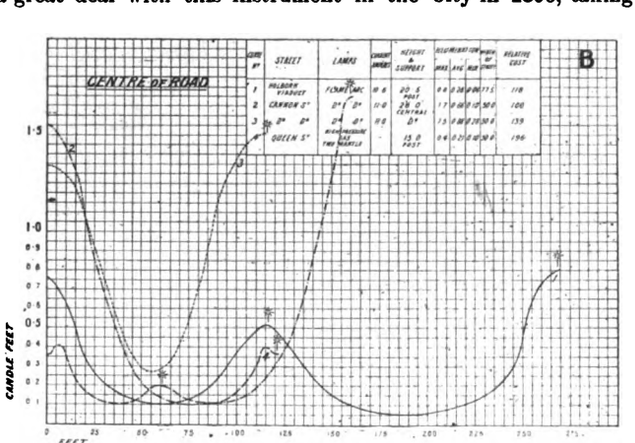
EXPERIMENTAL ELECTRIC LIGHTING IN THE CITY OF LONDON.

Mr. A. A. Voysey, the electrical engineer to the city of London, has now issued his report on the recent experiments that have been made with a view to improving and cheapening the street-lighting in the City. His report reads as follows:



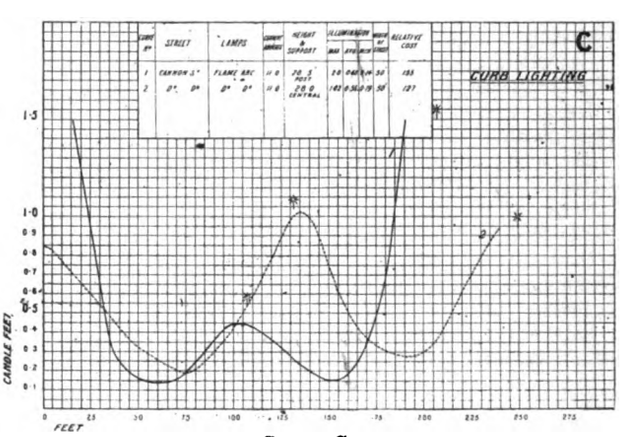
CURVE A.

Many people even to-day, in dealing with questions of artificial light, are content with a statement of the candle-power of the source of light—a statement frequently as false as it is vague—taking no account of the directions in which light is given, of the globe, lantern, reflector, position, and surroundings of the lamp, all factors of the utmost importance in determining the useful lighting effect. However important the study of the source of light may be, the study of the actual illumination in the street under working conditions is far more essential. In 1892, the work of Mr. A. P. Trotter, now the electrical adviser to the Board of Trade, showed the lines on which such an examination might proceed, and at the same time provided an excellent illumination photometer for the purpose. I worked a great deal with this instrument in the City in 1896, taking measurements of the illumination on a horizontal surface 6in. from the ground, and formed the opinion that the illumination measured on a horizontal surface may be taken as a sufficient indication of the effective lighting of a street. I am now again led to the same conclusion. But as the tendency is to measure illumination at a height of 4ft. from the ground, my recent tests have been made at this level. The photometer used is an improvement on the one used in 1896, and was sent to the National Physical Laboratory for verification. The unit of illumination is that produced by 1 c.p. at a distance of 1ft., and is called one candle-foot.



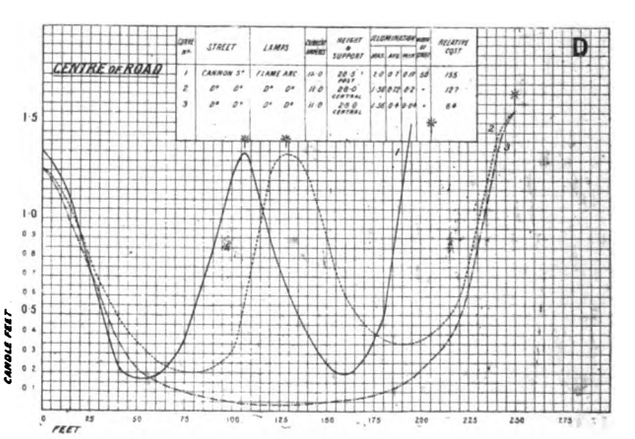
CURVE B.

Attached hereto will be found some curves showing the illumination given in Holborn, Cannon-street, and Queen-street by the experimental lamps. The length of the street in feet is plotted along a horizontal scale and the vertical scale is marked in candle-feet and fractions thereof, so that the curves show the variation in illumination along the street. Curves A show the illumination along the kerb line given by flame arc lamps in Holborn-viaduct and Cannon-street and by gas in Queen-street. Curves B are similar, but are taken along the centre of the road. Curves C show the difference in illumination along the kerb in Cannon-street, between the central suspension of lamps at a height of 28ft. and lamps on posts at a height of 20½ft. Curves D are similar, but along the centre of the road. There is also shown the effect of turning out one of the centrally-hung arc lamps. Curves E show the effect of suspending the lamps in Cannon-street at 26ft. instead of 28ft. Curves F show the effect of lighting Tower Royal with the centrally-suspended flame arc lamp in Cannon-street with a flame arc on a post and with two incandescent gas lamps. The arc light curves marked A and B are each taken as the mean of several curves, and the atmospheric conditions, when the tests were made, were clear and favourable. The Curves C, D, E, and F were taken with a view to make specific comparisons, and they each represent a single set of observations. The atmospheric conditions prevailing when Curves E were taken were distinctly inclined to be foggy.



CURVE C.

It is now necessary to consider what conclusions can be drawn from the curves. I have already stated that I think the illumination given on a horizontal surface can be taken as a sufficient indication of the value of the lighting in a street. Next, I have formed the opinion, from observation and testing, that the minimum illumination is the most important factor in good lighting, and I have come to the conclusion that about one-tenth of one candle-foot is the minimum below which it is not desirable to go in the main streets of the City. If that figure is adopted and maintained, then I think that the main streets of the City will be very well lighted. If the curves for Holborn-viaduct are studied, it will be seen that, although Holborn-viaduct is a very wide thoroughfare, the lighting is not very far from complying with the minimum value which I think necessary. In order to meet any possible objection to unpleasant colour, the Holborn-viaduct lamps are trimmed with carbons giving a pleasantly-toned light, but the illumination is thereby reduced. If 7mm. and 6·35mm. (cores 3-32in. and 1-16in. respectively) carbons are used in Holborn-viaduct, giving a yellower light, the minimum illumination would be increased so as not to fall far short of the necessary value, and it could be regarded as approximately fulfilling what I think are the reasonable requirements for the sufficient lighting of a City main street. I do not think that Holborn-viaduct can properly be compared with Cannon-street, because, in addition to other reasons, the width of the Viaduct is about 50 per cent. greater than the width of Cannon-street. Therefore, I determined to make



CURVE D.

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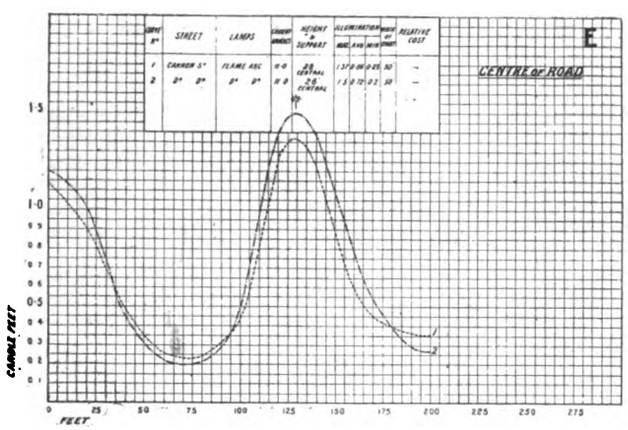
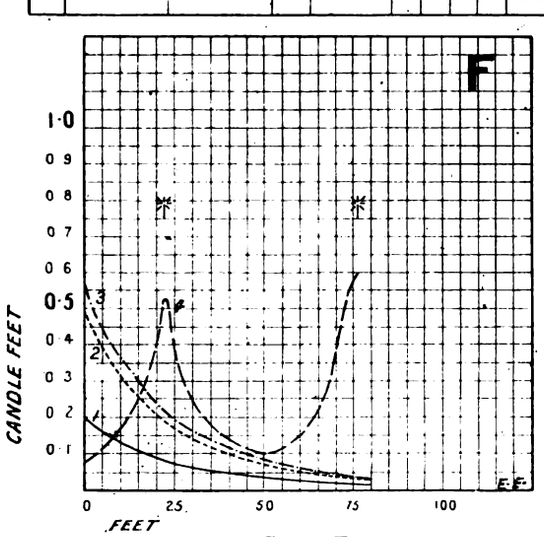
another test in Cannon-street, first with the centrally-hung lamps as used at present and then with identical lamps on posts on the footway, keeping the conditions of current and carbons the same for both. The arrangements for this test were kindly made for me by the City of London Electric Lighting Company, and the results shown in Curves C and D indicate the advantage obtained by central hanging in a street such as Cannon-street, which is fairly typical. The illumination curves of the centrally-hung lamps in Cannon-street show that the lighting also fulfils the suggested condition that the minimum should not be less than one-tenth of one candle-foot, and I think the curves are very good ones and indicate what is obvious from an examination of the street—namely, that the lighting is very good, and, if we study the curves, the advantages of the central suspension and the extra height of the lamps are evident. From the central suspension there is, however, an



CURVE E.

additional gain for side streets and at the junctions of streets owing to the fact that the light of one lamp can be used over a greater area. For instance, 45 per cent. of the cost of lighting in Cannon-street is saved on gas in the side streets. This economy could to some extent be obtained by placing posts at the corners of streets, but I do not think it could be obtained to the same extent as is possible with the higher centrally-hung

CURVE No.	STREET	LAMPS	CURRENT AMPERES	HEIGHT & SUPPORT	ILLUMINATION MAX	ILLUMINATION AVG	ILLUMINATION MIN	WIDTH OF STREET	RELATIVE COST
1	TOWER ROYAL	FLAME ARC	11 0	20 5 ON POST	0 2	0 08	0 05		NIL
2	〃 〃	〃 〃	11 0	28 0 CENTRAL	0 48	0 16	0 04		NIL
3	〃 〃	〃 〃	11 0	26 0 CENTRAL	0 56	0 19	0 04		NIL
4	〃 〃	LOW PRESSURE GAS SINGLE MANTLE		11 6 BRACKET	0 6	0 25	0 08		£644 PER ANNUM



CURVE F.

amp. An experiment was made in Cannon-street at the suggestion of the late chairman, Mr. Stopher, some of the lamps being hung at 26ft. instead of 28ft. The result is given in Curves E, which, I think, show that the higher position is slightly better than the lower one. Curves F show the illumination in Tower Royal, a turning off Cannon-street, lighted by the centrally-hung arc lamp, and by the arc lamp on a standard in Cannon-street and by the two incandescent gas lamps on brackets in Tower Royal. The curves show the advantage of the central suspension. Attention should be drawn to Curve D, No. 3, which shows the effect of extinguishing alternate lamps in Cannon-street. The curve does not fulfil the requirements of a well-lighted main street, but it shows a better result than Queen Victoria-street, and the lighting is very fair. If it were not for the fact that the cleansing of the streets is an operation which may be greatly assisted by good lighting, I should be inclined to recommend the turning out of half the lights in main streets at midnight, and I think the matter is worth consideration. This is, perhaps, an opportune place to discuss the question of lighting hours. In my opinion, the fixing of lighting hours between sunset and sunrise is a mistake, and I think the lighting might be curtailed on an average by about one hour per day, half in the morning and half in the evening if a reasonable reduction were made in the annual charges. It is now desirable to consider the question of comparative cost, and this is bound up with the question of spacing.

The average distance between the centrally-hung lamps in Cannon-street is approximately the same as that of the standards in Holborn, though Holborn is 50 per cent. wider than Cannon-street. The average spacing of the centrally-hung lamps in Cannon-street is a little closer than the spacing of the old standards in that street, there being 11 of the suspended to 10 of the lamps on standards. The extra lamp results really from the consideration of the side streets rather than from any need in Cannon-street itself. With regard to spacing, a regular distance should be followed as closely as possible, but due consideration must be paid to side streets and cross streets in order to obtain the most economical results. As will be seen from the curves, the distance between the lamps in Cannon-street varies from 112ft. to 165ft. I think the latter distance may be regarded as the extreme, beyond which it is not desirable to go; whereas the former is closer than is necessary, and can only be justified by a consideration of the side streets.

For the purpose of comparing the effect of gas with electric lighting I made a test in Queen Victoria-street, but I found a large portion of this street with a very low illumination, and neither from observation nor test did it appear to me at all comparable with Cannon-street. I therefore sought out a piece of good gas lighting, and I found this in a portion of Queen-street. It was interesting to find that the piece of street I picked fulfilled the condition which I had fixed as essential for a well-lighted street—namely, that the illumination on a horizontal surface 4ft. from the ground should in no place be less than one-tenth of one candle-foot. The average illumination of the picked piece of gas lighting in Queen-street, which is, fortunately, just the same width as Cannon-street, is only about half that in Cannon-street, though it is about double the cost. This confirms what I reported three years ago as the result of some photometric tests—namely, that light for light high-pressure incandescent gas light costs four times as much as the flame arc light. It may here be observed that departments of the Corporation, other than the Public Health Departmemt, are now saving at the rate of about £3,000 a year, partly by changing from gas to electricity and partly by bringing electric lighting up to date, and I have good reason for saying that this sum could be considerably added to.

On the whole, I think it may be fairly assumed that about 500 11-ampere flame arc lamps will light the main streets well, whether centrally hung or on standards. The cost of these at £17. 10s. each would be £8,750. The present cost of lighting the whole City is about £22,000 a year, about half the cost being for electric light and the other half for gas. In addition to this a sum of about £17,000 appears to have been spent in the last nine years on providing and maintaining apparatus for gas lighting. The side streets can be very much better lighted by centrally-hung arc lamps than they are at present for a sum which I estimate approximately at £5,000 to £6,000 per annum. It is very important in my opinion that the main street-lighting should not be arranged independently of the side streets. Economical effective lighting of both is bound up one with the other. A few lamps arranged in the side streets off Cannon-street would quickly show what can be done. I have very little doubt that the average illumination throughout the whole of the City streets can be at least doubled, and a saving of about £6,000 a year effected.

On the subject of lamp supports, I think it may be remarked, with regard to the central suspension, that the plan followed in Cannon-street of making them as invisible as possible is a good one. Attachments would have to be securely made and the supporting wires carefully examined, and, no doubt, the existence of a large number of such supports in the City would necessitate some extra cost to the Corporation in the supervision of overhead wires. But if reasonable care is used in the matter, there should be no danger whatever attaching to the central suspension of lamps. In the main streets the plan of trimming the lamps in position during the early hours of the morning is a sound one. No doubt some small occupation of the roadway space during busy hours would take place when a lamp went wrong at such a time, but it must be remembered that a standard on the footway remains for several thousands of hours each year as an obstruction to traffic, and must necessarily be a much greater cause of inconvenience than

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the very occasional visit for a few moments necessitated by a fault in a centrally-hung lamp. In narrow streets it would be advisable to arrange for bringing the lamps down to the footways for trimming, because otherwise a serious obstruction to traffic would occur. In some very wide streets, like Holborn and Farringdon-street, it might be advisable to use standards placed in the centre of the road, and in any case a certain number of standards may be required. While I recognise the importance of economy and the consequent need to use existing material as much as possible, I think I ought to point out the unsatisfactory condition of London in the matter of lamp standards, and especially electric lamp standards. The design is usually left to an ironfounder's draughtsman. Mr. Norman Shaw has very kindly given his gratuitous aid in matters affecting the appearance of London, and I think his help might very well be asked. If new posts are found to be necessary, I think some endeavour should be made to redeem the reputation of London in this matter.

I will restate my main conclusions: (1) that the illumination on a horizontal surface 4ft. from the ground is a sufficient indication of the useful light in a street; (2) that the minimum value of such illumination is the most important factor in good lighting; (3) that such minimum should not be less than one-tenth of one candle-foot; (4) that this illumination can be approximately obtained by 11-ampere flame arc lamps with yellow flame carbons, spaced approximately as at present, either on standards at 20½ft., as in Holborn-viaduct, or centrally hung, as in Cannon-street, at 28ft. from the ground; (5) that a more even distribution of light and a more economical result can be secured by the centrally-suspended lamp at 28ft. than by the lamp at 20½ft. on a standard; (6) that economy and efficiency require the treatment of main streets and side streets together; (7) that a demonstration should be made in the side streets of centrally-hung arc lamps as soon as possible; (8) that about £6,000 a year may be saved and a doubling of the average illumination throughout the City streets effected by flame arc lighting assisted by a few metallic-filament lamps where arc lamps have not a sufficient area for economical lighting; (9) that where central suspension is used, it should be without lowering gear in broad streets and with lowering gear in narrow streets; (10) that any new standards which may be required should be designed according to the advice of some reliable guide, such as Mr. Norman Shaw; (11) that the lighting hours can be reconsidered with a view to economy without prejudice to lighting efficiency; (12) that the question of reducing the lighting in the main streets at midnight should be considered.

In order to obtain as soon as possible the great advantages in economy and better lighting that I have shown to be possible, I think a small demonstration should be invited from both companies in the side streets, and some of the streets adjoining Cannon-street would be very suitable for the purpose. I also think it would be a great advantage if a provisional decision were come to as to whether the lighting is to be divided between the two companies, and, if so, in what proportions. If that is done, and the side-street demonstration of lighting found satisfactory, then the way will be clear for the preparation of complete plans and specifications for lighting the whole of the City, and instructions might be given accordingly.

INSTITUTE OF METALS.

A meeting was held on Wednesday afternoon at the Institution of Mechanical Engineers with a view to the formal inauguration of the new Institute of Metals. Sir Wm. White presided over a large attendance, and in opening the proceedings explained the object of the proposed institute, which was, he said, to increase knowledge with regard to the non-ferrous metals and their alloys, to publish reports of transactions containing papers on metallurgical subjects, and to offer a means of communication between members upon questions bearing upon the manufacture of metals, apart from questions relating to wages, and to arrange for periodical meetings for the purpose of discussing practical and scientific subjects relating to the manufacture, working-up, and use of non-ferrous metals. He thought the time had arrived when such an institute ought to be established. He could promise it the hearty support of the Institution of Mechanical Engineers, and the fact that Prof. Gowland, the immediate past-president of the Institute of Mining and Metallurgy, was present at the meeting proved that that body had friendly feelings towards the proposed institute. He expressed the hope that the Institute of Metals would work in close connection with the National Physical Laboratory. He moved the following resolution, which was unanimously adopted: "That, in view of the widely-recognised need for a medium of communication for the advance of knowledge in connection with the production, manufacture, and use of the non-ferrous metals and their alloys, a society, to be called the Institute of Metals, shall be, and is hereby constituted."

Sir Wm. White was unanimously elected the first president of the new institute, and the following gentlemen were selected to serve as an interim council: Prof. Gowland and Prof. Turner (science), Mr. J. T. Milton and Vice-Admiral Oram (marine engineering), Dr. F. Elgar and Mr. A. F. Yarrow (shipbuilding), Mr. Odo Vivian and Mr. L. Sumner (copper), Mr. J. D. Bonnor (Brit. aluminium), Mr. Ristori (aluminium), Mr. G. A. Baeddicker (nickel), Mr. Norman Cookson (lead, antimony), Mr. G. W. Nisbet and Mr. R. Kaye Gray (cables), Mr. J. A. Bayliss (King's Norton Metal Company), Mr. G. B. Hunter (shipbuilding), Mr. Williams Harvey (tin), Mr. Hurry Riches (locomotive engineering), Mr. Cecil Wilson (precious metals), Mr. Ralph Heaton (The Mint, Birmingham), Mr. Corfield (spelter), with Prof. C. H. Carpenter and Mr. W. H. Johnson as joint hon. secretaries.

The annual subscription of the institute was fixed at two guineas, with no entrance fee at present.

MUNICIPAL ELECTRICITY ACCOUNTS.

Birmingham.

The statement of accounts of the city of Birmingham electric supply undertaking for the year ended March 31, 1908, has just been issued. The total capital expenditure on the undertaking amounts to £1,205,009, of which £122,458 was incurred during the past year. The balance of capital account now stands at £32,408. The revenue account for the past year shows an income of £156,789, compared with £102,502 for 1907, and an expenditure of £95,862, compared with £48,090 for 1907, leaving a gross balance of £60,927, as against £54,412 for the preceding year. Details of the revenue account appear in the following table:

Income.

Sale of current (private lighting, power and traction, and contract sales)	£153,956
Meter rents	2,390
Rents receivable	121
Contracting department—surplus, including sale of lamps...	44
Motor hire department—surplus	43
Contributions for superannuation	234
	£156,788

Expenditure.

Generation of electricity	£38,681
Distribution of electricity	8,965
Rents, rates, and taxes	6,876
Management	11,260
Insurance	396
Bad debts	200
Sundries	46
Special expenditure—battery and buildings, Parker-street; alterations to mains; switchboard, Water-street, being replacements	9,159
Plant abandoned, Dale End (part)	20,278
	£95,861
Balance to profit and loss account	£60,927

This balance has been appropriated in the following manner: interest on Birmingham Corporation 3 per cent. stock, £13,316; interest on mortgages and loans, £20,612; redemption of debt—Corporation loans fund for redemption of stock £8,126, sinking fund for repayment of mortgages £16,753; bank interest, £2,120. The balance to the credit of the reserve fund is £68,701. These figures show the stability of the undertaking under the control of Mr. R. A. Chattock.

Blackpool.

The city of Blackpool electricity undertaking accounts for the year ended March 31, 1908, show a substantial balance on revenue account, and, after providing for certain standing charges, leave a balance which has been allocated to the reserve fund and to the relief of the borough rates. The income on revenue account last year was £36,565 and the expenditure £16,140, leaving a balance of £20,425. Some of the chief items of expenditure were: generation, £10,164; distribution, £1,489; public lighting, £1,188; rents, rates and taxes, etc., £1,404; management, £1,606; general, £288.

Of the balance of £20,425, interest and sinking fund absorbs £6,539 and loan repayment £5,430. The net profit was £8,465, out of which £3,000 is carried to the electric light reserve fund (which at March 31, 1908, stood with a balance of £6,153), and £5,456 is appropriated to the general district fund.

The number of consumers during the past year was 1,176. The prices charged for current are: for private lighting, 6d. and 2d. and 5d. (power and heating 3d. and 1d.) per Board of Trade unit (Wright's D.I. system); for the Corporation tramways and the Blackpool, St. Annes, and Lytham tramways, 2d. per Board of Trade unit and 1¾d. after 250,000 units; for public lighting, 3d. and 2½d. per Board of Trade unit. The total number of units generated during the year was 3,704,150. The length of mains was about 103 miles. The maximum load observed was 2,602 kw. (Sept. 21, 1907), the

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lighting load being 1,844 kw. and the traction 758 kw. The total capacity of the dynamos is 4,450 kw.

PERSONAL.

Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, inform us that they have taken into partnership Mr. John MacFarlane Kennedy and Mr. Sydney Bryan Donkin. The name of the firm remains unaltered.

Mr. A. E. Farrow, chief engineer to the Windsor and Slough and Datchet Electric Lighting Companies, has been granted a patent for a new invention intended to do away with noise, smell, and vibration in motor omnibuses and commercial motor vehicles.

Mr. J. B. Hamilton, general manager of the Leeds tramways, is celebrating his silver wedding, and on the 3rd inst. the staff under his control took the opportunity of showing their regard for him by presenting him with a large silver rose bowl, a pair of silver candlesticks, and a meerschaum pipe

We regret to announce the death of Mr. Edward Thomas Pugh, chief traffic assistant in the Liverpool Corporation tramways department. He had been connected with the Liverpool tramways, first with the old company and with the Corporation since the latter took over the system, for about 22 years.

The principal prize of 200 guineas offered by the American Co-operative Electrical Development Association for a canvassers' handbook dealing with data concerning electric light, heat, and power useful to canvassers and central station managers has been awarded to Mr. R. Borlase Matthews, consulting engineer, London. Mr. Matthews was the only successful English competitor.

The Liverpool City Council have confirmed the recommendation of the Tramways and Electric Power and Lighting Committee appointing Mr. C. W. Mallins, the traffic manager, as general manager of the Corporation tramways. Since the death of the late Mr. Bellamy, Mr. Mallins has practically carried out the duties of general manager, and his appointment is the natural outcome of his services in that capacity.

The *London Gazette* announces that the partnership between Messrs. F. Simpkin, W. A. Wilkinson, and C. Gibson, carrying on business as electrical and mechanical engineers at 66, Kirkstall-road, Leeds, has been dissolved by effluxion of time so far as concerns W. A. Wilkinson, who retires. Messrs. Simpkin and Gibson will continue to carry on the business in partnership under the same title of Simpkin, Wilkinson, and Gibson.

COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER.

The report of the Aron Electricity Meter for the term of six months to March 31, 1908, states that the profit and loss account for that period, after providing for general charges and depreciation, shows a net profit of £11,485. 15s. 7d., making, with the balance carried forward from the last accounts of £6,228. 8s. 7d., a total available profit of £17,714. 4s. 2d. The directors recommend the payment of a further dividend of 7 per cent. on the preference shares, amounting to £8,742. 14s. 5d., and a transfer to the reserve towards goodwill and patents of £5 000, leaving to be carried forward the balance of £3,971. 9s. 9d. The directors are pleased to record a further progress of trade in all the Company's branches. They ascribe the satisfactory results during the half year to an increased demand in all European countries for the Company's meters and clocks. The factories continue to be fully employed, and have again been added to in order to cope with the increased business. The Company have recently placed on the market a taximeter which has been approved by the Commissioner of Police and passed by the National Physical Laboratory, and it is hoped that this new enterprise may prove an additional source of income to the Company in the near future. Two directors, Lieut.-Colonel R. E. B. Crompton, C.B., and Mr. S. Barclay Heward, retirefrom office at this meeting, and, being eligible, offer themselves for re-election.

BRUSH ELECTRICAL ENGINEERING.

The report of the Brush Electrical Engineering Co. for the year ended Dec. 31, 1907, to be presented at the meeting on the 16th inst., states that effect has been given in the balance-sheet to the reduction of capital approved by the shareholders in August, 1907, and sanctioned by an order of the Court, dated April 4, 1908. The amounts standing to the credit of the general reserve and depreciation reserve funds, as well as the balance of profit brought forward from the year 1906, have also been absorbed. The patents and goodwill account is now represented by the round figure of £100,000, while the Company's investments, which were entered in the 1906 balance-sheet at £164,522, now stand at £101,335. The general profit and loss account shows a gross profit of £63,294. After debiting general charges and maintenance, the amount carried to net profit and loss account is £32,294, and after paying debenture and other interest the net balance is £10,229. Consistently with the character of the present balance-sheet, which is essentially one of reduction and adjustment, the directors recommend that this balance be applied to initiate a new general reserve fund. The output from the works during 1907 has been the largest in the history of the Company, but the directors regret that the profits realised have not been commensurate. This is chiefly due to the fact that competition in the electrical engineering industry continues to be very keen, while the after effects of the strike at the Company's Loughborough works have been severely felt. The Company has also suffered in its operations by the lack of adequate working capital. The contracts upon which it has been engaged have involved a large lock-up of money while in progress, and this situation has had to be met by temporary loans from bankers and others, which, owing to the financial stringency that prevailed for so long a period during 1907, carried a high rate of interest. A portion of these loans was obtained from the British Electric Traction Co. without security, and, as part of the arrangement then made, the directors have waived their option to call upon the British Electric Traction Co. to accept £2 ordinary shares at par in satisfaction of the advance of £30,740 made by that company in 1901, and have agreed to repay the said advance by 12 half-yearly cash instalments, commencing in January, 1909, and carrying interest at the rate of 3½ per cent. per annum. With a view to placing the Company in a position to carry on its business under more favourable and economic conditions, the directors put forward in January last a scheme to consolidate the existing £250,000 first and second debenture stocks, and to make a further issue of £100,000 4½ per cent. debenture stock. This proposal, however, was not supported by the first debenture stockholders, and the directors have now arranged to make an issue of £125,000 5 per cent. prior lien debenture stock, which will be specifically secured upon the freehold and leasehold lands, buildings, and fixed plant of the Company at Loughborough. The reduction of capital embodied in the present balance sheet makes the Company's preference and ordinary shares of the face value of £1. 6s. 8d. In order to arrive at a more marketable denomination it is proposed to subdivide these shares into shares of 6s. 8d. each, and to consolidate every three of the latter into one £1 share, thus giving the shareholders four £1 shares for every three shares at present held. Similarly the unissued 74,268 ordinary shares of £2 each will be converted into 148,536 ordinary shares of £1 each. An extraordinary general meeting to consider and, if thought fit, adopt resolutions to give effect to such subdivision is to be held after the general meeting. The directors have decided to give the preference shareholders the right to convert 25 per cent. of their holding into ordinary shares.

NEW COMPANIES REGISTERED.

Millwall Rubber Co., Limited.—Registered May 22. Capital, £10,000 in £1 shares. Objects: to acquire the rubber business carried on by Sir Charles B. Lewis-Wittewronge, Bart., or on his behalf, at the Atlas Chemical Works, West Ferry-road, Millwall, and to carry on the business of manufacturers of and dealers in rubber and rubber products, regenerators and utilisers of waste or perished rubber, tyre manufacturers, cycle dealers, wheelwrights, etc. No initial public issue. Table "A" mainly applies. Registered office: 16, Finsbury-circus, E.C.

Rhenish Rubber and Celluloid Co. (1908), Limited.—Registered May 20. Capital, £15,000 in £1 shares. Objects: to acquire the business of celluloid merchants carried on at 68, Basinghall-street, E.C., as the Rhenish Rubber and Celluloid Co.; to adopt an agreement with the Rheinische Gummi und Celluloid Fabrik, and to carry on the business of manufacturers of and dealers in celluloid and rubber and articles made wholly or partly therefrom. No initial public issue. Registered office: 68, Basinghall-street, E.C.

Rex Electric and General Supplies, Limited.—Registered May 23. Capital, £3,000 in £1 shares. Objects: to carry on the business of electrical and general engineers, contractors, manufacturers of electrical and mechanical appliances for lighting, power, and traction, etc., and to acquire the goodwill of the wholesale electrical supply department of D. Santoni and Co. (1906), formerly carried on at 15-17, Beauchamp-street, Brook-street, E.C., and to adopt an agreement with D. Santoni. No initial public issue.

Sun Power Co. (Eastern Hemisphere), Limited. — Registered May 27. Capital, £300,000 in 1,500 founders' shares of 1s. each and 299,925 ordinary shares of £1 each. Objects: to acquire any inventions relating to the utilisation of solar heat, and apparatus used in connection therewith; in particular to acquire the rights for the eastern hemisphere relating to certain inventions of F. Shuman, of Philadelphia, U.S.A.; to adopt an agreement with the said vendor as president and on behalf of the Sun Power Co., of Tarcony, Philadelphia; to manufacture and deal in sun or solar engines, and plant, works, apparatus and machinery of all kinds, including machinery and apparatus for refrigerating and ice-making and for the production or supply of liquid air, electricity, light, heat, and power; to manufacture, create, generate, produce, and deal in and with ice, liquid air, electricity, light, heat, and power of any kind, etc.

Liens Registered.

Gould Storage Battery Co., Limited (London).—Issue on May 21 of a £50 6 per cent. debenture, part of series created same date, to secure £5,000, charged on the company's property, present and future, including uncalled capital. No trustees.

Economic Acetylene Engineering Co., Limited (London).—A memorandum of satisfaction in full of debentures dated Feb. 7 and March 18, 1908, securing £30, has been filed. A trust deed, dated May 28, 1908, to secure £200 debenture stock, charged on a certain leasehold workshop and premises at East Ham, and the company's undertaking and property, present and future, including uncalled capital, has also been registered. Trustee: A. Page, 28, King-street, E.C.

Edmonton (Alberta).—The Public Works Department have purchased two sites in Strathcona for the erection of a local telephone exchange building which is to be erected at a cost of 10,000dol.

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BUSINESS NOTES.

LIGHTING AND GENERAL.

Mexican Light and Power Co.—The directors of the company announce a dividend of 1 per cent. on the outstanding ordinary shares.

Stepney.—The Electric Lighting Committee of the Borough Council have decided to lay mains through Stepney-square, Mile End Old Town.

Mirfield.—The District Council have decided to seal an agreement with the Yorkshire Electric Power Co. for the supply of current for street-lighting purposes.

Market Harborough.—The Board of Trade have extended the period of the revocation of the Urban District Council's electric light provisional order for one year dating from June 22.

Crewe.—At the last Town Council meeting the Electric Lighting Committee reported that after meeting all the charges on the electric light undertaking there was a surplus for the year of over £800.

Sheffield.—The Corporation are applying to the Local Government Board for powers to borrow £20,000 for electric lighting purposes. About half of this sum will be devoted to mains and sub-stations.

Wigan.—The Corporation have decided to shut down the Pemberton electricity works and to transfer the machinery to Bradford-place station, which they will extend at an estimated outlay of £36,500.

North Bay (Canada).—Application has been made by the Town Council of North Bay to the Hydro-Electric Commission to develop Smoky Falls, on the Sturgeon River, and supply North Bay with electric power.

Heanor.—Upon the suggestion of the Electric Light Committee, expert advice is to be obtained by the Urban District Council as to the advisability or otherwise of lighting a part or the whole of Heanor, Langley Mill, and Marpool wards

Glasgow.—After a good deal of discussion, the Town Council of Glasgow have agreed, subject to permission being obtained from Parliament, to pay out of the common good the loss of £16,000 sustained in the working of the Corporation telephones.

Birnam.—At a meeting of the Perthshire Highland District County Council Committee on Saturday, a requisition was submitted from ratepayers in Little Dunkeld asking that Birnam be formed into a special lighting district. The motion was agreed to.

Bacup.—The Town Council have resolved to empower the Electricity Sub-Committee to obtain particulars and submit a scheme for the installation of a producer gas-driven plant or otherwise for the supply of electrical energy for all purposes within the borough.

Long Eaton.—The engineer to the Urban District Council reports that during the month 42,840 units have been generated, exclusive of station supply, showing an increase of 12 per cent. For public lighting the number of units generated was 6,709, a decrease of 17 per cent.

Enniskillen.—The installation of the new telephone system in Enniskillen has now been almost completed. All the principal wires through the streets have been put up and the work of putting in the private connections is proceeding rapidly, and will probably be completed during the course of next week.

Holywood (co. Down).—At the monthly meeting of the Urban Council it was reported that the committee appointed in connection with the proposed electrical lighting of the town had had a consultation with a consulting expert regarding the probable cost of the same. A further report will be made on the subject.

Govan.—At the Town Council meeting it was agreed to apply to the Secretary for Scotland for increased borrowing powers to the extent of £23,000 to meet the probable expenditure in connection with the electric installation during the next four years. Up to date the Council have spent on the scheme £125,186. 7s. 7d.

Cannock.—At the monthly meeting of the Urban District Council a letter was read from the Cannock and Rugeley Colliery Co. asking for permission to carry an electric cable over the highway at Littleworth, and it was decided to offer no objection on the company giving an undertaking to indemnify the Council from any claim in respect thereof.

Toronto.—The City Council have decided to establish an electrical construction department, with a consulting board of three experts, and an engineer of construction under the board. The construction department may be continued for the purpose of operating a city electric plant, and making any extensions that may be deemed necessary.

Newcastle-Emlyn.—The promoters are busy making arrangements for the installation of electric light for the town. It is understood that the company will not be handicapped by the want of capital, as sufficient is forthcoming. Mr. Parkington has promised to do his best to fix it up by the August Eisteddfod in order to electrically light the pavilion.

Longton.—The output of electricity from the Corporation works during the four weeks ending May 21 was 16 153 units, being an increase as compared with last year of 2,821 units. The electricity main is to be extended at an outlay of £58. The gas undertaking is in a bad way, having experienced a drop of 136,000 cubic feet during the four weeks as above.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Metropolitan Electric Tramways' further issue of £178,800 4½ per cent. debenture stock. The committee has also ordered Tandjong Rubber Co.'s 70,000 shares of £1 each, 10s. paid, Nos. 1 to 70,000, to be quoted in the official list.

Bath.—The documents in connection with the sale of the Bath electric lighting undertaking to Mr. Schenk, by the Bath Corporation, have been exchanged, and a cheque for the amount of the deposit, £22,500, has been received by the town clerk. The sanction of the Board of Trade to the proposal has now to be obtained.

Newport.—The Newport Gas Co. has invited the Corporation Electricity Committee to take part in a trial made by competent independent lighting experts, comparing under such conditions as may be agreed upon by the experts the relative values for public lighting of incandescent gas lamps and incandescent electric lamps. The Corporation have decided that they do not think it necessary to take part in such a test.

Dover.—The Town Council have decided to raise the price of electric current by ½d. per unit, and to reduce the cash discount from 1d. to ½d. per unit. The estimates for the year ending March 31, 1909, showed a deficit of £2,147 brought forward from last year. On the coming year's working, including payment of interest on loans, repayment of capital, etc., it was estimated that the deficit would be increased to £2,293.

Canada.—The report of the Canadian section of the International Waterways Commission advises that all companies developing electric power from the Niagara Falls should be compelled to supply the Canadian demand proportionately and at reasonable rates and should only be allowed to export the surplus to the United States. The report further advises that the export should be controlled by the Federal Government.

Islington.—The Electricity Committee are recommending the extension of electricity mains at an estimated cost of £320. During the nine weeks ended May 16, 1908, the premises of 66 additional consumers were connected to the mains, additions to existing installations were made in 14 cases, and 26 consumers were disconnected. The result is a net increase in the maximum supply of the equivalent of 5,986 8-c.p. lamps.

Australian Preferential Tariff.—We have been asked by our agents to specially notify shippers to that country of the new customs regulation: "All invoices must be accompanied by a declaration signed by the responsible head of the firm, and in the case of a company bear the company's seal or stamp, and all signatures must be duly witnessed. In the absence of such declaration, goods will be charged at the higher rate of duty."

Glossop.—At the meeting of the Urban Electric Supply Co., which includes Glossop and other towns in the North of England, the Chairman said in four towns the returns were less this year than last. In Glossop there was a decrease of £298 The lighting revenue had increased by £77, but there was a decrease on the tramway profits of £242, and an increase of expenditure of £234. Last year was a bad one on account of wet weather, and the cost of coal had been very much higher.

Axbridge.—At the last meeting of the Board of Guardians Mr. R. H. Tucker (who had been requested to inspect and report upon the electric lighting plant) duly presented a report, the effect of which was that the accumulators were in a very unsatisfactory condition. A report from the Electric Sphere Co. (Bristol) was also read to like effect. It was resolved to ask the Sphere Electric Light Co. to make a further inspection and present a report, together with an estimate as to cost of repair.

Barnsley.—The Electric Lighting Committee reported at the last meeting of the Corporation that the number of units generated during May was 53,417, compared with 25,637 during the same month of last year. They recommended the Council to authorise the engineer to arrange an exhibition of electrical appliances at the Park fêtes, and that the chairman and engineer attend the annual convention of the Municipal Electrical Association at Nottingham. The report was confirmed.

Lofthouse Park.—A new pleasure ground on the Leeds and Wakefield road has been opened by a company registered as Lofthouse Park, Limited. An extensive scheme of illumination has been provided, the company having set down in the grounds an electric substation capable of producing a supply of electricity for 40,000 to 50,000 lights. The park will present a magnificent spectacle by night, myriads of vari-coloured lights being placed all over the buildings and gardens, and on certain evenings there will be pyrotechnic displays.

Taunton.—At the last Council meeting the Electricity Committee presented their accounts for the year ended March 31, which showed a net profit of £281. 3s. 9d. after paying all charges, including interest and redemption of loans. Of this profit, the committee had transferred the sum of £265. 4s. 1d. to the motor purchase fund, and had carried the balance forward to next year's account. The committee reported that the whole of the motors purchased for hire purposes had now been paid for out of revenue. The cost of the same had now been transferred to the capital account.

Wrexham.—At the last meeting of the Corporation there was submitted the electrical engineer's monthly report, including the following statement: connections and supply—used for tramways, 13,263 units; lighting, etc., 34,940 units; total units generated, 48,203. New consumers connected, 0; consumers disconnected, 0; 8 c.p. equivalent of additions to connections, 181; total number of consumers, 278; total of 8 c.p. equivalent for private supply, 20,779. The public lighting is not included in the above totals of 8-c.p. lamps. The report was adopted.

St. Annes.—The engineer reported to the last Council meeting that the units sold during April were 55,354, and the total number of consumers 677. He had in hand applications from 12 consumers for the equivalent of 315 8-c p. lamps. The Council resolved that electric motors be obtained and let out on hire to consumers, and that the scale of charges therefor be referred to the Electricity and Lighting Sub-Committee. It was also resolved that application be made to the

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Local Government Board for sanction to borrow a loan of £3,500 for the purpose of a new electricity main feeder cable.

Batley.—At the last Town Council meeting Councillor Clark submitted the minutes of the Electric Lighting, Traction, and Tramways Committee, and mentioned that on the year's working there was a dividend. He was glad to be able to congratulate the manager on the very efficient way he had conducted the business during the year, and also the members of his staff. The dividend was not so large as last year, but that was very easily accounted for by the increased price of coal and increased taxation. Those were the things which had gone a long way against them showing a better dividend.

Grays.—At the last meeting of the Urban District Council Mr. Long reported that the gross profit on the electric light undertaking was £1,911, and that the surplus after paying all capital charges was £228 during the past year. The Chairman remarked that that ought to satisfy some of their good neighbours. They would see that not everything the Council took up was a failure. Mr. Farrow suggested that the engineer should bring up a report as to a reduction of the scale of charges for the supply of motive power. Mr. Sutherden thought as they were doing so well they might have a sliding scale. It was agreed that the engineer be instructed to bring up a report.

Grimsby.—At the last meeting of the Town Council a profit of £2,085 was reported on the year's working of the municipal electrical undertaking. The engineer (Mr. Vignoles) recommended that the whole amount be carried forward to the next account, giving as his reason that the committee were carrying out an improvement for which the Local Government Board would not sanction a loan, and which must be met out of revenue. Alderman Pickwell moved that £1,000 be allocated to the relief of the rates. He thought the ratepayers should have some of the benefits. The Town Clerk said the undertaking could well afford the thousand pounds, and ultimately it was agreed to allocate £500 to the relief of the rates.

Edinburgh. — A deputation from the Edinburgh Merchants' Association, consisting of Mr. William Lindsay (president), Mr. William Cuthbertson, J.P., Mr. W. D. Macgregor, and Mr. William Morrison (secretary), waited on a committee of the Corporation of Edinburgh at the last meeting with reference to telephone charges. They urged the Town Council to see to the enforcement of the agreement between the Corporation and the company, taking special exception to the proposed measured rate. It was pointed out, however, that under the agreement any subscriber had the right to demand an unlimited service for payment of £10. The committee declined to entertain a proposal to institute a competing municipal service, especially as the licence would only be granted by the Government till 1913.

Swansea.—At the last meeting of the Electricity Committee the borough accountant presented the annual statement of accounts of the electricity department, which showed a net profit on the year's working of £1,230, despite a substantial increase in the price of coal, and £230 allowed for bank overdraft. Deducting £441 outstanding in respect of sinking fund, there remains a credit balance after seven years' working of £789. The electrical engineer reported the number of consumers on the books at the end of May was 1,162. A subcommittee was appointed to consider extension of mains on to Pantygwydr Estate and Spring-avenue. The committee recommended that £450 be expended on a new feeder cable and works connected therewith, the chairman observing that this was absolutely necessary before next winter.

Limerick.—The mayor (Alderman Donnellan) and several members of the Corporation attended at the electric power station on the 6th inst., when the new engine recently installed for generating purposes was set running for the first time. The formality of switching on the machine was performed by his worship, and the test, which proved highly satisfactory, was made in presence of the representatives of the suppliers and contractors (the Westinghouse Co. and Messrs. Crompton and Co.) and the borough electrical engineer. The engine is of 250 h.p., practically as much as that of the three engines which have been doing the work of the station since the plant was first put down. The addition, while relieving the work of those machines, will conduce to a better and more continuous supply of current, and increase the earning capacity of the department.

Wadebridge.—At the Urban District Council's last meeting, on the question of the electric lighting scheme a letter was read from Mr. G. L. Ellis, as representing a syndicate who offered to form themselves into a limited liability company for bringing an installation of electric light into the town, provided the approval of the Council and public support could be obtained, with the proviso that no rival scheme should be allowed within 12 months after the completion of their work. The suggested system was by a method of overhead wires, which, the communication pointed out, did not require the sanction of the Board of Trade, was more economical than wires underground, and also did not interfere with the roads. The scheme in detail was read by the clerk, and much discussion ensued thereon. Ultimately it was decided to adjourn consideration of the matter for one month.

Morley.—At the last meeting of the Corporation the borough electrical engineer's report showed that the output from the electricity works for the month of April was 13,154 units, compared with 13,245 for the corresponding month of last year, being a decrease of 91 units. There had been sold to customers by meter 10,215 units, as compared with 9,073 the same month of last year, being an increase of 1,142 units. A letter was read from the Board of Trade sanctioning the erection of overhead wires for lighting up Scatcherd lane. The town clerk submitted the correspondence with the Local Government Board with respect to the application of the Council for sanction to borrow loans for new electric cables, and additional machinery and plant. It was resolved that the engineer proceed with the completion of the plans and specifications, and that the town clerk furnish the Board with the information asked for.

West Bromwich.—The report on the Corporation electricity undertaking shows that the total revenue for the year ending March last amounted to £12,971. 8s. 7d., against £13,033. 5s. 4d. the previous year. The income from the sales of current showed an increase of £53. 12s. 11d., and motive power £387. 8s. 10d., but the tramways showed a decrease of £434. 15s. 11d., and public lighting (owing principally to expenditure on new lamps) a decrease of £131. 18s. 10d. The total expenditure on the trading account amounted to £6,914. 16s. 3d., against £6,540. 7s. 10d. in the preceding year, an increase of £374. 8s. 5d. The revenue account was charged with interest on loans and Corporation stock, and the proper instalments for redemption and extinction of debt, amounting in all to £1,026. 3s. 5d., leaving a surplus for the year of £2,030. 8s. 11d., a decrease of £593. 8s. 10d.

Tonbridge.—At the last meeting of the Urban District Council, upon the recommendation of the Electricity Committee, the engineer was authorised to carry out an extension to Pembury-road, as soon as it could be definitely seen that the same would yield an annual revenue of £30, including street-lighting. Messrs. Seale, Austen and Barnes applied for a supply of electricity for illuminating High-street during cricket week, and it was decided that a supply be given of not exceeding 1,000 8 c.p. lamps to be used from Monday to Friday at 3d. per unit. Mr. Race said the extra demand during cricket week proved the need of an immediate extension of the plant. They had no reserve to fall back upon. The engineer thought they might take the risk, but it was impossible to shut their eyes to the fact that the risk existed. If the extra plant was available, there was little doubt that the contractors would have taken double or treble the amount.

Stockton.—The electricity works have now taken a place among Stockton's producing municipal undertakings. During the municipal year ending March 31 the income from the sale of current was £7,636, an increase of £236, and the total income from all sources £7,915, or an increase of £291. The cost of generation and distribution was £4,475, leaving a gross profit of £3,438. Of this, interest and redemption absorbed £3,172, leaving a net profit of £265, which has been placed to reserve. There has been an increase in the cost of production amounting almost to ⅛d. per unit, but the increased price of coal during the year more than accounted for this. Owing to the abnormal depression of trade locally there are 35 services which are not in use owing mainly to empty premises, and under such difficulties the manager, Mr. J. J. Smith, is to be congratulated upon having, after several years' hard work, thoroughly established the works as a remunerative concern.

West Hartlepool.—The past year may be regarded as a satisfactory one for the electricity undertaking of the West Hartlepool Corporation. The year's working shows that after providing for all charges, including redemption of loans and interest, there was a small balance on the right side. The amount of debt repaid during the year out of the earnings was £3,098, or equivalent to 3¼ per cent. on the capital expenditure, while the interest on loans amounted to £2,902, or 3 per cent. on the capital. Despite the heavy advance made in the price of coal during the year, there was no increase made by the Corporation in the price of electricity to consumers, and the undertaking has still been able to pay its way. The average price paid for coal last year, it might be added, was 12s. 1½d., compared with 10s. 5d. in the previous year. The consumption of current has, however, shown a considerable increase during the year. Had the price of coal last year remained the same as the previous year there would have been a credit balance of £530.

Exeter.—The Electric Lighting Committee recommended at the last meeting of the Council the transfer of the responsibility for the purchase of the coal used by the undertaking from the Stores Committee to the Electric Lighting Committee. Alderman Reed said the coal used was entirely different from that used by the other departments, and was the largest item of their expenditure, and if they were to be charged with the responsibility for the undertaking they ought to be allowed to purchase the article which entailed the largest expenditure. Tenders would be invited for alternative prices for bringing the coal by rail and canal, as the Council directed, though he did not think the coal could be brought so cheaply for their works by canal. Councillor Ross thought they would get their coal much cheaper by the canal than by rail. If it was found that they could get their coal cheaper by the canal, perhaps the Council would consider the making of the alterations necessary to allow steamers of from 500 to 1,000 tons register to use the canal. The report was adopted.

Lisbon Telegraph Conference.—At a plenary sitting of the telegraph conference on the 15th inst., Reglement 8, dealing with the use of pronounceable and artificial code works, was adopted, with the following addition to the second paragraph: "Codes intended for correspondence in conventional language may be submitted to the telegraphic administrations designated to that effect, with a view to permitting the persons concerned to obtain the assurance that the words contained in these codes fulfil the conditions of the present paragraph." To meet the above requirements a special board of control will be appointed, consisting of representatives of England, France, and Germany, to which it will be optional to submit codes for approval. In the course of the discussion in the sub-committee, Mr. Babington Smith (the first British delegate) laid stress on the fact that codes which may not be presented for approval, as well as those which may not be approved, will, nevertheless, remain in force, but each administration shall have the right of accepting or refusing the words which they contain.

Yarmouth.—Mr. A. H. Johnson, chairman of the Electricity Committee, reporting to the Council on the financial working of its undertaking during the past year, said that they had taken £213 more for current sold to private consumers, £85 more for motors, £842 more from the tramways, £268 more on contracts, £81 more on street-lighting, £27 more from meters, and £6 more from rents, the total

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increase in receipts being £1,523. The works costs, owing to their having so good an engineer, came to very little more, the total expenditure being £12,442, against £10,225. The extra expenditure was entirely due to the higher price paid for coal, which cost £2,325 more than last year. Objection was taken to the smoke from the works chimney, and they had to buy a better coal. If the coal had been the same price as in the previous year, they would have shown a handsome profit. This year they paid in interest and sinking fund £6,190, and they were hardly hit, as the money borrowed was for a shorter period than the tramway loans, but it would be sooner paid off. They had borrowed £95,000, and had paid off about £25,000, so that the undertaking now stood to the credit of the Council for £70,000.

Gillingham.—At the last meeting of the Town Council the report from the engineer showed that the equivalent of 220 8-c.p. lamps had been connected with the mains since the last meeting of the committee, making a total of 22,991 equivalent 30-watt lamps with 355 consumers connected, and that applications had been received for the equivalent of 135 30-watt lamps. The committee have had under consideration the question of laying a cable along a portion of Franklin-road, in order to supply new houses with electric current, and the engineer reported that the cost of same would be £25, including the erection of one street lamp. The Council decided that the necessary cable should be laid. The surveyor submitted estimates from the electric light department for electric lighting at the park: wiring and fixing five electric lights on entrance gate piers £35. 5s. 10d.; two electric light standards at the entrance to the ring round the bandstand, £13. 18s.; and two electric light standards opposite the side of the ring, £23. 10s. The Council have decided to ask the electric light department to submit an estimate for arc lamps for lighting the circle round the bandstand, and that the surveyor consult with the electrical engineer with regard to the improvement of the light in Canterbury-street at the park entrances.

Farnham.—At the Urban District Council meeting the clerk reported that his attention had been drawn by the chairman to an advertisement in the local Press giving notice that an application had been made to the Board of Trade by the Farnham and District Electric Supply Co. for consent to the placing of electric lines above ground throughout the urban district (except in Castle-street) for the purpose of the supply of energy under the company's order of 1905. He (the clerk) communicated with the Board of Trade, enclosing copy of the correspondence between the Council and the electric light company, and pointing out that up to the present time the Council were without any acceptance of the condition imposed, and which was precedent to their consent. He invited an assurance from the Board of Trade that the steps taken by them in the matter of their consent to the proposed overhead wires might not operate to the prejudice of the Council. In reply, the Board of Trade wrote that they would be glad to be informed of any decision which might be arrived at by the Council; and with respect to the proposed overhead wires, the Board would defer giving a decision until after the meeting of the Council. The Chairman said they could not do anything further until they had got plans from the electric supply company. The Council approved the correspondence.

Rotherham.—On the 4th inst. Mr. H. R. Hooper held an inquiry relative to an application made by the Borough Council for sanction to the appropriation of a site for a refuse destructor of land forming part of the site of the Corporation electricity generating station in Rawmarsh-road. The evidence given by various officials showed that with regard to the site it met with the approval, amongst others, of Mr. Cross, electrical engineer, who was of opinion that a refuse destructor with water-tube boilers, on land adjoining the electricity works in Rawmarsh-road, was very desirable from the point of view of his department. He estimated the value of the refuse fuel to the electricity department at approximately £1,000 per annum. With respect to the electricity works, Mr. Cross considered it to be extremely urgent that extensions should be made to cope with the additional light for the forthcoming winter. The capacity of the works at the present time was 1,208 kw., and the maximum load last year was 862 kw. for traction and lighting purposes. The number of consumers of electricity for lighting was growing, there were several applications for energy in bulk, and the tramway system was being extended. The committee recommended the installation of a 500-kw. direct-current turbo-generator with condensing plant. There was no opposition raised to the various proposals, and Mr. Hooper at the conclusion of the inquiries visited the sites.

Luton.—The Electric Light and Power Committee reported to the last meeting of the Town Council that the borough accountant had presented the revenue account of the electric lighting undertaking for the year ended March 31, 1908. He reported the gross profit was £5,018. 2s. 7d., being equivalent to 9·4 per cent. of the capital expenditure, and the net profit (after providing for interest and capital charges) £1,263. 4s. 9d., equal to 2·37 per cent. The previous year's figures were 7·99 and 1·97 per cent. respectively. The committee had considered the disposal of the net profit, and resolved that the sum of £630 be handed over to the credit of the general district fund, and the balance appropriated as follows: reserve for capital expenditure, purchase of meters, £233. 4s. 9d.; reserve fund, £400. Also resolved that the question of investing the £400 placed to the reserve fund be referred to the Finance Committee. The electrical engineer reported that since May 1 last 58,168 units had been generated for general supply and 24,414 for traction, an equivalent of 71 8-c.p. lamps and two motors of 12 h.p. connected, making a total of 485 consumers, with 26,473 lamps and 229 motors of 1,415½ h.p.; that the number of units generated for general supply showed an increase of 23 per cent. over the number generated during the corresponding period of last year; and that at the present time applications were in for over 1,400 additional lamps and 270 h.p. motors. It was resolved that the electricity main in Ashburnham-road be extended at an approximate outlay of £116.

Homerton.—After some discussion the City Board of Guardians have decided by a small majority in favour of electricity as the illuminant for their new workhouse and infirmary at Homerton. At the last meeting the architect submitted statistics regarding electricity and gas which he had obtained from the electrical engineer to the borough of Hackney, who would be the electric lighting authority, and the Gaslight and Coke Co. These showed that the comparative total cost would be as follows:

	Electricity.	Gas.
Initial cost	£1,000 0 0	£289 7 9
Annual cost of illumination	150 0 0	283 16 8
Annual cost of maintenance	60 0 0	82 15 0
Total of two last items	£210 0 0	£366 11 8

The total candle-power given for the gas scheme was more than double that of the electricity scheme, but it was pointed out by the architect that the latter had a greater variation in the illuminating power of the lamps, and one 8-c.p. lamp would be used in a position only requiring a small light, whereas in the same position a gas lamp would be using a 60-c.p. illuminant. Mr. G. H. Lile strongly objected to the figures of an official of the Hackney Borough Council, and moved as an amendment to the report that the matter should be referred to committee to obtain the services of an independent expert. Mr. Millar Wilkinson seconded, but the amendment was lost by two votes.

Colchester.—At the last meeting of the Council the engineer reported the following particulars: output of electricity in units during April, 1908—lighting, 64,265, against 63,947 in 1907 and 42,888 in 1906; traction, 38,397, against 37,364 in 1907 and 43,081 in 1906; used in generating station, 20,976, against 13,542 in 1907 and 9,447 in 1906; number of consumers at end of April, 1,328, against 1,122 in 1907 and 904 in 1906; total number of 8-c.p. lamps connected, 47,670, against 43,746 in 1907 and 37,127 in 1906. In his report the engineer set forth a request received by him from the drivers and stokers at the works, asking that arrangements may be made whereby they may be able to get a week's holiday during the summer months. It was resolved that the engineer obtain particulars as to the practice followed in towns similar in size to Colchester. The borough accountant submitted, and the committee had considered, a statement of income and expenditure of the undertaking for the year ended March 31, 1908; also special report of the engineer on the statement of accounts and matters relative thereto. The financial result for 1907 8 was given as follows: interest and redemption on loans, £4,960. 1s. 11d.; gross profit on year's working, £4,938. 5s.; deficiency for the year, £21. 16s. 11d. The Council were recommended to engage the services of Messrs. Lacey, Sillar, and Leigh to prepare a scheme and the supervision of work in connection with the construction of the proposed auxiliary generating station, at a fee of £5 per cent. on the capital expenditure. All the proposals were adopted by the Town Council.

Stafford.—At the last meeting of the Town Council the annual report from the Electric Lighting Committee showed that the total capital expenditure in connection with the electricity department had been £33,063. 5s. 2d., and the loans repaid amount to £9,961. 11s., leaving an amount still owing on loan account of £22,538. 9s. The quantity of current sold for power purposes during the year had been 194,322 units, as compared with 155,509 units in the preceding year, and during the same period 158,556 units were used for private lighting, against 143,225 units last year. The quantity used for public lighting was 8,744 units this year, and 8,587 units last year. The total number of units sold, therefore, was 361,622, as compared with 307,321 units in the year ending March, 1907. There was connected to the mains during the year the equivalent of 2,046 8-c.p. lamps, making the total 22,299, as compared with 20,253 last year. The total revenue from all sources was £4,371. 8s. 6d., compared with £3,971. 4s. 4d., and the expenditure was £1,784. 3s. 10d., as compared with £1,526. 3s. 1d. last year. The gross profit has, therefore, been £2,587. 4s. 8d., as compared with £2,445. 1s. 3d. for the preceding year. Charges against net revenue account amounted to £2,090. 3s. 4d. The committee had decided to ask a contribution from the rates equal to the amount of the loans repaid—namely, £1,148. The committee recommended that, in pursuance of the arrangement as to profit-sharing by the employés, a bonus of £66. 18s. (representing 7½ per cent. on the wages) be paid to the officials and workmen of the electricity department in respect of the past year's working. In moving the adoption of the report, Alderman Wright said the output of electricity for the month showed an increase of 6 per cent. He had on many occasions brought before the Council what he considered, and what the Council considered, excellent reports on the undertaking, and he thought the one presented on that occasion was the best which had ever been placed before the Council and the ratepayers.

Aberdeen.—Operations have been commenced for the installation of the underground telephone system in Aberdeen. When the work in connection with the widening of Union Bridge was in progress the opportunity was taken to lay the necessary ducts for carrying the telephone equipment across the bridge, and the operations begun have regard to the installation of the underground system eastwards and westwards of this point. The work is being carried out by the Postmaster-General, under whose control the whole telephone system in the country will be transferred in 1911, but until that time the arrangement is that the underground undertaking will be leased by him to the National Telephone Co. In the execution of the present work the Postmaster-General has parliamentary powers, but the local authority has sanctioned the beginning of operations in Union-street, on condition that they are completed in three weeks' time. With the approach of the visitors' season, and the increased summer traffic, the Town Council felt that great public inconvenience would be caused by the breaking up of the principal thoroughfare at

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this season, but in order to have the work advanced, an undertaking was given that the disturbance to Union-street would not extend over a period of three weeks. With this in view day and night squads of workmen are employed, and the work is being pushed on as fast as possible. When the system on Union-street has been laid, operations will be proceeded with in other streets, and it is expected the whole area of the city will be covered in six months. Altogether the number of streets and lanes proposed to be opened up is 209, and the length of the route extends to about 21 miles. The work is being carried out under the supervision of a contractor employed by the Postmaster General, and the Corporation's workmen are employed in the restoration of the surface of the streets. When completed the underground telephone system will have many advantages over the present mode of overhead wires. The chief benefit to users and all concerned will be the freedom from dislocation owing to storms. But under the new system overhead wires will not be entirely done away with. At different centres distributing areas from the underground junctions will be established. In the centre of the city standards will be placed on buildings, and from these different areas will be connected, while in the outskirts the poles will be erected on roads, streets, and lanes, and where possible the latter.

TRACTION.

Leith.—The receipts from Leith electric tramways for last week amounted to £527. 2s. 1d., an increase when compared with the corresponding week of last year of £14. 9s.

Baltimore.—Eight persons were killed and twenty injured in a head-on collision between two tramcars in one of the suburbs of Baltimore on Saturday. Several of the injured are not expected to recover. Many of the victims were going to a Naval Academy ball at Annapolis.

Wigan.—The tramways engineer, in a recent report to his committee, states that all the narrow-gauge cars are being overhauled and repainted at the Martland Bridge car-shed. Work has also commenced on the Hurst-Nelson cars at the Pemberton shed. The estimated cost is £1,300.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending June 3, 1908, converted to gold, were £3,699; corresponding period, 1907, £3,981—decrease, £282. Aggregates from Jan. 1, 1908, £83,806; aggregates from Jan. 1, 1907, £83,417—increase, £389.

Blaydon.—At the last Council meeting a resolution was carried to appoint a deputation from the Council to wait upon the Tramways Committee of the Newcastle Corporation with a view to securing an extension of the tramways from Scotswood to Westwood by way of Swalwell, Winlaton Mill, and Rowland's Gill.

Portsmouth. — The Corporation Tramway Committee have again had under consideration the proposed extension of the service from Fratton Bridge along Goldsmith-avenue, but have deferred any further action until the issue of the balance-sheet showing the results of the past year's working. This is expected shortly.

Yarmouth.—The Tramways Committee have reported to the Town Council that on consideration of the yearly financial statement it was resolved to place £1,500 to reserve for renewals, and to carry the balance forward. The takings for the past month were £1,215, a decrease of £17, but last year Whitsuntide receipts came into the May account. The aggregate return from April 1 showed an increase of £46.

Southampton.—The Tramways Committee have considered the question of the extension of the tramways to the Royal Pier by the following scheme: a line down High-street to bottom, and on the Town Quay in a westerly direction to the pier, a double line at the end on the Town Quay opposite the pier, and a passing place at the bottom of High-street. They are recommending the Council to adopt the scheme.

Perth.—Mr. John Lambert, the tramway manager, reports that for the four weeks ended May 26 the total number of passengers carried on the various routes was 127,870, while the receipts amounted to £582. 18s. 5½d., and the miles run 17,640. Compared with the corresponding four weeks of last year, this shows an increase in passengers of 991, a decrease in mileage of 367 miles, and a decrease in drawings of £2. 5s. 4d.

Fraserburgh.—A deputation of business men from Fraserburgh and district has waited upon the directors of the Great North of Scotland Railway at Aberdeen in support of a proposal for the construction of a light railway from Fraserburgh along the northern coast of Aberdeenshire to New Aberdour. It is understood that Sir David Stewart, chairman of directors, indicated that they were favourably disposed towards the proposal.

West Bromwich.—At the last Town Council meeting reference was made by the chairman of the Highway Committee (Councillor Turley) to the tramway undertaking. He mentioned that the profits for the past year were £309. 5s. 7d., and they reasonably expected that the profits would increase yearly as the capital expenditure was being reduced. In 15 years the loan would be paid, and the tramways would then bring in a profit of £2,000 or more a year.

Belfast.—Some trouble has arisen amongst the cleaners at the depôts in consequence of a number of the men being paid off and the remainder having to clean more cars than formerly in consequence of an improved system. The men, it is announced, are working under protest. The proposed change in the tram fares is also unpopular with the public. The retrenchment necessary to make the service pay is not meeting with general approval, it being urged that the tramway is over-staffed by well-paid officials.

Brighton.—Although the Corporation trams ran 43,000 fewer car miles last year than in the preceding 12 months, the bill for electric current was £568 more. Councillor Sone suggested at the last Council meeting that there was something radically wrong. Alderman Carden replied that one of the things wrong was that, a year or two ago, the tramway meter was under-registering; another explanation was that tramways and tramcars are getting older, so that more current is needed to move the cars.

Penge.—It has been announced that as there had been a number of accidents at the corner of Croydon-road owing to the tramways, the Council had corresponded with the tramway company on the matter, and it had been agreed that the tramcars coming from the Penge entrance to the Crystal Palace should slow down just before they came to the corner, which they should take at a very few miles an hour, and the cars coming from Croydon would not stop at the corner, but would go on some distance.

Kirkcaldy.—The gross receipts taken for the year ending May 15 of the Kirkcaldy tramways totalled £14,546, while the miles run amounted to 459,065. The figures for the previous year are: receipts £13,488 and miles run 466,919. Thus an increase is shown in the receipts of £1,058 and a decrease in the car miles of 7,852. From the increased receipts and the lessened mileage, with the corresponding reduction in expenditure, the year's working will approximately turn out to be £1,200 better than the previous year.

Walsall.—The Tramways Committee of the Walsall Town Council recommend that notice be given by the Corporation to the Wolverhampton and District Electric Tramways to determine on Dec. 31 next the agreement between the company and the Corporation, dated Feb. 19, 1906, under which the Corporation run their tramcars over the lines of the company, extending from the Walsall-road Council schools, Willenhall, unless in the meantime a satisfactory arrangement is come to with the company for the continuance of such running.

Ecclesall.—Three motions bearing on the extension of the tramways to Ecclesall will come before the Sheffield City Council at their next meeting. Councillor Bennett will move that the Psalter-lane extension be not proceeded with until the effect of the extension from Rustlings-road to near Ecclesall Church can be ascertained. Councillor Sandford will propose that the extension be not carried at present beyond the point where Psalter-lane joins Ecclesall-road. From Councillor Kelley will come a motion that the paving on the extensions be not with granite and macadam, as agreed by the Council in December last, but with wood.

Airdrie.—At the last meeting of the Town Council the Provost referred to the negotiations and endeavours by Coatbridge Town Council to persuade the Corporation of Glasgow to bring out their tramways to Coatbridge. While Coatbridge was, perhaps, more nearly related to the Glasgow tramways, still it would be of advantage to Airdrie as well, and he suggested that they should move in the matter by sending a memorial to Glasgow Corporation, or a deputation or otherwise, to support this extension. It would be a great advantage to Airdrie to have the two lines connected. The Provost's suggestion was remitted to the Tramways Committee to consider.

Portslade.—On the 10th inst. Lieut.-Colonel Von Donop, R.E., conducted a Board of Trade inquiry into the cause of the recent tram accident on the Brighton and Shoreham tramway at Portslade. The accident occurred near the bottom of Fishersgate-hill, about 7.15 p.m. on Sunday, May 17, as a result of which several passengers sustained painful injuries. The tram, which was driven by John Clark, was descending the incline, proceeding in the direction of Hove, at the time, and the mishap took place where there is a loop line a few yards from the Britannia Flour Mills. The car apparently left the line, and after going a brief period turned over. The inside passengers suffered to the greatest extent. After hearing evidence the inspector closed the inquiry.

Pontypridd.—The report of the engineer to the Pontypridd Electricity and Tramways Committee for the past month shows that the increased revenue is being maintained. The electrical department showed receipts amounting to £543. 6s. 10d., as against £467. 12s. 11d. for the corresponding period. The takings for the cars on the Treforest and Cilfynydd route totalled £769. 7s. 8d., as against £782. 15s. 8d., but the figures on the Trehafod route made up for the deficiency, the increase on this section being practically £200. The receipts for the corresponding period of last year included the Whitsun holidays' traffic. It was estimated that the workmen are taking full advantage of the conveniences afforded them, and last month no less than 63,000 used the cars.

Derby.—At the monthly meeting of the Town Council a report is to be submitted by the Tramways Committee containing recommendations as to the electric tramway fares, the revision of which they have lately had under consideration. The proposed revisions affect the various routes, and the committee propose to introduce a system of 1½d. fares, without, however, interfering with the present 1d. fares except to some slight extent on the Alvaston route. Alvaston will share largely in the new benefits, though the committee's recommendations may not concede all that the representatives of the ward at that end of the town appealed for. It is not intended by the revision to establish ½d. fares, as it is considered that the experience of other towns proves them to be unprofitable.

Hammersmith.—A letter has been received by the Borough Council from Messrs. Hicks, Davis, and Hunt, solicitors, complaining of the source of danger to vehicular traffic in King-street arising from the defective condition of the track of the London United Tramways. The borough surveyor has reported upon the track referred to, and has submitted a detailed schedule of the defective places. The Borough Council have adopted the recommendation of the Works Committee that a notice, accompanied by a copy of the schedule of defective places in the tramway track in King-street, be served upon the London United Tramways, requiring them forthwith to put into good condition and repair the whole of those parts of the

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roads named whereon their tramways are laid and for the maintenance of which they are liable.

Newcastle-on-Tyne.—The annual financial statement in connection with the working of the Newcastle tramways for the 12 months ending March 31, 1908, has been issued by the general manager, Mr. Ernest Hatton, subject to audit. It shows that during the past 12 months the total mileage travelled by the cars exceeded that of the previous year by 148,571 miles, whilst there was an increase of £60. 9s. 11d. in the total traffic receipts. The total working expenses were increased by £3,533. 6s. 7d. on the previous year, or ·32d. on the cost per average car mile. The sum of £19,477. 12s. 4d., equal to 1·06d. per average car mile, has been set aside for reserve and renewals, an increase of £4,621. 11s. 3d. on last year, or ·224d. per average car mile, and the sum of £62,322. 17s. 5l., which has been carried forward to the next balance sheet, is an increase of £18,808. 0s. 4d. on the balance carried forward last year.

Twickenham.—At the last meeting of the District Council the clerk reported as follows in reply to a question by Mr. Cowen as to the authorised speed of tramway cars between Stanley-road and the Green: "On Nov. 10, 1902 the inspector appointed by the Board of Trade with reference to the lengths of tramways along Heath road, Hampton-road, and Stanley-road reported that the speed on those lines should be restricted to eight miles an hour with the following exceptions: (1) along the Hampton-road between South-road and the drinking fountain at the junction of the Hampton-road and the Staines-road, 10 miles an hour; (2) along the Green between the above described drinking fountain and Lion-road, six miles an hour; (3) along Heath-road between Lion-road and Cross Deep, 10 miles an hour; (4) round the curve between Stanley-road and Hampton-road, four miles an hour." Mr. Cowen thanked the clerk for the information and gave notice of motion on the subject.

Wolverhampton.—The report on the accounts of the Wolverhampton Corporation tramways undertaking for the year ended March 31, 1908, which will be presented at the next meeting of the Corporation, shows that, though there has been a profit on the year's working, nothing is to be given in relief of the rates. The total income was £44,431. 13s. 9d., and the working expenses amounted to £26,460. 8s. 4d. The payment in interest on capital was £7,074; repayment of capital, £3,988; income tax on profits, £150; leaving a net balance of £6,762. This sum was disposed of as follows: to renewals fund, £4,416; loss on motor omnibuses, £34; wiping off deficit on previous year's account, £1,292. The balance of net profit, amounting to £392, was carried forward to a general reserve fund, "the first in the history of the undertaking." While the year's income shows an increase of over £500 as compared with that of 1907, the working expenses last year were increased by over £1,500.

Ruralem.—At the last meeting of the Highways Committee a letter was read from the Potteries Electric Traction Co. with reference to the repairing of the tramway track in Waterloo-road, and stating that the refusal of the Town Council to allow more than 100 yards of the track to be taken up at one time would prevent the work being carried out as satisfactorily and expeditiously as the company had desired. Another letter was read from the town clerk of Hanley, enclosing print of a petition against the Potteries and N.S. Tramways (Amendment) Order sealed by the Hanley, Longton, Stoke, Tunstall, and Fenton Councils, and it was recommended that the Town Council support the petition and instruct the town clerk to co-operate with the clerks of the petitioning authorities in the matter. A further letter from the town clerk of Hanley stated that the chairman of the tramway company would be in the district on the 29th inst., and was prepared to meet representatives of the local authorities with reference to the recent increase in tramway fares, was read, and the town clerk stated that he had notified the members of the Tramways Sub-Committee of the appointment.

Lowestoft.—At the last meeting of the Town Council the Tramways Committee reported total receipts from Oct. 1, 1907, to May 30, 1908, £5,219, as compared with £5,111 in the corresponding period of the previous year. The town clerk read a letter from the Lowestoft and Kirkley Ratepayers' Protection Association, urging upon the Town Council the absolute necessity of doubling the present tram fares—that is to say, to make each fare 2d. for the whole or any part of the journey during the height of the summer season, from July 15 to Sept. 15. After a long discussion it was referred to the general manager and the chief clerk to submit figures for the consideration of the committee at its next meeting, when the matter of the increase or otherwise of the fares shall be further discussed. Mr. Orde, in moving, gave the figures of the Whitsuntide traffic compared with the corresponding period of last year, as follows: Saturday, £40. 3s. 10l., against £33. 3s. 9d. in 1907; Sunday, £26. 2s. 1d., against £20. 3s. 8d.; Monday, £76. 6s. 5d., against £62. 0s. 10l.—a total of £142. 12s. 4d. for the three days, against £115. 8s. 3d. The total increase to date on the corresponding period was £170. 15s. 3d., which he thought was very satisfactory. The report was adopted.

Aberdeen.—The accounts of the Aberdeen Corporation tramways have been completed for the past year, and disclose a satisfactory and gratifying state of matters. For the 12 months to May 31 the receipts from 16,632,304 passengers, 33,839 luggage tickets, and 12,938 parcel delivery tickets amounted to £71,078. 15s. 7½d., as compared with £71,778. 14s. 10d. for the corresponding period of the previous year, a decrease of £699. 19s. 2½d. It has to be borne in mind, however, that the Royal visit and the University quarter-centenary celebrations had to be contended with, that week alone accounting for an increase in the receipts of between £1,100 and £1,200. Thus it will be seen that the ordinary traffic of the system has been considerably augmented during the past year. The result is much more gratifying than was expected, but the glorious weather of the last 11 days of May witnessed an unusual increase in the number of passengers carried, and showed an improvement in receipts of £531. 4s. 1d. compared with the nine days of the previous year. It is anticipated that the expenditure all over will show a substantial reduction, as there is a decrease on wages expended on car repairs since Dec. 1 alone of £274, notwithstanding the fact that the mileage run during the year has increased by 36,436. During the year composition tickets of the value of £2,768. 2s. 8d. were issued.

New Cross and Forest Hill.—An enthusiastic meeting of representatives of the four local associations who have been identified with the agitation for the construction of tramways from Lewisham High-road through Brockley to Forest Hill was held at 30, Dartmouth-road, Forest Hill, last week. Mr. J. Arthur Pyne, who was elected to the chair, said the time had come to make a big united effort to persuade the County Council to put the line in hand at once. They were there that afternoon to informally discuss the best method of bringing pressure to bear on the County Council. After discussion it was decided that at any future meetings of the joint committee the representatives of Deptford and Lewisham on the London County Council should be asked to attend; that in any further communication with the County Council the total amount of rateable value which is represented by the various committees should be mentioned; that the Lewisham and Deptford Borough Councils should be asked to receive a joint deputation from the committee to urge them to put pressure on the County Council to get the line included in next year's estimates; and that an open-air demonstration be held at the end of June or beginning of July in favour of the immediate construction of the line. It was arranged to leave the arrangements for this meeting to a sub-committee consisting of three representatives from each association.

Plymouth.—To the Corporation Tramways Committee at their last meeting the borough treasurer presented his annual statement on the working of the tramways for the year ended March 31 last. The income of the undertaking for the year amounted to £32,931. 17s. 10d., as against £32,453. 17s. 10d. in the previous year. Excluding capital charges, the expenditure totalled £24,550. 0s. 11d., compared with £23,049. 10s. in the previous year, leaving a gross profit of £8,381. 16s. 11d., as against £9,404 7s. 10d. in 1906-7. On the net revenue account the gross profit of £8,381. 16s. 11d. was increased by £75 transferred from the district fund towards interest and sinking fund charges, and £1,182. 10s, the amount received from the Plymouth, Stonehouse, and Devonport Tramways Co. on account of the Union-street tramways. These items made a total net revenue of £9,639. 6s. 11d., against £10,661. 17s. 10d. in the previous year. After payment of interest and sinking fund, amounting to £8,866. 12s., there was left a net profit on the year's working of £772. 14s. 11d., compared with £1,352. 11s. 2d. in the previous year. Of the net profit £76. 6s. 7d. was appropriated towards the costs of the Plymouth Corporation Bill of 1903, and the balance of £696. 8s. 4d. was transferred in aid of rates. On capital account during the year new capital was raised to the amount of £644. 8s., which was expended principally on the reconstruction and electrification of the West Hoe section and the purchase of cars. The committee directed the statement to be printed in the minutes for submission to the Council at their next meeting.

Warrington.—At the last Town Council meeting the mayor moved the adoption of the committee's minutes and submitted the financial statement for the year ended March 31. The gross profit on the tramways department was £8,346, and after paying sinking fund and interest charges there was a balance of £2,579—an increase of £1,270 on last year. The working expenses had decreased ½d. per mile, chiefly owing to less consumption of current and reduction of cost of repairs to track. The income from Sankey, Latchford, and Stockton Heath routes had increased, the largest increase being £473 on the Latchford section. The income from the Cemetery and Longford routes had decreased. They had saved something like £300 in adopting a new electric light. The outstanding debt was £88,540 and the reserve fund amounted to £4,110. The gross profits in the electricity department amounted to £7,533, and after paying sinking fund and interest charges there was a balance of £2,213, being £303 less than last year. The income from current for private consumers had increased by £1,345, but the income from the tramway supply had decreased by £310. The working expenses had increased by £1,172, chiefly owing to the increased price of fuel. Out of the profits £2,000 had been handed over to the relief of rates and the balance carried to the reserve fund. The outstanding debt was £83,053 and the reserve fund amounted to £7,165. The department, continued the mayor, was being worked at a cost almost as low as any station in existence. He believed Warrington stood third or fourth in the lowness of working expenses.

Southport.—A report has been prepared relative to the working of the tramways for the year ending March 31, which states that the total capital expended on the lines worked by the Corporation now stands at £118,708, having been increased by £225 during the year, owing to the purchase of top covers for two cars. The outstanding capital, however, only amounts to £95,598, having been reduced by £3,269 during the year, and £23,110 since the opening of the tramways. The traffic receipts, including contracts, etc., have increased from £18,176. 10s. 7d. to £18,652. 13s. 5d., or £476. 2s. 10d. more than last year. The advertising receipts show a decrease of £43. 2s. as compared with the previous year. The total receipts, therefore, amount to £18,916. 2s. 6d. as compared with £18,483. 1s. 8d. for the previous year, or an increase of £433. 0s. 10d., which is very satisfactory, as up to the middle of last September the receipts were not equal to those of the years 1906-7. The working expenses show an increase of £168. 11s. 8d., having advanced from £11,225. 18s. 11d. to £11,394. 10s. 7d., which is due to increase of wages to motormen and conductors, increase of mileage owing to improved service, increase of current consumption owing to the above and to the heavier loads, and one extra day's working owing to Leap Year containing 314 working days as compared with the usual 313. This results in a gross profit of £7,521. 11s. 11d., or £264. 9s. 2d. more

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than for the previous year, which has been disposed of as follows: to interest on capital, £3,835. 2s. 11d.; to sinking fund, £3,269. 5s. 2d., leaving a net balance on the year's working of £417. 3s. 10d., which has been transferred to the profit and loss account.

Exeter.—At the last meeting of the City Council the Tramways Committee reported that the capital expenditure for the year had been £510. 1s. 2d. A surplus beyond working expenses was shown on the year's revenue of £4,984. 11s. 1d. This amount, however, was insufficient by £132. 5s. 5d. to meet the interest and sinking fund charges. The tramway manager (Mr. Bartlett) reported that 388,084 miles had been run, being an increase of 45,939 over the previous year. The number of passengers was 3,754,705, an increase of 99 592, the receipts being £15,420. 17s. 1d. Running expenses were 2·539d. per car mile and the receipts 9·537d. The Alphington-street section had not been so remunerative as was anticipated. The tramway staff numbered 75. Councillor Perry, chairman of the committee, in moving the adoption of the report, said that last summer was by general consent the worst experienced by tramway undertakings throughout the country for many years. But, notwithstanding this, the trams carried 99,000 more passengers than in the previous year. With regard to complaints as to the winter service, people should be moderate in their demands, for the service could not be increased on sound financial lines. The net result was not so satisfactory as in previous years, as they had been unable to put anything to the reserve fund, and the car mileage receipts worked out at 9½d., as against 10½d. the previous year. They had at the present time £2,000 in the reserve and renewals fund invested at 3½ per cent., and in two years' time they would have paid off the cost of the preliminary expenses, releasing £1,000 a year, which he should advocate carrying to the reserve fund. During the three years the tramways had been in existence 10,730,000 passengers had been carried, the total income had been £44,659, they had paid in interest on loans £7,885, and reduced their capital debt by £6,008, besides paying £829 in rates. Therefore, putting aside the question of the great boon to the public which the trams had been, and the great fillip they had given to the city, the financial position was extremely satisfactory.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Madrid.—The Public Works Department invite tenders for the construction of light railways. Tenders by Oct. 31.

Cologne.—Tenders are invited for six electric cranes for the Prussian Government Railways. Tenders by June 25.

Bukarest.—Tenders are invited for the supply of steel bars and steel wire required by the War Office. Tenders by June 13.

Rome.—The Admiralty invite tenders for the supply of electric cables. Estimate, £4,000. Tenders by June 12.

Melbourne.—The City Council invite tenders for the supply and delivery of one 500-kw. motor-generator. Tenders by July 3.

Sofia.—Tenders are invited by the Bulgarian State Railways for electrical apparatus. Estimate, £6,800. Tenders by June 20.

Brussels.—Tenders are invited for supply and erection of coal conveyors at the Laaken electricity works. Tenders by June 19.

Hull.—The Corporation invite tenders for the supply of clothing for the tramway employés. Tenders to the Town Clerk by June 19.

Bukarest.—Tenders are invited for the supply of 800 tons of mineral oil for the Roumanian State Railways. Tenders by June 16.

Bangkok.—Tenders are invited for fishplates, fishbolts, bearing plates, etc., required for the Royal Siamese Railways. Tenders by Oct. 1.

Portsmouth.—The Corporation invite tenders for the supply of coal for the electric lighting station. Tenders to the Town Clerk by June 17.

Madrid.—The Public Works Department invite tenders for the construction of a railway from Betanzos to Feros. Tenders by June 23.

St. Annes.—The Urban District Council invite tenders for laying a feeder cable. Particulars from the Electrical Engineer. Tenders by June 27.

Canterbury.—Tenders are invited for painting the lamp brackets at per 100 and the columns at per 100 for the Electric Lighting Committee.

Brussels.—The Société National des Chemins de Fer Vicinaux invite tenders for overhead equipment for electrical railways. Tenders by June 17.

Chatellerault (N. France).—Tenders are invited for the supply of 2,000 incandescent electric lamps for the National Arms Factory. Tenders by July 6.

Newport (Mon.).—Tenders are invited for the supply of continuous and alternating current prepayment meters. Particulars from the Electrical Engineer.

Brussels.—The Société Nationale des Chemins de Fer Vicinaux invite tenders for the construction of a line from Olloy to Ognies Tenders by June 30.

Sofia.—Tenders are invited for the installation of electricity in mines. Particulars from the Director of Mines and Minerals. Tenders by June 19.

Liege.—Tenders are invited for the installation of an electric lighting system. Particulars from the Secretaire Communal at Amay. Tenders by June 25.

Madrid.—The Public Works Department invite tenders for the laying of tramway track in Madrid. Estimate, 582,670 pesetas. Tenders by June 25.

Glasgow.—The Corporation invite tenders for one or two motor first-aid machines required for the fire department. Tenders to the Town Clerk by June 30.

Paris.—The Municipality invite tenders for two electric motors and two centrifugal pumps. Particulars from the Hotel de Ville de Paris. Tenders by June 18.

Canterbury.—The Town Council invite tenders for the annual supply of coal to the electricity works, Northgate-street. Tenders to the Town Clerk by June 29.

Stanislau.—The Municipality invite tenders for the establishment of an electric tramway system, also for the erection of a generating station. Tenders by Aug. 31.

Dewsbury.—The Corporation invite tenders for the annual supply of coal for the electricity works, Bradford-road, Dewsbury. Tenders to the Town Clerk by June 20.

Blois.—Tenders are invited for the construction and maintenance for 50 years of public tramways. Particulars from the Prefecture de Loir-et-Cher. Tenders by July 15.

London, S.W.—The Metropolitan Asylums Board invite tenders for new hot water storage cylinders, etc., at Tooting Bec Asylum, Tooting, S.W. Tenders by June 23.

Bradford.—The Guardians invite tenders for the installation of an electric lighting main cable at the workhouse, Horton-lane. Tenders to Mr. Crowther, the clerk, by June 12.

Auckland.—The Auckland Harbour Board require tenders for electrical capstans, etc. Particulars from the McArthur Engineering Co., Silk-street, Cripplegate, London, E.C.

Malvern.—The Urban District Council invite tenders for the supply and erection of 50-kw. steam alternator, exciter, etc. Tenders to Mr. Whatley, clerk to the Council, by June 29.

Dundee.—Tenders are invited for the supply of electricity meters for the electricity department. Particulars from Mr. H. Richardson, the general manager. Tenders by June 13.

Adelaide.—Tenders are invited by the Municipal Tramways Trust, Adelaide, for the supply, delivery, and laying of underground electric cables. Tenders to the Chairman by June 23.

Gravesend.—The Electricity Committee invite tenders for the supply and erection of yellow flame arc lamps, columns, etc. Tenders to the Town Clerk by June 27. See advertisement.

London.—The London County Council invite tenders for the manufacture, supply, and delivery of tramway feeder pillars. Particulars from the Clerk of the Council. Tenders by June 23.

Cologne.—The Prussian Government Railways invite tenders for the supply of copper plates for locomotive fireboxes, copper wire, copper tubes, and copper bars. Tenders by June 26.

Hornsey.—The Town Council invite tenders for the annual supply of coal to the electric lighting station, Tottenham-lane, Hornsey. Particulars from the Town Clerk. Tenders by June 15.

South Australia.—The Postmaster-General invites tenders for telephone instruments, telegraph instruments, telephone switchboards, and telephone line material. Tenders by July 1.

Sale of Plant.—Tenders are invited by the Sheffield Corporation Tramways Department for the purchase of lighting plant. Particulars from the General Manager. Tenders by June 19.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Croydon.—The Town Council invite tenders for lighting the swimming bath in Scarbrook-road, Croydon. Particulars from the Borough Engineer. Tenders to the Town Clerk by June 23.

Adelaide.—The Municipal Tramways Trust invite tenders for the supply and erection of motor equipments and car wiring. Tenders to the Chairman, 8, King William-street, Adelaide, by July 7.

Willesden.—The Urban District Council invite tenders for the supply and erection of 300-kw. converting plant. Particulars from Mr. J. G. Bruce, the electrical engineer. Tenders by June 18.

Stepney.—The Electricity Supply Committee invite tenders for the supply of about 12 000 tons of coal for the electricity works. Tenders to the Chairman of the Electricity Supply Committee by June 29.

Manchester.—The Corporation invite tenders for the annual supply of direct-current motors and motor starters, ampere-hour meters and watt-hour meters, and fuse boxes. Tenders by June 30.

Edinburgh.—The Corporation Electric Supply Committee invite tenders for the supply of wrought-iron riveted pipework. Particulars from Mr. F. A. Newington, electrical engineer. Tenders by June 22.

Bristol.—The Electrical Committee invite tenders for the construction of an extra high-tension sub station at Pembroke-road, Shirehampton. Tenders to the City Electrical Engineer by June 19.

Poplar.—Tenders are invited for a new hot-water boiler and works in connection therewith at the Poplar and Stepney District Sick Asylum. Tenders to Mr. W. Foskett, clerk to the Managers, by June 16.

Belfast.—Tenders are invited for the painting of tramway poles and feeder pillars, for the Tramways and Electricity Committee. Particulars from Mr. Bloxam, city electrical engineer. Tenders by June 20.

London, W.—The Great Western Railway Co. invite tenders for the supply of various stores for 12 months from July next. Particulars from Mr. G. Mills, secretary, Paddington Station. Tenders by June 15.

Oldham.—The Electricity Committee invite tenders for the supply of coal for the electricity works. Particulars from Mr. S. Wilmott Newington, Electricity Offices, Oldham, to whom tenders should be sent by June 22.

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Bukarest.—Tenders are invited for the supply of brass bars, brass tubes, and copper, etc., required by the War Office Tenders by June 23.

Ilford.—The Urban District Council invite tenders for the installation of a low-pressure hot-water heating system and ventilation at the library and public hall, Seven Kings, Ilford. Tenders to the Clerk by June 22.

Stepney.—The Electricity Supply Committee invite tenders for the annual supply of arc lamp carbons, ampere-hour meters, demand indicators, and time switches. Tenders to the Town Clerk by June 29. See advertisement.

Trimdon Grange.—The Trimdon Coal Co. invite tenders for a six months' supply of general stores, including oils, grease, etc. Particulars from Mr. J. Penney, Deaf Hill Colliery, Trimdon Grange. Tenders by June 20.

Ilford.—The Urban District Council invite tenders for wiring for electric lighting in connection with the Seven Kings Library and Hall. Particulars from Mr. A. H. Shaw, Electricity Works, Ley-street, Ilford. Tenders by June 23.

West Sussex.—The West Sussex, East Hants, and Chichester General Infirmary Committee invite tenders for the supply and fixing of hot-water heating and supply boilers. Tenders to Mr. A. Marshall, secretary, by June 16.

Gillingham.—Tenders are invited for the supply and delivery of coal for electricity generating station for period ending June 30, 1909. Particulars from the Borough Electrical Engineer. Tenders to the Town Clerk by June 22.

Cornsay.—Tenders are invited for the annual supply of general stores—including wire ropes, steel and metal castings, etc.—for the Cornsay Colliery. Particulars from Messrs. Ferens and Love, Market-place, Durham. Tenders by June 13.

Gravesend.—The Electricity Committee invite tenders for the supply of approximately 2,500 tons of rough small coal required between July 1, 1908, and June 30, 1909, for the electricity works. Tenders to the Town Clerk by June 26.

Spain.—The Direccion General de Obras Publicas invite offers for the construction and working of an electric tramway from La Coruna to Burgo. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by July 31.

Belfast.—The Tramways and Electricity Committee invite tenders for the supply of coal to the electric station, East Bridge-street, Belfast, for 12 months from July 1. Particulars from Mr. Bloxam, city electrical engineer. Tenders by June 20.

Wrexham.—Tenders are invited for the supply and erection of steam-piping and heating apparatus at the Corporation baths, Tuttle-street. Particulars from the Borough Electrical Engineer, Willow-road, Wrexham. Tenders to the Town Clerk by June 16.

London, E.C.—Tenders are invited for the supply and delivery of (*a*) wrought iron, (*b*) steel material, for the Bengal and North-Western Railway Co. Tenders to Mr. Alexander Izat, managing director, 237, Gresham House, Old Broad-street, London, E.C., by June 12.

Edinburgh.—The Edinburgh and Leith Corporations' Gas Commissioners invite tenders for the supply of about 2,000 to 2,500 tons per annum of sulphuric acid over a period of one, two, or three years. Particulars from Mr. Herring, general manager. Tenders by June 29.

Colne.—The Electricity Committee invite tenders for the supply of induction motor-generator and high-tension transformer, high and low tension switchgear, and high-tension, lead-covered paper-insulated cable. Tenders to the Chairman of the Electrical Committee by June 15.

Ealing.—The Town Council invite tenders for the supply of best cylinder oil, crank-chamber oil, paraffin, engine oil, best rope waste, and stoneware pipes required at the electricity works. Tenders to Mr. J. Douglas Knight, the borough electrical engineer and manager, by June 27.

New South Wales.—Tenders are invited for the supply of the following for the Postmaster-General's Department: 69 tons wire (hard-drawn copper, 300lb. per mile), 1 ton tape, binding copper (200lb. per mile), 15,000 insulators (best white porcelain, large). Tenders by Aug. 5.

Melbourne.—The Postmaster-General invites tenders for the erection of wireless telegraphy stations at Cape York, Thursday Island, Goode Island, Port Moresby, and Freemantle. Particulars from the Australian Commonwealth, Victoria-street, Westminster. Tenders by Aug. 26.

Christiania.—The Commercial Intelligence Branch of the Board of Trade are informed by his Majesty's Consul at Christiania that the Kongsberg Small-Arms Works have issued a call for tenders for the supply of a number of steel tubes and plates. Tenders to Kongsberg Vaabenfabrik, Kongsberg, by June 12.

Cleethorpes (Lincs.).—Tenders are invited for the erection of a new wireless telegraphy station at Cleethorpes, consisting of a power-house, torpedo instructor's house, and men's quarters, etc. Tenders to the Director of Works Department, Admiralty, 21, Northumberland-avenue, London, W.C., by June 12.

Spain.—The Public Works Department, Madrid, will shortly invite tenders for the installation of a new submarine telegraph cable from Cadiz to Teneriffe, thence to Gran Canaria, Palma y Gomera, from the latter island to Hierro, from Gran Canaria to Fuerteventura, and from thence to Lanzarote. Estimate, £172,420.

Perth.—The School Board of the burgh of Perth invite tenders for electric light wiring works, bells, etc., in connection with the erection of the new northern district school, Dunkeld-road. Particulars from Mr. Young, 42, Tay-street, Perth. Tenders to Mr. Martin, clerk of the School Board, 44, Tay-street, by June 20.

Adelaide.—The Postmaster-General invites tenders for the supply of telephone and telegraph instruments, switchboards, telephone line material, six tons sulphate of magnesia, one ton sal-ammoniac, crushed, etc. Particulars from the Australian Commonwealth, 72, Victoria-street, Westminster. Tenders by July 1.

Manchester.—Tenders are invited for general builders' work required in erection of an electric car depôt and buildings at Princess-road, Manchester, for the Tramways Committee. Particulars from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders to the Chairman by June 23.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors, 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

Aberaman.—The Powell Duffryn Steam Coal Co invite tenders for the annual supply of stores, including electrical goods, indiarubber and asbestos, girders, channels, and rails, etc. Particulars from the Stores Manager, Aberaman Offices, near Aberdare. Tenders to the Directors of the Powell Duffryn Steam Coal Co., 101, Leadenhall-street, London, E.C., by June 15.

Adelaide.—Tenders are invited by the Municipal Tramways Trust for the supply, delivery, and erection of rotary converters, transformers, boosters, switchboards, and equipment for converter stations Nos. 1 and 2. Particulars from Mr. W. G. Goodman, the electrical engineer, 8, King William-street, Adelaide, S.A. Tenders to the Chairman by July 14.

Camberwell and Lewisham.—The London County Council invite tenders for the roadwork and platelaying required for the construction, on the underground conduit system of electric traction, of the authorised tramways from Dulwich Library (Lordship-lane) to Forest Hill, Camberwell, and Lewisham. Particulars from Mr. Fitzmaurice, chief engineer of the Council. Tenders by June 30.

Antwerp.—The Commercial Intelligence Branch of the Board of Trade have received from the Acting British Consul-General at Antwerp copies of specifications issued by the Antwerp Municipal Authorities in connection with calls for tenders for the supply of 1,600m. of electric cable. A deposit of 2,000fr. (about £80) will be required. Tenders to M. le Bourgmestre de la Ville d'Anvers, Hotel de Ville, Antwerp, by June 18.

Glasgow.—Tenders are invited for the construction of three branch railways for the Young's Paraffin Light and Mineral Oil Co.—viz.: (1) railway from near Addiewell Works to Baads coal mine; (2) railway from near Gavieside to Alderstone shale mine; (3) railway from Hopetoun Works to Niddry shale mine. The permanent-way material will be supplied by the company. Tenders to Mr. John Fyfe, managing director, 7, West George-street, Glasgow, by June 13.

Christiania.—His Majesty's Consul at Christiania reports that the Norwegian State Railways have issued a call for tenders for the supply of 30,400 pairs of carbon points of various dimensions. Tenders are to be marked "Anbud paa Kulspidser," and delivered at Styrelsens Expeditionskontor, Christiania, by June 12. Copies of the conditions and specification may be examined by British makers on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

RESULTS OF TENDERS.

Derby.—The Town Council have accepted the tender of Johnson and Phillips for the supply of bitumen cables for £470.

Canterbury.—The Council have accepted the tender of the Brush Electrical Co. for the supply of an electric fan and accessories for £33.

Swindon.—The tender of Graham Bros. and Co. has been accepted for the supply of coal to the electricity works for the period ended March 31, 1909.

Wallace.—Mr. J. Reid, of Virden, Manitoba, has secured the contract for the construction of telephone lines in the municipality of Wallace for the sum of £2,246.

Worthing.—The Town Council have accepted the tender of the Midland Engineering Company for the supply and erection of condensing plant, etc., at the generating station, for £830.

Croydon.—The tender of Chas. Pullan, Bradford, has been accepted by the Corporation for the installation of electric light in the new buildings in connection with the mental hospital, for £428.

Edmonton (Alberta).—The contract for the supply of material for the 700 meter of long-distance lines to be constructed this year has been secured by the Northern Electric Co., of Montreal and Winnipeg.

Manchester.—The Electricity Committee have accepted the tender of the British Westinghouse Electric Co. for the supply of a 400-kw. transformer, and that of the British Thomson-Houston Co. for a high and low tension switch panel.

Walsall.—The Electricity Committee recommend the acceptance of the tender of Willans and Robinson, of Rugby, for supplying and erecting a condenser with three-throw air pump, Balcké cooling tower, Templar and Rancol separator, and Lasson and Hjort purifier for £2,775.

Paisley.—The following tenders have been received for the supply of coal and oil for the Corporation electricity department: Logan, Sons, and Co., Paisley, coal, 8s. 4d. per ton (accepted); Vacuum Oil Co., Glasgow, oil, 1s. 10d. per gallon; J. M. Middleton, 63A, St. Vincent-street, Glasgow, 2s. 3d.; J. and D. Hamilton, 118, Queen-street, Glasgow, 2s. 1d.

Winnipeg.—The Provincial Telephone Department has accepted the following tenders for supplies: Wire and Cable Co., Montreal, copper wire; F. B. Cook, Chicago, copper sleeves; Canadian General Electric, Montreal, weatherproof iron wire; W. E. Skinner, Limited,

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Winnipeg, steel strand wire; Northern Electric Co., Winnipeg, wood side brackets, insulators, top pins, pole line, hardware; E. Bissel and Sons, Toledo, Ohio, and the Northern Electric Co., cross arms.

Holborn.—The following tenders have been received for the provision of electrical fittings for the new Council offices:

J. W. Singer and Sons (accepted)	£368	17	6
D. Hulett and Co., old brass finish	390	6	0
Ditto, bronze finish	451	15	5
Hart, Son, Peard, and Co.	472	7	6
Galsworthy, Limited	477	8	0
T. Elsley, Limited	542	15	0

Woolwich.—The following tenders have been received for the supply of a motor-alternator:

Vickers, Son, and Maxim	£754	0	0
Bruce Peebles and Co.	775	0	0
Siemens Bros. Dynamo Works	775	5	0
British Thomson-Houston Co.	784	10	0
British Westinghouse Co.	789	15	0
General Electric Co.	790	15	0
T. H. Holmes and Co.	804	0	0
Brush Electrical Engineering Co.	833	10	0
Lancashire Dynamo and Motor Co.	878	10	0
Dick, Kerr, and Co.	924	0	0
Brush Electrical Engineering Co.	995	0	0

Each of these tenders includes a provisional sum of £40 to cover any special expenses which may become necessary during the execution of the contract. The Electricity Committee, reporting on the tenders at the last meeting of the Borough Council, said that the most potent factors in the selection of the machine were those of efficiency and time of delivery, and as it was required for long-hour running generally at the lower loads the higher the efficiency under these conditions the greater would be the saving to the Council.

OPENINGS FOR CONTRACTORS.

ABER—New schools, Ogmore Education Committee.

ABERDEEN—Additions to the science laboratories of the Central School (£700), School Board.

ABERDEEN—Alterations in connection with Balnagask House, Balnagask-road—Messrs. Kelly and Nicol, architects; dwelling-house, west side Bayview-road—Messrs. Sutherland and George, architects; dwelling-house, south side Rubislaw Den North—Mr. George Courts, architect; alterations in connection with dwelling-houses, Great Western-road—Mr. William Beattie, architect; workshops, stores, etc., west side Back Hilton-road—Mr. William Smith, architect; alterations and additions in connection with premises, North-esplanade West, Scottish Co-operative Wholesale Society—Mr. J. Davidson, architect.

ABERTRIDWR—Elementary school, Glamorgan County Council.

ABERTRIDWR—Twenty houses, Old Mill Cottage Club.

ABERYSTWYTH—Library, Council of the National Library of Wales.

ASPULL—Two houses, Hall-lane, Mr. V. Abbott.

ATHLONE—Labourers' dwellings (£17,028), Rural District Council.

AUCKLAND—Four semi-detached villas, Cockton Hill; 14 houses, Oak-terrace, Cockton Hill.

AUCKLAND—Plans for the erection of 27 houses at Auckland park, 12 at Canney-hill, and 26 at Coundon have been passed by the Rural District Council.

AUDENSHAW—Sunday school in connection with the United Methodist Church (£2,000), Trustees.

BACTON—Special subjects centre (£600), East Suffolk County Council.

BALHAM, S.W.—Laundry and mortuary; home for aged Jews, Mr. G. W. Beale; clubhouse, Mr. W. Bartholomew.

BALLYTRASNA—House, Mr. R. Byce.

BALLYWALTER—Additions to Ballywalter House, Mr. W. J. Fennell.

BANBURY—Elementary school, Education Committee.

BANBURY—Extensions of offices, Gatteridge-street, Messrs. G. F. Broggins and Co.; six houses, Gibbs-road, Grimsbury, Mr. J. Perry.

BARNSLEY—Eight houses, Middlesex-street, Mr. J. Baron; three houses, Park-grove, Mr. J. R. Parker; three houses, Cemetery-road, Mr. J. F. Atkinson; 15 houses, Dillington road, Mr H. Hibbert; 21 houses, Pond-street, Mr. J. K. Taylor; two dwelling-houses, Hawthorne-street, Mr. W. Dunk.

BARROW—Steam disinfector buildings, Town Council.

BARWICK-IN-ELMET—Public elementary school, West Riding County Council.

BATLEY—Extensions to girls' grammar school (£4,300), Education Committee.

BATLEY—Alteration of post office into shops, Batley Co-operative Society.

BECKENHAM—Alterations to technical institute, Urban District Council.

BECKENHAM—Extending office accommodation for the inspector of nuisances, Urban District Council.

BELFAST—Offices, workshop, and stores, Messrs. Coates and Son, Fountain-street.

BELFAST—Offices, workshops, and stores, Messrs. Young and Mackenzie; goods shed, Donegall Quay, Belfast Harbour Commissioners.

BELFAST—Alterations, Springfield-road dispensary, Mr. J. W. Robb; alterations at workhouse, Guardians.

BELFAST—Extensions to National Club, Berry-street, Mr. W. J. Moore.

BENTHAM—Dwelling-house, Mr. R. C. Ford.

BENTHAM—Elementary school, West Riding Education Committee

BERE FERRERS—Elementary school, Devon Education Authority.

BERMONDSEY, S.E.—Factory, Tower Bridge-road, Messrs. Barlow and Roberts; rebuilding Yorkshire Grey public-house, Bermondsey-street, Messrs. Courage and Co.

BEXLEY—Nine houses, Rowan-road, Mr. A. Clark; 11 houses, Park View-road, Mr. H. A. Roberts; five houses, Day's-lane, Mr. E. S. Curram.

BIRMINGHAM—Underground convenience, Station-street, City Council.

BISHOP'S STORTFORD—Alterations and additions to workhouse infirmary, Guardians.

BLACKPOOL—Church, Lytham-road, Ecclesiastical Commissioners.

BLAENAU—Elementary school Llandilo Rural District Council.

BOVEY TRACEY—Elementary school, Devon Education Authority.

BRADFORD—Electric lighting main cable at the workhouse, Mr. F. Holland, engineer and architect.

BRADFORD—Electrically lighting town hall extension, City Architect.

BRIDLINGTON—Elementary school to accommodate 500 scholars, Education Committee.

BRIGHTON—Enlargement and improvement of Pelham-street infants' school (£1,300), Education Committee.

BRITON FERRY—Alterations and additions to Neath-road Council school, Glamorgan County Council.

BROOMHILL—Additions to Red Row Club, Mr. G. Reavell.

BRYNNA—Thirty houses near Llanharan, for the Brynna Building Committee.

BURNHAM—Restoration of Ulph Parish Church, Ecclesiastical Commissioners.

BURNHAM — Technical institute (£1,300), County Education Authority.

CAERPHILLY—Sixteen houses, Energlyn Building Club.

CARDIFF—Warehouse, Wood-street, Mr. C. C. Joseph.

CARLOW—Labourers' dwellings, (£92,175), Rural District Council.

CATFORD—Development of Forster Estate, Mr. J. Everington.

CHESILBOURNE—Council school (£798), Education Committee.

CHESTER—Underground conveniences, Northgate-street (£1,449), Bridge-street (£761), Town Council.

CHICHESTER—Secondary school, Sussex and Chichester Joint Education Committee.

CHILTON BUILDINGS—Elementary school to accommodate 700 scholars, Durham County Council.

CHOPWELL—Four shops, Mr. J. McTaggart.

CLEATOR—House, Mr. Wm. Colebank.

CLEETHORPES—Telegraph station, Director, Admiralty Works Department.

CLIFDEN—Labourers' dwellings (£16,938), Rural District Council.

COLCHESTER—Asylum (£11,300), Essex County Council.

COLEFORD—Twelve houses, Tufthorn-road, Coleford Building Club.

COMBE HAY—Elementary school (£1,400), Somerset Education Committee.

CONSETT—Sixteen houses, Medomsley road, Mr. J. Moyle.

COVENTRY—Extension electricity mains to the Horefield Estate (£300), City Council.

CRANBROOK (B.C.)—Hydro-electric power plant, St. Mary's River, Cranbrook Electric Supply Co.

CRICK—Alterations and additions, Church of England school, Crick, Northamptonshire. Mr. J. T. Blackwell, architect.

CROMPTON—New mill, Hawk Mill Co.; four houses, Beal-lane, Mr. W. Nutter.

CROWBOROUGH—Alterations and additions at the Council schools, Cornwall Education Committee.

CROYDON—Lighting swimming-baths in Scarbrook-road, Town Council.

CROYDON—Alterations and additions to the workhouse, Guardians; improvements and additions to the mental hospital, County Council.

CUMBERLAND—Extensions to the institution, Governors of the Cumberland Infirmary.

CWMGWRACH—Dwelling-house, Mr. W. Llewellyn.

DEPTFORD—Premises for National Telephone Co., Messrs. C. P. Roberts and Co

DEVONPORT—Municipal offices (£60,000), Town Council.

DEWSBURY—Enlargement of technical school (£2,000), Dewsbury and District Education Authority.

DINNINGTON—Chapel, Trustees.

DOVER—House at Kingsdown, Mr. A. W. Thompson.

DUBMIRE—Council school to accommodate 360 scholars, Durham County Council.

DUDLEY—Thirty-four new dwelling-houses; additions, St. Edmund's Church, Ecclesiastical Commissioners.

DURHAM—Dwelling-house Auton Stile, Mr. G. Innes; two dwelling-houses and shop, Bowburn, Mr. Robert Bambling; additions to five houses, Shincliffe Colliery, Mr. J. R. Irving; sub-station building near Aden Cottage, Durham, County of Durham Electrical Power Distribution Co.

DYSART—Additional accommodation at the joint isolation hospital, Hospital Committee,

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DROITWICH—Shop and offices, Ombersley-street, Droitwich Salt Co.

EASTBOURNE—Six houses, Prentice-road—Mr. C. Crisford, architect; detached house, Granville-road, Mr. P. D Stonham; additions, Prince of Wales's Inn, Seaside-road—Mr. W. Bussey, architect; house, The Goffs—Mr. P. D. Stonham, architect; seven houses, Green-street, Mr. A. Avard.

EAST HAM—Twenty-three houses, Central Park-road, Messrs. J. and T. Reid; enlargement of 25, High-street North, Mr. F. J. Bowhill; extensions to 3, The Parade, Aldersbrook-road, Mr. F. J. Harding.

EAST SUFFOLK—School to accommodate 100 scholars (£5,000), County Council.

EBBW VALE—Additions to Catholic schools, Rev. J. F. Rose.

EDINBURGH—Offices in George-street (site and building £50,000), United Free Church Assembly.

ELLEL—Two houses, Wham's Farm, Mr. Ingham; alterations to house at Dolphinholme, Messrs Proctor and Sons; additions to house, Mr. Calvert; additions to house at West Bank, Rev. W. H. Towers.

ELLESMERE PORT—Library (£1,250). Plans approved by Council.

ELY—Bottling stores, Messrs. Cruswell's Cardiff Brewery, Limited.

EMSWORTH—Elementary school, Southampton County Council.

EPSOM—Extending electricity mains (£1 500), Council.

EPSOM—Eight houses, Mr. T. Hersey.

ESTEVAN (CANADA)—Extensions to electricity plant (83,000dol.), Municipal Council.

ESTON—Church hall, adjoining the church (£1,400), Ecclesiastical Commissioners.

FARNBOROUGH—Cookery-room at Council school, Kent County Education Committee.

FERMOY—House at Coryn, Mr. W. F. Maye.

FILEY—Masonic temple, Filey Royal Lodge of Freemasons.

FLEETWOOD—Church institute on ground adjoining St. Margaret's Mission Church (£1,000).

FOLESHILL—Children's homes, Coventry Guardians.

FORT STEELE (B.C.)—Power plant, Bull River, Bull River Power and Light Co.

FROME—Extensions, public schools (£3,500), Somerset Education Committee.

FULHAM, W.—Factory buildings, Wyfold-road, Mr. J. A. Keynes.

GARNDIFFAITH—Institute. Plans passed by the Committee.

GLANWYDDEN—Council school, Education Committee.

GLASTONBURY—Offices at the Abbey House. Plans passed by Council.

GORGIE—Slaughter-houses (between £40,000 and £50,000), Edinburgh Corporation.

GRANGEMOUTH—Higher-grade school (£8,000), School Board.

GRAVESEND—Elementary school, Town Council.

GUERNSEY—Country hospital, Mr. T. Robin.

HALIFAX—Seven houses off Queen's-road, Councillor T. S. Dodd; two houses, Hanson-lane, Mr. E. Dyson; 12 houses, Queen's-road, Mr. R. Turner.

HAMILTON (ONT.)—Brewery (250,000dol.), Managers.

HANDSWORTH—School buildings, Rose Hill-road, Governors of King Edward VII. Schools.

HANLEY—Electricity undertaking (£20,643), Town Council.

HARLECH—Elementary school at Las Ynys, County Education Authority.

HAROLD WOOD—Alterations to The Grange, West Ham Borough Council.

HARROW—Eight houses, Dorset-road, Mr. J. H. Perkins; house, Greenford-road, Mr. W. Barnes; two houses, Devonshire-road, Mr. W. H. Watts.

HASLINGDEN—New infirmary and boiler-house, Board of Guardians.

HAYES—Workshop, High-road, Mr. A. Hewens.

HEADINGLEY—Pair villas, Mr. C. H. Frooke.

HELSBY—Parochial hall, Station-road, Churchwardens.

HENDON—Four houses, Radnor-road, Messrs. F. and W. Bettsworth; seven houses, Cunningham Park-road, Mr. D. Jones; six houses, Headstone, Mr. G. M. Kenyon; two houses, Garratt-road, Mr. W. G. Fuller.

HEREFORD—Secondary school, Aylestone Hill, Education Committee.

HEXHAM—Secondary school (£10,000), Northumberland Education Committee.

HORNSEA—Two houses, Clifford-street, Mr. J. O. Pickering.

HOUNSLOW—Music hall on site adjoining King's Arms Hotel.

HUDDERSFIELD—Additions to tramway depot, Council.

HULL—Three houses, Marlborough-avenue, Mr. G. E. Kirkwood; nine houses, Faraday-street, Mr. G. Kennington; 14 houses, Exmouth-street, Mr. J. E. Wray; seven houses, Exmouth-street and New-street, Mr. F. Neal; eight houses, New-street, Messrs. Atkinson and Trotter; 10 houses, Portobello-street, Mr. L. Charles; five houses, Exmouth-street, Mr. J. Franklin; four houses, Wellesley-avenue, Mr. G. Garbutt; 32 houses, Haddon-street, Messrs. Daulton and Stebbings; three almshouses, Southcoates-lane, Trustees, Eleanor Scott's Charity; new premises, Jarratt-street, Hull Brewery Co.; vestry, Marlborough-avenue, Trustees, St. Cuthbert's Church.

HUNTSVILLE (ONT.)—Scheme for electric lighting of the town, Municipal Council.

HYTHE—House, Earlsfield-road, Mr. S. Wise; bakehouse, etc., Chapel-street, Mr. Burch.

ILFORD—Wiring for electric light in connection with the Seven Kings library and hall, Urban District Council.

JARROW—New bakery, Jarrow and Hebburn Co-operative Society.

KEA—Additions to dwelling-house, Higher Lanner, Mr. W. J. Jennings.

KENDAL—Additions to Castle Villa, Mr. S. Shaw.

KENSINGTON, W.—Shops, High-street, Messrs. Ashby Bros.

KINSALE—Labourers' dwellings (£3,176), Rural District Council.

KINGSDOWN—Council school to accommodate 500 scholars, Bristol Education Committee.

KING'S NORTON—Public offices (£2,166), District Council.

KINGSTON ON-THAMES—Constitutional club, Mr. B. Billcliffe.

KNARESBOROUGH—Offices for the Urban District Council.

LANCASTER—Public lavatories, Brook-street, Council.

LANCASTER—Classroom in Main-street, Trustees of Skerton Primitive Methodists; dwelling-house, Railway-street, Mr. R. Baines; two dwelling-houses and shops, Messrs. Crook and Linthwaite; house and shop, Sibsey-street, Mr. Cooper; house, Westbourne-road, Mr. R. Whiteside; alterations and additions to house, Lily-grove, Mr. Whineray; two houses, Newsham-place, Mr. J. Lockhart.

LANCHESTER—House, Langley-park, Mr. T. Haviland; additions to infant school, Durham County Council; two houses, Mr. F. Harrison; alterations at North Farm, Cornsay, for Ushaw College; additions to stationmaster's house at Ebchester, for the North-Eastern Railway Co.; two houses, Villa Real, Mr. J. Walton; additions to schools at Cornsay Colliery; new infant school at Cornsay Colliery.

LANGLEY PARK—Primitive Methodist church, Trustees.

LEE—Elementary school, Manor-lane, London County Council.

LEEDS—Firemen's dwellings (£7,048), Corporation.

LEWES—Enlargement of Burgess Hill elementary school, East Sussex Education Committee.

LEWISHAM, S.E.—Two houses, Baring-road, Mr. A. Durbin; 12 houses, Muirkirk-road, Messrs. Norfolk and Prior.

LEYTON—Additions to Holy Trinity Church, Mr. W. J. Maddison; two vicarages, Messrs. Mattock and Parsons; additional accommodation at town hall (£8,600), Messrs. Newman and Jacques.

LEYTON—Seven houses, Dames-road, Mr. R. M. Banks; five houses, Hainault-road, Mr. R. Grimes; factory, Church-road, Mr. A. W. Hudson.

LINTHORPE—Secondary school (£7,000), Middlesbrough Education Committee.

LIVERPOOL—Electric power sub-station, City Council.

LLANDRINDOD WELLS—Steam laundry, Duffryn-road, for the Steam Laundry Co.

LOANHEAD—Enlargement of public school, Lasswade School Board.

LONGTON—Extensions to Dresden Schools, Education Committee.

LONGUEUIL (QUEBEC)—Market and town hall, Municipal Council.

LOSSIEMOUTH—Laboratory and classroom at Council schools, School Board.

MAIDSTONE—Six houses, Bower Mount-road, Messrs. Clarke and Epps; four houses, Sheals-crescent, Mr. W. T. Burrows; extension of Eiffel Tower Factory, Messrs. G. Foster, Clark, and Co.

MANCHESTER—Restoration of cathedral (£2,000); municipal secondary school (£8,000), Town Council.

MANCHESTER—Additions to education offices, Education Committee.

MANSFIELD—Extensions at Broomhill and Rosemary Schools, Education Committee.

MARCH—High school (£4,000), Board of Education.

MARSDEN—Elementary school, Colne Valley Education Committee.

MASON DINNINGTON—Alterations and additions, elementary school, Northumberland Education Committee.

MEAFORD (ONT.)—Town hall (17,500dol), Municipal Council.

MERRITON (ONT.)—Scheme for electrically lighting the town, Municipal Council.

MERTHYR—Workmen's dwellings (£7,650), Town Council.

MIDDLESBROUGH—Alterations to 17 houses, Linthorp-road.

MILKWALL—Twelve houses, Tufthorn-road, Coleford Building Club.

MONK BRETTON—Two houses, Mount Vernon-road, Mr. G. Frudd; five houses, The Walk, Birdwell, Mr. Sylvester.

MONTREAL—Concert hall and assembly hall at Berthelet-street (20,000dol.); fire station, Chenneville street (15,000dol.), Municipal Council.

MORESBY—Houses at Mill-grove, near Moresby, Mr. Burnyeat.

MORRISTON—Parish hall, Mr. C. S. Thomas.

NELSON—Additions to St. John's Church, Ecclesiastical Commissioners.

NETHER TABLEY—Alterations and improvements at the Council school, near Knutsford, Cheshire County Council Education Committee.

NEWCASTLE—Two villas, Osborne-road; eight houses, St. Margaret's-road; two villas, Holme-avenue, Walker; two villas, Mitchell-avenue; and four semi detached villas, Fern-avenue. Plans passed by Council.

NEWCASTLE—Alterations to premises for a concert hall. Plans passed by Council.

NEW WESTMINSTER (B.C.)—Electrical equipment of railway between New Westminster and Westminster Junction, Canadian Pacific Railway.

NORTHALLERTON—Isolation hospital, Urban District Council.

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NETHERTON — Iron school building to accommodate 180 scholars, Northumberland Education Committee.

OKEHAMPTON—Elementary school, Devon Education Authority.

OKEHAMPTON—Additions to workhouse, Guardians.

OLDHAM—Twenty-five houses. Plans passed by Council.

OMAGH—One hundred and eighty-eight cottages (£33,103), Rural District Council.

OTTAWA (CANADA)—Electrically wiring Frederiton post office and store building, Secretary, Public Works.

PADDINGTON, W.—Business premises, Irongate Wharf-road, Messrs. Forsyth and Maule.

PENCOED—Three houses, Mr. M. Jones.

PENCOED—Elementary school, Glamorgan County Council.

PENCOED—Infants' school, Glamorgan County Council.

PENRIKYBER (WALES)—Three officials' houses, Penrikyber Colliery Co

PERTH—New academy, School Board.

PETERBOROUGH—Elementary school, Midland-road (£700), Education Committee.

PICKERING — Schoolroom in connection with Catholic chapel. Presbytery; houses, Mr. J. Hurst.

PLYMSTOCK—Elementary school, Devon Education Committee.

POCKLINGTON—Alterations and improvements, workhouse, Guardians.

PONTARDAWE—Office accommodation (£1,200), Guardians.

POOLE—House, Breakheart-road, Mr. C. Sims; house, Longfleet-road. Mr J. A Hawkes; house, Carter's-avenue, Mr. T. R. Sanders; house, Spurhill-avenue, Mr. F. W. Burton; house, Penn Hill-avenue, Mr. C. H. Goater; pair houses, Sterte-road, Mr. J. Dudman; two houses, St. Clair-road, Mr. Cosser; house, The Esplanade, Messrs. Hawkes and Mitchell; house, Ravine-road, Mr. V. Wiltshire.

POOLE—Municipal offices (£2,534), Town Council.

POPLAR—Eleven houses, Ridgdale-street, Mr. E. Evans; factory, Messrs. W. Lawrence and Sons.

PORTADOWN—Alteration of signalling apparatus, Great Northern Railway Co. (Ireland).

PORT ARTHUR (ONT.)—Municipal building (150,000dol.), Municipal Council.

PORTSEA—Out-patients' department, Royal Portsmouth and Gosport Hospital.

PUTNEY, S.W.—Sixteen houses, Roehampton-lane, Mr. C. J. Kerven; Baptist Sunday school, Mr. T. H. Smith.

QUAKER'S YARD (WALES)—Twenty houses on the Woodlands Estate, Woodlands Building Club.

RAMSGATE—Elementary schools, Lilian-road, Town Council.

RHYDYGWERN—Improvements at Council school, Glamorgan County Council.

RICHMOND—Alterations at the Vineyard School (£1,600), Education Committee.

RINGSTEAD—Bakehouse, etc., Distributive Co-operative Society.

RIPON—Secondary school (£5,200), Education Committee.

ROCHDALE—Sixty-eight houses (plans passed by Council), two shops, for the Pioneer Society; bleach-house, Messrs. Bright Bros.; additions to works, Messrs. T. Robinson and Son's premises.

ROCHDALE—Police station, Mellor-street (£1,520).

ROME—Scheme for the erection of a municipal electric power station, Municipal Council.

ROTHERHAM — Extensions, electricity undertaking (£3,500), Town Council.

ROWLANDS GILL—Two houses, Highfield, Mr. R. Hodgson.

RYHOPE—Forty-eight houses, Sunderland Rural District Council.

RYTON BARMOOR—Nine houses, Blayton Industrial and Provident Society.

RYTON—Wesleyan church, Clara-vale, Local Trustees.

ST ALBANS—Factory on site adjoining the North Metropolitan Electric Supply Co.'s power station.

ST. ANNES—New town hall, Council.

ST. ANNES—Three villas, Park-road, Mr. W. Crawshaw; two villas, Riley-avenue, Mr. J. Sutcliffe.

ST. NINIANS—Additions to the elementary school at Milton (£700), School Board.

SALOP—Nurses' home in connection with the infirmary (between £6,000 and £8,000).

SCOTTON—Additions to Wesleyan chapel (£400), Trustees.

SELKIRK—Repairs, etc., at the court-room (£80), Council.

SHEEPRIDGE—Three houses, Wiggan-lane, Mr. J. H. Hall.

SHILDON—Workmen's institute and cottages, New Shildon, N.E.R Co.; 19 houses. Plans passed by Council.

SHIREHAMPTON—Electrical sub-station, Bristol Corporation Electricity Committee.

SOMERSET BRIDGE—Elementary school (£2,300), Somerset Education Committee.

SOUTHFIELD—Five houses and stable, Messrs. Woodley Bros; house, Bective-road, Mr. S. Witton; eight houses, Messrs. Mulliner and Sons.

SPENNYMOOR—Higher-grade elementary school (£9,000), Education Sub-Committee.

STAINLAND—Extensions to mill, Messrs. Walsh and Nicholas.

STEPNEY, E.—Building for business premises, Artillery-lane, Mr. W. A. Lewis.

STEPNEY, E.—Lighting portion of White Horse-street, Brook street, and Govel-lane by means of six-ampere flame arc lamps (£540), Borough Council Electricity Committee.

STOKE—Crèche for the accommodation of babies (£140), Guardians.

STOWMARKET—Secondary school (£5,350), East Suffolk County Council.

STREATHAM, S.W.—Twelve houses, Beecmead-avenue, Messrs. Holiday and Stanger; seven houses, Messrs. Elyatt and Porter; 14 houses, Mr. C. Preble.

SUSSEX—School to accommodate 600 scholars on a site near the Dyke-road, in Preston parish, Education Authority.

SWINDON—Wesleyan church and school, Monkton-hill (£2,000), Trustees.

SWINDON—Eleven houses, Plymouth street, Mr. J. George; 34 houses, Grafton-street; 44 ditto, Granby-street; 47 ditto, Grosvenor-street; and 11 ditto, Kent-road—Mr. A. J. Colborne; studio rear of 82, Lansdown-road, Mr. F. Nunney; house, Ashford-road, Mr. J. Bennett

TENTERDEN—Extension of Ashford-road schools, Kent Education Committee.

THACKLEY—School near Buck Wood, Bradford Education Committee.

THOMASTOWN—Thirty houses, Welsh Navigation Building Club.

THRAPSTON—Repairs, workhouse, Guardians.

THURLES—Labourers' dwellings (£15,652), Rural District Council.

TORONTO—Sub station, Toronto Electric Lighting Co.

TORONTO—Deaconesses' home, Avenue-road (100,000dol.), Methodists.

TRANENT—Alterations to Tranent School, School Board.

TUNSTALL—Forty-eight houses, Sunderland Rural District Council

TWICKENHAM—Underground conveniences, York street, District Council.

UNSWORTH—Workmen's dwellings (£12,000), Durham County Council.

UTTOXETER—Workshop, Messrs. Ward and Goldehere; additions, Brookside House, Mr. H. Ford.

VENTERDON—Renovation of Wesleyan Chapel, Trustees.

WALSALL—Additional accommodation at the workhouse (£3,600), Guardians.

WALTHAMSTOW—Parish hall, Shernhall street, Mr. W. A. Lewis; classrooms, Church-hill road, Mr. C. W. Hodgson; four houses, Hillcrest-road Mr. A. Attwel; three houses, Woodstock-road, Messrs. W. Silk and Son.

WANDSWORTH, S.W.—Workshops, Garratt-lane, Mr. J. Warwick.

WARFORD—Special school for epileptic children, Manchester Education Committee.

WASHINGTON — Elementary school to accommodate 360 scholars, Durham County Education Committee.

WATFORD—New theatre and hippodrome.

WELLINGTON QUAY—Alterations and additions, elementary school, Northumberland Education Committee.

WEMBLEY—Four houses, Perivale-lane, Mr. H. Haynes; two houses, Eagle road, Messrs. Damarell and Perkins; four shops, Ealing-road, Mr. Batten.

WEST CAMEL—Chapel, local Primitive Methodists.

WESTON-SUPER-MARE—Primitive Methodist school-chapel, Brighton-road (£5,000), Trustees.

WILFORD—Block of almshouses (£5,000), Mr. Jesse Boot.

WISSETT—Elementary school (£785), Education Committee.

WOLBOROUGH—Elementary school, Devon Education Authority.

WORMHILL—Elementary school (Peak Dale) to accommodate 320 scholars, Derbyshire Education Authority.

WORSBOROUGH—Two houses, Mount Vernon road, Mr. G. Frudd.

WORTHING—Grand hotel. Mr. S. E. Davies, architect.

YORK—School at Harrogate Hill, Darlington Education Committee

PROVISIONAL PATENTS, 1908.

MAY 28.

11608. Improvements in and connected with trolley wheels for electric tramway and like purposes. Vittorio Giovanni Lironi, 18, Southampton-buildings, London.

11610. Improvements in connections for electric batteries. The New Ignition Syndicate, Limited, Francis James Rouse, and Wallace James Lambert Sandy, 24, Southampton-buildings, London.

11633. Improvements in and relating to alternating-current dynamo-electric machines of the commutator type. Allgemeine Elektricitäts-Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, May 29, 1907, being date of application in Germany.) (Complete specification.)

11634. Improvements in and relating to electric distributing systems. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

MAY 29.

11650. New or improved dynamo to give a constant output when driven from a varying speed source. Robert Chalmers Black, 43, Kelvinside-gardens, Glasgow.

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11710. Improved manufacture of a plastic mass from tungsten compounds. Siemens und Halske A.-G., Birkbeck Bank-chambers, Southampton-buildings, London. (Date applied for under Section 91 of the Act, Aug. 3, 1907, being date of application in Germany. Application for patent of addition to No. 16489/07.) (Complete specification.)

MAY 30.

11758. Improved alternating-current electromagnet. David Leonard Lindquist, 7, Southampton-buildings, London. (Complete specification.)

11806. Improved alternating-current electromagnet. David Leonard Lindquist, 7, Southampton-buildings, London. (Complete specification.)

11814. Electro-automatic sounding apparatus. Carlos Fernandez Varela, 245, Abbey-road, Barrow-in-Furness. (Application for patent of addition to No. 5444/08.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on June 18.)

1907.

4713. Transmission of energy by electromagnetic waves. Fessenden.

9397. Manufacture of compositions suitable for electric insulation and for other purposes. De Pont.

12369. Electric arc lamps. Brzeski and Strauss-Collin.

12436. Cross-arms for carrying electric telegraph, telephone, or other wires, or ropes on posts. Sciple.

12443. Regulation or control of electric motors. Raworth and Raworth.

12902. Enclosed electric arc lamps. Quint.

13285. Circuit breakers and the like for the protection of alternating-current induction electric motors. Ellison.

13596. Wireless telegraphy. Jahr.

15012. Magnet or solenoid coils for electrical apparatus. Ross.

15050. Electric fire and burglar alarm, automatic or otherwise, portable or otherwise. Yates.

15878. Electrically-controlled selective switch and a transmitter of current impulses for use therewith. Siemens Bros. and Co. and Grimston.

16092. Alternating-current machines of the commutator type. Allgemeine-Elektricitäts Ges. (Date applied for under International Convention, July 13, 1906.)

17796. Electric sign or display apparatus suitable for advertising and like purposes. Fricker.

18245. Electrically-driven vehicles. Ransford. (Compagnie Parisienne des Voitures Electriques procédés Krieger.)

19891. Automatic safety device for overhead electric lines. Bourdil. (Date applied for under International Convention, Sept. 7, 1906.)

19907. Portable electric vulcanising apparatus. Hay, Couper, and Lindsay.

21535. Electric transformers. Maiche. (Date applied for under International Convention, Dec. 6, 1906.)

23329. Means for causing an electric current of variable direction to flow always in one direction only. Felten und Guilleaume-Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Oct. 22, 1906.)

25123. Electric meters. Arcioni.

25444. Electrical ignition devices for internal-combustion engines. Barreto.

25830. Electric switches. Loebl and the British Ever Ready Electrical Company.

27073. Electrical systems or arrangements for driving machinery subject to variable loads. Siemens-Schuckertwerke-Ges. (Date applied for under International Convention, Dec. 8, 1906.)

1908.

66. Arc lamp electrodes. Little. (Date applied for under International Convention, Jan. 5, 1907.)

665. Material for the purpose of separating or enclosing plates of secondary batteries. Strohmenger.

878. Arrangement on electricity meters for determining the maximum consumption. Siemens Bros. Dynamo Works. (Elektrizitäts-Akt.-Ges. vorm. Schuckert und Co.)

1615. Electrical apparatus for reproducing at a distance pictures or designs produced in slight relief. Belin. (Date applied for under International Convention, Jan. 24, 1907.)

4112. Section insulating arrangements for conductors used in the overhead construction of electric railways or tramways. Siemens Bros. Dynamo Works, Limited. (Siemens Schuckertwerke-Ges.)

4432. Single-phase commutator motors. Maschinenfabrik Oerlikon. (Date applied for under International Convention, March 9, 1907. Application for patent of addition to No. 28968/04.)

4464. Manufacture of coils of large sections for electromagnetic apparatus. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

7219. Electrically-controlled apparatus for seeing at a distance. Adamian.

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid. £		Last price. £
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	½-⅝
—— Ord., 1,125,000	1	..	⅛-¼
Aron Electricity Meter, 6 p.c Cum. Pref. Shares, 1-125,000	1	..	23/32-27/32
—— Ordinary, Nos. 1 125,000	1	..	3/16-5/16
British Aluminium Co., Ordinary, 2 001 40 000	5	..	3-3½
—— 7 per cent. Cum. Pref., 1-40 000	5	..	1-4½
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4½-5½
—— 4 per cent. Funding Certificates, 1-20 000	5	..	3½-4½
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	104-108
—— 5½ per cent. Loch Leven Deb. (Reg.). Red., 1-3 000	100	..	95 98
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5½-6½
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5½-6½
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	93 98
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275,001-475,000	5	..	7/16-11/16
—— 4 per cent. Mortgage Debenture Stock	100	..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	3/16-7/16
—— 4½ per cent. 1st Debenture Stock	100	..	70-75
—— 4½ per cent. 2nd Debenture Stock	100	..	55-60
Callender's Cable, Debentures	100	..	107-109
—— Ordinary	5	..	9⅜-10⅜
—— 5 per cent. Pref.	5	..	5½-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	¾-¼
Crompton and Co.	5	..	1½-1⅝
—— 5 per cent. Debentures	—	..	92-96
Dick, Kerr, and Co., Ordinary, 1 260 000	1	..	1 1/16-1 5/16
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99,261	5	..	⅛-¼
—— "A" Shares, 01-017,139	5	..	1½-2½
—— 5 per cent. Debentures	100	..	85-87
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112,100	2	..	¼-⅜
—— 7 per cent. Cumulative Pref.	2	..	1½-1⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	64-68
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	75-80
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅞-8½
—— 4 per cent. 1st Mort. Deb. Stock	100	..	87-90
W. T. Henley's Telegraph Works, Ordinary	5	..	10½-11½
—— 4½ per cent. Preference	5	..	5-5½
—— 4½ per cent. Debentures	100	..	104-106 xd
India Rubber, Gutta Percha, and Telegraph Works	10	..	15½-16½
—— 4 per cent. Debentures	100	..	98-100
National Electric Construction Co., 1-170,000	1	..	⅜-½
Parker, Thos., Limited, Ordinary	10	..	10-10½
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	29½-31½
—— 4 per cent. Bonds	100	..	101½-103½
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	7½-8½

Electric Lighting and Supply.—

Name.	Amount paid. £		Last price. £
Adelaide Electric Supply Co., 6 p c. Cum. Pref., 1-10,000	5	..	4⅝-5½
Bournemouth and Poole, Ordinary	10	..	10½-11
—— 4½ per cent. Cum. Pref., 7,501-15 000	10	..	9½-10⅜
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10½-11
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105
Bromley (Kent) Electric Light and Power Co	5	..	4½-5
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	94-97
Brompton and Kensington, Ordinary	5	..	6½-7½
—— 7 per cent. Preference	5	..	6½-7½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5	..	5½-6½ xd
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	86-90
—— 7 per cent. Cum. Pref. Stock	$100	..	108½-110½
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98-101 xd
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5	..	3½-4
—— 4½ per cent. Cum. Pref., 1-80,000	5	..	4⅛-4⅝
—— 4 per cent. Debenture Stock, Red.	100	..	96-99
—— "City Undertaking," 4½ p c Cum. Pref., 1-40,000	5	..	3½-4½
—— ditto (1905) 40,001-80,000	5	..	4⅛-4⅝
	5	..	3-3⅜
Chelsea Electricity Supply	100	..	101-104
—— 4½ per cent. Debentures			
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 4½ per cent. Debenture Stock	100	..	124-127
—— 4½ per cent. 2nd Deb. Stk., Red.	100	..	102-105
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	2½-3
—— 5 per cent. Preference, 1-50,000	5	..	3½-4½
County of London Elec. Supply, Ordinary	10	..	7⅛-8⅛
—— 6 per cent. Cum Pref.	10	..	10⅛-1 ⅛
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	107-110
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	98-.01
Edmundson's Electricity Corporation, Ordinary, 1-80,000	5	..	0-¼
—— 6 per cent. Cum Pref.	5	..	⅛-1
—— 4½ per cent. First Mort. Deb	100	..	6:-73
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	85-88 p.c.
Electric Lt. & Traction Co. of Aust., 6 p c. Cm. Pf., 1-30,000	5	..	2½-2⅝
—— 5 per cent. Debenture Stock, Red.	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	90-93
Folkestone Electric Supply, Ord., Nos 1-10 000	5	..	4⅜-5½
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	..	5-5½
—— 4½ per cent. First Deb Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-13,000	5	..	6-6½
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100	..	95-98
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100	..	90-93
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	⅜-½
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	..	7-8
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	97-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3	⅜-1⅜
—— 6 per cent. Pref.	5	4⅛-4⅜
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	90-93
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	85-90
Metropolitan Ordinary, 100,001-200,000	5	4⅛-5
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4⅛ 5
—— 3½ per cent. Mortgage Debenture, Red.	100	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-5,000 ($500), M 1-4,400 ($1,000	—	82-84 p.c.
Mexican Light and Power Co., Capital Stock	$100	56½-58½
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	86½-88½
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	5½-6
—— do., 57,010-87,500	5	5½-6
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	5½-6
—— 5 per cent., Pref., 1-57,009	5	5.-5½
Notting Hill Electric Lighting	10	11½-12½
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	95-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5⅜-6½
—— 4 per cent. Debenture Stock	100	94-98
River Plate Electricity Co., Ord., 1-119 687 & 120,501-120 507	1	27/32-31/32
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	⅞-1
—— 5 per cent. Debenture Stock, Red.	100	96-99
Rosario Electric Co., 5 per cent. Cum. Pref., 1-20 000	5	4⅝-5¼
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅛-5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	⅛-⅜
—— 4 per cent. Debenture Stock	100	70-74
South London, Ordinary	4	2⅛-2⅜
South Metropolitan Electric Light and Power, Ord.	1	⅜-⅝
—— 7 per cent. Cum Pref.	1	1 1/16-1 5/16
—— 4½ per cent. 1st Mort. Deb.	100	99 102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7⅛-8¼
—— 7 per cent. Pref.	5	6⅛-7⅛
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1-2
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅜-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	87-90
Westminster, Ordinary	5	7⅛-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅞-5⅛

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum. Pref., 1-250,007	5	6⅛-6½
—— 10 per cent. Non-Cum. 2nd Pref., 250,008-280,007	5	8 5/16-8 9/16
—— Permanent 6 per cent. Debenture Stock, 1888	100	140-145
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	104-107
Barcelona Tramways, Ord., 1-20 000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent. Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	⅜-⅝
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	⅜-⅝
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk., Red.	100	95-96
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	10⅛-10⅜
—— 4½ per cent. Deb. Stock, Red.	100	93½-96½
Brisbane Tramway Invest., Ord., 1-75,000	5	4⅛-4⅜
—— 5 per cent. Cum. Pref., Nos. 1-76,000	5	4 13/16 5 1/16
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	98-102
British Columbia Electric Railway Co., Ord Def.	100	127-131
—— Ord. Pref.	100	108-112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	107-111
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	99-102
—— 4½ per cent. Vancouver Power Deb.	100	101-104
British Electric Traction, Ord. 1-300 000 & 60,001-90,000	10	1⅛-1⅜
—— 6 per cent. Cm. Pf., 30,0001-60 000	10	3⅛ 3⅜
—— 5 per cent. Perpetual Debenture Stock	100	91-96
—— 4½ per cent. 2nd Deb. Stock	100	73-77
Bueno Ayres and Belgrano Trams	5	4⅜-4⅞
—— "A" 6 per cent. Cm. Pf., 1-4 ,000	5	4⅝-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅝ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	96-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	100-104
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	99-103
Buenos Ayres Lacrcze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	92-95
Calcutta Tramways, Ord., Nos. 1-137,610	5	5⅝-6⅜
—— 5 per cent. Cum. Pref., Nos. 1 20,000	5	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	103-106
Cape Electric Tramways, Nos. 1-480,000	1	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4⅛-4⅜ xd
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	97-100
City of Buenos Ayres Trams. Co. (1-04), 1-248,000	5	5⅛-5⅜
—— 4 per cent. Deb. Stock, Red. 1985	100	98-102
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	88-91 xd
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12½-13½
—— 6 per cent. Pref., Nos. within 1-60,000	10	12½-13½
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	94-97
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	80-85
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	⅛-⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	87-91
—— 6 per cent. "B" Deb. Stock	100	71-75
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296,500 2nd Mort. Deb. Stock	—	—
—— £83,350 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-425,553	1	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	90-95
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7-8
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	81-86
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	96-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5	4⅛-5
—— 1½ per cent. 1st Mort. Deb. Stock, Red.	100	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	11/16-13/16
—— ½ per cent. Deb. Stock, Red.	100	94-97
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	88½-89½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort. Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	⅛-⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1	⅛-⅜
—— per cent. Cum. Pref., 300,001-545 000	1	⅛-⅜
—— per cent. Debenture Stock	100	91-94
Provincial Tramways Co., Ordinary, 1-24,912	10	4⅜-5⅛
—— per cent. Cum. Pref., 1-10,000	10	9⅛-10⅛
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5	5⅛-5⅜
—— 4½ per cent. 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	129-134
—— 5 per cent. 1st Mort. Deb., Red. 1929, 1-12,000	$500	95½-97½ p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-1
—— 4 per cent. Deb. Stock, Red. 1940	100	77-81
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1,600	100	73-78
Yorkshire (West Riding) Elec Tram. Co., Ord., 70 001-110,000	5	⅜-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	3⅛-3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100	81-84
—— 4 per cent. Pref.	100	90-92
—— " " deferred	100	64-67
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	102-105
City and South London, Consolidated Ordinary	100	40-42
—— 4 per cent Debenture Stock	100	100-103
—— 5 per cent. Pref. Stock '91	100	113-116
—— " " " '96	100	112-115
—— " " " '01	100	110-113
—— " " " '05	100	105-108
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3⅛-4⅛
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent Profit-Sharing Secured Notes	—	39-43
—— Deposit Receipts	—	39-43

Telegraphs and Telephones.—

Name.	Amount paid.	Last price
	£	£
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	83-91
Anglo-American Telegraph Co., Ordinary	100	59-62
—— 6 per cent. Preferred Ordinary	100	103-105
—— Deferred Ordinary	100	15⅜-17⅛
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44,000	5	7-7½
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	86-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	7⅛-8¼ xd
—— 10 per cent. Preference, 1-6,000	10	15⅜-16⅜ xd
Direct Spanish Telegraph Co., Ordinary	5	3-3⅛
—— 10 per cent. Cum. Preference	5	8-9
—— 4½ per cent. Debs., 1-600	50	100-103
Direct United States Cable Co.	20	13½-14
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100-102
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	99-101
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	100⅛-102⅛
Eastern Extension, Australasia and China, 1-300,000	10	12⅜-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100	100⅛-102⅛
Eastern Telegraph Co., Ordinary Stock	100	130-135
—— 3½ per cent. Preference Stock	100	83⅛-86⅛
—— 4 per cent. Mortgage Debenture Stock	100	100⅛-102⅛
Great Northern Telegraph Co. (of Copenhagen)	10	29-29
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100	100-102
Indo-European Telegraph Co.	25	52-55
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1	⅛-⅜
Monte Video Telephone Co., Ordinary, 1-72,680	1	29/32-1 1/32
—— 5 per cent. Preference, 1-86,492	1	15/16-15/16
National Telephone, Preferred	100	108-110
—— Deferred Stock	100	111-113
—— 6 per cent. Cum. First Pref.	10	10⅛-12⅛
—— 6 per cent. Cum. Second Pref.	10	10⅛-12⅛
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	9 ⅛-100⅛
—— 4 per cent. Deb. Stock, Red.	100	102-104
Oriental Telephone and Electric Company	1	1 5/16-1 7/16
—— 6 per cent. Cum. Pref.	1	1⅛-1⅛
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	99-102
United River Plate Tele. Co., Ordinary, 1-100,000	5	6⅜-6⅞
—— 5 per cent. Cum. Pref., 1-40,000	5	5-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	100⅛-102⅛
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10⅛
West Coast of America, 1-30,000 and 53,001-53,008	2½	1⅜-1⅝
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	99-102
West India and Panama Telegraph Co., Ordinary	10	19/32-28/32
—— 6 per cent. Cum. 1st Preference	10	8⅛-9
—— 6 per cent. Cum. 2nd Preference	10	9⅛-10⅛
—— 5 per cent. Debs., Red., 1-800	100	101-104
Western Telegraph Co., 1-207,930	10	13⅜-13⅞
—— 4 per cent. Debenture Stock, Red.	100	100⅛-102⅛

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	June 3	1,442	1,376	+ 66	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·34
Ayr Corporation	,, 6	295	282	+ 12	—	8	8	,, 15	15,283	3,603,789	378,884	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	May 30	2,940	2,415	+ 525	+15,329	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	June 7	1,174	1,045	+ 129	+ 513	23·53	25·53	March 31	55,408	11,686,691	1,324,743	—	—	—	5·1
Birmingham Corporation	May 30	6,394	5,754	+ 640	—	56½	56½	,, 31	18,557	5,352,098	215,345	·87	16·2	9,228	—
Blackburn Corporation	,, 20	1,123	1,349	− 225	+ 97	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12 64	2,309	8·02
Blackpool Corporation	June 4	664	710	- 46	− 1,532	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	,, 7	2,375	2,327	+ 48	+ 719	42	42	March 31	111 294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 3	1,499	1,497	+ 2	− 1,204	29¼	24¾	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	May 30	4,830	4 250	+ 580	+ 2,022	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10·79	2,421	—
Brighton Corporation	June 7	9.6	837	+ 99	− 251	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 5	5 291	4,952	+ 342	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 6	1,235	1,173	+ 62	—	19¾	19¾	,, 31	62,699	11,967,488	1,205,83	1·31	12·48	5,825	8·21
Burton Corporation	,, 7	303	295	+ 7	—	9⅞	8½	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	June 6	192	170	+ 22	+ 16	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 6	6,656	5,791	+ 765	+ 101	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62 29a	55,357	5·22a
Charing X, Euston, & Hamp. Ry.	May 30	3,345	—	—	—	7¾	6¼	—	—	—	—	—	—	—	—
City and South London Railway	June 7	3,148	3 102	+ 46	+ 6,171	9	6¼	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	May 6	181	195	− 14	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	June 4	531	481	+ 50	- 409	15½	15½	Dec 31	25,032	5,966,364	891,998	—	6·74	—	4·78
Croydon Corporation	May 29	1,522	-	—	—	12 c	12 c	March 31	62,065	13,514,9 8	1,502,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 29	2·7	257	—	—	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	,, 30	328	207	+ 121	— 204	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	June 5	134	112	+ 22	+ 82h	6¾	6¾	—	—	—	—	—	—	—	—
Dublin U.T.	,, 5	5,839	5,723	+ 116	− 1,794	54¼	48¾	—	—	—	—	—	—	—	—
Dundee City Tramways	April 5	1,144	1 195	- 51	—	22	22	May 15	57.672	15 554,905	1,162 792	·878	1·9	4,352	7·3
East Ham Corporation	June 6	893	883	+ 10	- 619	14	14	March 31	47,140	15,049,240	1,062,151	·74	0 49	3,636	7·14
Glasgow Corporation	,, 6	18,687	17,2 0	+ 1,467	- 4,399h	177½	169	May 31	387,381	224,063,088	20,350,367	95	0·47	5,035	5·21
Gloucester Corporation	,, 3	291	249	+ 42	—	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	May 30	5.500	4,500	+1 300	+24,001	9¼	9	—	—	—	—	—	—	—	—
Halifax Corporation	,, 5	1,490	1,515	− 25	—	52·574	37	,, 31	77,996	18,899,242	1,624,275	—	1·52	—	8·65
Huddersfield Corporation	,, 30	1,587	1,439	+ 148	- 146	35½	35	,, 31	81,196	15,252,150	1.804,745	1·22	0·79	2,770	5 9d
Hull Corporation	June 6	2,473	2,371	+ 102	- 178	26	26	,, 31	121,186	29,151,543	2,956,406	1	·984	—	—
Ilford Corporation	May 2	410	449	- 39	—	10½	10½	,, 31	26,499	6,586,754	615,117	89	9 58	2,225	6·5
Ilkeston Corporation	June 3	148	131	+ 17	+ 2	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	May 6	249	256	- 7	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7 55	1,73	4 95
Lancashire United Tramways	June 3	1,421	1,104	+ 317	+ 1,036	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	May 30	6,747	5,940	+ 807	- 28	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	0·69	3,352	5 58
Leicester Corporation	,, 30	2,297	2,118	+ 59	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 30	11,169	11,064	+ 105	- 2,594	104	104	Dec. 31	563,793	122,094,528	12,115,934	1 108	1 17	5,421	7·75
Liverpool Overhead Railway	,, 31	1,452	1,480	- 28	- 778h	9·25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 23	35,478	33,716	+1 762	+ 20 240	98	98	March 31	1378,014	314,227,090	30,130 297	1·05	10 98	—	8·56
Lowestoft Corporation	,, 23	174	219	- 45	—	3½	—	Sept. 30	11,009	2,622,922	343,190	1 03	7 9	2,156	6 39
Maidstone Corporation	,, 28	189	78	+ 111	—	3¼	2	March 31	5,913	1.186,566	157,050	1·14	8 6	2.956	6·2
Manchester Corporation	,, 23	15,519	17,869	- 2,320	+ 4,837	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	,, 30	9,703	8 289	+ 1,014	+ 21.285	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	June 7	16,111	15 9 8	+ 203	+ 2,757	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 6	154	132	+ 22	- 117	2⅜	2⅜	March 31	7,309	2,035,300	203,203	86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	May 20	3,683	3,905	− 222	− 3,658	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 30	655	659	- 4	- 213	14½	14½	,, 31	32,421	7,760,403	772 753	1 03	10 01	1,525	6·87
Oldham Corporation	,, 3	1,894	1,871	+ 23	- 321	35¾	35¾	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·239
Portsmouth Corporation	,, 30	1,912	1 847	+ 65	—	28½	28½	,, 31	98,911	20.668.825	2,.99,823	1·15	10 79	—	—
Reading Corporation	—	—	—	—	—	13½	13½	,, 31	32,661	8,130 179	918,825	96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	June 1	4,951	4,304	+ 647	- 1,539	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	
Sheffield Corporation	May 31	5,314	5,247	+ 567	- 1,186	65½	65¾	March 25	276,907	73,966,299	6,804,656	898	9 767	4,174	
Southampton Corporation	,, 6	1,079	932	+ 147	+ 202	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	June 3	401	335	+ 66	- 9	9	9	,, 31	20,076	4,431,728	390,578	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248 656	—	9 464	—	4·849
Sunderland Corporation	May 31	1,196	1,3 2	- 116	- 2,414	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	June 4	289	89	+ 200	—	5 16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 6	937	807	+ 130	+ 209	12 68	12·43	‡ ,, 31	42,810	8,312,592	850,906	1·23	11·53	3,376	—
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965.296	429.785	—	10·724	1,989	6·95
West Ham Corporation	May 28	2,200	2,274	- 74	— 2,051	14·7	14 7	,, 31	122,881	35,502,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	June 3	852	801	+ 51	- 506	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·095

* 1905-6 figures. ‡ 1907-8 figures. † And 86 miles of interlacing track. c Train mile. e Miles of route. h Half-year's figures

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THE NEED FOR CONCERTED ACTION.

The disorganised state of the British electrical manufacturing industry is never so apparent as when it is viewed in direct comparison with the well-regulated conditions under which the same industry thrives in other lands. In the United States, in Germany, and in countries where electrical manufacturing is carried on in a somewhat less degree, the growth of this industry continues in a most satisfactory manner, and, what is of greater importance, with good financial results to the companies engaged therein. It is frequently asked why the land in which the electrical industry may be said to have had its birth should be so far outdistanced by other countries in respect of the technical and particularly of the commercial development of that industry; why expansion should be arrested, and why the financial results should be so exceedingly disappointing? A great deal of ingenuity has been expended by manufacturers and by writers in their endeavour to find a means for improving the state into which the electrical industry has languished, but the disappointment of their hopes has filled them with a degree of pessimism that has, as a matter of fact, unduly narrowed the range of their perspective, and blinded them to certain factors which are very material to the situation, so that a solution of the difficulty seems as hopeless as the discovery of the much sought for philosopher's stone. It is a common thing when discussing this question to draw a dolorous category of the influences which so distress the electrical manufacturing industry, then stop short. And the worst feature of the situation is that while manufacturers and directors of companies fully realise one or other of these external influences, they do not, or will not, see that they have in their own hands a prophylactic that will most effectively allay the distress at present prevailing in their industry if only they will use it. But instead of concentrating their forces, they remain a disunited and disjointed body, each member of which has to struggle (ineffectively, as it is now plainly evident) against overwhelming forces. One section cries out for an alteration of the country's fiscal system as the only possible way of salvation; another section points to the present restricted market for electrical plant, and to unfavourable financial conditions; while the need for a thorough, co-ordinated system of technical education and the encouragement of original research are among the requirements insisted upon. The importance of these factors cannot be over-estimated. But, at the same time, we think it should be pointed out that while tariff reform must undoubtedly bring a certain amount of benefit to the electrical industry, the extent of such benefit will be dependent on our ability to obtain cheap and adequate supplies of raw material, our present sources of which are in foreign countries. The demand of tariff reform by the electrical industry is clearly for protective purposes, and if ever the country sanctions a departure from its present fiscal system, it is unlikely that the manufacturer of articles which to the electrical manufacturer are essentially raw materials will be denied that means of protection for which he also calls, and to which, we must in all fairness admit, he has as much right as the electrical manufacturer. It will be seen, therefore, that great care must be taken in handling a double-edged weapon like tariff reform, which might make it very unpleasant for the user. Then as to exploiting new markets. It should not be forgotten that these would be just as accessible to our foreign competitors as to ourselves, and that the superior organisation of our rivals would give them an advantage which we do not enjoy.

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The need for concerted action among British electrical firms, in order to do away with much of the unnecessary competition that compels them to accept work at unremunerative prices, and to safeguard them against unfair specifications which consulting engineers or resident engineers are apt to foist upon them at times, was never so much in evidence as it is to-day; and without suggesting that some form of understanding is the sole panacea, we do most tenaciously believe that it is the only immediate step that will save the electrical industry from stagnation and many firms from insolvency. The Engineering Employers' Federation has been instrumental in stemming the growing power of the trade unions and in resisting the extravagant demands of organised workpeople. In Germany electrical manufacturers have combined for the purpose of regulating the sale of their manufactures, which has been done without abrogating the liberty of individual firms. Surely the directors of English companies can make an attempt to follow this sound, businesslike, and highly profitable course It only requires them to drop their short-sighted and self-destructive suspicion of one another, and to meet and consider some such arrangement as, we are sure, will guide the electrical industry through the depression which now hems it, in into better organised and more lucrative paths.

ANOTHER OBJECT LESSON.

A recent visit to Blackpool during the meeting of Municipal Engineers enabled us to renew acquaintance with the Blackpool electricity generating station, and to see and hear at first hand the improvements introduced and carried out by Mr. Furness during his reign of office. So to speak, we have been somewhat closely acquainted with the Blackpool station during three reigns—those of Mr. Hesketh, of Mr. Quin, and now of Mr. Furness. The object lesson to which we refer is, that the evolution of an electricity station is continuous and harmonises with the progress made in the industry. The position of a consulting engineer during the early years of an industry is an exceedingly difficult one. No one understands what the future may bring forth. The industry may dry up. On the other hand, it may rapidly expand, and in the expansion all matters of practice will probably be continually changing. Blackpool shows conclusively how under intelligent management a station designed at an early period may be always kept up to date. In our issue of Oct. 20, 1893—nearly fifteen years ago—is a description of the station as opened, and at the time we commented upon the necessity to look ahead—that the minimising of initial expenditure was not always economy. In our issue of April 26 last year we gave a curve showing the result of the improvements introduced by Mr. Furness. From figures given at that time it will be seen that no less than 15·1lb. of coal were required per unit generated. In 1907 this consumption was reduced to 5·65lb. of coal per unit generated—that is, the coal bill per unit generated was reduced very nearly to one-third of what it was originally. Another way of emphasising the improvements carried out is to say that in 1894 *four* units were sold per £1 of capital expended, that capital amounting to £26,000, while in 1907 *fifteen and a quarter* units were sold per £1 of capital expended, the capital then reaching to £189,778. Up to the year 1902 the net balance was sometimes on the one side and sometimes on the other, although the profits came out about £4,300 in excess of the loss. Since 1902 the net profit has been continuous, rising from £58 in 1902 to £8,229 in 1907. Practically the great advance is due entirely to the advice of Mr. Furness, who is strongly in favour of a turbine plant and condensing. Part of the reciprocating plant has been replaced by turbine plant, and condensing is the word throughout; hence, when inspecting the boiler-house, it is found that several boilers are idle. That this is so would be understood from the great diminution in the coal consumption. The improvements have been met out of revenue and reserve, though much of the plant could legitimately have been charged to capital. It is quite an object lesson to examine the diagrams showing an increasing output with a diminishing coal bill, but the extra price of coal during the past year has played its part in diminishing revenue, as has the introduction of the metallic filament lamp. We are under the impression that, although the watts per candle-power of lamp will temporarily lead to a lessened demand, the ultimate result will be to install a far larger number of lamps and to largely increase the demand. At any rate, at Blackpool the closest attention is given to every detail, and whatever happens the result under such enlightened management will be good.

THE KEARNEY HIGH-SPEED RAILWAY.

The description of this railway by the inventor or the promoters of the Kearney High-Speed Railway Company, Limited, leaves much to be desired. The most desirable course for the inventor to have taken would have been to spend on expert advice the money wasted on the Aldwych display. The model shown there disclosed no new ideas, and the statements made in the description circulated are open to severe criticism from an engineering standpoint. We feel sure that this young inventor is honest in his belief that he has invented something new, and his enthusiasm has infected a few of his friends. These beliefs they are quite justified in holding and in spending as much of their own money as they like in proving the correctness or otherwise of the same. When, however, the public are asked to subscribe money for the same object, we feel bound to state our opinions on the subject. In the first place, the Patent Office have had the matter under discussion and have granted a patent, but that is only for a particular type of upper rail which is to be used on the proposed railway. This rail has for its object the restriction of the contact surface between the upper wheels on the car and the overhead railway which is relied upon to keep the car upright. The reason for this is presumably to reduce friction, and the same result could be obtained more mechanically by two inclined guide wheels such as have been used before on other types of monorail lines. The above construction is the only patent to be transferred by the inventor to the company, and the other advantages claimed for the Kearney high-speed railway or tube could, if really obtainable, be exploited by any railway company. Take the tube lines, for instance. If the monorail system really did reduce the working expenses to about half what they are at present, there is nothing Mr. Kearney can do to prevent the present underground railway companies from making the change to such a system. Again, as to the statement that his tube railway, with its grades of 1 in 7 on each side of the station, will cost only half what it has cost to construct the present tubes, there are no figures given which justify this wild statement, and we are sure the Board of Trade would never pass such grades. Mr. Kearney is young, and could not have known the history of the Waterloo and City Railway when he was working out his idea. We would suggest that he should look up the same in

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our issues. Again, he is young, and his six years of experimental work have evidently prevented him from attending places of amusement. We would advise a trip on the "topsy-turvy" railway or on the scenic railway in the Franco-British Exhibition to test his theory that "our passenger will not be conscious of sitting on an inclined plane during this downward rush (1 in 7), owing to the forces due to acceleration exactly counterbalancing the effects of the gradient." He will find that all the ladies on the cars on these railways scream on such grades, which, perhaps, he will attribute to unconscious actions of their escorts. The most novel idea disclosed by the inventor in his public demonstration is that the safe speed of a train is a function of its linear dimensions. The model shown was one-tenth full size, and he suggested that the low speed obtained justified his claims for very high safe speeds on the full-sized trains. This idea is as novel as it is untrue. He should collect data as to the size and pace of racehorses and carthorses respectively, and will find that the over-all lengths of ocean tramps and torpedo boats do not determine their speeds. In conclusion, we emphatically state our opinion that there is nothing in the suggested railway to warrant a call for public subscriptions to a company.

RIVAL ILLUMINANTS.

There is a marked contrast in tone between the calm observations of Mr. Doig Gibb, the president of the Institution of Gas Engineers, on the question of the competitive forms of artificial lighting—gas and electricity—and the bellicose utterances on this question that appear weekly in the journal in which we read an account of Mr. Gibb's presidential address. Mr. Gibb opened with a remark which is now recognised as a truism, when he asserted that electric supply undertakings continue, with few exceptions, to progress. But the caution of his implied admission, that the growth of electric lighting has adversely affected the gas-lighting industry, strikes us as an ingenious attempt to sweeten a pill that must be very unpalatable to gas engineers and managers and their aggressive henchmen in the gas journals. Mr. Gibb rightly affirms that the severe competition has had its benefits, and that a more liberal standard of illumination is being established. He admits that there is a field for electric supply companies, and has no doubt they will increase and prosper as gas undertakings have done. He paints a very roseate future for gas lighting at the expense of electric lighting, and says, "I do not anticipate quite such a fierce competition in the future, in consequence of electricity losing its glamour, and being more often compared with gas in a logical and commercial way." This generalisation is so entirely opposed to existing facts that it may almost be dismissed as a platitude. The extension of electric lighting in private houses, in large assembly halls, in public buildings, and in streets—in fact, everywhere where artificial illumination is required, either temporarily or permanently, is so general, and is helped on so much by the new metallic-filament lamps, that we may hope to find the electric light soon installed in the small house, and in the houses of the working classes, yes, even with "penny-in-the-slot" meters. We can only say that the whole of the community which prefers electric lighting to gas, in spite of what the advocates of the latter tell us about the superiority of their commodity, its economy, its efficiency, its hygienic properties, and what not, that such a community must be suitable inhabitants of the state of Bedlam. We do not believe that the public are likely to be deceived by the extravagant claims of perfervid gas advocates in the matter of lighting.

SWITCHGEAR CONTROL APPARATUS AND RELAYS FOR ALTERNATING-CURRENT CIRCUITS.*

BY CHARLES C. GARRARD, MEMBER.

1. *Introduction.*—The installation of control relays on high-tension alternating-current circuits has become standard practice, and is likely so to continue. The correct design and lay-out of such relays is of the highest importance. On their proper action a large part of the success of the system depends. Recognising this, it is somewhat remarkable that many systems are in operation to-day designed on wholly erroneous lines. This is due, no doubt, in part, to the fact that the relay control apparatus has not been deemed worthy of great attention in comparison with, say, the performance of the generators and prime movers. Another reason is that of apparent economy. The object of this paper is, first, to deal with a number of such instances which have come under my notice; and, secondly, to examine some other systems of control working at present in use or proposed to be put into application.

2. *Polyphase Maximum Time Element Relays.*—A considerable number of such relays have been installed in various supply stations. They consist of a polyphase-wound relay having a single moving element, which moves under the action of the currents in two or three of the phases. We will consider such a relay in use on a three-phase four-wire circuit, in which case it would have three windings energised by each of the three phases. Let us suppose it to be set to operate after, say, 30 seconds continued overload at 150 per cent. of full load. This means that after 150 per cent. of full load has flowed in *each phase* for 30 seconds the relay operates. It is obvious, of course, that each phase contributes under these conditions one-third of the operating torque in the relay. If T be the operating torque, we may set

$$T = K\left(\frac{3}{2}\,c_1 + \frac{3}{2}\,c_2 + \frac{3}{2}\,c_3\right),$$

where K is a constant and $c_1 = c_2 = c_3 = c$ = full-load phase current. Suppose, now, that instead of the overload occurring on each of the three phases simultaneously it only took place in one phase, as is quite possible on a four-wire system, due to the breakdown of one phase to earthed neutral. It is clear that in order to operate the relay the overload on the single overloaded phase must be much greater than before. If the current flowing in the other two phases be the normal full-load current, we get

$$K(C_1 + c_2 + c_3) = \frac{3}{2}K(c_1 + c_2 + c_3)$$

$$\therefore\ C_1 = \frac{5\,c}{2}.$$

This is to say, the current in the single overloaded phase will have to rise to two and a half times the normal full-load current before the relay will operate. Of course, these equations are only illustrative, as the law connecting operating torque and current in a relay is generally more complex than a simple proportion. They, however, illustrate the undoubted fact that with polyphase maximum relays very large and dangerous overloads can continue to flow in any one phase without causing the relay to operate and to open the circuit. Polyphase relays should never be used, but always single-phase relays connected entirely separately on two or three of the phases on three or four wire systems respectively.

3. *Polyphase Reverse Relays.*—Exactly the same objection applies to the use of these as to the use of polyphase maximum relays. If, for example, the reverse relay be set for 15 per cent. reversal on any one phase, it is clear that if the reversal occurs on all three phases at once—as, for example, when a bad attempt at synchronising is made—a reversal of 5 per cent. is sufficient to operate the relay, which would be too delicate a setting for the case in question. On the other hand, if a reversal of 15 per cent. in all phases at once is required to operate the relay, a very large reversal in any one phase can take place before the circuit be open-circuited. In fact, under some conditions

* Paper read before the Institution of Electrical Engineers.

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with a reversal in one phase only the tendency towards operation in the relay due to this reversal is neutralised by the increased forces in the opposite direction due to the unreversed phases, and the relay quite fails in its action. The only perfect solution is to install a separate single-phase relay on each phase, either two or three, as the case may be.

4. *Solenoid Relays.*—A considerable number of maximum time-limit relays, operating on the solenoid principle, are in use at the present moment. They consist of a solenoid having a movable iron plunger, which is sucked up when the current in the solenoid exceeds a certain value. The iron plunger is attached to a dashpot or air-bellows which retards the travel of the plunger, the amount of the

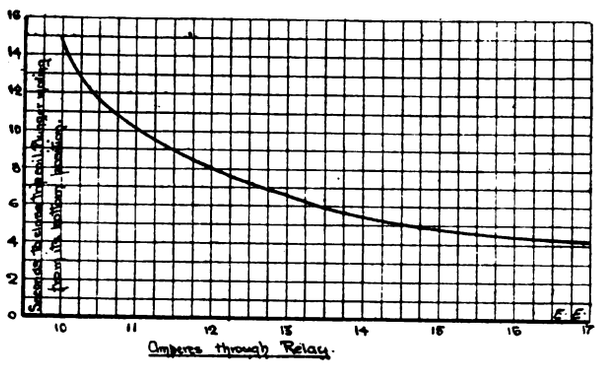

FIG 1.—Calibration Curve of Solenoid Relay.

retardation being varied by means of a small valve which controls the clearance in the dashpot, or at the rate at which air can pass in or out of the bellows, etc. Thus the plunger is caused to take a certain time to travel to its top position. When the top position is reached contact is made in the trip-coil circuit and the controlled circuit is opened. A typical relay, made by a well-known firm, operating upon this principle was experimented upon, and its calibration curve is shown in Fig. 1. The coil in this relay consists of about 325 turns of wire. Some measurements made on this instrument are represented in Fig. 2. The current through the coil was maintained constant at 10 amperes, 50 ~ per second, and whilst the position of the plunger in the solenoid was varied, the volt drop across the terminals of the coil was measured. It will be noted

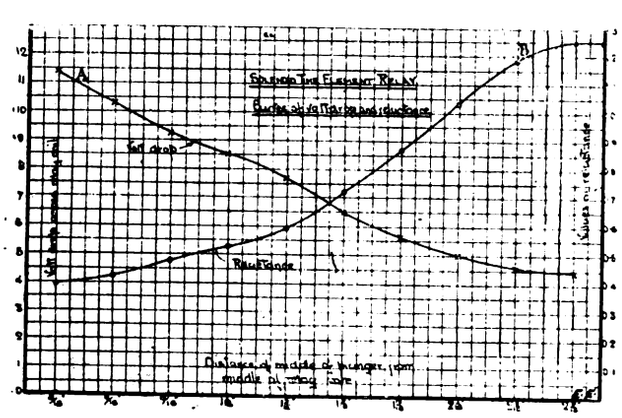

FIG. 2.

that as the plunger is raised within the solenoid the volt drop across the same is increased largely, and, of course, the volt-ampere consumption of the relay goes up. From these measurements and the known ohmic resistance of the coil it is possible to calculate the coefficient of self-induction in henrys, L, and from this, and the number of turns, S, the magnetic reluctance of the circuit can be calculated from the formula

$$\text{Reluctance} = \frac{4\pi S^2}{10^9 L}.$$

The variation of the magnetic reluctance of the relay with alteration of the position of the plunger is given in Curve B of Fig. 2. As the plunger goes up the magnetic reluctance goes down. Now, with a constant magnetising force in the relay the attractive force on the plunger varies inversely as the square of the reluctance. It follows that if, due to the passage of a certain current through the relay, the plunger is caused to travel upwards, the higher the plunger goes the less the current necessary to keep it in its new position. Thus the current in the controlled circuit can fall again to its normal value, but the plunger will not fall, but remain "floating" for an indefinitely long period near its top position. If now the current again increases the plunger will complete its upward journey, but without any time element whatever, this being due to the fact that the first small movement in a dashpot is unretarded, no matter from what position in its travel the plunger starts. Experiments made to test this theory confirmed it in every particular. It was found that if the plunger was allowed to travel upwards, due to the passage of an excess current, and the current was reduced to its full-load value before contact had been made in the trip-coil circuit, the plunger did not fall, but remained floating near its top position. The next time the overload came on the relay closed the trip-coil circuit without any time element whatever. This test is in exact parallel with actual practical conditions. The figures of an actual test are as follows: The relay are adjusted so that contact was made between the trip contacts when nine amperes—that is, the starting current—flowed through the winding. On reducing the current, however, the plunger did not at once fall. At 7½ amperes the trip circuit was just broken, but not until 5·2 amperes was reached did the plunger fall back to its bottom position. Now, 5 2 amperes in the relay would correspond to about full-load current in the primary circuit. Translated into practical conditions, these results mean as follows: At time

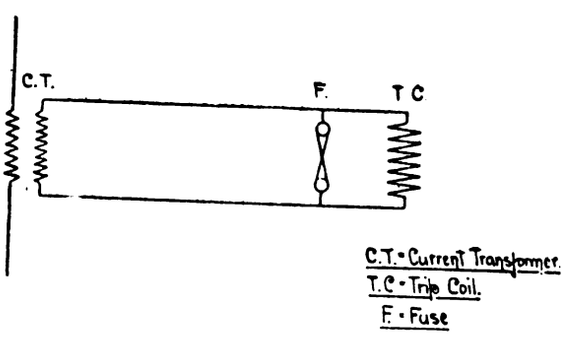

FIG. 3

of full load a short comes on the system which is intermittent in nature. The current increases sufficiently to pull up the plunger of the solenoid relay, but not for a sufficient time to close the trip contacts. The short goes off, but the full load remains flowing in the circuit. Consequently the plunger does not fall, but remains floating near its top position, and the next time the short comes on the relay operates without any time element whatever, and the whole object of the apparatus is vitiated. These results show pretty conclusively that the dashpot solenoid type of maximum relay is not to be relied upon for dealing with intermittent overloads or shorts.

5. *Fuse Shunted Trip Coils.*—A method sometimes adopted to impart a time-element characteristic to an ordinary circuit breaker is to shunt the trip coil with a fuse (Fig. 3). Normally the secondary current of the current transformer flows through the fuse and not through the trip coil, until the fuse blows and the current is diverted through the coil. The time taken for the fuse to blow gives the time element. It is only possible to use this scheme for alternating currents, as with continuous currents the whole of the current passes through the trip coil, and a sufficient volt drop to blow the fuse cannot be obtained. The chief advantage of this scheme is cheapness. Its efficiency may be judged from the following considerations. The two essential functions of a time-element device are as follows: (1) The time lag should prevent the circuit breaker opening with every momentarily abnormal rush of current; (2) a discriminating action should be obtainable—that is, if two time-element circuit breakers are in series, it should be possible to adjust one to open before the other. The second function is vital in all important circuits. As an example, consider a high-tension feeder going to a sub-station in which motor-generators are working. Maximum time-element circuit breakers would be installed in the

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generating station on the outgoing feeders, and also in the sub-station between the 'bus bars and the motors. In the event of a dangerous overload on a machine, it is necessary that its circuit breaker should operate before that installed on the feeder at the generating station. If this happens, the faulty machine is cut out satisfactorily and a disturbance of the supply does not result. The point to be ascertained is how far this discriminating action can be attained. The following experiments were made to elucidate this: The trip coil used was a standard 10-ampere one, having a volt drop of 2·8 volts at 50 ~, the plunger being set so that it was pulled up with 10 amperes through the coil. In order to approximate to working conditions, the current through the coil and fuse in parallel was kept constant at eight amperes and then suddenly increased by definite amounts, and the time noted which elapsed before the trip coil operated. Curves (Fig. 4) give the results obtained by varying the thickness of the copper fuse wire. It will be seen that altering the thickness of the wire not only alters the current at which the combination works, but also affects the time element enormously. Thus independent adjustments of the time and the current calibrations are not feasible—at least, if fuse wires of constant length and of the same material are used. The resistance of 2in. of No. 30 S.W.G. copper wire is 0·011 ohm at 60deg. F. As the impedance of the trip coil is 0·28 ohm, it will be seen that practically all the current flows through the fuse. It follows that regulation of the current at which the arrangement works can only be

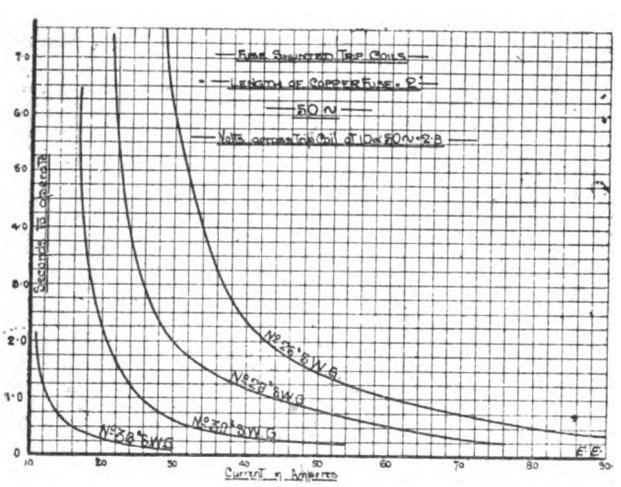
Fuse Shunted Trip Coils
Length of Copper Fuse, 2"
50 ~
Volts across Trip Coil at 10 = 50 ~ 2·8
Seconds to operate
No 28 S.W.G
No 29 S.W.G
No 30 S.W.G
Current in Amperes

FIG. 4.

effected by altering the fuse wire, and simply raising or lowering the plunger in the solenoid will have no effect. A characteristic of all the curves of Fig. 4 is that on large overloads the times taken all become practically zero—that is to say, on heavy overloads any time discrimination disappears altogether. It might be urged that as putting in a thicker wire both increases the time element and also the current at which the combination works a solution of the problem may be obtained. It must be remembered, however, that the current through the fuse is the *secondary* current of a current transformer, and although the primary current in the generating station may be larger than the primary current in the sub-station, yet the secondary currents are generally equal, the ratios of the current transformers being varied according to the values of the primary current. For important distributions, therefore, the fuse-shunted trip coil is not suitable. It may, however, find useful application on motor-control panels where ordinary fuses are not desired, and where a discriminating action apart from the prevention of the machine being cut off due to every temporary overload is not wanted.

6. *Maximum Relays Connected on the "Resultant Principle."*—(*a*) *Three Phase Three-Wire Systems.*—For three-phase three-wire systems two separate single-pole relays are theoretically necessary to afford complete protection. When what may be designated the "resultant" scheme of connections has been used a single one phase relay only has been installed, but in conjunction with two current transformers, so connected that the current in the relay is the vectorial resultant of the current in each of the phases in which the current transformers are situated (Fig. 5). A superficial examination would lead one to think that as the relay current is the resultant of the currents in the two phases, an overload in either will cause the relay to operate and thus afford complete protection. A number of supply stations in this country have protective apparatus installed in this manner. On working out the currents in the relay vectorially, however, it will be found that the protection afforded by this method is doubtful. We will assume the normal full-load secondary current of the transformers to be 10 amperes, and that the relay is set to operate at

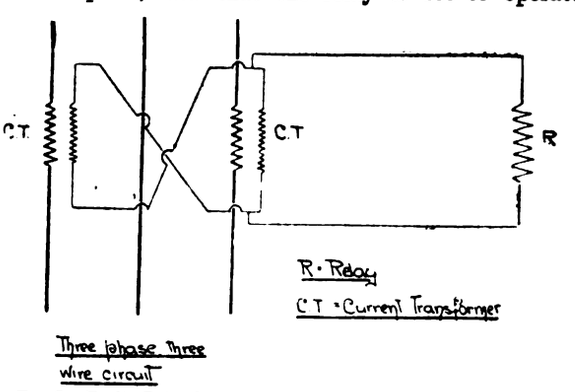

FIG 5.—Faulty Relay Connections on Three-Phase Three-Wire Circuit.

200 per cent. of full-load current—that is, it will operate when 34·6 amperes flow through it. If now the overload occur on both the phases connected to the relay, and the phase displacement in each phase is the same, then the circuit is opened when 20 amperes secondary current flows in each phase. It is quite likely, however, that the overload will only occur in one of the phases, and in this case the phase displacement will most probably not be the same in each phase. If the angle of lag in each phase is equal, and only one of them is overloaded, it will require 282 per cent. full-load current in the single overloaded phase to cause operation. Should, however, the current in the overloaded phase lag 60deg. more than the other phase, which is quite possible, then the current in the overloaded phase would have to increase to 386 per cent. of full-load current before the circuit is broken. That is to say, with this scheme of connections and the circuit breaker set so that it comes out with the ordinary test at 100 per cent. overload, one of the phases, and, of course, the unprotected phase, could be overloaded to the extent of 200 per cent. or 300 per cent. overload without the circuit being opened. It will be agreed that such a scheme of protection is some-

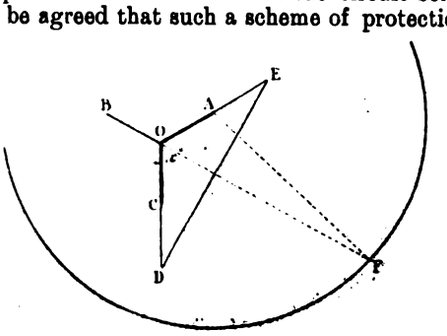

FIG. 6.

what illusory. The figures given above can be obtained from a simple clock diagram (Fig. 6). The three full-load normal currents are O A, O B, and O C. If O E = 2 O A, then E D = the current through the relay which causes it to operate. If a circle with radius = D E be struck from A as centre, then the current flowing in the phase O C for any particular angle of lag x is O F, it being supposed that the current O A remains constant. The two current transformers are, of course, in phases O A and O C.

(*b*) *Three-Phase Four-Wire Systems.*—The three-phase four-wire system is shown in Fig. 7. It will be seen that three current transformers are necessary, but only two relays are used, the idea being to save the cost of the third relay. At first sight it would seem that, as

Current in R_1 = current in c + current in a,
and Current in R_2 = current in b + current in a,

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there could not be an abnormal current in anyone of the three current transformers without there being a corresponding current in R_1 or R_2. Exactly the same consideration, however, can be applied to this case as in section (*a*), as it is quite possible for one phase to be overloaded since it has a return path through the fourth wire. If this overload has a large phase displacement relative to the currents in the other phases, then the condition may arise of very big overloads in the one phase and the circuit breaker not operating. The only safe arrangement is to have the same number of relays as current transformers. If the circuit be a four-wire one, then three relays are necessary; if three-wire, then only two relays are essential.

7. *Alternating-Current Reverse Power Relays*.—Such relays are installed between 'bus bars and sources of electrical energy; thus they are used for controlling generator switches and the switches at the far ends of feeders. In such positions complete protection is afforded by the reverse relay, and the installation, in addition, of maximum current circuit-breaking apparatus at the same places must be regarded as bad practice. The requirements to be met on generator circuits and on the ends of feeders are, however, different, and also vary with the type of prime mover.

8. *Reverse Relays on Generators*.—These should only come into operation when a serious fault has developed on the generator or prime mover of the nature of an insulation breakdown in the winding, or a total failure of steam

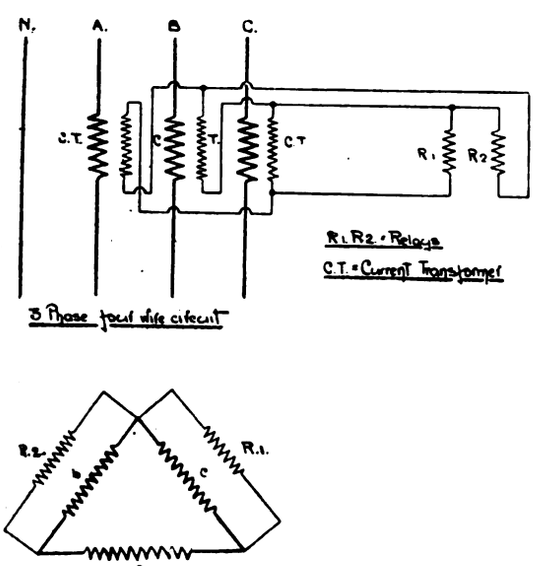

FIG. 7.—Faulty Relay Connections on Three-Phase Four Wire Circuit.

power. A short consideration will show several cases of accident to the prime mover, in which an automatic disconnection from the 'bus bars would only be an aggravation of the trouble. For example, consider two or three large compound Corliss engines with three-phase generators running in parallel. A not uncommon fault is the failure of one of the admission valves to open, with the result that steam is admitted to only one side of the piston. Under these circumstances a large surging current passes backwards and forwards from the faulty to the good machines. This is due to the very uneven turning moment in the engine caused by the unequal distribution of steam in the cylinders. The wattmeter and ammeter needles are set into a violent state of oscillation, but the generator remains in step. The fault with the valve is but a small matter, and is noticed at once by the driver, who attends to it immediately; the surging current ceases, and everything goes on as before. If, however, this set had been cut off the 'bus bars, the other generators would have become seriously overloaded, with probable variation in volts, and all the trouble of synchronising would have had to be gone through. A satisfactory generator reverse relay should withstand, therefore, without operating, such a surging of power from one machine to the other, provided the two remain in synchronism. These surges into the faulty set are, of course, reversals, and, moreover, of considerable magnitude. From this instance it follows clearly that a generator relay which operates instantaneously on a reversal is not desirable. In fact, it cannot, under the above set forth circumstances, be used at all.

9. *Failure of Field Current of Generator*.—With the diminution or total failure of the field current of a generator, the current in the windings increases greatly and leads considerably on the machine volts. Provided the set remains in synchronism, and the steam supply is in order, the alternator continues to supply energy to the system, and there is no reason why it should be disconnected from the 'bus bars. The large increase of current is noticed by the switchman, who immediately seeks for and remedies the fault without any serious disturbance of the supply. If when the field circuit fails the set drops out of step, then it should rightly be disconnected, but this would generally follow, as, with the set out of step, a large flow of power into the machine from the 'bus bars would most probably take place.

10. *Effect of Reduction of 'Bus-Bar Voltage on Generator Reverse Relays*.—It will be understood that any form of relay, one of whose constituent parts is a shunt coil, will be affected by variation in the voltage applied to the same. The shunt coil of the generator reverse relay is excited (through the intermediary of potential transformers) directly from the 'bus bars. On the occasion of an accident to one of the generators the 'bus-bar volts will tend to go down. The trouble is intensified by the fact that, as has been shown, an instantaneous relay cannot be used, therefore there is more time for the voltage to fall. It must be remembered, however, that a failing generator in parallel with one or more good ones is not likely to pull the volts down to any very alarming extent. Probably a 50 per cent. reduction is the maximum to be expected. It is clear, however, that the

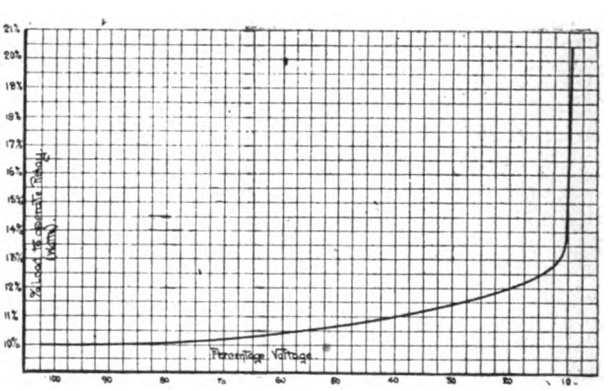

FIG. 8.—A.C. Reverse Relay.—Variation of Calibration with Voltage.

calibration of the relay should be as little affected by variation in the 'bus-bar voltage as possible. Curve Fig. 8 shows the effect of reduction of the shunt voltage on the calibration of a reverse-power relay, consisting of a specially-designed wattmeter movement. It will be seen that the calibration is practically unaffected down to 10 per cent. of the normal voltage. The limit down to which it works is 7 or 8 per cent. below that it becomes inoperative. The relay is also absolutely inoperative on forward power under all conditions. Tests made up to ten times full-load current in the forward direction proved this.

11. *Setting of Reverse Relay on Generators*.—The most suitable value to which a generator reverse relay should be set is such that it will operate, after the requisite time element, with an energy reversal of 10 per cent. of the full rating of the machine. With this setting the current which can flow in the generator windings is never very excessive. It has been suggested that 10 per cent. is too fine. A case which came under my notice was that of some triple-expansion three-crank engines driving 6,600-volt three-phase generators. These engines were fitted with emergency stop valves. Owing to the method adopted for operating these valves, they would occasionally close accidentally and shut off the steam. Under these conditions the energy reversal would exceed 10 per cent., and, therefore, a 25 per cent. setting was asked for, so that the machine should not be cut out of circuit, but remain in step, allowing the driver time to open the valve again. The proper cure for the trouble would be, however, to arrange the emergency valve so that it did not operate in this manner

12. *Reverse Relays at the Ends of Feeders*.—The function

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of such relays is to prevent a fault on the feeder being fed back from the sub-station or distribution network. The currents which flow into such a fault will have passed through long lengths of feeder, the C R and inductive drop in which will cause the voltage applied to the shunt of the relay to fall. Thus reverse relays, situated at the ends of feeders, are far more likely to be affected by drop in volts than are those on generators. For this reason it is desirable for the relay to operate as quickly as possible after the occurrence of the reversal. The objection to instantaneous reverse relays on generators does not apply here, as a similar action to the slow surging of current, or cross-current, from one generator to another cannot take place. Temporary reversals of energy in a feeder may happen, however, due to hunting of the sub-station machinery. The hunting may be set up by a temporary disturbance in the system, such as a short-circuit, with consequent lowering of voltage. With an instantaneously operating relay the first reversal, providing it be of sufficient amplitude, will cause the relay to operate, and thus the circuit may be opened when there is not any need for it. As the time-limit relay is inadmissible, this action must be obviated by other means. The determining factor is obviously to what degree may hunting occur in the sub-station machinery without the same falling out of step? Naturally, if it be going to fall out of step, the opening of the circuit is an advantage. On the other hand, a moderate temporary swing might be set up between the sub-station and the generating station, which will be damped out immediately and not do any harm. The instantaneous reverse relay at the far end of the feeder should be set, therefore, so that the minimum power required to operate it should be above that likely to flow back, owing to such a harmless hunting of the sub-station machinery. It follows that the feeder-end relay should be set proportionately higher than the reverse relay on the generator; probably if it were set to operate at 25 per cent. of the normal full-load capacity of the feeder, it would form the most suitable arrangement. Other considerations also indicate that a higher power setting of the feeder-end relay than the generator relay is admissible. With the latter the motoring current may be of very low power factor, and in order to keep the current within moderate limits the power setting of the relay must be kept relatively low. The feeder-end reverse relay is intended, however, to prevent a feeding back into an earth or short-circuit. Such current would be of high power factor, and, if not interrupted, of considerable magnitude. Thus the high watt setting of the relay is justified.

13 *Protection of Interconnector Cables.* — Interconnector alternating-current cables are used generally to connect up one sub-station with another. The ordinary system of generating station and sub-stations without interconnectors is shown in Fig. 9A. To guard against stoppage of supply it is necessary to have at least one spare cable to each sub-station. With an interconnector cable between S_1 and S_2 (Fig. 9B), however, the necessity of these two spares is done away with. Also in many cases the distance, S_1 S_2, is shorter than the distance from either sub-station to the generating station, so that the interconnector results in a saving in capital expenditure. The standard method of protection for ordinary feeders is by means of an inverse time-limit maximum circuit breaker at the generating station end and a reverse circuit breaker at the sub-station end. It is obvious that this system is not applicable to the interconnector, as power may flow either from S_1 to S_2 or from S_2 to S_1. In fact, if S_1 and S_2 are running in parallel, the direction of flow in the interconnector will alter according to the relative loading of the sub-stations.

14. *Conditions under which the Interconnector should be Automatically Disconnected.*—A diagrammatic representation of a generating station feeding two sub stations connected together by an interconnector is given in Fig. 10. It is obvious that the interconnector should be protected against excessive loads going through it of such a magnitude that the cable itself is likely to be damaged. It is conceivable that, owing to faulty superintendence, the current in the interconnector may mount up to such an extent that damage to it may result. Some kind of a maximum circuit-breaking device is desirable therefore, and as the only object of this is to prevent thermal damage, the time element should be very long—longer than any of the other maximum circuit breakers on the system, whose function it is to deal with shorts and accidental temporary overloads. For shorts and overloads on the system, other than those caused by the failure of the interconnector itself, the circuit breakers on the feeders, motors, and generators must be relied upon. The interconnector, from the point of view of control, virtually makes two sub-stations into one—that is, it is a prolongation of the sub-station 'bus bars. So long, therefore, as the interconnector is in good condition, and not permanently overloaded sufficiently to be burned, overloads and shorts on the system should never cut it out of circuit. The

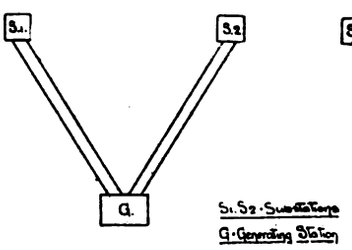

FIG. 9A.

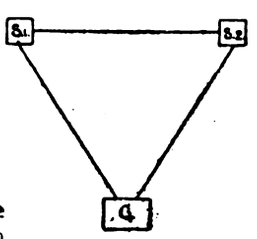

FIG. 9B.

occasion when it should be cut off is when it goes wrong itself either by grounding or shorting. It is obvious that to attain this end something more is needed than simply maximum or reverse relays at either end of the interconnector, as these cannot discriminate between shorts or grounds in the interconnector, or in other parts of the system. To solve the problem it is only necessary to consider that the function of the interconnector is to pass energy from one sub-station to the other in either direction. So long as it is doing this it may be said to be performing its function. It is, however, not doing so when it takes energy from one sub-station and does not deliver it to the other—that is, when energy flows into

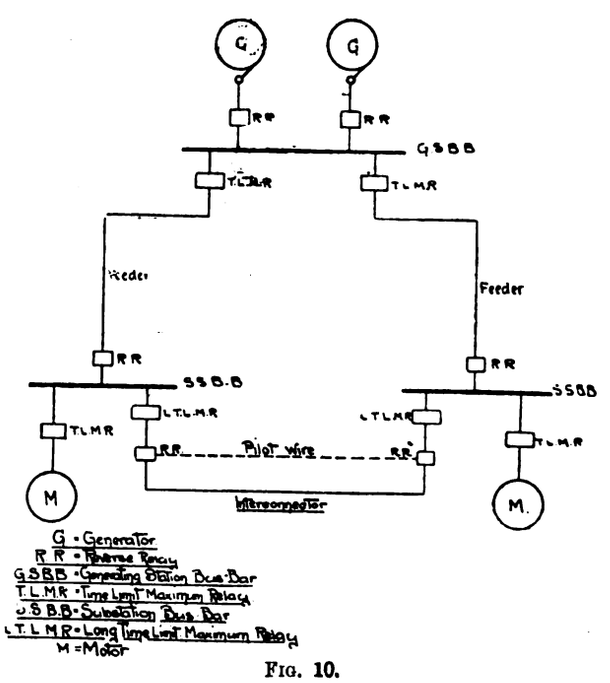

FIG. 10.

the cable at both ends at the same time. It follows that a circuit-breaking apparatus must be installed at either end, and that these must be interconnected together. This is done generally by means of one or more pilot wires.

15. *Merz and Price's Systems.*—The principle on which this method depends is illustrated in Fig. 11. A current transformer, C.T., is included in the interconnector at either end, the secondaries of which are connected together through the trip coils, T.C, and the pilot, the return circuit being *vid* earth. So long as the current flows through both current transformers in the same direction—it is immaterial in which direction—the E M.F.'s induced in the secondaries of the C.T.'s balance, and current does not flow through the pilot and trip coils.

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So soon, however, as the currents at either end become unequal, or a reversal at the one end relatively to the other takes place, current begins to flow in the trip coils, and when this has reached sufficient value the switches are opened. It may be mentioned that differential relays are used usually, in addition, for operating the tripping mechanism of the switches, as the arrangement of Fig. 11, although quite right theoretically, cannot be applied practically in the simple form shown. The advantage of Merz and Price's arrangement is that potential transformers are done away with altogether. In order to secure full pro-

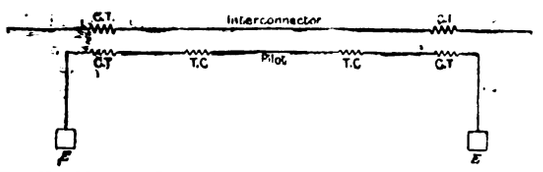

FIG. 11.—Merz and Price's System of Protection of Interconnections.

tection, however, more than one pilot wire has to be run for each three-phase interconnector.

16. *Protection of Interconnector Cables by Means of Electrically Interlocked Reverse Relays.*—As the criterion of failure of an interconnector is the simultaneous flow of power into it at either end, such a circuit can be protected by the installation of reverse power relays at both ends, both relays being connected in a common tripping circuit arranged so that only when energy is flowing into the cable at both ends is the trip-coil circuit closed at both relays, and the main switches caused to open circuit (see Fig. 12). Normally the trip circuit is broken at one relay and made at the other, or *vice versâ*, according to the direction of flow of power in the circuit. The relays close circuit with a slight time element, so that, on the flow of current reversing, one of the contacts is opened at the one relay before the other one is closed. On reference to Fig. 12 it

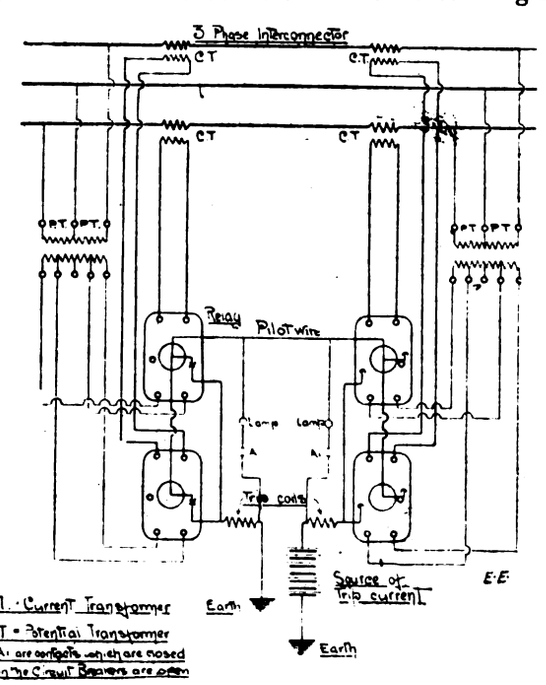

FIG. 12.—Protection of Three Phase Interconnector by means of Electrically Interlocked Reverse Relays.

will be seen that only when power is flowing into the cable at both ends at the same time is the trip-coil circuit complete through each trip coil and the circuit ruptured at both ends. A and A_1 are each a pair of contacts which are closed automatically when the main circuit breaker at the corresponding end opens. Thus, if the switch at the left end of the interconnector opened slightly before the one at the right-hand end, the trip-coil circuit would be closed at A and by the relay at the right-hand end. Thus the circuit breaker at the right-hand end would also operate. The object of this arrangement is to ensure that both ends of the interconnector will be disconnected even if the two switches do not act quite as quickly as each other. Each trip coil is also arranged so that it is cut out of circuit when its main switch has opened circuit, after, however, A (respectively A_1) has been closed. The trip coils, therefore, experience no danger of burning out. The state of affairs might, however, arise that the left-hand switch was open and the right-hand switch was closed, there being a short or earth on the interconnector. By the act of closing the right-hand switch the trip coil of this switch will be put into circuit ready for operation, and the circuit through the same will be complete through the right-hand relay, which operates due to the flow of current into the fault, and through A. Thus the right-hand circuit breaker will be opened, while at the same time cutting out its own trip coil. Thus it is impossible to connect up the interconnector at either end while there is a fault on the same.

FIG. 13.

The arrangement as set forth above, of course, necessitates that there should be some voltage in order to operate the relays. If the voltage absolutely disappears, the reverse relay will not work, and it may be thought that in the case of a very bad short-circuit this will happen. Considerable experience has shown, however, that even under the worst conditions the voltage does not entirely disappear, and that if the calibration of the apparatus is unaffected by fall of potential down to 10 per cent. of the normal working voltage all working conditions will be met (compare Fig. 8). As the pilot wire only carries the tripping current it will be seen that only one pilot is necessary whether the relays are single, two, or three pole. On a three-phase system the relays will be a two or three pole, according as to whether the system be three-wire or four-wire. Messrs. Merz and Price suggest that the pilot wire, or wires, can be made up in the same multicore cable as the main conductors, there being generally sufficient space for this in the filling, which is used to make up the cable to a cylindrical cross-section.

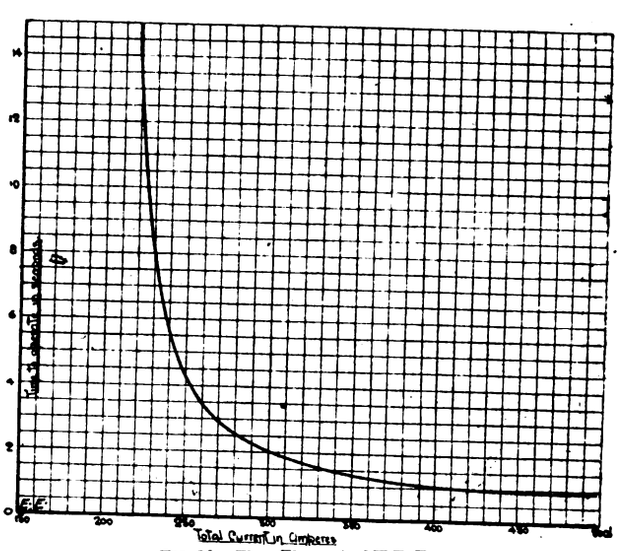

FIG. 14.—Time Element of H.T. Fuse.

This, however, is open to the serious objection that if a serious fault or burn-out occurs the pilot wire will be broken most probably. It would be much better to keep the pilot wire quite distinct from the main cable, preferably laying it in a different duct. A system, therefore, which under all conditions only requires one pilot wire is of advantage in this direction.

17. *Time-Limit Maximum Circuit Breakers.*—At the present time it is general practice to install time-element maximum circuit-breaking devices in various positions on all large systems. There have been a variety of forms used. Some have had a constant time element independent of the degree of the overload. These are but rarely required, and we will only consider inverse time-element circuit breakers. In reading descriptions of the various plants in different parts of the world, it is very difficult to arrive at any conclusion as to the actual time element employed. It is very common, for example, to read that the time element

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in such and such a switch was two seconds. This does not convey any clear meaning. In order fully to understand the arrangement it would be necessary not only to know at what current the switch just opens and in what time, but also the time taken on a dead short-circuit, which, of course, is very different. It is this latter time which fixes the order of succession in which inverse time-element circuit breakers, which are in series one with another, operate on heavy short-circuits. Hitherto it has been considered generally that fuses possess an inverse time element action.

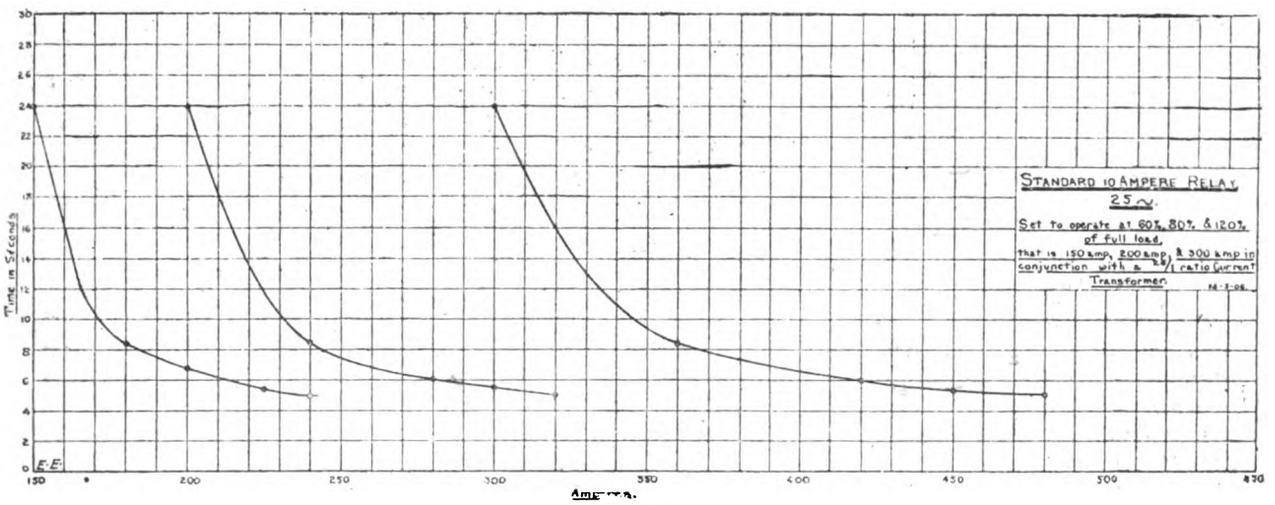

FIG. 15.

It must not be assumed that this is always the case. R. P. Jackson (*Transactions* of the American Institute of Electrical Engineers, Dec. 28, 1906) gives oscillograms of 38,000-volt (phase to earth) expulsion fuses, which show that these operated in one or two cycles. It is, however, often true. The photograph in Fig. 13 illustrates a 105-ampere high-tension fuse which has been used on the outgoing feeders in the 50-~ generating station referred to later. These consists of seven strands of No. 24 S.W.G. silver wire, each strand being enclosed in a small glass tube, for a short distance in the middle, the whole being surrounded by an

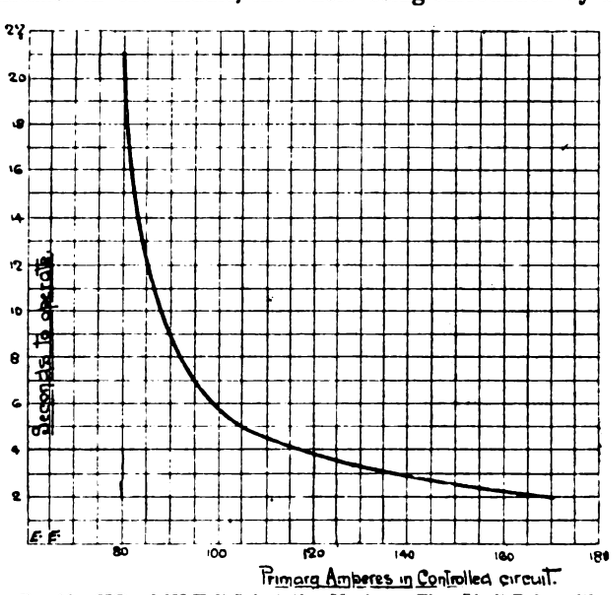

FIG. 16.—25~ 6,600-Volt Sub-station Maximum Time-Limit Relay with Induction Motor-Generators in Sub-stations.

outer glass tube. The wires are spaced out by asbestos washers, and the outer tube is filled with French chalk, except for the small space in the middle where the wires are enclosed in the small glass tubes. The engineer has kindly informed me that these fuses have never blown due to shorts on the low-tension network. Whenever they have blown it has been due to a failure in the feeder, in that part of it between the generating station and the first sub-station. The time element of this fuse is given in the curve in Fig. 14. This curve was taken by keeping 80 amperes flowing through the fuse till normal temperature was reached, then suddenly increasing the current to the value given in the curve and noting the time taken to blow. Of course, apart altogether from the difficulty of arranging two fuses in series with the certainty of one operating before the other, high-tension fuses cannot now compete with automatic circuit breakers either in cost or efficiency.

18. *Inverse Time Limit Circuit Breakers on Feeders.*—If it has been decided that a time-element circuit breaker is necessary on the outgoing feeder, the next point to determine is what this time element should be. If it were only a question of arranging the various switches so that they opened in a predetermined order, the feeder time lag would be made as long as possible, as, naturally, the longer it is the more chance have the distant circuit breakers of operating before the feeder. Fig. 15 shows the calibration of outgoing feeder relays installed on the 6,600-volt, 25-~ three-phase feeders in a large generating station in Scotland. I am indebted to the chief engineer for the curve in Fig. 16, which shows the curve of the switches which are installed on the machines in the sub-stations. The curves of Fig. 15 were arranged so that, under all conditions, the machine breaker should operate before the feeder breaker had time to do so. These settings have proved to be satisfactory on the system in question. The sub-station machinery in this case con-

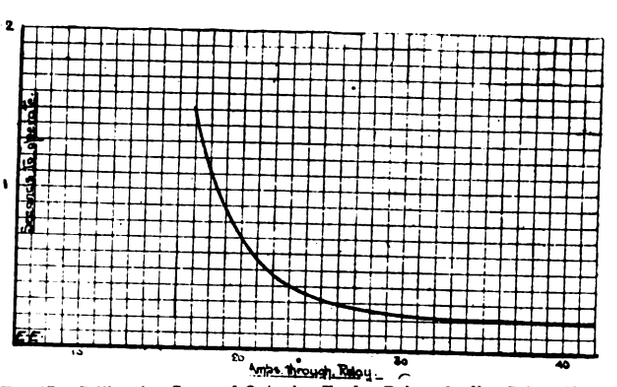

FIG. 17.—Calibration Curve of Outgoing Feeder Relays feeding Sub stations containing 50~ Synchronous Machinery.

sisted almost exclusively of induction motor-generators. Relays having time elements, as in Fig. 15, were subsequently installed on the outgoing feeders in a similar English 6,600-volt system, except that in this case the sub-station machinery consisted almost exclusively of 50-~ synchronous motor-generators. The difficulty was at once experienced that with the comparatively long time elements whenever a severe high-tension short came on the system, the shock was so great that a great deal of the synchronous sub-station machinery fell out of step. Generally a swinging of the current to and from the sub-stations was set up, which increased until the motors fell out of step. To get over this the time elements were shortened several times until the calibration curve as given in Fig. 17 was obtained on the outgoing feeders. It is considered that with such

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settings the system will be able to clear itself of high-tension short-circuits without any danger of affecting the synchronous machinery other than that fed by the faulty feeder. It will be seen that in order to prevent the falling out of step of the synchronous machines the advantage of the long time-element circuit breakers has (in this case) to be dispensed with. On examining Fig. 17 the thought arises, Is this very short time element worth keeping? Would it not be just as good to go the "whole hog" and abolish the time lag altogether? This may seem a plausible thing to do, as it might be considered that the difference between Fig. 17 and an instantaneous action is inapprcciable. Really, however, this is not so, and there is more difference between curve No. 17 and an instantaneous action than there is between curves Nos. 15 and 17. In order to get an idea as to what time a so-called instantaneous release mechanism took to work, an ordinary alternate-current trip coil was investigated. An examination showed that the time taken for the plunger to rise from the bottom to the top position did not exceed one-tenth of a second. It follows that the time element of an instantaneous release is less than one-fifteenth of the time element shown in the curve No. 17, and to go from this curve to the instantaneous release is a larger step than the sum total of the previous steps taken in arriving at curve No. 17. There is no doubt that instantaneous releases have been tried and found unsatisfactory by reason of too often and unnecessary operation. If now it should be found that the transitory currents that have given trouble with the instantaneous release are of shorter durations than the times of the curve in Fig. 17, then the retention of the time element, even if shortened to the extent of Fig. 17, is desirable. The general conclusion to be drawn from these notes is that the necessary and desirable time elements of the circuit breakers on each system must be determined experimentally. When installing maximum relays, therefore, they should be such that their time elements may be varied within wide limits independently of the currents at which they operate. It is not desirable to have the time element too easily adjustable by means of a screw or some such arrangement outside the relay, as this provides grave danger of the time settings being altered by unauthorised persons. The time elements of all the circuit breakers on the system must be considered as a whole, and after the correct values have been found the settings need never be altered. The curve in Fig. 14 gives a time element which need not be exceeded on the outgoing feeders on the 50-~ synchronous sub-station system considered. Relays set with longer times than this resulted in the synchronous motors falling out of step when a high-tension short came on the system, and to get over this difficulty very short time settings had to be resorted to. This entailed a sacrifice of a great deal of the possibility of arranging a selective action of the circuit breakers in series with one another. It would, however, be inadvisable to resort to absolutely instantaneous-action circuit breakers on this system. Much longer time elements can be used on a system consisting of induction motor-generator sub-stations, and, therefore, a better grading of the circuit breakers can be obtained.

AN ELECTRICAL ANEMOMETER.

A new method of overcoming the difficulties and inaccuracies met with in measuring wind velocities has been recently suggested by Prof. R. B. Goldschmidt in the *Elektrotechnischer Anzeiger*. In principle it depends on the fact that the temperature, and, therefore, the resistance, of a platinum wire carrying a constant current depends on the air draught circulating around the wire. With a view to neutralising the effect of variation in the atmospheric temperature, the apparatus is arranged for differential action, as shown in Fig. 1. P is the wire exposed to the current of air or other gas whose speed is to be measured, and P_1 is an exactly similar wire mounted in a protecting tube so that whilst not exposed to the direct draught it is yet free to take up the temperature of the surrounding air readily and quickly. Variation in the reactance of the protected and the unprotected wires are indicated by the deflections of the galvanometer, G_1, connected in Wheatstone bridge fashion. The galvanometer is calibrated by running the wire, P, round at varying known speeds in still air by means of a special rotating arm. The second Wheatstone bridge, to the right, with its galvanometer, G_2, is for the quite independent purpose of indicating the direction of the wind whose speed is indicated by G_1. For this purpose a weather vane is arranged to move a mercury control around the resistance, W. The deflection of

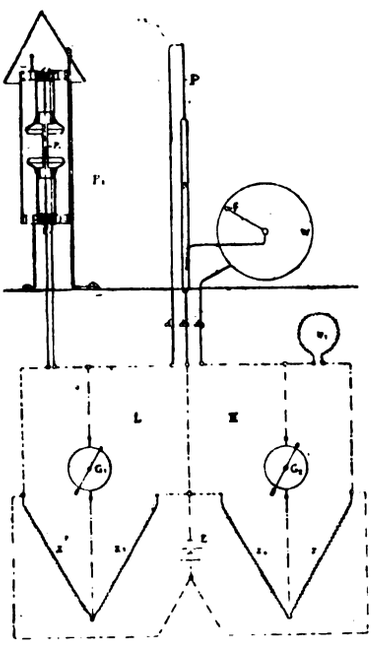

FIG. 1.

galvanometer G_2 varies with the position of this contact, and so serves to determine the position of the vane and the direction of the wind. By means of recording galvanometers a permanent record of the force and direction of the wind can be automatically obtained by this apparatus.

THE SEWAGE PUMPING STATIONS AT DAYTON, OHIO.

The city of Dayton lies in a valley surrounded by hills whose slopes drain very rapidly. At this point several streams unite to form the Great Miami river. This stream in summer is of insignificant proportions, but in late winter and early spring after a sudden rain or melting snow it rises in a few hours to the proportions of a great river. To protect the city from inundation, levees are maintained, but a rise in the river cuts off the sewers, and it is necessary to close the gates at the outfalls to prevent the river backing up into the streets and houses. At such times it is necessary to raise the sewage and discharge above the flood level. After careful investigation and some costly and unfortunate experiments with steam pumps and pneumatic ejectors, which either required too much attention or were too expensive or uncertain in operation, the city of Dayton decided to install automatic electric pumps. When electric motors were decided upon as the driving power, central station power was also accepted as the only satisfactory generating source, since power can be obtained on a moment's notice at any time, night or day. Consequently there is the entire elimination of steam boiler and engine troubles, as these are all cared for by the central station, which is running at all times, whether the water in the river is high or low. Were any other power adopted for the pumps, the maintenance and operating charges would be increased.

Three stations have so far been constructed in various sections of the city. The first is equipped with two vertical 2,500-gallon Brooks submerged centrifugals geared to 20-h.p., horizontal, three-phase, 60-cycle, squirrel-

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cage Westinghouse motors. The motors are started and stopped by standard oil switch compensators, which are operated by hydraulic pistons controlled by float switches designed and built by the Dayton Hydraulic Machinery Company under their patents. The lift is variable, averaging about 20ft. The discharge is through a check valve at a point below extreme high water. The operation of these pumps is entirely automatic, it being only necessary to inspect them occasionally and keep the oil receptacles filled. Upon notice of a rise in the river, the gates are closed and the current turned on, after which the pumps cut in and

FIG. 1.—Lehman Street Sewage Pumping Station.

cut out automatically with the rise or fall of the sewage in the pits.

The second station, at Longworth-street, has three units and the third station, at Lehman-street, two, each consisting of a double suction vertical submerged 4,500-gallon Brooks centrifugal direct connected to a 40-h.p., vertical, three phase, 60-cycle, 2,080-volt, squirrel-cage Westinghouse motor. The starting apparatus at these last two stations consists of floats which operate the valves on a hydraulic piston, using water under pressure from the city mains. On starting, this piston raises the lever on a Westinghouse

FIG. 3.—One of the 4,500-Gallon Centrifugal Pumps.

auto starter to the starting position, at the same time rotating an arm carrying a heavy counterweight, which by the time the motors have picked up speed, falls, and by means of a pawl drops the lever to the running position. On stopping, the reverse motion given the counterweights, moves the lift to the cut-out position. The operation of this apparatus is extremely satisfactory, and the motors cut in and cut out automatically with great regularity and

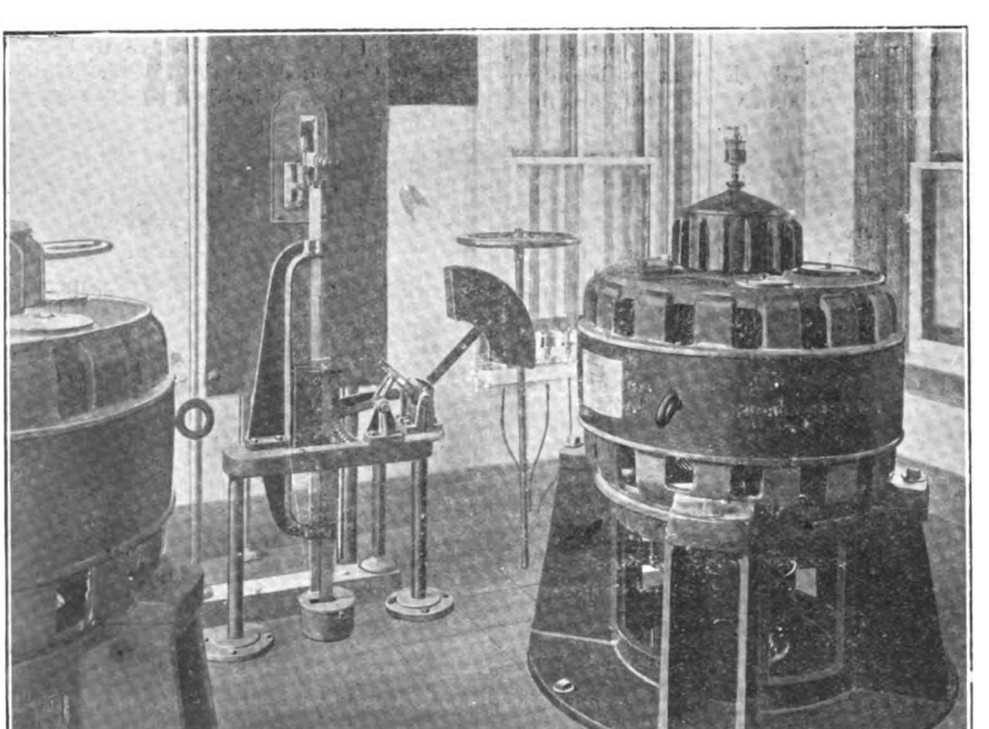

FIG. 2.—Interior View of the Station.

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smoothness. During a heavy rain, when the river was quite high, one pump was sufficient to take care of the flow in the sewers at the Lehman-street station when running three minutes out of each ten, being idle the remaining seven minutes.

THE FRANCO-BRITISH EXHIBITION.

Although many of the sections of the Franco-British Exhibition which make a special appeal to those visitors connected with or interested in the engineering industries are as yet incomplete, there is, nevertheless, sufficient to be seen already to justify the opinion which we expressed at the opening of the exhibition, that the engineering and the scientific exhibits would be of great and varied interest.

As to the exhibition itself, it is enough to say that the early good promise which it gave seems well on the way towards ample fulfilment. The grounds are tastefully laid out, the white palatial structures interspersed by lagoons or canals with high and white buildings being of uniform design and presenting a homogeneous appearance. The architecture embodies many imposing features, but particularly striking is the Court of Honour, which is of an Indian style of architecture, with its colonnades, its lake, and its gorgeous cascade. The illumination of the grounds and of the buildings afford various examples of the art of illuminating engineering. There are in all 75,000 incandescent electric lamps, each of 5 c.p., and 1,500 small arc lamps. The arrangements for the supply of electricity are under the control of the Hammersmith Borough Council, in whose area the exhibition is held, but the supply is taken from the station of the Kensington and Notting Hill Electric Supply Company which adjoins the exhibition, as well as from the Fulham Palace-road station of the Hammersmith Borough Council. Many of the Colonial pavilions contain their own plant for supplying electrical energy for power and lighting, but throughout the exhibition the chief buildings and the grounds are lighted by alternate sections of lamps which obtain their supply from one or other of the sources, thus removing every conceivable chance of a complete failure of supply for lighting. Adjoining the machinery hall are sub stations, in which the pressure of the electricity supply is transformed.

The machinery halls occupy three sides of a great court, and are splendidly spacious and airy. Unfortunately, these halls are far from completed. Even at the beginning of this week there were many stands without their exhibits, and a number of packing cases remained yet unopened. No catalogue has yet been issued and the stands have not been finally numbered, so that we must defer our notice of what is contained in the machinery halls until these are in a more complete and ordered state. We may just mention, in passing, however, that a number of leading firms have their exhibits quite ready, and these are already attracting considerable attention from the thousands of sightseers who flock to the machinery halls. Entering on the left side of the right wing of the building, one's attention and interest are raised first of all by Messrs. Crossley Bros., Limited, impressive display of gas and oil engines, patent gas plants, and working exhibits, which include gas-engines with direct-driven dynamos; and by Messrs. Mather and Platt's mechanical and electrical plant. In another portion of the buildings the stand of Messrs. W. H. Allen, Son, and Co., Limited, containing high speed steam-engines, oil-engines, dynamos, high and low lift turbine pumps, air-pumps, condensers, etc., makes a very effective display. The United Flexible Metallic Tubing Company, Limited, have a cabin made entirely of different sizes of the tubing, and it presents a very pretty appearance. A vertical gas-engine with continuous-current generator for 500 kw. was in the course of construction for the British Westinghouse Company. Of these and of the many other interesting exhibits more anon.

For the moment the feature of the machinery hall which is particularly noteworthy is the collective exhibit of the London electric supply companies. The history of the Electrical Section (the failure of the efforts of the Institution and the entry, at the last moment, of the electricity supply companies of London into the arena vacated by the Institution) is now well known, and we must heartily congratulate the conference of chief officials of the London electric supply companies, with Mr. Cunliffe Owen and Mr. F. J. Walker (hon. secretary) at their head, on their courageous and, as we feel sure it will turn out, successful effort. Many of the leading electrical firms are taking part in the display, but in most cases the stands were not yet finished when we visited it. Particularly striking is the small house furnished by Messrs. Waring and Gillow, Limited, which shows how admirably electricity is adapted to domestic purposes, and brings out to advantage the neatness and the economy of electricity. The dining-room is fitted with a three-light corona, and has its complement of electric hot-plates, kettles, and other dining-room utensils. A fine effect of the art of concealed illumination is obtained in the drawing-room, where the lamps are hidden behind the cornice, and the lights reflected from a cream-white ceiling. The kitchen has a complete equipment of heating and cooking apparatus, and demonstrations are being given of electric cooking, ironing, sewing, etc. All the kitchen apparatus were supplied by Messrs. Rashleigh Phipps and Co., 147, Oxford-street, London, W. The crowds that pass through these rooms show their appreciation of the electrical arrangements in no uncertain manner, and it is not too much to say that to many the domestic uses of electricity come as a great revelation.

The Science Section is now complete, and the exhibits collected are representative of the actual work of scientific exploration, and also of the history of scientific discovery, including some of the modern work in the various branches of experimental science. The "Magnetism and Electricity" Section contains a number of interesting historical exhibits of general physical interest, but it is particularly rich in early telegraph appliances invented by Wheatstone and others, as well as apparatus used in the development of wireless telegraphy by Marconi. A sequence of electric incandescent lamps shows the development of the present-day types from the historic original lamp made by Sir Joseph Swan. The first form of electric measuring instruments devised by Kelvin are shown, as well as later types, from Ayrton and Perry's designs to those more recently designed by Duddell and others. The first light sensitive selenium cells made by Shelford Bidwell are shown, as well as those used by Kerr in the earliest forms of apparatus for transmitting pictures by telegraphy. Amongst the exhibits of historic interest are to be found Leyden jars used by Cavendish in the eighteenth century, apparatus and material used by Joule, and some of the apparatus used by Kerr in making his electro-optic discoveries.

LIGHTNING ON A 72,000-VOLT TRANSMISSION LINE.

Mr. F E. Greenman, in a recent paper before the Chicago section of the American Institute of Electrical Engineers, gave some interesting observations as to lightning on a 72,000-volt line of the Grand Rapids-Muskegon Power Company between Grand Rapids and the two power-houses of that company. The majority of interruptions to service, he stated, were due to lightning. The pole line has a continuous grounded wire for lightning protection, and the transmission wires are placed two on a lower cross-arm and one on a short upper cross-arm. On the other end of this upper cross-arm is the grounded wire. He did not speak at all favourably of the grounded wire as a lightning protection. In some cases lightning would strike the transmission wire located below the grounded wire. He could not detect that the grounded wire had taken any discharges. Apparently the most satisfactory operation of the line has been obtained when no lightning arresters were connected at the terminals. With no lightning arresters in use, the discharges would enter the sub-stations, but would do no damage. With lightning arresters discharges would sometimes jump to the walls. In cold weather static discharges affect the pins; these are of wood simply boiled in oil, and are destroyed rapidly. Creosoted maple pins are being put on all cross-arms, and these give good service.

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ON FIRST-AID WORK IN CENTRAL STATIONS.

BY S. LEES.

In most manufacturing engineering concerns there is usually provision made for rendering "first aid" in cases of injury to limb, or where an employé may suddenly be taken ill. The arrangements provided vary from the modest roll of sticking plaster, in the case of a very small concern, to an elaborate outfit, including one or more ambulance carts, stretchers, etc., in the case of a large modern works. It seems somewhat strange that, even in these enlightened days, the necessity for proper first-aid appliances has not been fully recognised in central electricity works. Electricity we still hear spoken of as being still in its infancy, but, in the case of central-station supply, it is surely a rather robust infant by this time. The writer has, during many years' experience in central stations, not failed to observe the almost utter indifference which is often paid to this most important question of ambulance equipment. Why central-station managements, that lose no opportunity of advertising themselves as being all that is progressive and up to date, should show such disregard for a matter which may mean as much to them is a little hard to understand. It surely cannot be on the score of first cost and subsequent upkeep, as these items are comparatively trifling. In any works where there is running machinery accidents to employés are of frequent occurrence. Although these are mainly of a comparatively trifling nature if attended to at once, yet the needless suffering so frequently caused by the ignorance of unskilled persons, and the lack of proper appliances, is as undoubted as it is deplorable. By rough handling, or even the mere want of the slightest knowledge of how to support an injured limb, a simple fracture has been made compound, or even complicated. The method of arresting bleeding from an artery is quite easy, yet thousands of lives have been lost, the very life-blood ebbing away in the presence of sorrowing spectators perfectly helpless because none among them had been taught one of the first rudiments of instruction of an ambulance pupil — the application of an extemporised tourniquet.

The writer remembers a case of a labourer who fell from some scaffolding, cutting his head and arms severely. Although bleeding profusely the poor fellow had to remain in suffering until the arrival of the horse ambulance from a sub-fire station, owing to the utter lack of ambulance material. Yet this station was over 3,000 kw. in size, and had some 30 or 40 men always in or about the works. Another instance was that of a stoker who was severely scalded about the legs owing to a defective hot-feed tank. This case also had to wait until removal to hospital, as the works did not possess so much as a roll of sticking plaster. The writer has worked through a shift, until the usual relief arrived, with a hand almost pierced through caused by a collapse of some metal-work, nothing whatever being available for dressing the injured member beyond water and an handkerchief. This instance happened in a works of over 6,000 kw. Were it necessary, further instances could be enumerated of much suffering borne by station workers due to burns, scalds, and cut wounds, these being the most common form of accident met with in central-station work. And yet, notwithstanding, there are some otherwise well-meaning persons who seem to think that an electrical shock is the only mishap which can happen to station operators. A case in point was that of a municipal works, with which the writer was formerly connected, which once received a visit from the factory inspector. The result of his observations was shown some time after in the fixture of a fearfully complicated arrangement of solid bar steel guards, made up as a sort of hand-railing, encircling each piece of dynamo machinery in the engine-room. The addition of the railing at the commutator end of the machines was really an added source of danger owing to its close proximity to live metal parts, and to reduce risk of accident the staff found it necessary to insulate the upper portion of the railing with vulcanised fibre tubes, the rails for this purpose being dismantled in sections and the tubes slipped on whole. Although the works boiler-house was a veritable death-trap owing to unprotected gear, yet its existence was apparently forgotten, or perhaps the inspector's uniform was given first consideration—anyway, accidents were of frequent occurrence owing to unguarded gearing on stoker and motor drives. These included rope, belt, chain, and wheel gearing, which, excepting some flimsy tin-can affair on the latter, were all unprotected by guards of any description. Even the motor-starting switches and light fittings were operated by the broom-handle—a not uncommon method in a good many central-station boiler-houses.

It is the duty of managing authorities to see that a complete ambulance outfit is provided, and, further, it is equally as important that they insist on their workers being efficiently trained in first-aid work, probably under the auspices of the St. John Ambulance Association, whose regulations are, perhaps, too well known to need describing at any length here. The value of first-aid appliances depends almost entirely on the rapidity with which they can be obtained, and, in case of accident, the benefit of a complete ambulance outfit on the spot is incalculable. Such outfits should always be kept in accessible places, and, preferably, never under lock and key. Whilst some managements have recognised the importance of providing first-aid material, they have gone just a little bit too far in the matter of keeping the outfit safe from misuse, and while the material is available for use during office hours, it cannot be obtained after the offices are closed—*i.e.*, during nights or at week-ends. That this is a fact the writer knows from painful experience. Another point is the careless way in which ambulance material is handled. A not uncommon sight is that of a sheet of wool or lint reposing on a bed of greasy packing; bottles of Carron oil and Friar's balsam unstoppered and exposed to dust and dirt; and if a piece of sticking plaster is requested it is cut by means of a pair of scissors lately used for cutting off a length of graphite packing. The importance of proper lavatory arrangements goes without saying, and whilst attention is given to this in all well-appointed stations, yet there are not wanting instances where practically no accommodation whatever for this purpose exists. This may seem to be a lamentable state of things in an industry which boasts of its progressiveness above all things, but it is nevertheless a fact.

The following list of ambulance outfits is given as affording a wide variety of choice in the matter of selection, as it is practically impossible to lay down hard-and-fast rules as to what is suitable for this or that station without knowing something of local conditions:

Small Ambulance Hamper, with waterproof cover and strap, for use in stations, factories, etc., containing one set splints, one elastic tourniquet, three tampons for washing wounds, two packets lint, four roller bandages (wide and narrow), four triangular bandages, cotton and boric wool (in tin cases), spool of adhesive plaster, knife, scissors, thread, tape, needles, and pins. Weight complete, 6½lb.; length, 1ft. 6in.; depth, 5in.; width, 7in.; price, £1. 11s. 6d. This size is exceedingly compact and of very handy form, and would be very suitable for small stations.

The undermentioned first-aid box is designed to be placed on the litter (Ashford 1899 model), which will be described later, but is further adapted to be hung up on a wall. A detachable leather handle is also fitted for carrying purposes. Contents: one set wooden splints, one elastic band tourniquet, carbolic wool, boric lint (in tin cases), one roll adhesive plaster, 12 roller bandages (assorted), six triangular bandages, three pieces tape, one pair scissors, one knife, one kidney-shaped basin, one graduated measure, 2oz. each olive oil, tinct. eucalyptus B.P.C., sal volatile, and spirits ether comp., 8oz. Carron oil, pins, safety pins, needles, and thread. Price complete, £2. 10s.

Large Ambulance Hamper, suitable for large stations and tramway and railway purposes. — The hamper contains one set cane splints, one elastic band tourniquet, ½lb. carbolic cotton wool and ½lb. boric lint (in tin cases), one roll adhesive plaster, 20 roller bandages (assorted), one dozen triangular bandages, three pieces tape, 4oz. sal volatile, 4oz. bicarbonate of soda, 4oz. olive oil, 4oz. spirit ether comp., ¼lb.-tin powdered boric acid, 4oz. tinct. eucalyptus B.P.C., one pair Péan's forceps, one pair scissors,

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one knife, one dozen surgeon's needles, one packet each safety and plain pins, ½oz. carbolised Chinese twist, ½oz. silkworm gut, one reel each black and white sewing thread, one kidney-shaped basin, one stopper loosener, one graduated measure, one cake 20 per cent. carbolic soap, one nail brush, three empty 8oz. bottles. Price complete, £4.

A "stretcher" is an indispensable adjunct to an ambulance outfit, and should be provided in all stations. The "Furley" ordinary stretcher for general use, complete with webbing slings, costs £1. 17s. 6d. An improved pattern of the "Furley" stretcher is provided with telescopic handles, for greater convenience of working in confined situations. Price, £2. 3s. 6d.

For stations of large size or in cases where a works is out of easy reach of a recognised ambulance depôt, a litter should always be provided. The "Ashford" litter (1899) consists of a two-wheeled undercarriage fitted with springs, and either of the "Furley" stretchers, mentioned before, with a cover so arranged on a jointed frame that it can be folded up inside the stretcher or with a hood and apron. The undercarriage having a cranked axle, the bearers can pass between the wheels with the stretcher, and thus avoid lifting it over them. When travelling, the legs of the undercarriage are raised, and thus form the handles by which to propel it. Should it be necessary to pass over rough ground two bearers can easily lift the litter and patient. The "Ashford" litter, complete with ordinary stretcher and iron tyres to wheels, costs about £12. 17s., or if fitted with indiarubber tyres, £16. 2s. With the telescopic handled stretcher the price runs about £13 5s. and £16. 10s. respectively.

The following is a list of text-books, etc., on first aid: "First Aid to the Injured," by James Cantlie, M.B, F.R.C.S., the authorised text-book of the first-aid course; 1s. Dr. G. H. Darwin's "First Aids," a card to hang up, giving treatment of various accidents; 2d. "Directions as to the Restoration of Persons Suffering from Electric Shock," large print, poster size; 3d. each, or 2s. 6d. per dozen. "Aide Memoire," on cardboard in linen-lined envelope for the pocket, by the late Surgeon-Major P. Shepherd, containing useful hints for first aid to the injured; 3d. "Emergency Book," for instantaneous reference, giving concise instructions, to hang on wall; size about 1ft square; price, 2s. 6d. "How to Act when Clothing takes Fire", by J. E. H. Mackinlay, M.R C S.; unmounted, 2d.; mounted on card and varnished, 4d.

An oil lamp, preferably of the watchman type, should always form part of an ambulance outfit—in fact, a few such lamps are a good investment for any station, as the electric light, notwithstanding its many advantages over some other forms of illumination, is not yet quite infallible. Another useful stand-by for use in emergency is gas. This may, perhaps, sound rather funny to some readers, but the writer was formerly connected with a station which had a gas service laid on, and the management made it a strict rule that two jets were to be always kept burning above the main switchboard from dusk to daybreak. In this instance "the light that *didn't* fail" was blessed on more than one occasion, when the network insisted on giving the station a holiday, of a sort.

The question of "electric shock" received wide consideration some short time ago, and at the present time most stations have adopted the rules suggested in an excellent publication issued by a contemporary journal, and others those of the "directions" listed above. In passing, mention should be made of the absurd to length which some authorities have gone in the matter of *protecting* their workers from the electric shock, the while making no provision for a first-aid outfit. This is well illustrated in the instance referred to earlier in the article, and which, by the way, is by no means an isolated case.

There will be a good many readers who, in common with the writer, have worked in central stations where certain shifts were worked on a one-man plan, usually on the score of economy. It is enough to make one pause and consider what might happen (more, what has happened) in such cases were a worker so placed rendered incapable of attending to his work through an accident or sudden illness. It is hardly to be wondered at that committees sometimes get hold of an idea that anybody can run an electricity works when they discover that their precious station is run for quite long periods by one man, and he getting maybe but a small fraction of the salary rate paid their chief engineer.

In all stations the addresses of at least two medical men (preferably connected by telephone), and also the 'phone numbers of the nearest hospital and ambulance depôt, should be kept posted up in a prominent position in the engine room.

All the stores, etc, mentioned in the foregoing article may be obtained from the St. John Ambulance Association, St. John's-gate, Clerkenwell, London, E.C., to whom also the writer's thanks are due for the facilities granted him in describing same.

ECONOMICAL ASPECTS OF THE VARIOUS ELECTRIC ILLUMINANTS.*

The cost of light production is a decisive criterion for the selection and final adoption of a certain illuminant. Of course, it cannot be denied that other qualities and features of a lamp, as size or candle-power, light distribution or polar curve, also the colour of the light, have to be taken into first consideration, and that very often a certain lamp drops out of the discussion before the question of economy arises. Nobody, for instance, would consider a flaming arc lamp instead of an incandescent lamp when the illumination of a small living-room is concerned, or an incandescent lamp for the illumination of a large thoroughfare, or a mercury-vapour lamp for a ballroom. As soon, however, as a certain set of lamps is found suitable for a particular purpose at hand the relative cost will determine which lamp should be given the preference.

Furthermore, attention must be called to the fact that the latest developments in the art of lampmaking have markedly disarranged and shifted the relative territories of the various lamps. The enclosed arc lamp has found a strong competitor in the tungsten lamp, the flaming arc lamp in the mercury-vapour quartz lamp, etc, so that a readjustment of the boundaries is timely and desirable. A general and up-to-date survey of the whole field of lighting will, therefore, convey a clear and comprehensive idea of the present situation and considerably assist the estimating illuminating engineer.

The actual or total cost of light production per mean spherical kilocandle-hour is made the basis for the following discussion. It involves not only the cost of electrical energy consumed by a thousand mean spherical candles per hour, but also takes into account the cost for maintenance and renewals. Depreciation and interest of the invested capital will not be considered separately, as they do not materially influence the cost of the kilocandle-hour; moreover, it is impossible to subject the investment cost to the general rules, as the cost of the general outfit of an arc lamp would come in the same category as the cost of fixtures, or at least of shades or reflectors of incandescent lamps, and this would lead too far. The ballast resistance of an arc, vapour, and Nernst lamp must certainly be included in the calculations not only as far as the energy consumption of the lamp is concerned, but also, as in the case of the Nernst lamp, in connection with the renewal cost.

The cost of energy consumption per kilocandle-hour:

$$C_c = R \times S \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

R = rate for electric energy per kilowatt-hour; and
S = specific watt consumption per mean spherical candle.

The present article takes into account the mean spherical candle-power as a basis for all lamps. The writer does not consider it feasible to compare mean spherical candles of incandescent lamps with mean hemispherical candles of arc lamps. It would be possible and, perhaps, also correct to make the mean hemispherical candle the basis for both types of lamps employing reflectors in the case of incandescent lamps, and assuming that for both classes of lamps all light is utilised in one hemisphere. The light absorp-

* Abstract of an article by A. A. Wohlauer in *Electrical World*.

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TABLE I.

Illuminant.	A	V	W	L_h	L_s	S_h	S	P	l	C_r	Rating.	$C_t = S_s \times R + C_r$ Rate R in pence per kilowatt-hour. 1	2	3	4	5	6
Incandescent Lamps.																	
Carbon	·31	110	50	20	13·2	2·8	3·8	8	450	1·35	16 c.p.	5·15	8·95	12·75	16·55	20·3	24·1
Gem	·45	110	50	26·5	16·5	1·9	3·05	10	450	1·35	20 c.p.	4·4	7·4	10·5	13·5	16·6	19·6
Meridian	2·3	110	250	130	82	1·9	3·05	35	450	·95	100 c.p.	4	7·05	10·1	13·1	16·2	19·2
Nernst	1·0	110	110	79·4	42·5	1·37	2·6	32·5	500	1·5	110 watt	4·1	6·7	9·3	11·9	14·5	21·6
Tantalum	·36	110	40	25·5	17	1·57	2·3	25	700	2·25	20 c.p.	4·55	6·8	9·1	11·4	13·7	16
Tungsten	·91	110	100	115·0	72	·87	1·4	100	800	1·8	80 c.p.	3·2	4·6	6	7·4	8·8	10·2
Direct-Current Arc Lamps.																	
Open arc	10	55	550	725	400	·76	1·3	4	10	1	10 A., 2 in series	2·3	3·6	4·9	6·2	7·5	8·8
Enclosed	5·0	110	550	435	260	1·16	2·1	4·5	150	·1	5 A., 110 V.	2·2	4·3	6·4	8·5	10·6	12·7
Carbone	10	110	1,100	950	550	1·16	2·0	4	16	·5	10 A., 110 V.	2·5	4·5	6·5	8·5	10·5	12·5
Miniature	2·5	110	275	220	150	1·25	1·8	3	20	1	2·5 A., 110 V.	2·8	4·6	6·4	8·2	10	11·8
Magnetite	3·5	110	385	400	225	·96	1·7	5	150	·155	3·5 A., 110 V.	1·85	3·55	5·25	6·95	8·6	10·3
Flaming	10	55	550	1,200	600	·4	·75	8·5	10	1·2	10 A., 2 in series	1·95	2·7	3·45	4·2	4·95	5·7
Blondel	5	55	275	1,080	550	·255	·5	17·5	18	1·25	5 A., 2 in series	1·75	2·25	2·75	3·25	3·75	4·25
Inclined flaming	10	55	550	2,150	1,100	·255	·5	9	10	·8	10 A., 2 in series	1·3	1·8	2·3	2·8	3·3	3·8
Inclined enclosed flaming	5·5	100	550	2,200	1,500	·25	·365	15	70	·155	5·5 A., 110 V.	·52	·88	1·26	1·61	2	2·34
Alternating-Current Arc Lamps.																	
Open arc	15	—	530	470	300	1·10	1·75	5	13	1·1	15 A.	2·85	4·6	6·35	8·1	9·8	11·6
Enclosed	7·5	—	600	350	230	1·7	2·6	4·5	100	·2	7·5 A.	2·8	5·4	8	10·6	13·2	15·8
Flaming	10	—	330	750	425	·4	·8	8·5	7	2·8	10 A.	3·6	4·4	5·2	6	6·8	7·6
Inclined flaming	10	—	550	1,950	1,000	·3	·55	9	10	·65	10 A.	1·45	2	2·55	3·1	3·65	4·2
Blondel	10	—	350	1,400	715	·265	·5	12·5	15	1·15	10 A.	1·65	2·15	2·65	3·15	3·65	4·15
Mercury-Vapour Lamps.																	
Cooper Hewitt	3·5	110	385	—	770	—	·5	600	4,000	·2	3·5 A.	·7	1·2	1·7	2·2	2·7	3·2
Quartz	4·0	220	924	—	2,740	—	·33	350	1,000	·125	4·2 A.	·42	·72	1·02	1·32	1·62	1·92

tion due to the reflectors, however, has not the same value for the different types of reflectors, and in the case of arc lamps a certain amount of light is thrown uselessly into the other hemisphere, so that the adoption of the mean spherical candle-power is preferable as the most correct basis, while the mean hemispherical candle-power is stated in every individual case, allowing a loss of 20 per cent. of light with incandescent lamps for absorption in the reflectors.

The cost for renewal and maintenance is

$$C_r = \frac{P \times 1{,}000}{l \times L_s} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

wherein

L_s means spherical candle-power;
l = life of lamp for incandescent lamps,
life of glower for Nernst lamps,
life of electrode for arc lamps,
life of vapour tube for vapour lamps;
P = price of bulb for incandescent lamps,
price for renewal of glower, ballast, and for Nernst lamps,
price for renewal of electrodes and trimming for arc lamps,
price for tube for vapour lamps.

As the average life of the glower of Nernst lamps is 500 hours, and the ballast and heater last about 2,000 burning hours of the lamp, the price for renewals on Nernst lamps during the period of the life of the glower consists of the price for glower plus a quarter of the cost for ballast and heater. The cost for trimming of arc lamps varies between 1d. and 2½d. per trim on multiple circuits, as was ascertained by the writer from a number of reliable sources, and the corresponding value is added to the price of electrodes. The total or actual cost of the kilocandle-hour will be thus

$$C_t = C_c + C_r \quad . \quad . \quad . \quad . \quad . \quad (3)$$

These three formulæ have been used to calculate the data given in the table and diagram. The abbreviations used in the table mean: A = current in amperes; V = voltage of the line; W_t = total watts; L_h = mean hemispherical candle-power; L_s = mean hemispherical candle-power; S_h = watts per mean hemispherical candle; S_s = watts per mean spherical candle; P = renewal cost per trim or life; l = life of lamp or electrode; C_r = renewal cost per kilocandle-hour (pence); C_t = total cost per kilocandle-hour (pence); R = rate per kilowatt-hour (pence).

The lamps represented in the table may be considered as typical or normal for the special kind of lamp in question, the data regarding quality and performance of the lamps are taken from trade and other publications, and it has been endeavoured to give proper values for each lamp without palliation or misrepresentation; the prices are standard or average trade prices. Some of the lamps are comparatively new to the general public, especially the mercury-vapour quartz lamp, which is a new type of lamp not yet manufactured in this country. The chamber containing the mercury is made of quartz, which has a very high melting point and considerable heat-resisting ability. For this reason, it is possible to use a much higher current temperature and vapour pressure in quartz lamps than have been customary in mercury-vapour lamps, and, consequently, an increase of the efficiency of the lamp is obtained. The Carbone lamp is also comparatively unknown in this country; it may be called an arc lamp with inclined normal carbon electrodes yielding a rather long arc of a sun-like colour, and possessing somewhat longer life than

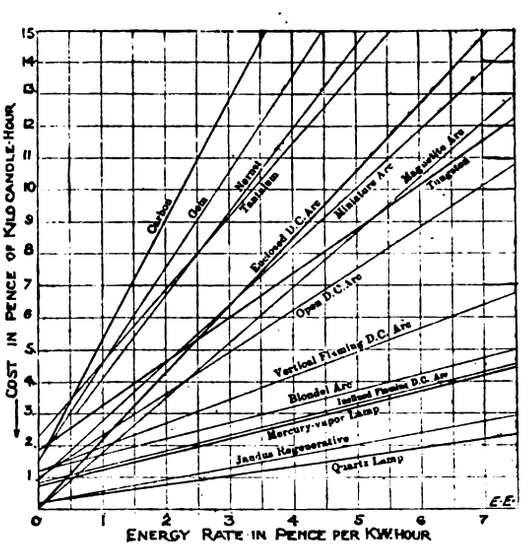

FIG. 1.

the vertical open arc carbon lamps. Another lamp has become of interest of late which might be classified as an "enclosed flaming arc lamp." The commercial name of it is "Jandus regenerative arc lamp." It has been described recently in the English technical Press. As stated there, the lamp is intended mainly for street, open space, and workshop lighting, indicating that the annoyance from fumes and gases has not yet been overcome, although its efficiency is greater and its life is considerably longer than that of the ordinary flaming arc lamp. All the other lamps have been freely described in standard periodicals, and do not require any special mention.

Table I. gives the total cost of light production for different rates for energy varying from 1d. to 6d. per kilo-

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watt-hour, and Fig. 1 is the graphical illustration thereof. In general the table is self-explanatory and does not require any further comment. The influence of the renewal cost is obvious, being comparatively small for higher energy rates, but of intrinsic significance if efficient illuminants are used at a low rate for energy. The advantage of the mercury-vapour lamp over the flaming arc lamp is due to the low renewal cost of the former; the superiority of the tungsten lamp over the enclosed miniature arc lamp is also remarkable. If one compares the cost of the kilo-candle-hour of the old carbon incandescent lamp at a rate of 5d. per kilowatt-hour—namely, 20·3d.—with the latest mercury-vapour quartz lamp at 1·62d., he is in a position to appreciate the progress which has been made in increasing the efficiency and decreasing the cost of light production.

THE KEARNEY HIGH-SPEED RAILWAY.

The experimental model of the above railway which has been on view this week in Aldwych has been widely advertised and visited by a large number. To everyone attending, the policeman at the door has handed a description of the Kearney high-speed railway and a prospectus of the Kearney High-Speed Railway Company, Limited, with an invitation to subscribe to this company. The capital asked for is only 9,500 shares of £1 each, and it is clear that the company aim at a larger flotation in time. In view of the financial facts we feel called upon to deal somewhat plainly with this so-called high-speed railway. It is, perhaps, best to take the inventor's own description of his invention, and the following are extracts from the pamphlet above referred to:

The Kearney high-speed railway system, which is now introduced for the first time in its present form, is the result of some six years' experiment, following upon an exhaustive research into the numerous systems of railway which have from time to time been introduced for the purpose of reducing the cost or increasing the speed as compared with the ordinary twin-rail road. The causes of the want of success of previously conceived "monorails" have been entirely eliminated, the result being a method so completely simple and effective as to immediately allay the doubts of those who look upon any great advance upon the express railway speed of to-day as a hazardous undertaking. On the Kearney system the cars are gripped top and bottom by a single line of wheels engaging on two rails, one vertically over the other, so that derailment is physically impossible unless an actual breakage of the permanent way is effected. The centre of gravity being very low with electrically-driven cars, owing to the motors being directly coupled with the axles, the presure of the guide wheels on the top rail amounts only to a few pounds when the car is at rest, and practically to none at all when the train is running at speed on the straight. It is only on curves that any appreciable stress is put upon the top rail, and then only when the running speed exceeds or falls below the speed for which the line is constructed. With electric traction it is easy so to control the speed of trains that they will travel at any given rate over any given portion of a line of railway, but even if this were not the case, danger of derailment is out of the question with the Kearney system. The top rail, which would be more strongly supported on curves, would effectually correct any tendency of the train to leave the track. As the result of innumerable experiments it has been determined that the safety and economy of the Kearney system depend on the correct design of the guide wheels. No other form than that employed combines immunity of derailment with entire absence of rubbing friction, at the same time rendering possible a simple arrangement of the guide rail at points and crossings.

Travelling by tube when the Kearney system is employed will be a very different proceeding from the present-day experience. The platforms will be constructed immediately below the street level, and intending passengers will merely have to walk down an easy flight of stairs similar to those in Kingsway giving access to the London County Council tramway; the delay caused by lifts will be non-existent, and the passenger will step into the train at once by one of the numerous self-operating doors. No opposing stream of humanity will block his way, as on Kearney tubes people will get in on one side and go out on the other. Immediately he has taken his seat, the signal will be given, and he will experience rapid acceleration, but no jerk. The train will glide smoothly and quickly out of the station, and every wheel being equipped with its own little motor, the maximum amount of tractive force is obtained. Having passed the end of the platform, our passenger will be conscious, owing to the increasing hum of the wheels on the rails, and for no other reason, that the train is gathering speed at a tremendous rate. For some seconds the train will be running down a gradient of 1 in 7, so that in about 200 yards and 17 seconds in time from the station the train will reach a depth of 90ft. below the station level. Our passenger will not be conscious of sitting on an inclined plane during this downward rush, owing to the forces due to acceleration exactly counterbalancing the effect of the gradient. He will, therefore, not be subject to the jerks and consequent discomfort experienced on the present railways during the starting and stopping of the trains, and yet within 20 seconds of leaving the platform he will have been accelerated to a speed of 50 miles an hour!

Supposing the stations to be 1,000 yards apart (which is rather more that the average distance on the existing tubes), the train will now run along a level stretch of line for a distance of about 600 yards, and, maintaining its speed of 50 miles an hour, will cover the distance in 24 seconds. The rise into the next station will then commence, and our passenger will be whirled up an incline similar in every respect to the one he has just come down. During the ensuing 17 seconds the train will be losing speed as rapidly and as easily as it acquired it, and, again, our passenger will not be conscious that he is sitting on a considerably inclined plane—the opposing forces of gravity and retardation again exactly counterbalancing each other. Only when the train has reached the level alongside the platform, and the brakes are gently applied, will he realise the slackening speed. As the train stops he will notice the doors on both sides of the car glide apart, and he will hear a voice reminding him that it is "This side out," and if he attempts egress on the other he must not mind suffering the inconvenience and loss of time to which he is accustomed on other railways. If he still lingers on the platform wondering the while at the new experience, he will see the doors close behind him and the cars disappear into the bowels of the earth. And by the time he has walked leisurely up the single flight of steps to the street level the train will be half-way to the next station.

To give some idea of what Kearney tubes will do for London, the schedule of times below will be of some interest. The basis of calculation is that the stations are on an average placed every 1,100 yards, and that a stop of half a minute is allowed for each. It may be remarked that on the existing tube with end doors only 10 seconds is allowed for stops at many of the stations. As it is proposed to adopt numerous side doors on Kearney tube trains and run the trains between two platforms, so as to separate the outgoing from the incoming passengers, it will be realised that an average stop allowance of 30 seconds is really somewhat excessive, so that the results in the table are not so good as they would probably be in practice. It must also be remembered that there is an average loss of four minutes per journey on the existing tubes owing to the lifts, and this time is not included in the estimated point-to-point times given in the schedules of the tubes of to-day.

	Time by present system.	Time by Kearney system.	Distance in miles.	Stops.
		Min.		
Marble Arch to Cricklewood ...	17	8½	4	5
Marble Arch to Victoria	5	2½	1¼	1
Strand to the Crystal Palace ...	30	15	7½	9
Strand to Alexandra Palace ...	26	13	6½	8
Putney to Victoria	17	8½	4¼	5
Piccadilly-circus to the Bank...	8	4	2	2
Monument to Tottenham	26	13	6½	8

The cost of tubes on the Kearney system should not exceed £250,000 per mile as compared with £500,000 required for ordinary tubes. The working expenses for any given train service will also be reduced to about half in the case of the Kearney system. The immense economies effected will be better understood when it is stated that had the existing tubes been constructed on the Kearney system, the poorest of these lines would now be returning a dividend of 10 per cent. on the capital involved if only the same traffic was carried. But as the speed would have been double the present speed, and the inconvenience caused by the use of lifts avoided, it is reasonable to suppose that a much heavier traffic would have resulted.

This description and the prospectus, which we have neither the space nor inclination to print in full, will, in our opinion, lead some people to the idea that the whole system shown in Aldwych is new and protected by the Patent No. 17,583, which the new company will acquire from Mr. Kearney. Hence it will be well to refer to this patent before taking shares in the company, and we were not surprised to find that the Patent Office have not granted a patent for much that is old in Mr. Kearney's railway. The patent granted to him is for

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"Improvements in grooved wheels for mono-railway and tramway systems." According to the specification :

The primary object of the invention is to provide a construction of wheel whereby the contact between the same and the rail or guide therefor is reduced to a minimum and a good rotating action of the wheel is secured when this is in contact with the rail. In the latter connection the groove in the wheel is preferably made wider than the bulb-shaped head of the rail or guide so that both the sides of the groove will not make contact with the rail of guide at the same time. According to my invention instead of making the groove of the wheel to correspond with the guide-rail head and arranging the latter to extend practically to the bottom of the groove, I arrange the wheel and the guide-rail head so that when the latter is in contact with the wheel it will touch on the sides or a side of the

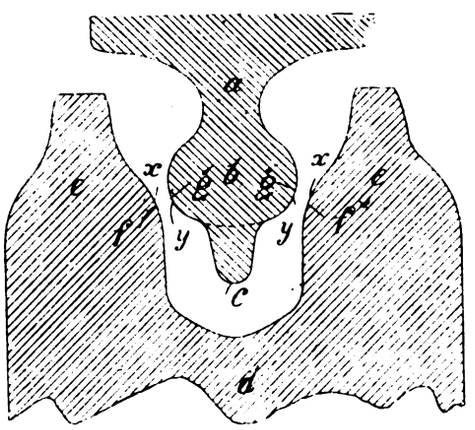


FIG. 1.

groove thereof only, the contact parts of the sides of the groove being rounded or curved oppositely to the curvature of the guide-rail head so that the contact is made between convex surfaces and point contact between the guide-rail head and the wheel can therefore only take place at any given instant.

The two drawings reproduced herewith will show how the above idea is carried out, and the claims in the patent read :

1. In grooved wheels for engaging guide rails having bulb-shaped heads, forming the sides of the grooves of the wheels with convex surfaces between which only and the guide rails contact takes place, substantially as and for the purpose described.

2. The combination with a guide rail having a bulb-shaped head with or without a rib such as c, of a grooved wheel the inner sides of the flanges of which are formed with convex

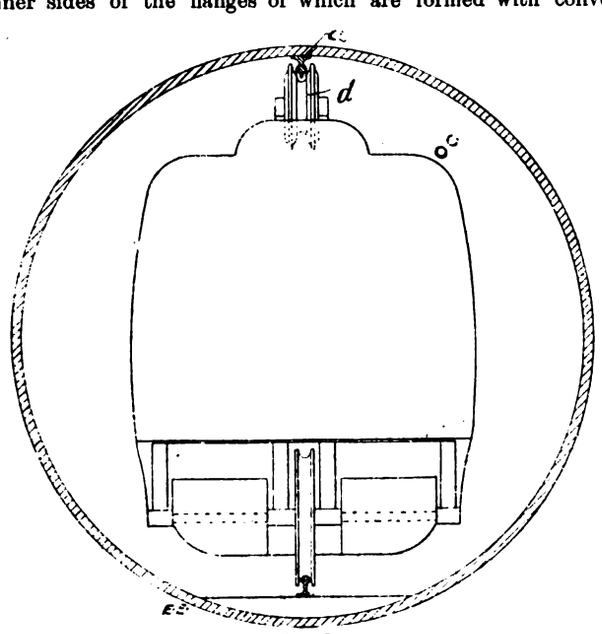


FIG. 2.

surfaces for contact with the rail head laterally such lateral contact being the only contact between the wheel and the rail substantially as and for the purpose described.

The rest of the details of the Kearney high-speed railway are apparently not protected because they are old, and we deprecate the way in which this matter has been placed before the public.

REACTIVE-COIL PHENOMENA.

When the source of E.M.F. is withdrawn from a simple reactive coil, either by breaking a direct current or by subsidence of the wave of an alternating current, the voltage upon and current therein induced falls off from the initial value, at first somewhat rapidly and then more slowly, in an exponential curve, as shown in Curve 2 of Fig. 1; the controlling elements being the reactance and the resistance of the circuit. But when a closed secondary coil is added, the primary current at first falls off very rapidly, at a rate approximately corresponding to the self-inductance reactance of the stray field between the primary coil and the secondary coil. At the same time there appears in the secondary coil a current which rises at first very rapidly, and then more slowly, reaches a maximum, and then gradually drops. As soon as this rise of current in the secondary coil slows up and ceases, the fall of the primary current also becomes less rapid and ultimately very

FIG. 1.

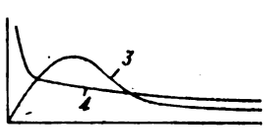


FIG. 2.

slow, so that the primary current is maintained over a period much greater than is the case without the secondary coil. This interaction of the two coils is shown in Fig. 2, where Curve 3 represents the rise and fall of the secondary current, and Curve 4 represents the changed primary current due to the retarding of the drop in voltage by reason of the counter-action of the secondary coil.

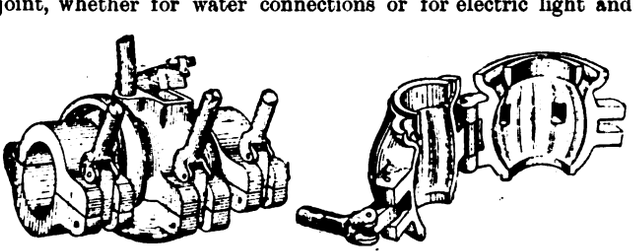
According to a patent issued April 7, Dr. C. P. Steinmetz proposes to employ short-circuited secondaries in connection with the reactive coils of mercury-vapour rectifiers in order to obtain a discharge curve extending over a long period of time. The secondary coil has fairly good mutual inductance with the main coil, but there is some stray field between the two coils.—*Electrical World.*

GRAPHITIC THERMO-ELECTRIC COUPLE.

In order to obtain an inexpensive thermo-electric couple for measuring temperatures of molten metals, Mr. W. H. Bristol employs for the two elements different forms, kinds, or grades of carbon or graphite. These elements are capable of withstanding extreme temperatures and they do not appreciably alloy with most molten metals. In a patent issued April 21, it is stated that a particularly satisfactory couple can be made by using as one element pure carbon or graphite and combining from 15 to 20 per cent. of Bavarian clay with carbon or graphite to form the other element.—*Electrical World.*

DEVICE FOR WIPING LEAD JOINTS.

A labour-saving device designed for wiping any kind of lead joint, whether for water connections or for electric light and



telephone cables, is shown herewith. The apparatus is known as the Corcoran wipe-joint machine, and it is said will wipe branch joints as well as horizontal joints. A feature of the device is that by it a stronger and more perfect joint is possible than by the old method, because a richer solder can be used. The solder is heated in an ordinary soldering pot, and the machine is clamped around the parts to be joined and the solder poured in the trough, which has been previously heated by a

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blow-torch. The machine is moved back and forth a few times and then allowed to stand for a minute. When the excess solder in the trough has hardened it is removed and the machine unclamped. Clamps at either side of the device serve to centre the machine directly over the joint to be made. No solder is wasted by the device, and it is made in various sizes to fit standard pipes and cables. The clamp is manufactured by the Wipe-Joint Machine Company, of Cleveland, Ohio.—*Electrical World.*

PROTECTION OF ELECTROSTATIC VOLTMETERS.

Electrostatic voltmeters are nowadays not so much in favour for use in electrical control systems as they were some years ago. There is, however, one field of application for such instruments where they are still used very considerably. We refer to their use as ground detectors on high-tension circuits. According to the Home Office regulations, on every completely insulated system in a coal mine a ground detector must be kept connected up continuously in circuit, which shall indicate the leakage current. As is well known, this regulation cannot be carried out, as no method is known whereby the leakage current of, for example, a 2,000-volt three-phase circuit can be continuously indicated. On such circuits, therefore, an attempt is made to comply with the spirit of the regulation by installing three electrostatic voltmeters connected between phases and ground. Messrs. Ferranti Limited have got out an instrument containing three electrostatic voltmeters in one case for this purpose. A rather unfortunate property of electrostatic voltmeters, however, is that they sometimes spark across internally. If some means of protection is not provided, this generally results in the instrument being burned out.

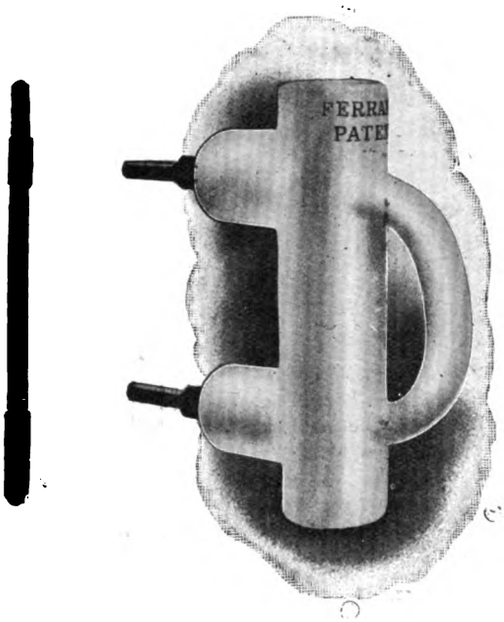

FIG. 1.

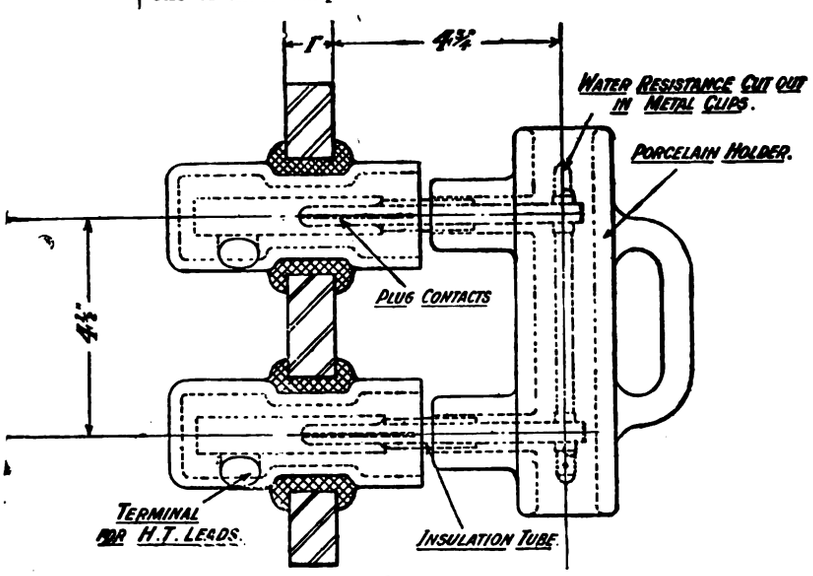

FIG. 2.

Fuses of the oil type, and of other types, have been used for this purpose without success. The amount of current which passes through even the smallest practical fuse is sufficient to burn up the delicate vanes of the electrostatic voltmeter. Fuses in combination with choke coils and resistances have been used, but their success, however, is very questionable, and, moreover, they are expensive and cumbersome. If the choke coil be allowed to get dirty or wet it will break down, and is itself then the cause of trouble. The resistance cut-out (Garrard's patent) manufactured by Messrs. Ferranti Limited, Hollinwood, Lancs., has been put on the market as a solution of the problem. The apparatus consists of a small glass tube (Fig. 1) filled with water of a certain conductivity corresponding to the voltage of the supply. A small valve is provided in the glass tube near the bottom, consisting of a hole covered with a piece of rubber tubing. This water-tube resistance is placed in series with the electrostatic voltmeter. The current is led in at the bottom of the glass tube, and taken out at the top by means of platinum wires fused into the sides of the tube. The whole thing is enclosed in a removable porcelain handle (Fig. 1), and the method of mounting is shown in Fig. 2. The resistance of the water-tube is so adjusted that if sparking occurs, for any reason, within the voltmeter, the current is limited to such an extent that but a few watts are liberated in the water-tube. If the current continues to flow the water is heated and boiled, and a slight jet of steam issues from the valve above referred to, interrupting the circuit.

The device has been subjected to very severe tests, such as placing it directly across the terminals of a 3,000-volt alternator, when the circuit was interrupted so quietly as to be scarcely perceptible. The device is now in successful operation in many parts of this country and abroad. It is to be noted that this resistance cut-out is only suitable for protecting electrostatic voltmeters, and is not, for example, intended for protecting synchronising transformers.

FOOTLIGHTS IN A CHICAGO CHURCH.

Those interested in providing good church illumination have doubtless met with the objection sometimes made by ministers and public speakers of having all light come from above, so that the eyebrows shade the eyes. In the Hyde Park Presbyterian Church in Chicago this has been overcome by placing a pair of footlights in each corner of the pulpit. These footlights are in boxes sunk level with the floor, each box containing a 32-c.p. lamp with a conical mirrored concentrating reflector pointed in the direction of the minister's face. There is thus one of these lamps on each side and a little in front of the minister. The footlight boxes are covered with diffusing glass so as to soften the glare.

PUBLICATIONS RECEIVED.

"THE LAW OF PATENTS, DESIGNS, AND TRADE MARKS." Published by Cruickshank and Fairweather, Limited, Glasgow and London.

"ELECTRO-METALLURGY," by John B. C. Kershaw, F.I.C. London: Archibald Constable and Co., Limited, 10, Orange-street, Leicester-square, W.C. 6s. net.

Programme for the session 1908-9 of the Department of Technology of the City and Guilds of London Institute, containing regulations for the registration, conduct, and inspection of classes, and examination of candidates in technological subjects, and for the award of teachers' certificates in manual training and domestic economy.

ELECTRICAL ENGINEERS (LONDON DIVISION).

Orders for week ending Saturday, June 27.

MONDAY, JUNE 22.—"A" Coy.—Technical instruction for recruits, 6 p.m. to 9.30 p.m.

TUESDAY, JUNE 23.—"B" Coy.—Technical instruction for recruits, 6 p.m. to 9.30 p.m.
Medical inspection for recruits, 6 p.m. to 8 p.m.

THURSDAY, JUNE 25.—"C" Coy.—Technical instruction for recruits, 6 p.m. to 9.30 p.m.

FRIDAY, JUNE 26.—"D" Coy.—Technical instruction for recruits, 6 p.m. to 9.30 p.m.

SATURDAY, JUNE 27.—(Plymouth)—N.C.O.'s and men attending this camp will parade at 10.30 a.m., G.W.R., Paddington.

(Signed) J. H. S. PHILLIPS, Captain,
Acting Adjutant.

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TO CORRESPONDENTS.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed. Letters should reach the Editor not later than Wednesday afternoon to be included in that week's issue of the Journal.*

LONDON ELECTRIC POWER BILLS.

The House of Lords Committee presided over by Lord Cromer resumed consideration of the London Electric Power Bills on Tuesday. The whole of the opposition to the London and District Electric Power Bill has been heard, and it was arranged that Mr. Fitzgerald, leading counsel for the promoters, should defer his reply till he opposed the companies' Bill. Mr. Balfour Browne, K.C, thereupon opened the case for the London Electric Supply Bill, which is being promoted by the eight existing electric companies for the incorporation of a joint committee representative of the companies, and to link up the existing stations and supply electric energy for power purposes. Mr. Browne contended that this was the best scheme for bringing about a supply of cheap electricity, as it meant utilising existing resources on which £14,000,000 capital had been expended. The Bill provided for the ultimate transfer to the London County Council or some other authority of the whole unified system at the expiration of a certain term. Power was taken for erection of buildings in five years for the generation of 27,000 kw. for the joint committee, the plant to be owned and worked by the companies, and the joint committee to pay for the work upon agreement or arbitration terms. Two of the companies had placed at the disposal of the joint committee plant for 11,000 kw. The capital proposed for the preliminary works and for trunk mains was £1,000,000, and this was to be guaranteed by six of the companies, and he anticipated that there would be no difficulty in raising this money at 4 per cent. on the guarantee of dividend-paying companies. The revenue of the joint committee would be distributed, first, in the payment of interest on the guaranteed stock; secondly, in creating a sinking fund on the basis of 42 years. Beyond a profit of 6 per cent. the amount would be shared between the generating companies and authorised distributors in the proportion of two-thirds to the latter. The promoters believed that for the near future an additional 23,000 kw. would be sufficient. Income would be mainly derived from authorised distributors. If a railway entered into a contract with the companies or committee, special plant would be provided. For tramway purposes the promoters did not expect a demand. The question of supplying in bulk had been carefully considered by the companies. The six principal stations of the joint committee scheme were: at Bow (owned by the Charing Cross Company), Bankside (City of London Company), Wandsworth (County of London Company), Deptford (London Electric Company), Willesden (Metropolitan Company), and Blackwall (South Metropolitan Company). Altogether there were 14½ acres now unoccupied by buildings, and the present average capacity was 14,860 kw. The engineers of the companies had come to the conclusion that the way to solve the problem of a cheap supply was by the method proposed in the Bill. With the proposed expenditure and use of existing buildings and sites the growth of the demand in London for electrical power for the next five or six years would be met. The capital cost of plant and transmission mains for supplying a load of 25,000 kw. from steam-turbine plant erected at Barking (as proposed by the new company) would be £1,137,630. On the other hand, the items on the plant on the existing sites of the companies made a total of £843,658. The working expenses were: for the new scheme with 97,350,000 units delivered, £197,280; by the proposals in the present Bill, £178,866; the cost per unit being ·486d. and ·441d. The promoters asked for a modification of existing purchase powers. Two dates for purchase were provided, 1932 and 1952, and the purchase would be effected by the London County Council or other authority authorised by Parliament, by redemption of the joint committee's stock minus the amount of the sinking fund. The authority would have the option of purchase in 1932, and if they exercised it they would have to give compensation for loss of profit to the joint committee between 1932 and 1952, to be determined by arbitration.

Mr. J. S. Highfield, chief engineer to the Metropolitan Electric Supply Company, was called in support of the opening statement, and gave evidence on the Bill. The view of the promotors was that as over the whole of the London area distributing mains were laid for supplying low-tension current to power users, who were comparatively small consumers, the existing network should be utilised. He urged there should not be new mains laid down with the extra cost of pulling up the streets and laying ducts, thereby increasing the cost of supply to small users. There existed already mains adequate to supply any expected demand in the near future.

Mr. J. Conacher, general manager to the Metropolitan Electric Supply Company, said the restriction upon association by the companies had resulted in a large number of separate systems of supply, and the Bill offered the best means of bringing about the unification of the different systems in London. He expressed an opinion that there would be no difficulty in raising the £1,000,000 capital at 4 per cent, seeing that there would be the guarantee of six companies distributing £331,000 in dividends after paying debenture interest.

ELECTRIC LIGHTING AUDITS.

The President of the Board of Trade was asked in the House of Commons whether his department had decided in future to accept the audit of electric lighting companies' own auditors as sufficient for the purposes of a public audit under the Electric Lighting Acts.

Mr. Churchill replied in the negative. He thought there was some misapprehension as to the action taken by the Board of Trade in regard to the audit of the accounts of electric lighting companies. The Board continued to carry out their statutory duty of appointing official auditors who were specially instructed to direct their attention to the protection of the interests of the consumers and of the possible purchasing authority, and who were responsible for this audit to the Board of Trade. The official auditors appointed by the Board to audit the accounts of electric lighting companies for the year 1907 were professional accountants, who were in a good many cases, but by no means in all, identical with the shareholders' auditors.

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This was an arrangement which he was informed avoided a certain amount of unnecessary duplication of work, though it carried with it some possible disadvantages. It had not been adopted in any case in which the local authority was empowered to purchase the undertaking at a price dependent on the amount of capital expenditure, and he would watch the progress of the arrangement carefully in case it should be necessary to make any change.

FIRES IN ELECTRIC LOCOMOTIVES.

Mr. A. P. Trotter, electric adviser to the railway department of the Board of Trade, has issued a report on the fire which occurred on May 24 in an electric locomotive belonging to the City and South London Railway Company at the Clapham Common Station. In the course of his report Mr. Trotter says:

There seems to be no evidence to show that the fire was due either directly or indirectly to the electric current, and it is impossible to connect it with any electrical cause. It seems to have burned most fiercely at the corner where a cupboard stands, and at the opposite corner where there is a considerable collection of insulated cables. The contents, including controllers and other machinery above the floor level, were destroyed. A little woodwork remained not quite burned, and this was extinguished by the firemen. The amount of wood has been reduced in the newer locomotives. The carriage next to the locomotive was uninjured inside, the glass of the door was broken by heat, and the paint blistered. If any servants of the company had been present when the fire first broke out it could have been extinguished in a few minutes, but being allowed almost to burn itself out, it afforded an interesting and satisfactory test. The wooden platform showed no traces whatever, and the only signs that there had been a fire were a little smoke on the roof, split tiles, and the partial burning of a few feet of wood moulding round the advertisements. The complete escape of the carriage coupled to the locomotive is a point in favour of separate locomotives. The cause may have been (1) a lighted match thrown down by a man just before leaving, or (2) the emergency oil lamp which may not have been extinguished, or (3) spontaneous firing of oily waste in the cupboard. No large amount of oil waste is kept on the locomotives, and spontaneous firing, I believe, does not occur with small quantities.

MUNICIPAL ELECTRICITY ACCOUNTS.

CROYDON.

The statement of accounts and balance-sheet relating to the county borough of Croydon for the year ended March 31, 1908, shows that the total capital expenditure at that date amounted to £341,411. The total income last year under revenue account £66,937, and the total expenditure £31,133, leaving a gross surplus of £35,800. The following is an abstract of the revenue account for the year ended March 31, 1908:

Income.

Sale of current, etc.	£58,110
Public lamps	7,555
Meter rents	971
Sundry receipts	231
Balance from last year's account	70
	£66,937

Expenditure.

Generation	£19,210
Distribution	2,587
Public lamps	1,404
Rents, rates, and taxes	2,462
Management expenses	3,625
Insurance, parliamentary, and other expenses	462
Sundry expenditure	1,383
	£31,133
Balance to net revenue account	35,800
Balance carried forward	4
	£66,937

From the net revenue account £5,000 has been transferred to the reserve fund, which now stands at £22,410, and £3,000 has been allocated to improvements in public lighting and distribution, leaving a balance to that account of £14,490. The number of Board of Trade units generated during 1908 was 7,005,141, compared with 6,027,338 in 1907. Of last year's number 5,875,003 units were sold, 592,228 units were used on works, and 537,910 were unaccounted for. The number of public lamps last year were 418 arcs and 142 incandescent lamps, against 418 arcs and 134 incandescents in 1907. The total maximum supply demanded was 3,255 kw. last year; the demand during the previous year was 3,381 kw.

COLCHESTER.

The statement of accounts relating to the working of the Colchester Corporation electricity undertaking to the year ended March 31, 1908, states that the capital expenditure at the end of the year was £76,923, against £71,276 at the end of 1906-7. The revenue for last year amounted to £14,406, and the expenditure to £9,467, leaving a gross profit of £4,933, which bore a ratio of 6·65 per cent. to capital. The percentage of gross profit to capital in 1906-7 was 7·97 per cent. Interest on loans absorbed £2,109 and sinking fund £2,850, against £1,919 and £2,391 respectively in the preceding year. The financial result of last year's working was a deficit of £22; the result of the previous year was a surplus of £1,224. The capacity of the dynamos at March 31, 1908, was 2,030 kw., compared with 1,280 kw.; the maximum load reached 886 kw., against 852 kw.; the load factor was 17·75, against 16·33; the number of 8-c.p. lamps connected at end of year was 47,370, the figures for the preceding year being 42,371; the units sold numbered 1,381,842, against 1,218,637; and the units sold per 8-c.p. lamp (connections during year being averaged) being 19, against 17.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' Visit to Newcastle-on-Tyne.

We have received a programme of the visit to Newcastle arranged by the Students' Section. The party will leave St. Pancras Station on Monday, July 6, at 9.30 a.m., arriving at Derby 12.30 p.m., and will visit at 2.30 p.m. the works of the Midland Railway Company; the party will proceed from Derby by the 4.45 p.m. train, arriving in Newcastle at about 8 p.m. On Tuesday, July 7, the works of Messrs. Ernest Scott and Mountain will be visited. On Wednesday visits will be paid to the works of Messrs. Armstrong, Whitworth, and Co., Limited, and to the works of Messrs. J. H. Holmes and Co. The works of Messrs. Clark-Chapman, Limited, and the Consett Ironworks will be visited on Thursday, and the shipyards of Messrs. Swan, Hunter, and Wigham Richardson, and the Horden Collieries, Limited, on Friday, the tour winding up with a visit on Saturday to the Carville power station of the Newcastle Power Company.

The tickets for the return journey from London will cost 28s. 4d. each, and may be obtained direct from Messrs. Thos. Cook and Sons, of Ludgate-circus, on addressing a written request to them. The special tickets are only available to travel from London by the 9.30 a.m. train on Monday, July 6, and to return by the 12.42 p.m. train from Newcastle on Saturday, July 11. Arrangements have been made with the County Hotel, Newcastle, and members of the party will be accommodated on the following terms: (*a*) bed and breakfast, including attendance, 5s. 6d. each per day; (*b*) inclusive terms, 10s. 6d. per day, including bed, light, attendance, and all table d'hôte meals.

It is suggested that those taking part in the visit meet together for dinner at the hotel on Friday evening, July 10.

A few days previous to the date of the visit a final list of detailed arrangements will be forwarded to members of the party.

APPOINTMENTS VACANT.

Engineer Fitter, St. Patrick's College, Maynooth. Applications to Mr. S. Sharp, 34, Great George-street, London, S.W. See advertisement.

Senior Draughtsman. Well versed in design and manufacture of high-lift turbine pumps. Applications to No. 858, *Electrical Engineer* Office. See advertisement in last issue.

Charge Engineer, Bristol Corporation, Avonmouth sub-station. Salary, 25s. per week, rising to 35s. Applications to the city electrical engineer, Mr. H. Faraday Proctor. See advertisement.

Head of the Physics and Electrical Engineering Department, Northern Polytechnic Institute, Holloway, London, N. Salary, £300 per annum. Applications by June 29. See advertisement in last issue.

FORTHCOMING EVENTS.

Institution of Electrical Engineers.—Thursday, June 25, annual conversazione at Natural History Museum.

Incorporated Municipal Electrical Association. — Tuesday, June 30, to Friday, July 3, inclusive, annual convention at Nottingham.

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COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER.

The eleventh ordinary general meeting of the Aron Electricity Meter was held on Tuesday, Mr. H. Hirst, M.I.E.E. (the chairman), presiding.

The CHAIRMAN said it was only six months since he had the pleasure of addressing the shareholders of the Company and putting before them in very great detail the present financial position, so that he had very little to say except to place before the meeting a report of the six months' work, which, he was pleased to say, had borne out their prognostications. They had had a record six months in their history, as a glance at the credit side of their profit and loss account would show. The figures on the debit side were in close resemblance with those of their last balance sheet, allowing for the fact that it deals with only half the period. As regarded the balance sheet, a slight increase in stock and outstandings was due to the increased business. The rest of the items were similar to the previous report, except that loans against short notice had been reduced by £4,000, but cash at bankers and in hand was increased by more than that amount. He next referred to two events of special interest to the Company. One was that the Board of Trade had passed their prepayment meter for alternating currents—up to the present the only alternating-current prepayment meter on which this distinction has been conferred—and if they might be so sanguine as to hope that that system of metering would become as popular for electric light as it had become in certain quarters for gas, it was bound to prove a good thing for them in the future. The system of prepayment had not, as would be understood, hitherto been much in demand for electric light whilst the electric light was the commodity for the rich and more luxurious classes, but now, with the cheapening of the supply and the advent of the Osram and other metallic-filament lamps, which saved from 50 to 70 per cent. of the current, electric lighting bade fair to become the poor man's illuminant as well. There was reasonable ground to hope that the business in these prepayment meters—familiarly known as the "penny-in-the-slot" meters—might assume considerable dimensions. The second incident of considerable interest to the meeting was their success with a taximeter.

Mr. ROGER W. WALLACE, K.C., seconded the motion, which was carried unanimously.

The dividend of 7 per cent. recommended by the directors on account of arrears on the preference shares was approved.

BRUSH ELECTRICAL ENGINEERING.

The nineteenth ordinary general meeting of the Brush Electrical Engineering Co. was held on Tuesday, Lord Vaux of Harrowden (the chairman) presiding.

The CHAIRMAN, in moving the adoption of the report, referred at the outset to the reduction of capital. In fixing the reduction of 13s. 4d. per share, they naturally took into consideration the fact that the reserve funds would be absorbed in the general writing down of the assets. Both the general reserve fund and the reserve fund for depreciation of plant and buildings had, therefore, disappeared, and they had also absorbed the carry forward from 1906, and the fund they had established to provide for risks under the Workmen's Compensation Act at the time they were bearing these risks themselves. It would be seen from the balance-sheet that the depreciation reserve fund of £58,500 had been written off the item "property," and that property account, after adding expenditure during the year, stood at £300,051. The patents and goodwill account had been written down by £81,397, and now stood at the round figure of £100,000. Investments had been written down from £164,522 to £101,335. The item of stock showed a large reduction, mainly due to the fact that they entered the fiscal year 1907 with an abnormally heavy amount of work in progress, and in December last a special effort was made to get as much as possible finished and invoiced before the close of the year, so that on Jan. 1, 1908, the work in progress was comparatively small. Turning to the other side of the balance-sheet, it would be seen that reduced preference and ordinary share capital stood at £340,976. As regards loans and advances, the loan from the British Electric Traction Co. at the end of 1907 was £43,324, but that sum had since been somewhat reduced. The bank overdraft showed a reduction of about £20,000 compared with the figure in the previous balance-sheet, while the amount owed by them on trade accounts was about £48,000 less. The output from the works for the year had been a record one, but unfortunately a good deal of the business done had to be taken at very low prices, and profits had been quite disproportionate to the amount of work turned out. That unsatisfactory result was due to three principal causes: (1) strenuous competition; (2) the after effects of the strike of some of their workmen; (3) insufficient working capital. With regard to the first of these causes, he was glad to say that signs were not wanting in the electrical engineering industry of a desire on the part of manufacturers to hold out for better prices, and prices which would at least give some reasonable prospect of a living profit being earned. They hoped, therefore, that some improvement might be looked for, although it would be understood that, exposed as the British manufacturers were to unrestricted foreign competition, any general movement to enhance prices was badly handicapped, and until some amelioration came in that direction it must remain a hard struggle. As regarded the strike, there was no doubt that, coming as it did, just at a time when the shops were pressed to their utmost capacity, the effects were very serious and far reaching. It was not possible to immediately replace a large number of workmen who had become accustomed to their methods and to their class of work, and who had arrived at a certain standard of efficiency; and although they were able to fill up the places of the men who left, it was only after a lengthy weeding-out process, extending over many months, that they reached anything like their former efficiency in the shops affected. Another disability under which they had been working, and which had had an adverse effect upon profits, was the lack of sufficient working capital. With regard to future prospects, they hoped that the demand for tramcars for use in the United Kingdom would show some revival before long. During the last two years the number of enquiries for tramcars and trucks in this country had been very small, and that had compelled the Company to cultivate foreign markets, but they preferred home orders if they were to be obtained at fair prices. At present there was a temporary lull in the demand for main-line rolling-stock. Contracts of that class were peculiar, in that they usually came in groups, and were generally of considerable magnitude, so that it was difficult to take the same advantage of the demand when it arose as would be the case if the requirements were more regular and sustained. For steam and electrical plant the demand was of a more regular character, but owing to the great competition, both home and foreign—the latter especially—it was not easy to keep the shops filled with orders at remunerative prices. He hoped that before long some means might be found which would enable electrical manufacturers to supply their products at a fair margin of profit. In the meantime, every means possible to economise on working expenses and establishment charges by concentration and otherwise were being taken. Before concluding, the chairman made a short announcement of a a personal nature. He had now, he said, had the honour of being their chairman for some years, but he found that other interests had grown and that it was difficult to devote as much attention as was necessary to the affairs of the Brush Co. The Brush Co. now more than ever required daily personal attention, and though he came to London every week his home was in the country. Under these circumstances, Mr. Garcke, who was in former days intimately associated with the Company, had consented to take a seat on the Board and to accept the office of chairman for the present. Mr. Garcke informed him that although he was willing to do so now he could not promise that it would be a permanent arrangement, as other and important interests had to be considered. Though resigning the office of chairman, he would retain his seat on the Board and continue to do all in his power to further the interests of the Company.

Mr. W. L. MADGEN, M.I.E.E., seconded the motion, which was unanimously adopted.

The retiring director (Mr. Madgen) was re-elected, after which the CHAIRMAN proposed that Mr. Garcke be elected a director of the Company, which was seconded by Mr. MARCHMENT and agreed to.

An extraordinary general meeting was then held to consider a resolution to subdivide the shares.

The CHAIRMAN moved: "(1) That each of the 150,000 fully-paid non-cumulative 7 per cent. preference shares of the Company of £1. 6s. 8d. each be subdivided into four fully-paid non-cumulative 7 per cent preference shares of 6s. 8d. each; (2) that each of the 105,732 fully-paid ordinary shares of the Company of £1. 6s. 8d. each be subdivided into four fully-paid ordinary shares of 6s. 8d. each."

The resolutions were seconded and carried unanimously, and a vote of thanks to the chairman concluded the proceedings.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

An extraordinary general meeting of shareholders in the Buenos Ayres and Belgrano Electric Tramways Co. was held last week, Mr. J. B. Concannon (chairman of the Company) presiding.

Mr. J. BARBER GLENN proposed a resolution contained in the notice convening the meeting, which was to the effect that upon the completion of the sale of the Company's undertaking, under the agreement dated April 20, 1907, between the Company and La Compagnie Générale de Tramways de Buenos Ayres, the sum of £7,500 be paid to the directors as additional remuneration for their special services in negotiating and carrying into effect such sale, and authorising them to also pay additional remuneration, not exceeding the amount of £5,000, to the officers and servants of the Company. To his knowledge the directors had had a very large amount of work to do, and they had brought to bear upon the sale of the undertaking an amount of technical skill which was not often found in the city of London.

Mr. F. H. SIMPSON seconded the motion, which was agreed to unanimously.

BIRMINGHAM AND MIDLAND TRAMWAYS.

The twenty-fourth ordinary general meeting of the Birmingham and Midland Tramways was held last week, Mr. C. S. B. Hilton, chairman of the Company, presiding.

The CHAIRMAN, in moving the adoption of the report, explained that the income of the Company was derived from three distinct sources: (1) tramways; (2) electric supply; and (3) investments in subsidiary companies controlled and worked by a joint committee. Referring to the balance-sheet, he said capital remained at the same figure as last year. The loan from the City of Birmingham Tramways Co. remained at the same figure—namely, £75,000. Depreciation and reserve remained at the same figure—namely, £79,743. Renewals account had been raised to £4,000 by the addition during the year of £1,500, and it was the intention of the directors to add to this fund yearly, in addition to finding the necessary amount for the redemption of debentures, and when possible adding to the general reserve for all purposes. Finally, there was transferred to the profit and loss account £58,471. Capital expenditure had been increased by £25,000, less an amount of £644 which had been realised by sales. Of this sum £8,714 had been spent on the tramway account and £16,105 on electric supply. Investments had been increased during the year by a small sum of £3,500, and was represented by debentures in the

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Motor Omnibus Co. Turning now to the profit and loss account, the traction section showed a decrease in traffic receipts of £13,640, which was accounted for mainly by the fact that during the first six months of 1906 the receipts on the Dudley line came into the coffers of the Company. The lease had since expired, so they no longer got those receipts. The expenses, on the other hand, showed a decrease of about £4,200 on the working account, and a total decrease of £6,000. These expenses would have been reduced still further but for the increased rental which was now payable to the Corporation of Smethwick in consideration of an extension of tenure which was granted by the Corporation. With regard to the lighting and supply section, they had had an increased sale by meter amounting to £2,200, which was most satisfactory. The current supply for traction purposes had declined by £1,200, due to the loss of the supply to the lines in Birmingham, but there was a net gain in receipts of £1,000, whereas expenses had only increased by £122. This side of their business continued to show a marked and satisfactory increase, while the expenses, owing to the largely increased output from the station, continued to fall. He was sorry to see that there was a tendency in every direction to endeavour to reduce the price of current, but the policy of the directors had been, and would be, to take no business that did not show a fair margin of profit on its own merits. The chairman then referred to the investments of the Company and to the motor service.

Sir ERNEST SPENCER seconded the resolution, which was carried unanimously.

Sir E. Spencer and Mr. J. A. Lycett were re-elected directors of the Company.

R. WAYGOOD AND CO.

The eighth general meeting of R. Waygood and Co. was held on Tuesday at the Cannon-street Hotel, Cannon-street, E.C., Mr. Henry C. Walker presiding.

The CHAIRMAN, in moving the adoption of the report, congratulated the shareholders on the result of the year's working, the balance-sheet being an improvement on any previously submitted. The engineering trade throughout the country, he said, had been very bad during the past year, and competition exceedingly keen, which had made it necessary to do a larger turnover, in order to maintain the same profit. The directors had been able, by dint of hard work, and the hearty co-operation of their employés, to accomplish that result. Owing to the condition of the money market in the early part of the year a number of bad debts had been incurred. The management had been able to secure a continuation of the work in the direction of fitting lifts in ocean liners. Following the successful installation of passenger and goods lifts in the "Lusitania" and "Mauretania," the Company had fitted up several large ships for other lines. The output during last year had been larger than in any previous 12 months, both in tonnage and in number of lifts, which, including hand lifts, had been between 1,000 and 1,100. Among special places where they had fitted their lifts during the period under review might be mentioned Chatsworth House, Derbyshire, and Compton House, Eastbourne, for the late Duke of Devonshire, and they had also carried out work for other members of the nobility. They had been also successful in obtaining orders from various Government departments, hospitals, infirmaries, hotels, railway companies, clubs, and co-operative societies, and they had also completed one of the cliff lifts at Bournemouth for the Corporation. Lifts in some cases might be called luxuries, but, as a rule, they were necessities, and but for the modern lift, which R. Waygood and Co. had been pioneers in bringing to its present state of efficiency, the advance of the building and allied trades could never have been what it was. The profit on trading (£61,327) showed a considerable advance on that of last year. An interim dividend on the ordinary shares of 5 per cent. had been paid, and the directors now recommended the payment of 7 per cent. for the six months ending March 31, 1908, making 6 per cent. for the year, carrying forward a balance of £3,544.

Mr. R. PERCY SELLON seconded the motion, which was carried unanimously.

ALUMINIUM CORPORATION.

The report of the Aluminium Corporation for the period since its incorporation on April 10, 1907, to March 31, 1908, states that good progress had been made with the Dolgarrog works, for the construction of which the Company was primarily formed. The buildings of the power-house and furnace-house are completed, much of the plant is already installed, and as soon as the pipe line is finished the production of aluminium at these works will commence. The pipe line is expected to be ready for service in August next, and the existing natural storage afforded by the Company's water rights should give ample water power during the earlier stages of production in the summer until the works come into full operation. Since the date of the prospectus it has been decided not to erect a sub-station near the works of the North Wales Power Co., but to put such sub-station at Dolgarrog, thus concentrating all the works under the same roof. While this has involved the construction of a transmission line, the materials for which were furnished by the North Wales Power and Traction Co., the additional cost will be amply justified by the resulting convenience and economy in operating. The Wallsend works, which were referred to by the chairman in his address to the statutory meeting, are now completed and partially in operation. Aluminium of high quality is being produced. In conjunction with the furnace-house, carbon works have been erected on an adjoining site capable of manufacturing carbon electrodes to supply the whole of the Company's requirements at Dolgarrog as well as at Wallsend. The leases of valuable bauxite properties in the South of France have been acquired, so that the Company is now mining its own bauxite for the production of alumina, instead of purchasing the latter in the open market, as was at first contemplated. In conjunction with one of the largest chemical companies in Great Britain, the Corporation is forming the Bauxite Refining Co., and will hold three-fourths of its shares. The refining company will purchase bauxite from the Corporation at a price more than sufficient to cover the cost of production, and will supply alumina to the Corporation at a fixed rate of profit. In addition to the demand for aluminium in ingots there is a very large demand for sheets, and the directors have accordingly concluded arrangements with an important company to erect and equip rolling mills, which will supply the Corporation's requirements for aluminium in sheets at a fixed and reasonable rate of profit. The developments referred to have necessitated further financial provision, and £150,000 first mortgage debentures have been created. Arrangements are being made for the issue of £100,000 of these debentures, and shareholders will be given an opportunity of applying for them. They will give a first charge over the whole undertaking, and the holders will be entitled to exchange them at their face value for 7 per cent. participating preference shares at any time before Dec. 31, 1913, when the debentures are redeemable.

BUENOS AYRES GRAND NATIONAL TRAMWAYS.

The report of the Buenos Ayres Grand National Tramways Co. for the year ended March 31 last states that the gross receipts of the lines operated by the Company (consisting of the Company's lines and those of the Buenos Ayres New Tramways Co.) amounted to £380,969, as compared with £321,256 for the previous year. The working expenses amounted to £242,118, as compared with £220,389. The net receipts amounted to £138,851, as compared with £100,867. The Grand National Co.'s share of the net receipts amounted to £91,447, as compared with £68,406. After payment of London administration expenses, interest on debentures, etc., there remained a balance of £37,841, from which £3,502 has been transferred to debenture reserve funds and £3,726 to income bondholders' interest account. The directors recommend to place £3,293 to contingency fund (bringing that fund up to £7,000), and that £4,819 be carried forward. Continued progress has been made with the work of converting for electric operation the joint system of this Company and of the Buenos Ayres New Tramways Co., and of constructing further lines authorised by concessions from the municipality of Buenos Ayres. At March 31, 1908, there had been converted a total length of 85¾ miles, of which about 81 miles were being operated.

NEW COMPANIES REGISTERED.

Premier Electric Heaters.—Registered June 4. Capital, £2,000 in £1 shares. Objects: to adopt an agreement with G. H. Collins and H. F. Collins for the acquisition of the business carried on as the Premier Electric Heating Co. Registered office: Ashley-street, Birmingham.

Kirkstall Forge Co., Limited.—Registered June 5. Capital, £150,000 in £1 shares (133,500 preference). Objects: to carry on the business of manufacturers of iron and steel forgings, steel converters, iron and steel manufacturers, iron, coal, metal, and general miners, smelters of ores, metals, or minerals, salt masters and manufacturers, engineers, ironmasters, and founders, general contractors, makers of railway rolling-stock, engine, carriage, wagon, and motor builders, etc. No initial public issue.

Leeds and Bradford District Electric Railways, Limited.—Registered June 5. Capital, £60,000 in £1 shares (40,000 preference). Objects: to adopt an agreement with the Railway and Tramway Trust relating to the transfer to the company of the Morley and District Light Railway Order, 1901, etc., and to carry on the business of tramway, railway, omnibus, electrical, steam, or other mechanical carriage and van proprietors, carriers of passengers and goods, electricians, electrical, water, and gas engineers, suppliers of electricity, etc. No initial public issue.

Liens Registered.

British Hosiery and Electrolytic Bleaching Co., Limited, Nottingham and London.—A memorandum of satisfaction in full of a debenture, dated Dec. 21, 1905, securing £250, has been filed.

Nigeria Bitumen Corporation, Limited, London, E.C.—Particulars required by Sub-Section 4, Section 14, of the Companies' Act, 1900, May 20, relating to a series of £25,000 debentures of £3,125 each. No trustees. Property charged: all rigs and other oil-boring apparatus and machinery in the colony of Southern Nigeria.

Phillips's Commutator Grinder Co., Limited, London.—Issue on May 8 of £100 5 per cent. debentures, part of series created Aug. 19, 1904, to secure £5,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £850.

St. Helens Cable and Rubber Co., Limited, Warrington.—Trust deed registered May 19 for securing £100,000 debenture stock. Trustees: T. O. Callender and D. Sinclair. Property charged: freehold and leasehold hereditaments situated at St. Helens and Warrington; also the undertaking and assets, present and future, including uncalled capital.

Electrolytic Alkali Co., Limited, Middlewich.—Issue on May 23 of £500 and on May 25 of £100 4½ per cent. debentures, part of series created July 9, 1904, to secure £50,000. Charged on the company's undertaking and property, including uncalled capital. Trustees: Liverpool Mortgage Insurance Co., 6, Castle-street, Liverpool. Total amount previously issued of same series, £36,900.

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Sunderland District Electric Tramways, Limited.—A trust deed dated May 29, 1908, to secure £20,000 5 per cent. prior lien debentures, has been registered. Property charged: benefit of the Houghton-le-Spring and District Tramway Order, 1900, tramways, fixed machinery and plant, two acres of freehold land at Newbottle, Durham, and the company's undertaking and other assets, including uncalled capital. Trustees: C. S. Cockburn, Sutton Rock, Chesterfield, and C. Eves, Capel House, 54, New Broad-street, E.C.

Buenos Ayres Electric Tramways Co. (1901), Limited.—An acknowledgment of indebtedness under seal, dated May 27, 1908 (supplemental to a trust deed dated March 30, 1906, and acknowledgment of indebtedness dated March 7, 1907), to secure a further £20,000 second or "B" debentures, making, with £51,600 already created, a total of £71,600, out of a total authorised sum of £100,000, has been registered. Property charged: Certain tramway concessions, freehold land rights, and the company's undertaking and property, present and future, including uncalled capital. Trustees: W. Greenwell, 2, Finch-lane, E C.; and F. C. Tearks, 145, Leadenhall-street, E.C.

Sumatra-Deli Rubber Estates, Limited. — Particulars of £50,000 debentures, created by resolution of May 13, and secured by a trust deed dated May 20, 1908, have been filed pursuant to Section 14 (4) of the Companies Act, 1900. The above-mentioned trust deed has also been registered. Property charged: By debentures—The company's undertaking and property, present and future, including uncalled capital. By trust deed—Two concessions or leases for the carrying on of an agricultural undertaking on lands in Sumatra known as the Laut Tador and Mendaris plantations, and the company's undertaking and property, present and future, including uncalled capital. Trustees: M. Kempner, Berlin, and F. W. Darch, 20, Eastcheap, E C. An issue on May 20 of £30,000 5 per cent. debentures, part of above-mentioned series, has also been registered.

Nairobi Electric Power and Lighting Co., Limited.—£6,000 6 per cent. first mortgage debentures, created July 24, 1907, and dated May 29, 1908, have been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital, but excluding (*a*) £1,500 deposited in the joint names of the Crown Agents for the Colonies and the National Bank of India; (*b*) uncalled capital on 10,000 preference and 6,000 ordinary shares of £1 each; and (*c*) a contract dated July 26, 1906, and power conferred thereby, save so far as the company shall hereafter, with the previous consent in writing of the Commissioner for the East Coast Protectorate or the said Crown Agents on his behalf, subject the same to such charge. No trustees. Issue on May 27 of £200 debentures, part of series created April 8, 1908, to secure £4,000. Property charged: as above. No trustees. No previous issue of same series. A memorandum of satisfaction in full of five scrip certificates, four dated Oct. 30, 1907, and one dated April 23, 1908, securing £5,450, has also been filed.

PERSONAL.

Mr. Groves, manager of the Peterborough Tramways Co., has been appointed to a similar but more important office in the city of Worcester.

Mr. E. J. Lecot has been appointed sole representative of Messrs. Tuck and Co., the well-known asbestos packing and rubber manufacturers.

Mr. Sydney Potter, chief electrical engineer to the Birmingham Tame and Rea District Drainage Board, has accepted an important appointment in Mexico, and sails shortly on the Cunarder Compania."

The Partick Town Council have increased the salary of the burgh electrical engineer, Mr. W. Sillery, by £100 per annum, and that of the chief clerk, Mr. A. E. Thomas, by £14, and that of the station superintendent, Mr. S. Littlehailes, by £10 per annum.

We are informed that Messrs. L. E. Wilson and Co. have opened a branch establishment at New York Buildings, 67, Stanley-street, Liverpool, and have appointed Mr. F. L. Monkhouse, late manager in Liverpool for the Walsall Electrical Co., as managing engineer.

Mr. A. V. Mason, manager of Devonport and District Tramways, has been appointed general manager of the South Metropolitan Electric Tramways and Lighting Co.'s system at Sutton. Mr. C. W. Durnford, engineer under the South Metropolitan Co., has been appointed to succeed Mr. Mason at Devonport.

Mr. Arthur E. Cotterell, the assistant provincial superintendent for the Midlands for the National Telephone Co., is about to take up a similar position of wider responsibility in the southern province. The position which he vacates will be filled by Mr. John Scott, who is at present the district manager at Manchester.

Messrs. Dorman and Smith are removing their London office and stock-room from Charing Cross-road to more commodious premises at 17, Victoria-street, Westminster. The new offices will be in charge of Messrs. Sambidge and Ward, engineers, who have had much experience of both the technical and business sides of electrical works.

Mr. A. B. Mitchell, mains superintendent of the Glasgow Corporation electricity department, was entertained to dinner on the 12th inst. by his colleagues on the occasion of his forthcoming marriage. Mr. W. W. Lackie, chief electrical engineer, presided, and in proposing the toast of the evening, "Our Guest," spoke of the esteem in which Mr. Mitchell was held by his fellow officials.

The annual outing of the staff of the Linolite Co. was held on the 13th inst. Catching the 8.10 a.m. train from Vauxhall the party journeyed to Clandon, accompanied by Mr. A. S. E. Ackermann, engineer to the company, Mrs. Ackermann, and Mr. R. L. Matthews, assistant manager. After lunch, a spot was chosen for the annual cricket match, Office *v.* Works, the laurels of which event were earned this year by the works. Tea was welcomed at 5.30 p.m., the party eventually returning to town by the 8.30 p.m. train after having spent a very enjoyable day.

We are informed that Mr. Philip D. Ionides, who has acted for the past eight years as the manager in Scotland for the British Westinghouse Electric Co., will resign that position in the autumn to join Mr. Wilfrid L. Spence, of 31, St. Vincent-place, Glasgow, in his consulting practice, the business thereafter being carried on under the firm name of Spence and Ionides. Mr. Ionides, after some years of American experience following a British training, went to Glasgow in 1900 to install the Corporation tramway electric plant, and has since then handled all the Westinghouse Scottish business. Mr. Spence, prior to opening his own office, was for 5½ years engineer and managing director of the British Electric Plant Co., Alloa.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Belfast.—The City Council have decided to purchase a standing meter for testing purposes at an outlay of £25.

Southport.—The Council have decided to extend the condensing plant at the electricity works at an outlay of £910.

Malvern.—The District Council have decided to raise a loan of £1,000 for extensions to the electricity undertaking.

Radcliffe.—The District Council have decided to extend their electricity works and undertaking at an estimated outlay of £14,350.

Foleshill.—The Electrical Trades Supply, Limited, have accepted the Council's terms in respect of the installation of the electric light at the isolation hospital at Exhall.

Stockton.—The gross profits on the Corporation electricity works during the past year were £3,438, all of which, save £266, was absorbed in repayment of principal and interest.

St. Annes.—A Local Government Board inquiry will be held on June 23 into the application of the Council for sanction to the borrowing of £3,500 for extensions to the electricity undertaking.

Telephone Co. of Egypt.—The register of transfers of 4½ per cent. redeemable debenture stock is closed until June 30 inclusive, for the preparation of warrants for the half-yearly interest due July 1, 1908.

Manchester.—The Local Government Board have fixed June 25 as a date for holding an inquiry into the application of the City Council for sanction to the borrowing of £130,500 for the electricity undertaking.

Oriental Telephone and Electric Co.—The register of transfers of 4 per cent. redeemable debenture stock is closed until June 30 inclusive, for the preparation of warrants for the half-yearly interest due July 1, 1908.

Carmarthen.—The electric lighting promoters have written the Town Council that the confirmation Bill had passed through the House of Commons. They forwarded a map of the district which they asked the borough surveyor to certify.

Weymouth.—The Town Council have granted permission to the Electric Lighting Committee to carry a cable across the harbour, and also to attach a portion of it to the western side of the harbour bridge, subject to the payment of a wayleave of 6d per annum.

Walsall.—At the last Council meeting, on the recommendation of the Electricity Committee, authority was given for the erection of condensing and purifying plant at the electricity works at a cost of £2,775. Alderman Brownhill said it was hoped the expenditure would effect a considerable economy both in water and fuel.

Whitehaven.—At the last Town Council meeting the electrical engineer advised that a feeder pillar should be placed on Bransty-row, and it was resolved that one should be obtained, and that application be made to the Street and Sanitary Committee for leave to erect it at a suitable place to be decided on by the surveyor and the electrical engineer.

Arbroath.—The Arbroath Electric Light and Power Co. have commenced to lay cables along the principal streets. It has been decided to run cables out as far as Keppie-road, passing the skating pond and public fountain. The light is to be introduced into many shops and private houses, and several factories in the town are being supplied with motive power and light.

Dundalk.—The Board of Trade are pressing the Council to carry out their obligations under the provisional order granted them in 1907. The Council have decided to reply to the effect that they were awaiting their Bill now before Parliament to receive the Royal assent, upon receipt of which they propose to have the necessary plans, etc., prepared for the establishment of a generating station.

Bedford.—The Council Electricity Committee have decided to purchase 440 yards of armoured cable at an estimated cost of £68, to extend the main to Sydney-road at an outlay of £40, and to seal an undertaking with the Midland Railway Co. in regard to the laying of cables and fixing lamps along Ford End road bridge. An engine at the works is to be reconstructed at an estimated cost of £998.

Hoylake and West Kirby.—It was reported at the Urban District Council meeting that the number of units generated was 26,880, and the number sold 21,126. The houses connected to date were 950, and the estimated revenue £448. 17s. 9d., while the estimated cost was £579. 10s. 8d. The net loss for the month was £130. 12s. 11d., the net loss for the corresponding month of last year being £108. 16s. 3d.

Coventry.—It was reported to the Coventry Electric Light Committee at their last meeting that the net profit on the undertaking for

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the year amounted to £5,647. 4s. 6d., of which £1,000 is to go to the general district fund in relief of rates and the balance to the reserve fund. The Council are seeking the sanction of the Local Government Board to the borrowing of £35,000 for extensions to the electricity undertaking.

Epsom.—The electrical engineer submitted to the Lighting Committee at their last meeting a statement showing that during the quarter ended March 31 the receipts amounted to £1,428. 10s. 1d. and the expenditure to £700. 10s. 2d. The receipts for the half-year ended March 31 amounted to £2,238. 17s. 2d., and there was a sum of £100 to be collected in respect of private lighting, while the expenditure for the same period was £1,447. 15s. 6d.

Tottington.—The Lancashire Electric Power Co. have asked the Council's permission to cross Turton-road, near Walves reservoir, with an overhead line. Plans have also been submitted showing the proposed route of the power cables to be taken overhead on private lands from Brookhouse Bridge to the boundary of the Turton district. The Council have refused their permission, and have requested the company to lay the cables below the surface of the road.

Denny.—The Town Council have considered the advisability of making provision for lighting Stirling-street and Glasgow-road with electricity, and have resolved to include as separate items in the specification and schedule such apparatus as may be required for that purpose, on the footing that the Council retain power to omit such apparatus if they think proper; and they have resolved to delay deciding finally as to lighting the streets with electricity until offers are obtained.

Wakefield.—The report of the city electrical engineer, Mr. H. A. Neville, for the year ended March last is a highly interesting and important document. The net financial results obtained by the department are not as good as the previous year, owing to the increased heavy expenditures which have had to be met, but the position of the undertaking is sound. The expenditure for the year works out at £6,274. 15s. 7d., and gross income £10,703. 13s. 11d., giving a gross profit of £4,428. 18s. 4d.

Surbiton.—The Local Government Board have not yet given their decision in reference to the electric light loan applied for by the Surbiton Council. Although the matter was not referred to at the Council meeting on Thursday week, the clerk has received a communication from Mr. Hooper, the inspector who held the inquiry, stating that he intends holding an informal conference with the representatives of the Council and of Messrs. Callender on Tuesday, June 23, at the Council offices.

Blackpool.—At the last Council meeting during a discussion on the merits of the gas and electricity works of the Corporation, Councillor Bailey remarked that electricity made £20,000 during the past year and gas £27,000. For every £100 worth of electricity sold they made a gross profit of £56 as against £30 for gas. He said it would pay the town to develop the electricity department, seeing that they were making 56 per cent. above the working cost. In time he believed the electricity works would be a better concern than even the gasworks.

Stoke.—At the last meeting of the Electric Lighting Committee of the Board of Guardians, a lengthy detailed report from Messrs. Edwards and Shaw, consulting engineers, on their quarterly inspection of the electricity plant and other machinery was presented. The reports advised a number of repairs, minor alterations, and cleaning. Messrs. Edwards and Shaw recommended, now the Guardians own all the land between the workhouse and cottage homes, that the electricity cables to the homes should take a more direct course.

Stock Exchange.—The Stock Exchange Committee has appointed special settling days as under: June 19—British Westinghouse Electric and Manufacturing Co.'s scrip (fully and partly paid) for £250,000 6 per cent. prior lien debentures; June 26—Aluminium Corporation's 57,520 ordinary shares of £1 each, fully paid, Nos. 1 to 33,775 and 35,001 to 58,745; July 1—United Sumatra Rubber Estates' 40,000 shares of £1 each, fully paid, Nos. 1 to 40,000. The committee has also ordered Sao Paulo Tramway, Light, and Power Co.'s 6,000 additional shares of 100dol. each of capital stock to be quoted in the official list.

Darlington.—At the last meeting of the Town Council the minutes of the Electricity and Light Railways Committee showed that for the year ended March 31 last there was a net loss on the light railways department of £547. 11s. 7d. On the electricity department there had been a net profit of £2,313. 16s. 2½d. A report of the borough accountant and borough electrical engineer on the question of the depreciation fund and the repayment of the existing loans had been considered and referred to the Finance Committee. There was also a lengthy report from the electrical engineer dealing with the reduction of the price of energy.

Paignton.—At the last meeting of the Urban District Council it was reported that Dr. J. A. Purves, engineer, Paignton Electric Light and Power Co., had forwarded the plan of the site of the proposed generating station, on the side of the railway, and stated that the power would be generated by means of producer gas, and that consequently no chimney would be required; also that means would be taken for the prevention of any vibration. The Council approved the site of the station, and it was agreed that as soon as the clerk received the plans of the proposed building he should call a joint meeting of the Building and Lighting Committees.

Essington.—The Water Committee of the Wolverhampton Town Council report that the increased demand for water in Essington requires additional plant. It is proposed to dismantle the Short Heath pumping plant and erect a new pumping-house for electrically-driven pumps, each capable of raising 5,000 gallons per hour. The power will be obtained from the Midland Electric Power Co., who will provide the cable, the committee to make an agreement for 10 years at a rental of £20 per year towards the cost, and the payment of ½d. per unit of energy consumed. This will be a saving of £125 per year on the existing cost of maintenance of the works at Short Heath.

Paisley.—At a meeting of the Electricity Committee of the Town Council the clerk read a report by Mr. Parkinson, the electrical engineer, on the cost of supply wanted to Johnstone, to the effect that the capital expenditure necessary to give a supply of 500 kw. would be as follows: (1) to supply and distribute electricity in the burgh, £21,000; (2) to supply energy in bulk at a central point in the burgh, the distribution to be carried out by the Johnstone authorities, £12,200; (3) to supply in bulk at the Paisley burgh boundaries, £7,000. The clerk was instructed to communicate a note of these costs to the Johnstone authorities, and to ask whether they have anything to propose in view thereof.

Coombe and Malden.—The Board of Trade having written to the Parliamentary Committee of the District Council asking for the Council's observations in respect to the description of the system proposed to be adopted by the undertakers for the supply of energy under the Maldens and Coombe Electric Lighting Order, 1907, the clerk was authorised to confer with a municipal electrical engineer on the subject. At a subsequent committee meeting he submitted a professional report criticising the system proposed to be adopted by the County of London Electric Supply Co., and the committee accordingly directed the clerk to communicate with the company intimating that the Council would like an interview with them prior to formulating its reply to the Board of Trade.

Swansea.—The Swansea borough accountant, Mr. Hopton, has submitted to the Finance Committee of the Swansea Corporation a statement which shows that the profit over the sale of the municipal telephone system to the National Co. was £894. 14s. 11d. Alderman Solomon said the original estimated profit was £1,600 to £1,700, but the borough accountant said he knew of no such estimate. The Mayor said he was rather disappointed, because he thought the profit would be about £1,400. Mr. Solomon said probably the difference would be found in that the Corporation worked the exchange from March to August, and that the National Co. had not paid them. The Accountant, however, said every halfpenny had been paid. Eventually it was decided to refer the account to a sub-committee.

Lowestoft.—The Electric Lighting Committee of the Town Council have received a letter from the Local Government Board referring to the application of the Town Council for sanction to borrow £1,500 for the construction of a railway siding to the electricity works and the provision of a locomotive. With reference to the application for sanction to borrow £1,000 for free wiring, the Board asked for details of the expenditure of the previous loan of £940 sanctioned, and a statement showing how the proposed sum of £1,000 is made up. The chief clerk has been directed to forward the particulars required. The part of the letter referring to the siding is deferred for further consideration till after the inquiry. The deputy town clerk has submitted quotations for insuring the free-wiring installations of the Council placed in various properties in the borough, and has been instructed to insure same in the Sun Fire Office at a premium of 5s. per cent. up to an amount of £2,000.

Liquidations.—The *London Gazette* announces that for the purpose of carrying into effect the scheme for the conversion or exchange of the profit-sharing secured notes of the Underground Electric Railways Co. of London, and for other purposes, the company has been wound up voluntarily and Sir George Stegmann Gibb, of Hamilton House, Victoria-embankment, the deputy chairman and managing director of the company, appointed liquidator. The creditors of the Brockie-Pell Arc Lamp are required to send the particulars of their debts or claims to Mr. H. McLellan, of 6A, Devonshire-square, London, the joint liquidator with Mr. R. Warner, 10, Walbrook, London, and Mr. D. Watson, 102, Charing Cross-road, London, by July 6. A general meeting of the members of the Gardner Electric Drill and Hammer Co. will be held at 138, Salisbury House, London-wall, E.C., on July 8 at 12 noon, for the purpose of receiving the liquidator's account.

Gravesend.—The electrical engineer has submitted his annual report for the fifth completed year, and it has been adopted: Units generated 1,173,976, ditto year ending March 31, 1907, 1,087,650; units sold to tramway company 410,411, ditto year ending March 31, 1907, 419,492; units sold to consumers 361,817, ditto year ending March 31, 1907, 288,167; units sold to public lighting 169,975, ditto year ending March 31, 1907, 152,630; units used on works 132,737, ditto year ending March 31, 1907, 112,889; units unaccounted for 99,036, ditto year ending March 31, 1907, 113 923. Comparing the year now completed with the year ending March 31, 1907, the fuel cost £2,433, or ·62d. per unit sold, as against £2,472, or ·69d. per unit, during previous year; 3,181 tons of coal have been used, equalling 7·55lb. per unit, as against 3,891 tons, or 10·12lb. per unit, during the previous year. At last year's charges for fuel this reduced consumption is equivalent to a saving of £855.

King's Lynn.—The electrical engineer has reported to the Electricity Committee that since the last meeting applications had been received for three additional connections, consisting of 18 lamps of 8 c.p. or equivalent, making a total of 624 connections and 29,516 lamps. He also reported that all the outside wood and ironwork at the generating station, and the lamp arches in High-street and Norfolk-street, were being painted; further, that since the expiration of the coal contract he had obtained a supply at 9s. 2d. per ton, and also at 5s. 6d. per ton. His action was confirmed. The following statement was submitted: units generated, April, 1908, 41,774 (April, 1907, 41,679); total units sold to private consumers (light and power), 23,423 (22,639); units sold at lighting rates, 10,665 (9,403); units sold at power rates, 12,757 (13,236); cost of fuel, stores, repairs, and wages at station, £161. 19s. 6d. (£146. 17s. 7d.); cost per unit generated,

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0·9306d. (0 8547d.); wages of lamplighters and repairs to lamps, mains, and meters, £23. 18s. 11d. (£21. 10s. 8d.).

Wolverhampton.—The Electricity Committee have prepared a report relative to additional boilers, induced draught, and coal-conveying plant. They state that the constantly-increasing demand for electricity for motive power purposes renders it imperative that steps should be taken to increase the boiler-house capacity at Commercial-road before next winter, and it is pointed out that the increase in output at the present time is at the rate of 90 per cent. in excess of the corresponding period last year. The committee, in recommending the Council to extend the plant, estimate that the total cost of supply, delivery, and erection of the additional boilers, induced draught fan, and coal-conveying plant, together with all brickwork settings and foundations, will be approximately £6,000. They recommend that the Council approve of the scheme, that the tender of Messrs. Babcock and Wilcox, of London, amounting to £4,000, for the supply and erection of boilers be accepted, and that application be made to the Local Government Board for their sanction to a loan of £6,000 to cover the cost.

Grimsby.—At the last meeting of the Corporation Electric Lighting Committee the engineer, Mr. W. A. Vignoles, reported that during the month 121,751 units of current had been consumed, an increase of 29,868 units on the corresponding period last year. He also reported having been to the works of Messrs. Belliss, Birmingham, to inspect and test the new 500-kw. set, the construction of which had just been completed for the Corporation. The engine and dynamo were now being delivered and erected at the power station. The town clerk reported that the undertaking had a sum of £5,000 lying to its credit at the bank, which had been raised on mortgage of the rates and on property. He suggested that when next the committee were applying to the Local Government Board for a loan the Board's attention should be drawn to the sinking fund, and application made to them for power to use it as capital. The suggestion was adopted. Applications for increase of salary from Mr. Shannon, the assistant electrical engineer, and Mr. Horton, the cashier of the department, were considered, but were rejected by the committee.

Durham.—At the ordinary general meeting of the Durham Collieries Electric Power Co., Sir Douglas Fox, in moving the adoption of the report said that since they last met they had had to deal with very difficult circumstances, including the voluntary suspension of their contractors. Arrangements had been entered into for working in harmony with the Newcastle company, instead of in competition with it. The Newcastle company would operate the distribution system as well as the generating plant. It had been hoped that before now they would have come into a paying load. At the present time the load was between 10,000 000 and 11,000,000 units, and it was increasing rapidly each month. When it had reached 18,000,000 units the company would be in a fairly satisfactory position. Owing to the unissued balance of shares not having been taken up, the directors had now to make proposals for the creation of £100,0 0 6 per cent. second mortgage debentures, of which £50,000 were to be issued with as little delay as possible. Mr. A. W. Tait seconded the motion, which was agreed to. At an extraordinary meeting which followed, a resolution was carried authorising the directors to raise or borrow a further sum of £100,000, in addition to the £150,000 already borrowed by the company.

Eastbourne.—The borough electrical engineer and the borough accountant have completed their reports of the electricity undertaking, and these are again of a very satisfactory character, showing a substantial profit. The accountant deals with the financial position, showing that the income for the year totalled £24,695. 15s. 11d., against £22,404. 16s. 8d. in 1906-7, the net profit being £2.214. 4s. 4d., against £1,567. 16s. 3d. The increase of net profit is accounted for by the fact that, owing to the loan from the Huddersfield Corporation not being completed until late in the year, the net revenue has a smaller sum charged to it in respect of interest and repayment of loan. Otherwise, the net profit is practically the same as last year, and is most satisfactory considering the great increase in the cost of coal, etc. The net profit for the past year has been added to the balance in hand at March 31, 1907, and from this has been transferred the sum of £1 500 to depreciation and reserve, leaving £8,078. 16s. 4d. Another £2,CCO will be placed to that fund, leaving a working balance of £6 078. 16s. 4d. Dealing with the business details, the engineer states that the number of consumers is 1.235, against 1,175 last year. The units sold for private lighting amounted to 983,365—904,029 last year—and for power 84,5?5, as against 72,172 in 1906-7.

Handsworth.—The Urban District Council of Handsworth having applied to the Local Government Board for sanction to borrow sums amounting to £22 300 for the purposes of their electric supply undertaking, Mr. H. Shelford Bidwell held an inquiry at the Council House, Handsworth, on the 16th inst. into the subject-matter of the application. Of the total amount, £18 200 has already been expended upon the generating station, and £3,100 is now being spent upon additional plant to meet the estimated increase of current required for the ensuing winter, and £1,000 is required for a scheme of hire and hire-purchase of wiring in private residences. Mr. Ernest Ward, the clerk to the Council, gave the history of the undertaking, and said the Handsworth Urban District Council Act of 1901 gave the Council power to borrow £49,C50 for electric supply and £107,250 for tramway purposes. The Act contemplated two generating stations, but it was found advisable to have only one. Referring to the supply current for tramway purposes, he said negotiations had been entered into for the acquisition of the cable route, which would be electrically equipped. It was now a question of settling the price and obtaining possession. The application in respect of £18,200 was in effect for the cancelling of old and acquiring new powers. Sir Alexander Kennedy, consulting engineer to the Council, explained the plans and specifications, and stated that from the beginning it was decided to have only one generating station for lighting and tramway purposes, and the plant was so arranged that a large number of dynamos could be used for both purposes. Mr. Ward said the scheme of hire or hire-purchase of wiring in houses had received the most careful consideration of the Council, and having regard to the character of the houses in Handsworth, and what had been done in other towns, they had decided to try it. Mr. F. A Nixon, the electrical engineer to the Council, also gave evidence.

Bury.—The borough electrical engineer's report was presented by the Electricity Supply Committee at the last Town Council meeting. He stated that the past year (ending March 31 last) had been a record one from more than one point of view. A record number of units had been sold, and the income had exceeded the estimate by something like £430. The price paid for fuel had been the highest on record, and it was owing to this fact that the financial position of the department had unfortunately been somewhat retarded. The rise in the price of fuel was responsible for an additional outlay of approximately £290 over and above that of the previous year. Another item that had added to the deficit on the year's working was the waterworks new motor gearing, which was installed during the early part of the year. This was responsible for an additional outlay of £132 over the previous year. Owing to the high efficiency of the new gear in question as compared with the old gear originally in use, a saving of over 17,000 units was effected during the past year. Regarding the question of the waterworks pumping, the income derived from this source is £360 per annum. This amount was based on an estimate some six years ago, when the price of coal was about 17s. per ton. Since then, however, coal had risen to 21s. per ton, and a revision of this contract was suggested for consideration. Out of the total number of lamps connected during the year—viz., 1,247—540 were extensions made on the premises of over 50 consumers. This goes to prove that electric lighting only needs a trial for its use to become general. In conclusion, the engineer suggested for improving the lighting of some of the main thoroughfares of the town, apart from those now lighted by arc lamps, the present carbon-filament lamps should be replaced by metallic-filament lamps. Mr. Allingham proposed that the report should be referred back to the committee for its comments on the points raised, and this was agreed to. The engineer's statement of results of working of electric plant for six years showed that the deficit had varied as follows: £323, £590, £305, £227, £161, and £300. In the last two years the deficit included the payment of £100 towards establishment charges.

TRACTION.

Brierfield.—The Urban District Council have passed a resolution asking the Burnley Tramways Committee to provide a better tramway service.

Melbourne Tramway and Omnibus Co.—The directors announce a dividend of 4½d. per share (15 per cent. per annum) for the quarter ending 30th inst.

Ayr.—In the House of Commons on Thursday week the Bill to confirm the Ayr Corporation tramways order was considered and ordered for third reading.

Madras Electric Tramways.—The receipts for the fortnight ended June 15 totalled Rs 18 336, being an increase over the corresponding period of last year of 15 9 per cent.

Twickenham.—The District Council have decided to have the speed of the tramcars tested, with a view to calling the company to account for running the cars at alleged excessive speed.

Sheppey.—The Sheppey Rural District Council have given their consent to the application of the Board of Trade for powers to extend the tramways system from Sheerness East to Minster, and Sheerness East to Scrap's Gate.

Buenos Ayres Grand National Tramways Co.—The directors recommend a final dividend at the rate of 2s. 6d. per share, less income tax, making 5 per cent. for the year to March 31, 1908, on the £5 5 per cent. cumulative preference shares.

United Electric Tramways of Monteo Video Co.—The directors recommend a dividend of 5 per cent. (10s. per share), less income tax, on the ordinary shares for the year, appropriating £525 to extinguish expenses re debenture stock and carrying £11,953 forward.

Darlington.—The Electricity and Light Railways Committee have reported to the Council that the statement of receipts and expenditure for the year ended March 31, 1908, showed a net profit of £2,313. 16s. 2½d., which it was recommended be transferred to the reserve account.

Redruth.—The County Council have written the Urban District Council to the effect that unless the Council take steps to compel the Urban Electric Supply Co. to put the road adjacent to the tramway in satisfactory repair, the County Council surveyor will consider it a sufficient reason for refusing his certificate to enable the Urban Council to obtain the usual grant.

Ashton.—The manager has presented his report on the tramways to the Council Tramways Committee for the year ending March 25, 1908, and it has been resolved that the same be printed and a copy supplied to each member of the Council. The manager has been deputed to attend the conference of tramway managers to be held in Wolverhampton on the 28th and 29th inst.

Bournemouth.—Giving evidence at the Board of Trade inquiry on Wednesday, William Wilton, driver of the tramcar overturned at Bournemouth on May 1, with the result that seven persons were killed and many injured, told his story of the disaster, and explained that if he had known that the magnetic brake was out of order he could have stopped the vehicle with the hand brakes.

Derby.—The following are the receipts of the Derby Corporation tramways during the month ended May 23, 1908: £3,332. 6s. 6d.,

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being a decrease of £1. 17s. 9d. as compared with the corresponding period last year. Arrangements have been made with the Derby Gaslight and Coke Co. for the removal of the gas-main as far as it will be under the extended tramway on the Burton-road.

Tyneside.—The receipts for the Gateshead and District Tramways for the week ending June 5 were £999, as compared with £991 in the corresponding week last year. The receipts from Jan. 1 to June 5 amounted to £21,885, as against £21,741 of last year. The Sunderland District Electric Tramways receipts for the week ending June 10 were £668, as compared with £456 in the corresponding week last year.

Burton.—The Council have decided to fit six cars on the Winshill route, where there is a very steep gradient contiguous to Burton Bridge and the River Trent, with the emergency brake recently invented by the Burton Corporation tramways manager, Mr. Pringle. The chairman of the committee (Alderman Rowland) states that deputations from authorities in all parts of the kingdom had inspected the brake and declared it to be most effective.

Foleshill.—The Board of Trade have informed the Council that the Coventry Electric Tramways Co. had applied to the Department for an extension or renewal of the Board's consent to the use of electrical power on the lines in the Council's district. Any observations the Council desired to make were invited. The clerk stating this was an application which the tramway company made periodically, the Council have offered no objection.

Glasgow.—The Corporation tramway cars ran 398,166 miles last week as compared with 400,967 in the corresponding week of last year, carried 4,308,404 passengers as against 4,539,765, and drew £17.078. 14s. 8d. in comparison with £18,102. 1s. 9d. Since the beginning of the financial year on June 1 the number of passengers carried has been 8,439,783 as against 9,812,888 in the corresponding period of last year, and the receipts £33,527. 0s. 2d. as against £38,949. 7s. 2d.

Eccles.—The Town Council met in committee on the 17th inst. to consider the action of the South Lancashire Tramways Co. in running their tramcars on the lines of the Corporation between Parrin-lane, Winton, and the boundary of the borough at Alderforest, near Worsley, without first obtaining the Council's consent. It was decided to seek an injunction to prevent the company running its cars on the length of lines stated, which belong to the Eccles Corporation.

Stansted.—A letter was read at the last Council meeting from the Light Railway Commissioners enclosing a draft of the proposed order for the construction of the Elsenham and Thaxted light railway, and intimating that if the Council desired to submit any observations upon the draft the Commissioners would consider them, provided they reached that office before June 20. The Chairman remarked that he did not think the Council need make any observations upon it, and none were made.

Middlesbrough.—A shocking fatality occurred at Middlesbrough on Saturday last, Robert Clark, engineer, Grove-road, North Ormesby, being cut to pieces by an electric tramcar in Ormesby-road, near St. John's Church. It is stated that as the car was passing, Clark rushed into the road and threw himself under it between the bogie wheels. Before the car could be stopped it passed over him, and his body when extricated was in such a horrible mutilated state that it was beyond recognition. The remains were removed to the mortuary.

Southampton.—After long deliberation and some amount of opposition the Southampton Corporation have determined to apply to Parliament for the necessary powers to considerably develop the present system of electric tramways. It is proposed to continue the line from the High-street and run to the pier, at the top of the Town Quay, and immediately opposite the Royal Southern Yacht Clubhouse. The traffic to the pier is so great throughout the season that, if passengers were taken to it direct, it is thought there would be a very profitable source of income tapped that is at present lost.

Wolverhampton.—At the last Town Council meeting Alderman Mander submitted the report of the Tramways Committee, which showed a gross profit of £17,970 and a net profit of £2,112, after meeting a loss of £233. 11s. 3d. on the motor-omnibus account. He went through an analysis of the figures, and said they had now brought the tramways to a thoroughly prosperous condition. They had paid off all the debts on the old trams, and had placed £22,608 to the renewals account. He had passed through many troublous and stormy times in connection with the tramways, and he thought that now they were in a sound condition.

Westinghouse Brakes.—As a result of the successful performance of Westinghouse magnetic brakes on the Dunedin, Wellington (N.Z.), Sydney, Bendigo, Ballarat, Fremantle, and East Fremantle tramways, Australia, the municipal authorities of Adelaide have just placed an order with the British Westinghouse Electric and Manufacturing Co. for 120 magnetic brake equipments of their latest improved type, being similar to those in use on all the London County Council tramcars. The inventors of this brake have recently developed improvements which eliminate wheel skidding on the worst condition of track and on any gradient, and it may now be fairly said to form the most valuable accessory to the car equipment from the money-earning point of view.

Electrification of Railways.—Mr. Chiozza Money has given notice of the following question which he will address to the President of the Board of Trade on Tuesday next: "Whether his attention had been directed to the fact that the Prussian State Railways Administration is about to electrify some parts of its system; if, in the interests of British trade and locomotion, he can direct the attention of British railway companies to the fact; and if, in the event of British railway companies neglecting to avail themselves of electrical power, he will, in the public interest, introduce legislation to nationalise British railways in order to make them as efficient and as economical as those possessed by our greatest commercial rival."

Edinburgh.—A sub-committee of the Tramway Committee of Edinburgh Town Council have had a meeting with Mr. Shepherd, the general manager, and Mr. Harris, the engineer of the Edinburgh and District Tramway Co., in connection with the delay in the opening of the Broughton-street line. After hearing the officials of the tramway company, the sub-committee resolved to report to the whole committee that, in their opinion, the explanations were not satisfactory or adequate. With reference to the question of running the cars through from Broughton-street to Goldenacre, Mr. Shepherd stated that his directors had not yet come to a final decision as to making Canonmills the terminus, and the town clerk was instructed to communicate with the tramway company as to their intentions with regard to that matter.

Metropolitan Electric Tramways.—The Whitsuntide traffics on the Metropolitan Electric Tramways include some striking figures. On Whit Monday the number of passengers carried was 334,806, and the receipts amounted to £2.389, being at the exceptionally high rate of over £12 per car, or 25·99d. per car mile. For the week ending Friday, June 12—that is to say, the week including the Whitsuntide traffics—the passengers numbered 1,391,531, and the receipts amounted to £8,177. For the corresponding week last year, when there were no holidays, the number of passengers amounted to 1,005,073, and the receipts to £5,134. This year the route mileage in operation was 42, and last year it was 33. The aggregate receipts for this year up to the date mentioned are £123,161, as compared with £98,371 last year.

Brighton.—An important scheme for the extension of the Brighton tramways will occupy the attention of the Brighton Town Council at their next meeting. Messrs. Stephen Sellon and Partners, of Victoria-street, London, propose to run a service of trams from Kemp Town (East Brighton) through St. James-street, North-street, and Western-road, as far as Worthing. The Tramways Committee have by resolution expressed the opinion that the construction of such a tramway would be in the interests of the inhabitants, and ask the Town Council to authorise them to negotiate with the promoters and to report further on the question. The promoters are prepared to consider an arrangement whereby the undertaking within the borough would remain in their possession for a period of between 35 and 42 years, then passing into the hands of the Corporation without consideration. Throughout the period in which they would retain control of the trams they would pay to the Corporation an annual sum of £2,500.

Portsmouth.—Alderman Corke presented the report of the Tramways Committee to the Council at the last meeting, in which it was stated that the resolution of the Council as to the extension of the tramway from Fawcett-road, through Goldsmith-avenue, to Milton-road, referred from the full committee, had been considered, and Mr. Spaven's report on it read. The committee had resolved that the matter stand over until the annual balance-sheet had been submitted to the committee. Councillor Stobie criticised the action of the committee, and alleged that the matter had been unduly delayed. Councillor Dittman urged that there had been no delay beyond what was necessary. Councillor Groves strongly pointed out the necessity of waiting until the report was in hand, showing the effect of the reduction of fares on the Cosham route. The committee would not be justified in committing themselves to this extension of the tramway system while they had knowledge before them of the many failures of such extensions to outlying districts in other towns throughout the country. The report was adopted.

Liverpool.—The Tramways Committee at their last meeting decided to institute on the Garston-Pierhead route a six months' experimental service of first-class trams at fares double those at present charged on the different stages. The tramways manager, in a report he had compiled, suggested that no additional cars be provided, but that seven trams, either upholstered as first-class carriages or furnished with rattan seats, be substituted for seven of the cars at present in use. Seven cars will provide a quarterly-hour service from either terminus. It was stated that such superior cars had been asked for. Numerous objections were urged to the proposal, chief amongst these being delay in inclement weather to persons unable to afford the increased fare, and disorganisation of the present uniform fares. The chairman of the committee, however, stated that they had met the requirements of the working classes, and were now anxious to meet the wishes of the better class. Another member, while doubting whether the experiment would prove successful, said it would supply practical data and figures, and thus set at rest a lot of theory.

Dumbarton.—The new tramway system of the Dumbarton Burgh and County Co. from Dalmuir to Balloch, affording an unbroken journey from Glasgow to Loch Lomond, may now be said to be completed. Although there is a gap of about 100 yards to be finished in the centre of the village of Old Kilpatrick, the Board of Trade inspection of the whole new route—one running into 11 miles—is settled for Wednesday next. Everything will be ready then, and as no delay is expected as the result of any examination, the system will be almost immediately opened to the public. This event is being eagerly looked forward to in Dumbartonshire, and occurring in the height of the summer season it will likewise prove of interest in the city and environs. Already a successful trial run has taken place from Alexandria to the Balloch terminus. In the scheme provision is made for the taking in of Jamestown, by, of course, a branch off the main track, but owing to a difference between the tramway company and the North British Railway authorities regarding a bridge in Bunk-street, Alexandria, not having yet been settled, the work of completing the branch is being retarded. It can hardly be finished now before the end of the month. During the past week numerous new cars have arrived in Dumbarton, where large car-sheds have been completed for their reception.

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Huddersfield.—Progress is being made in the task of doubling the lines on four different sections of the Huddersfield Corporation tramway system. Having completed a distance of 850 yards—from Somerset-road to the Junction Inn—on the Moldgreen route, the men, employed directly by the Tramways Committee under the direction of Mr. K. F. Campbell, the borough engineer, are now engaged on the Birkby route, where the doubling will be from Fitzwilliam-street to Blacker-road, a length of about 1,000 yards. About 350 men were expected to be at work by Wednesday, of whom 100 will work through the nights. During the alterations, which, with favourable weather, will occupy from 14 to 17 days, a continuous line is to be secured by the division of the work into three sections and the provision of a temporary track, thus avoiding a repetition of the Moldgreen inconvenience, which necessitated passengers walking from one car to another. The next improvements to be tackled are on the Lockwood and Marsh routes. They too each extend about 850 yards, being respectively from Garden-street to the White Lion Inn, Salford, and from Park-drive to Luck-lane. The same safeguards for continuous running will obtain there. The whole of the improvements, for which the plans and specifications were prepared by the borough engineer, is estimated to cost about £14,000.

Woolwich.—The Borough Council have granted permission to Messrs. Kirk and Randall, builders, of Woolwich, to lay a light railway, about 316ft. in length and 2ft. wide, from their wharf in Warren-lane to the entrances to their sawmills. The General Purposes Committee reported to the Council at the last meeting that for some months they had had under consideration the question of the electrification of the London County Council tramways from Beresford-square to East Greenwich, in order to supersede the existing horse tramways, which must prove a great hindrance to through traffic and to the general use of the tramways. At the committee's request the borough engineer had prepared plans showing various routes suggested for such electrification, with estimates of the cost of the necessary widenings and street works, and after having given the matter very long and careful consideration they resolved to place before the Council two alternative routes—viz.: (1) the widening to 50ft. of the present tramway route along Beresford-street and High-street, thence the construction of a new road 50ft. wide, cutting through St. Mary's-churchyard into Church-street, and from thence along Church-street, Albion and Woolwich roads to the borough boundary; (2) the widening to 50ft of Beresford-street for a length of about 820ft., and from thence the construction of a new road, 50ft. wide, from Beresford-street to Albion-road, crossing Hare and Powis streets, and the widening of Albion and Woolwich roads as in the first-mentioned scheme. The committee recommended that the County Council be asked to adopt the first-named scheme. The recommendation was agreed to without discussion.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Madrid.—The Public Works Department invite tenders for the construction of light railways. Tenders by Oct. 31.

Cologne.—Tenders are invited for six electric cranes for the Prussian Government Railways. Tenders by June 25.

Victoria.—The Postmaster-General invites tenders for the supply of one common-battery switchboard. Tenders by June 23.

Sofia.—Tenders are invited by the Bulgarian State Railways for electrical apparatus. Estimate, £6,800. Tenders by June 20.

Bangkok.—Tenders are invited for fishplates, fishbolts, bearing plates, etc., required for the Royal Siamese Railways. Tenders by Oct. 1.

Melbourne.—Tenders are invited for the supply of insulated cables. Specifications at the City Electrical Engineer's Office. Tenders by July 3.

Madrid.—The Public Works Department invite tenders for the construction of a railway from Betanzos to Feros. Tenders by June 23.

St. Annes.—The Urban District Council invite tenders for laying a feeder cable. Particulars from the Electrical Engineer. Tenders by June 27.

Leipzig.—Tenders are invited for the supply of 18 Cornish boilers and superheaters for the municipal electricity works. Tenders by July 10.

Canterbury.—Tenders are invited for painting the lamp brackets at per 100 and the columns at per 100 for the Electric Lighting Committee.

Bukarest.—Tenders are invited for the supply of brass bars, brass tubes, and copper, etc., required by the War Office. Tenders by June 23.

Bromley.—The Education Committee invite tenders for supply and fixing of a new boiler at Wharton-road Council School. Tenders by June 20.

Weymouth.—Tenders are invited for the supply of steam coal for use at the electricity works, Stavordale-road. Tenders to the Town Clerk by June 24.

Chatellerault (N. France).—Tenders are invited for the supply of 2,000 incandescent electric lamps for the National Arms Factory. Tenders by July 6.

Salford.—Tenders are invited for rewiring the Royal Technical Institute. Particulars from Mr. M'Cowen, borough electrical engineer. Tenders by July 1.

Newport (Mon.).—Tenders are invited for the supply of continuous and alternating current prepayment meters. Particulars from the Electrical Engineer.

Brussels.—Tenders are invited for supply and erection of coal conveyors at the Laaken electricity works. Tenders by June 19.

Hull.—The Corporation invite tenders for the supply of clothing for the tramway employés. Tenders to the Town Clerk by June 19.

Brussels.—The Société Nationale des Chemins de Fer Vicinaux invite tenders for the construction of a line from Olloy to Ognies. Tenders by June 30.

Sofia.—Tenders are invited for the installation of electricity in mines. Particulars from the Director of Mines and Minerals. Tenders by June 19.

Odessa.—The Town Council invite applications for a concession for the installation and working of an electric station in Odessa. Tenders by Sept. 14.

Liege.—Tenders are invited for the installation of an electric lighting system. Particulars from the Secretaire Communal at Amay. Tenders by June 25.

Madrid.—The Public Works Department invite tenders for the laying of tramway track in Madrid. Estimate, 582,670 pesetas. Tenders by June 25.

Glasgow.—The Corporation invite tenders for one or two motor first-aid machines required for the fire department. Tenders to the Town Clerk by June 30.

Fulham.—The Guardians invite tenders for British-made vertical high-speed engine and a 20-kw. steam dynamo. Particulars from the Clerk. Tenders by July 2.

Canterbury.—The Town Council invite tenders for the annual supply of coal to the electricity works, Northgate-street. Tenders to the Town Clerk by June 29.

Stanislau.—The Municipality invite tenders for the establishment of an electric tramway system, also for the erection of a generating station. Tenders by Aug. 31.

Dewsbury.—The Corporation invite tenders for the annual supply of coal for the electricity works, Bradford-road, Dewsbury. Tenders to the Town Clerk by June 20.

Leeds.—The Tramways Committee invite tenders for the supply of clothing for the tramway employés. Particulars from the General Manager. Tenders by June 23.

Blois.—Tenders are invited for the construction and maintenance for 50 years of public tramways. Particulars from the Prefecture de Loir-et-Cher. Tenders by July 15.

Victoria.—The Postmaster-General invites tenders for the supply of telegraph and telephone material required during the year ending June 30, 1909. Tenders by Aug. 4.

London, S.W.—The Metropolitan Asylums Board invite tenders for new hot-water storage cylinders, etc., at Tooting Bec Asylum, Tooting, S.W. Tenders by June 23.

Auckland.—The Auckland Harbour Board require tenders for electrical capstans, etc. Particulars from the McArthur Engineering Co., Silk-street, Cripplegate, London, E.C.

Malvern.—The Urban District Council invite tenders for the supply and erection of 50-kw. steam alternator, exciter, etc. Tenders to Mr. Whatley, clerk to the Council, by June 29.

Bury St. Edmund's.—The Guardians invite tenders for providing and fixing a set of treble-throw pumps, with gear and incidental works complete. Tenders to the Clerk by June 25.

Adelaide.—Tenders are invited by the Municipal Tramways Trust, Adelaide, for the supply, delivery, and laying of underground electric cables. Tenders to the Chairman by June 23.

Ashley Down.—The Bristol Education Committee invite tenders for the heating and ventilating of the Council school to be erected at Sefton Park, Ashley Down. Tenders by June 23.

Gravesend.—The Electricity Committee invite tenders for the supply and erection of yellow flame arc lamps, columns, etc. Tenders to the Town Clerk by June 27. See advertisement.

London.—The London County Council invite tenders for the manufacture, supply, and delivery of tramway feeder pillars. Particulars from the Clerk of the Council. Tenders by June 23.

Cologne.—The Prussian Government Railways invite tenders for the supply of copper plates for locomotive fireboxes, copper wire, copper tubes, and copper bars. Tenders by June 26.

South Australia.—The Postmaster-General invites tenders for telephone instruments, telegraph instruments, telephone switchboards, and telephone line material. Tenders by July 1.

Sale of Plant.—Tenders are invited by the Sheffield Corporation Tramways Department for the purchase of lighting plant. Particulars from the General Manager. Tenders by June 19.

Bedminster.—The Bristol Education Committee invite tenders for the heating and ventilating of the Council school now in course of erection at Merrywood, Bedminster. Tenders by June 23.

Alford (Lincs.).—The Urban District Council invite tenders for the lighting of the town by gas or electricity from Aug. 14, 1908, to May 14, 1909. Tenders to Mr. T. Loy, clerk, by June 25.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Mosman Telephone Exchange. Tenders by Aug. 12.

Croydon.—The Town Council invite tenders for lighting the swimming bath in Scarbrook-road, Croydon. Particulars from the Borough Engineer. Tenders to the Town Clerk by June 23.

Adelaide.—The Municipal Tramways Trust invite tenders for the supply and erection of motor equipments and car wiring. Tenders to the Chairman, 8, King William-street, Adelaide, by July 7.

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Melbourne.—The City Council invite tenders for the supply and delivery of one 500-kw. motor generator. Tenders by July 3.

Cadiz (Spain).—Tenders are invited for the supply of two travelling steam-cranes for use on the Puntales Wharf at Cadiz Tenders addressed to the Junta de Obras del Puerto, Cadiz, by June 29.

Stepney.—The Electricity Supply Committee invite tenders for the supply of about 12 000 tons of coal for the electricity works. Tenders to the Chairman of the Electricity Supply Committee by June 29.

Manchester — The Corporation invite tenders for the annual supply of direct current motors and motor starters, ampere-hour meters and watt-hour meters, and fuse boxes. Tenders by June 30.

Edinburgh.—The Corporation Electric Supply Committee invite tenders for the supply of wrought-iron riveted pipework. Particulars from Mr. F. A. Newington, electrical engineer. Tenders by June 22

Bristol.—The Electrical Committee invite tenders for the construction of an extra high-tension sub station at Pembroke-road, Shirehampton Tenders to the City Electrical Engineer by June 19.

Melbourne.—Tenders are invited for the supply of 5 060 yards of insulated copper cables. Tenders to Messrs. McIlwraith, McEacharn, and Co. Proprietary, Billiter square-buildings, London, E C., by July 3

Belfast.—Tenders are invited for the painting of tramway poles and feeder pillars. for the Tramways and Electricity Committee. Particulars from Mr. Bloxam, city electrical engineer. Tenders by June 20.

Toronto —Tenders are invited by the Hydro-Electric Commission for the supply of transmission cables to be laid from Niagara Falls to St. Thomas. Particulars from the chairman, Mr. Adam Beck. Tenders by July 15.

Oldham.—The Electricity Committee invite tenders for the supply of coal for the electricity works. Particulars from Mr. S. Wilmott Newington, Electricity Offices, Oldham, to whom tenders should be sent by June 22.

West Wretham.—Tenders are invited for the purchase of the lead, copper, brass scrap, and wrought iron at Wretham Hall. Tenders to Mr. P. Ashburnham, Estate Office, West Wretham, Thetford, by June 30.

Ilford.—The Urban District Council invite tenders for the installation of a low-pressure hot water heating system and ventilation at the library and public hall, Seven Kings, Ilford. Tenders to the Clerk by June 22.

Stepney.—The Electricity Supply Committee invite tenders for the annual supply of arc lamp carbons, ampere-hour meters, demand indicators, and time switches. Tenders to the Town Clerk by June 23. See advertisement.

Trimdon Grange.—The Trimdon Coal Co. invite tenders for a six months' supply of general stores, including oils, grease, etc. Particulars from Mr. J. Penney, Deaf Hill Colliery, Trimdon Grange. Tenders by June 20.

Ilford.—The Urban District Council invite tenders for wiring for electric lighting in connection with the Seven Kings Library and Hall. Particulars from Mr. A. H. Shaw, Electricity Works, Ley-street, Ilford. Tenders by June 23.

Victoria.—Tenders are invited for the supply of sulphate of copper for the use of the Postmaster-General's department in the several States of the Commonwealth during the period ending June 30, 1909. Tenders by June 23.

London, E.C.—The Bombay, Baroda, and Central India Railway Co. invite tenders for metals, spring steel, pig iron, etc. Particulars from the Secretary, 2, 3, and 4, Bishopsgate-street, London, E.C. Tenders by June 23.

Manchester.—Tenders are invited for laying underground telephone pipes (Contract No. 14), with other appurtenant works. Tenders to the Chairman of the Paving, Sewering, and Highways Committee by June 24.

Gillingham —Tenders are invited for the supply and delivery of coal for electricity generating station for period ending June 30, 1909. Particulars from the Borough Electrical Engineer. Tenders to the Town Clerk by June 22.

Woolwich —The Borough Council invite tenders for the equipment of their Globe-lane generating station with coal-handling plant. Specification from the Borough Electrical Engineer. Tenders by July 23. See advertisement.

Belfast.—Tenders are invited for the supply of 40 lengths of double-grooved tram plate castings and 40 gate wheels, for the Belfast Harbour Commissioners. Tenders to Mr. W. A. Currie, secretary, Harbour Office, Belfast, by June 24.

Gravesend.—The Electricity Committee invite tenders for the supply of approximately 2 500 tons of rough small coal required between July 1, 1908, and June 30, 1909, for the electricity works. Tenders to the Town Clerk by June 26.

Spain.—The Direccion General de Obras Publicas invite offers for the construction and working of an electric tramway from La Coruna to Burgo. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by July 31.

Belfast.—The Tramways and Electricity Committee invite tenders for the supply of coal to the electric station, East Bridge-street, Belfast, for 12 months from July 1. Particulars from Mr. Bloxam, city electrical engineer. Tenders by June 20.

East Greenwich.—The London County Council invite tenders for the manufacture and delivery of high-tension main switchgear and low-tension auxiliary switchgear to be erected at the East Greenwich generating station. Tenders to the Clerk by July 7.

Brumby and Frodingham.—The Urban District Council invite tenders for fixing telephone between their offices and water-pumping station, about five miles. Particulars from Mr. J. Green, Council Offices, Frodingham, Doncaster. See advertisement.

London, S.W.—The London County Council invite tenders for the supply and delivery of (*a*) lanterns and lantern accessories, compressed gases, gas cylinders, etc.; (*b*) corks. Tenders to the Clerk of the Council, County Hall, Spring-gardens, S.W., by June 30.

Birmingham.—Tenders are invited for the annual supply of stores to the various generating stations and sub-stations of the Corporation electric supply department. Particulars from Mr. R. Chattock, the city electrical engineer and manager. Tenders by June 24.

Edinburgh.—The Edinburgh and Leith Corporations' Gas Commissioners invite tenders for the supply of about 2,000 to 2 500 tons per annum of sulphuric acid over a period of one, two, or three years. Particulars from Mr. Herring, general manager. Tenders by June 29.

Ealing.—The Town Council invite tenders for the supply of best cylinder oil, crank-chamber oil, paraffin, engine oil, best rope waste, and stoneware pipes required at the electricity works. Tenders to Mr. J. Douglas Knight, the borough electrical engineer and manager, by June 27.

New South Wales.—Tenders are invited for the supply of the following for the Postmaster-General's Department: 69 tons wire (hard-drawn copper, 300lb. per mile), 1 ton tape, binding copper (200lb. per mile), 15,000 insulators (best white porcelain, large). Tenders by Aug. 5.

Melbourne.—The Postmaster-General invites tenders for the erection of wireless telegraphy stations at Cape York, Thursday Island, Goode Island, Port Moresby, and Freemantle. Particulars from the Australian Commonwealth, Victoria-street, Westminster. Tenders by Aug. 26.

Stratford.—Tenders are invited for the electric lighting of the old portion of the hospital, for the Committee of the West Ham and East London Hospital, Stratford, E. Specifications and particulars can be had from Mr. A. W. Scrivener, secretary, to whom tenders must be delivered by June 27.

Spain.—The Public Works Department, Madrid, will shortly invite tenders for the installation of a new submarine telegraph cable from Cadiz to Teneriffe, thence to Gran Canaria, Palma y Gomera, from the latter island to Hierro, from Gran Canaria to Fuerteventura, and from thence to Lanzarote. Estimate, £172,420.

Perth.—The School Board of the burgh of Perth invite tenders for electric light wiring works, bells, etc., in connection with the erection of the new northern district school, Dunkeld-road. Particulars from Mr. Young, 42, Tay-street, Perth. Tenders to Mr. Martin, clerk of the School Board, 44, Tay-street, by June 20.

Adelaide.—The Postmaster-General invites tenders for the supply of telephone and telegraph instruments, switchboards, telephone line material, six tons sulphate of magnesia, one ton sal-ammoniac, crushed, etc. Particulars from the Australian Commonwealth, 72, Victoria-street, Westminster. Tenders by July 1.

Manchester.—Tenders are invited for general builders' work required in erection of an electric car depôt and buildings at Princess-road, Manchester, for the Tramways Committee. Particulars from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders to the Chairman by June 23.

Edinburgh.—Tenders are invited for the installation of electric lighting and power in the new engineering laboratory, Heriot-Watt College, for the George Heriot's Trust. Specifications from Mr. John Anderson, superintendent of works. Tenders to Mr. Peter Macnaughton, S S.C., clerk, 20, York-place, Edinburgh, by July 3.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors, 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

Adelaide.—Tenders are invited by the Municipal Tramways Trust for the supply, delivery, and erection of rotary converters, transformers, boosters, switchboards, and equipment for converter stations Nos. 1 and 2. Particulars from Mr. W. G. Goodman, the electrical engineer, 8, King William-street, Adelaide, S.A. Tenders to the Chairman by July 14.

Pontypridd.—The Urban District Council invite tenders for the annual supply of stores, including oil and colourmen's sundries, engineers' stores, brushes, ironmongery and stores, leather goods, rubber, and engine packings, etc. Particulars from Mr. P. Willoughby, engineer and surveyor. Tenders to Mr. J. Colenso Jones, clerk, Municipal Buildings, Pontypridd, by June 29.

London, E.C.—Tenders are invited for the supply of brass and other fittings and materials for railway carriages, steel cotters, twist drills, phosphor copper, tool steel, and other miscellaneous stores for the locomotive and carriage department as per specification to be seen at the Company's Office, for the Madras and Southern Mahratta Railway Co. (Madras Section). Tenders by June 29.

Camberwell and Lewisham.—The London County Council invite tenders for the roadwork and platelaying required for the construction, on the underground conduit system of electric traction, of the authorised tramways from Dulwich Library (Lordship-lane) to Forest Hill, Camberwell, and Lewisham. Particulars from Mr. Fitzmaurice, chief engineer of the Council. Tenders by June 30.

London, E.C.—Tenders are invited for the supply of: (1) rolling-stock—viz., 32 carriage underframes, 50ft. long, with bogies and vacuum brake complete; (2) carriage fittings—comprising wrought iron, steel hardware, screws, and sundries, for the South Indian Railway Co. Tenders, addressed to the Chairman and Directors of the South Indian Railway Co., must be left with Major-General J. Shaw Stewart, R E, managing director, 91, York-street, Westminster, by June 23.

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RESULTS OF TENDERS.

Bermondsey.—The Borough Council have accepted the tender of Babcock and Wilcox for £2,025 for a new boiler.

Tonbridge.—The Urban District Council have accepted the tender of the Western Electric Co. for the annual supply of cable.

Wallasey.—The Urban District Council have accepted the tender of Heenan and Froude for a refuse destructor for the sum of £3,427.

Kilmarnock.—The Corporation have accepted the tender of Babcock and Wilcox for supply of water-tube boiler and chain-grate stoker for £597.

Dowsbury. — The Town Council have accepted the following tenders: Midland Engineering Co., cooling tower; Haste Pump Co., condensing plant.

Weston-super-Mare.—The Weston-super-Mare Electric Supply Co. have received the contract for the lighting of Walliscote-road for a period of five years.

Burnley.—The tender of the British Insulated and Helsby Cables has been accepted for the supply of cable for the Padsham-road and Colne-road extensions.

St. Marylebone.—The Baths Committee have placed an order with Maple and Co. for the supply and fixing of 11 new battery wall telephones for £10. 18s.

Belfast.—The Tramways and Electrical Committee have accepted the tender of Munro and Brecknell and Rodgers for the supply of automatic point controllers.

Halifax.—An order has been placed by the Electricity Committee with the British Westinghouse Co. for 16 (35 h.p.) railway motors; also for 16 T.I.D. controllers.

Toronto.—The Board of Control have awarded the contract for copper wire to the Wire and Cable Co., and the contract for iron wire to the Canadian General Electric Co.

Falkirk.—The Corporation have accepted the tender of the Chloride Electrical Storage Co. for replating the battery and supplying one of their "Entz" type boosters and switchboard.

St. Marylebone.—The Electric Supply Committee recommend the acceptance of the tender of W. Cory and Son for the supply of coal to the generating station for the year ending June 30, 1909.

Liverpool.—Royce, Limited, have received an order for one five-ton, three-motor, electric overhead crane and steel gantry 700ft. long for Farnworth and Jardine, timber merchants, Seaforth, Liverpool.

Portsmouth.—The Town Council have accepted the tender of W. T. Glover and Co. for 2,500 yards of 2 square inch high-tension cable, £858, and for 600 yards of 15 square inch cable for £172.

Hamburg.—Messrs. J. Rennie and Sons, Cardonald, near Glasgow, have secured the order for the whole of the plant and tools required for an extensive shipbuilding yard to be established at Hamburg.

Manchester.—Royce, Limited, Trafford Park, Manchester, have received an order from Galloways, Limited, Manchester, for two 40-ton three-motor electric overhead cranes and gantry for their boiler works, Ardwick.

Victoria.—The Postmaster-General has accepted the tender of R. B. Hungerford, Pitt-street, Sydney, for the supply and delivery of 30 metallic-circuit telephone switchboards (100 lines), at £45. 18s. 7d. each—£1,377. 17s. 6d.

Adelaide.—The Municipal Council have placed an order with the British Westinghouse Electric and Manufacturing Co. for 120 magnetic brake equipments, similar to those in use on the London County Council tramways.

Contract for Electric Signs.—O. C. Hawkes, Limited, have received an order from the Underground Electric Railways for over 700 electric signs for the tube and other stations. The value of the contract is between £12,000 and £15,000.

Salford.—The Tramways Committee have accepted the tender of Mather and Platt, Salford, for the extension of the 2½in. water-mains in the centre pits of Nos. 1 and 2 sheds at the car depôt, and fitted with hydrant service, for the sum of £41. 8s.

Swindon.—The Town Council have accepted the tender of W. T. Henley's Telegraph Works Co. for service tee-joint boxes, that of Johnson and Phillips for service tee-joint boxes for troughing, and the tender of the British Insulated and Helsby Cables for fuse boxes.

Contracts for Condensing Plant.—The Mirrlees-Watson Co. have recently received orders for a number of condensing plants, among which are the following: J. Howden and Co. Glasgow, jet plant for Alexandria; P. J. Mitchell, jet plant for Barrow Collieries; London Zinc Mills, surface plant.

Stockport.—The Town Council have accepted the following tender: J. and W. S. Briscoe, repair of tramway routes, £599; W. Scott, Limited, rails and fishplates; Bayliss, Jones, and Bayliss, tie bars, bolts, and lock-nuts; Doulton and Co., porcelain troughing; W. T. Glover and Co., cable, £526.

Bath.—The Guardians have accepted the following tenders in connection with the extension of the supply of steam power at the workhouse laundry: Hutchinson and Co., Victoria Boiler Works, Elton, near Bury, Cornish boiler, £145; C. Whitaker and Co., Canal Engineering Works, Bradford, steam engine and donkey pump, etc., £105. 10s.

Bedford.—The Electricity Committee recommend the acceptance of the tenders of C. Franklin for the supply during the year ending June 30, 1909, of about 3,500 tons of Cotes Park coal at 11s. 10d. per ton, and about 1,000 tons of Birchwood coal at 9s. 11d. per ton; and the tender of Ellis and Everard for the supply during the same period of about 1,500 tons of Manners coal at 11s. 4d. per ton for use at the electricity generating station.

Homerton.—The following tenders have been accepted by the City of London Board of Guardians for installation of apparatus for new infirmary buildings at Homerton: Wenham and Waters, Paragon Works, Croydon, heating and hot-water apparatus, £2,409; Bradford and Co., laundry machinery, boiler, and steam-main, £2,265; Alliott and Paton, disinfector and steriliser, £319 and £114 respectively; McDowall, Steven, and Co., cooking apparatus, £313. 16s. 6d.

Glasgow.—The offer of C Quitman for the supply of opalescent electric lamp globes has been accepted. The Tramways Sub-Committee on Works and Stores recommend the acceptance of the following tenders: P. and R Fleming and Co., iron and steel works—turbines foundation, Pinkston; British Westinghouse Co. and Ateliers de Constructions Electriques de Charleroi, gear cases; National Conduit and Cable Co., lead-covered cable; S. Galbraith, scrap copper; Osborne and Co., scrap lead and brass.

Arran.—The following tenders have been received for the electrical installation at Arran for the Marquess of Graham (Messrs. Stevenson and McGuffie, consulting engineers, Glasgow): Lowdon Bros. and Co., £5,184 (accepted); Elmundson's Electricity Corporation, £5 209; Kennedy, Stark, and Co., £5,302; Anderson and Munro, £5,489; Cox-Walkers, £5,730; Allan, Arthur, and Ure, £5 999; Watson and Co., £6,138; Drake and Gorham, £6,223; Johnson and Phillips, £6,475.

New South Wales.—The following tenders have been accepted for supplies to the Public Works Department: Paul and Gray, wire rope; Turner and Henderson, draughtsmen's and surveyors' instruments; Colonial Rubber Co. and Dunlop Rubber Co. of Australasia, indiarubber goods, hose, etc.; J. W. Glenfield and Co., for certain items of Bell's manufacture; T. K. Steanes, Lawrence and Hanson, G. R. Hodson (Edison and Swan), India Rubber, Gutta Percha, and Telegraph Works Co., and Australian General Electric Co., electrical materials.

Portsmouth.—The following tenders have been received for the installation of electric light at the new laundry of the infectious diseases hospital:

Buck, Son, and Windsor (accepted)	£10	9	9
Southey, Limited	12	0	0
W. H. Sabine	12	8	0
W. J. Lenton	14	15	6
Grossmith and Co.	16	0	0
Woodville Electric Co.	16	10	0
Ashton and Holt	19	5	0

Salford.—The following tenders have been accepted by the Town Council on the recommendation of the Electricity Committee for the supply of the undermentioned goods during the ensuing 12 months:—General Electric Co., pure rubber solution 1s 5d. per lb., white tape 1s. 2½d. per lb., and carbon-filament incandescent lamps; Siemens Bros. and Co., London, pure rubber strip, 6s. 8d. per lb.; W. T. Henley's Telegraph Works Co., London, black tarred tape, 9d. per lb; Johnson and Phillips, Kent, tinned copper binding and fuse wire; Callender's Cable and Construction Co., London, tinned copper strip, 1s. 2d. per lb; J. Bassett, Salford, fine solder 9½d. per lb., plumbers' metal 8½d. per lb., tinfoil 2s. per lb.; L. Andrews and Co., Manchester, mica sheets 4s. 3d. per lb., rubber gloves 5s. 3d. per pair, rubber overshoes 4s. per pair, rubber caps; Adamant and Asphalte, Birmingham, bitumen, £5 per ton; Doulton and Co., London, stoneware troughs, covers, bridges, cable bearers, and cable protectors; Key Engineering Co., Manchester, fibre pipes; Howard Asphalt Troughing Co., Manchester, asphalt bridges; C. Jennings and Co., Bristol, wood troughing, bends, etc.; J. H. Tucker and Co., Birmingham, house service cut-outs; Edison and Swan United Electric Light Co., Manchester, gravity type ammeters; Whipp and Bourne, Castleton, circuit breakers; New Brotherton Tube Co., Wolverhampton, steel conduits for electrical wiring; Ward and Goldstone, Salford, cut-outs; Baxendale and Co., Manchester, tumbler and link switches; Sloan Electric Co., London, carbons for arc lamps, 20mm. by 10, cored 48s. 6d. per 1,000 pieces, 13mm. by 10, solid 20s. 6d. per 1,000 pieces; Andrew and Suter, London, carbons for arc lamps, 12mm. by 13, 11mm. by 12, 10mm. by 13, 9mm. by 10; Verity's, Limited, Manchester, electric motors, ½ h.p. to 5 h.p., high and low speed; Lancashire Dynamo and Motor Co., Manchester, 7½ h.p. and 10 h.p. low speed, 7½ h.p. to 30 h.p. high speed; R. Sturch and Sons, Salford, cotton driving rope 10½d. per lb., tarred twine 6d. per lb; R. Lauder, Pendleton, spun yarn, 5d. per lb.; T. Hart, Blackburn, special cotton driving rope, 1s. per lb.; R. Bell and Co., Manchester, sponge cloths, cotton waste, mutton cloths, and scouring cloths; W. H. Mitchell, Manchester, corrugated brass joint rings ½d. per inch flake graphite 1s. 3d. per lb.; United Asbestos Co., Manchester, boiler gauge glasses, sight-feed glasses, sight-feed glass rings, asbestos gland packing 11d. per lb., asbestos multiple-core packing 2s. 3d. per lb, asbestos powder 10s per cwt.; Clyde Rubber Works Co., Manchester, rubber insertion 1s. per lb., rubber insertion rings 2s. per lb., pure asbestos millboard 2d. per lb.

OPENINGS FOR CONTRACTORS.

ABERBARGOED.—Passenger station platform and goods warehouse, Brecon and Merthyr Railway Co.

ABERDEEN—Extension, Royal Infirmary (£25,000), Committee.

ABERDEEN—Dwelling-house, Pocra Quay, Aberdeen Harbour Commissioners.

ALNWICK—Motor-house for Schooner Hotel, Alnmouth; house, Christon Bank, Mr. A. S. Welsh; two houses, near Christon Bank Red Stead, Mr. Young; also house for Mr. Richardson.

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ALNWICK—Workmen's dwellings (£4,195), Urban District Council.

ALTRINCHAM—Isolation hospital, Sunderland-lane, Dunham Massey District Council.

AMPTHILL—Houses, Chalton, Mr. A. Bird.

ANTWERP—Fire station (£24,665), M. le Bourgmestre de la Ville d'Anvers, Hotel de Ville, Antwerp.

ARMAGH—Renovation of Tontine buildings for town hall. Mr. J. Lennon, town clerk.

ASHTEAD—House, Skinner's-lane, Mr. L. Littlewood; house, Oakhill-road, Caen Estate, Mr. Mitchell; motor-house, Longlands, Mr. P. C. Hodson.

ASHTON-UNDER-LYNE—Elementary school to accommodate 1,500 scholars, Education Committee.

BALLINLOUGH—Villa, Gregg's Cross, Mr. J. F. M'Mullen.

BANBURY—Elementary school, Council Education Committee.

BANGOR (IRELAND)—Hot sea-water baths Urban District Council; public library and technical school.

BANKYFELIN—Manse in connection with the Welsh Calvinistic Methodist Church.

BARNES—Development of building estate, Castelnau, Messrs. M. Thacker and Co., 53, Victoria-street, S.W.

BARNES—Villas, Messrs. C. Ellis and Co., 174, Upper Richmond-road, East Sheen, S.W., shops, Mr. F. W. Dunkley, Church-road.

BARNET—Iron schoolroom, Stapylton-road, Rev. Francis Pink.

BARNOLDSWICK—House and stable, Gisburn-road, Mr. J. Edmondson.

BARNSTAPLE—Houses, Fort-terrace, Mr. R. Prideaux.

BECKENHAM—Office and harness-room at the Council's depôt, Bromley-road, Urban District Council.

BEDFORD—Additions to house, Mr. G. Mayes; four houses, Tennyson-road, Messrs. Jacobs and Burton; house, Melbourne-street, Mr. T. Sinfield; house, Castle-road, Mr. S. Constant; two houses, Kingsley-road, Mr. W. Braybrook; additions to premises, St. Loyes-street, Mr. J. E. Robinson.

BEDFORD—Four houses, Honey Hill-road, Messrs. G. Burton and Son; six houses, Churchville-road, Messrs. B. Litchfield and Son; eight houses, Winifred-road, Mr. R. Jeakings; additions to house, St. Peter's-street, Directing Board of the Moravian Church; 12 houses, York-street, Mr. H. J. Jones; shop, St. Peter's-street, Ceylon and India Tea Co.; house and stables, Denmark-street, Mr. D. Francis; plan of shops, High-street, Mr. George Haynes; additions to house and stable, Goldington-road, Mr. V. S. A. Bell; house, Pemberley-avenue, Mr. P. J. Dunstall; two houses, Honey Hill-road, Mr. T. Ebden; additions to house, Park-avenue, for Colonel Dimmock; two houses, Honey Hill-road, for Messrs. J. Corby and Son; temporary studio, Midland-road, Mr. T. Welsh.

BELVEDERE—Factory, Aarhus Oliefabrik.

BIDEFORD—Extension of grammar school (£600), Education Committee.

BISHOP'S STORTFORD—Alterations and additions to workhouse infirmary, Guardians.

BOURNEMOUTH—House, Beaufort-road, Mr. W. J. Hiscock; house, corner Southern and Bracken roads, Mr. Thickness; house, Southern-road, Mrs. Sanderson; house, Warren Edge-road, Mr. A. J. Reeves; house, Richmond Park-crescent, Mr. L. E. Watts; house, Lowther-road, Mr. J. W. Davis, jun.; house, Muccleshell-road, Mr. H. Marks; house, Bengal-road, Mr. H. Walton; house, Pinecliff-avenue, Mr. J. Newbury; house, Burleigh-road, Mr. H. Mitchelmore; four shops, Southbourne-grove, Mr. S. Pellew; house, Green-road, Mrs. I. Pawsey; three houses, Fitzharris-avenue, Mr. G. Wilcox; house, Linwood-road, Mr. A. Edison; house, Ashley-road, Boscombe, Mr. T. V. Oilver; house, Queen's Park-drive, Mr. W. J. Kidman; house, Linwood-road, Mr. G. Bevan; five houses, Maxwell-road, Mr. A. Barnes; pair houses, corner Beaufort and Fenton roads, Mr. Stewart; house, Boscombe Cliff-road, Mr. R. Stokes; two houses, Southwood-avenue, Mr. H. Short; houses, Firbank-road, Mr. C. T. Rhodes; house, Evelyn-road, Mr. R. Watton; house, Southwood-avenue, Mr. A. S. Hook; five houses, Fenton-road, Mr. H. Hook; two houses, Marine-road, Mr. J. Edwards; seven houses and stabling, Edge Hill-road, Mr. H. Elliott; house, corner Heathwood and Talbot roads, Mr. H. Moores; house, Talbot-road, Mr. H. Moores; two houses, Heron Court-road, Mr. J. Belbin; house, Charminster-road, Mr. A. Smith; house, Chatsworth-road, Mr. F. Court.

BOURNEMOUTH—Public conveniences (£3,125), Town Council.

BOYNTON—Council school, etc., to accommodate 50 scholars, East Riding County Council Education Committee.

BRAMLEY—School at Bramley, near Malton, North Riding of Yorkshire County Council Education Committee.

BRIERFIELD—Three houses, Walter-street, Mr. J. T. Reynoldson.

BRIGHTON—Grammar school (£18,000), Education Authority.

BRISTOL—Council school at Sefton Park, Ashley Down, Bristol, Education Committee.

BRITON FERRY—Fifty-two houses (£12,021), Urban District Council.

BRIXHAM—Residence adjoining the Berry Head-road, Mr. C. Hellyer.

BROADSTAIRS—Electric motor house, North Foreland-avenue, Major T. B. Robinson.

BROAD-STREET, W.C.—Shops. Mr. F. G. Minter, builder, Putney, S.W.

BROMLEY—House, Denbridge-road, Mr. G. W. Hart; laundry, Cowper-road, Messrs. E. Peill and Son.

BROMSGROVE—Vestry, etc., parish church (£800), Ecclesiastical Commissioners.

BROMSGROVE—Alterations, infirmary, Board of Guardians.

BROWNHILLS—Sunday schools, Lichfield-road, Walsall Wood, Primitive Methodist Trustees.

BRYNNA—Thirty houses, Mr. J. T. Jenkins, Porth, Rhondda.

BURY—Alterations and additions to the offices at the electricity works, Town Council.

BURY—Institute in connection with parish church, Ecclesiastical Commissioners.

CAMBRIDGE—Additions, New-street, the Castle Soap Co., New-street; conservatory, &c., Adams-road, Mr. L. Cobbett, Adams-road; shop front, Market-passage, Messrs. Shippey and Sons, Sidney-street; covered way, Petty Cury, Mrs. Moyes, Lion Hotel; engine-house, Trinity-street, the Master, Fellows, and Scholars of Trinity College; open shed, Petty Cury, Mrs. Moyes, Lion Hotel; five houses, Castle-street, Messrs. Bennett and Sons, Gwydir-street; additions, Abbey-walk, Mr. E. Merry, Abbey-walk; chemical laboratory, Newnham College grounds, the Council of Newnham College; six houses, Suez-road, Messrs. Clark and Sons, Abbey Estate; two houses, St. Barnabas-road, Mr. W. Saint, Devonshire-road; additions, Trinity College, the Master, Fellows, and Scholars of Trinity College; office and weighbridge, Newmarket-road, Mr. G. Wardale, Primrose-street, Victoria-road; bicycle shelter, Corn Exchange-street, the Museums Syndicate, Downing-street; strong-room, lavatory, and w.c.'s, St. Andrew's-street, the Master, Fellows, and Scholars of Emmanuel College; 10 houses, Stanley-road, Mr. T. Buck, 22, Stanley road.

CANTERBURY—Additions to Wilton Lodge, Mr. H. R. Latter.

CANNOCK—Additions, union offices, Board of Guardians.

CARDIFF—Fifty seven houses, Universal Building Society and Mr. R. T. Rees.

CARSHALTON—Sixteen houses, Stanley-road, Mr. A. B. Cook; two houses, The Beeches, Messrs. Priest and Co.

CHATHAM—Additions to printing works in Fair-row, Messrs. Mackay; two houses, Capston-road, Mr. R. D. Bachelor; villa, Maidstone-road, Mr. E. Morgan; alterations to stores, Gun Wharf, Mr. S. Bessent; house, Street-end, Mr. Knowler; house and shop, Walderslade, Mr. F. Friday.

CHEAM—House, Washington-road, Mr. C. S. Rye; six houses, York-road, Mr. G. A. Gale.

CHELMSFORD—Business premises, Duke-street. Architect, Mr. F. Whitmore.

CHELMSFORD—Additions to Chelmsford and Essex Hospital and Dispensary (£4,820), Messrs. Young and Hall and W. H. Pertwee.

CHELTENHAM—Lodge at Lilleybrook, Mr. H. O. Lord.

CLACTON-ON-SEA—Houses, Page-road, Mr. Newman; houses, Holland-road, Mr. J. C. Burchardt.

CLAREMORRIS—Restoration, parish church, Trustees.

CLEATOR MOOR—Residence for the Rev. J. W. Stewart. Architect, Mr. E. Martindale.

CLITHEROE—House and shop, Downham-road, Chatham, for Clitheroe Co-operative Society.

CLOWNE—Two houses, Bakestone Moor, Mr. S. Godley; house, Barton-street, Mr. J. Walwin; two houses, Barton-street, Mr. R. Bradley.

CORK—Sanatorium on Streamhill site (£8,000), Joint Hospital Board.

COTFORD—Four houses, Somerset and Bath Asylum Commissioners.

COVENTRY—Scheme for municipal buildings, Town Council.

COVENTRY—Extensions to electric lighting (£35,000).

CRADLEY—Proposal to establish schools at Cradley, Board of Education.

CREWE—Eighteen houses Middlewich-street, Mr. W. Micklewright; six houses, Denver-street, Mr. J. Jones.

CRICK—Additions, Church of England schools, Ecclesiastical Commissioners.

CROWLAND—Church institute (£400), Ecclesiastical Commissioners.

CROYDON—Buildings in connection with the mental hospital, Corporation.

CROYDON—Secondary school for girls to accommodate 380 scholars, Education Committee.

CROYDON—Group of schools, Tavistock-road (£12,100), Town Council.

CROYDON—Twelve houses, Blackhorse-lane, Mr. S. Nixon, 11, Buckleigh-road, S.W.; nine houses, Mr. E. Bates, 2, Imperial-buildings, Croydon; 10 houses, Broad Green-avenue, Mr. C. A. Sedgewick, Frant-road, Thornton Heath; six houses, Mr. H. S. O'Reilly; two houses, Mr. W. Fear.

CUMWHINTON—Mission hall, Trustees.

DARTFORD—Repairs, etc., at the joint isolation hospital, Bow Arrow-lane, Joint Hospital Committee.

DOLGELLEY—Free library, District Council.

DORCHESTER—Repairs at the workhouse, for the Guardians.

DOUNE—Temperance hotel, Messrs. J. Innes and Sons.

DUBLIN—Technical school, Bolton-street, Technical Education Committee.

DUNBOYNE—Catholic schools, Messrs. W. H. Byrne and Son.

DUNDEE—Warehouse, Arklay-street, Mr. W. Cleghorn; business premises, Cowgate, Messrs. J. P. Matthew and Co.; houses, Dens-road, Messrs. Malcolm, Ogilvie, and Co; additions to works, Erskine-street, Messrs. Ogilvie and Smith; villas, Maryfield-terrace, Messrs. J. Foggie and Son; warehouse, Seafield-lane, Messrs. H. and A. Scott; motor-shed, Step-row, Mr. R. L. Watson,

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DUNFERMLINE—Alterations on property, Bridge-street, Mr. Kelt.
DUNGIVEN—Extensions, Presbyterian church, Trustees.
DURHAM—Additions to St. Giles's School, Education Committee.
EARBY—New church, Earby-in-Craven. Messrs. Bromet and Thorman, architects, Tadcaster.
EDINBURGH—Church and offices, Orwell-terrace, Kirk Session of the parish of West Coates.
EDMONTON (ALBERTA)—Local telephone exchange building, two sites in Strathcona (10,000dol.), Public Works Department.
ENFIELD — Houses, stables, and cart sheds, Clerk, Urban District Council.
ESTON—Church hall on site adjoining church (£1,400), Ecclesiastical Commissioners.
EWLOE GREEN—Elementary school, Flintshire Education Committee.
FALMOUTH—Rebuilding Seven Stars Hotel, Messrs. W. and E. C. Carne.
FARNHAM—Observation block, Joint Isolation Hospital Committee.
FATFIELD—Thirty-three houses, Lambton Colliery, Limited.
FEATHERSTONE—Public baths (£5,000), District Council.
FERRYHILL—Eight houses, Back-lane. Plans passed by Council.
FINCHLEY—Additional office accommodation, Urban District Council—Mr. C. G. Lawson, Urban District Council surveyor; six houses, Mr. G. Matthews; three houses, Mr. E. J. Smee; 12 houses, Bounds Green, Mr. A. Garrett; additions to Wesleyan Chapel and Sunday school; 10 houses and shop, Regents Park-road, and four houses, Great North-road, Mr. C. F. Day, 21, Regents-place; two houses, Arden-road, Mr. C. W. Scott; 18 houses, Mr. J. E. Hattersley; four houses, Windsor-road, Mr. A. E. Bailey.
FISHBURN—Seven houses, and church institute, Old Cornforth. Plans passed by Council.
FLEET—Houses, Mr. Ventham; warehouse, Mr. Pearson; motorworks, Mr. Wilson.
FOLKESTONE—New Harvey Grammar School (£4,000), Education Committee.
FOLKESTONE—Two houses, Grimston-gardens, Mr. W. White; alterations and additions to 56, Canterbury-road, Mr. A. R. Bowles; additions to Royal Bakery, Cheriton-road, Mr. T. B. Hewson; motor garage, Dover-road, Messrs. Webster and Son; five houses, St. Hilda-road, Mr. C. Rootes; alterations to 21, Bournemouth-road, Mr. W. Scott.
FOSTON—Alterations and additions to Council school, East Riding County Council Education Committee.
GEMBLING—Alterations and additions to Council school, East Riding County Council Education Committee.
GLASGOW—Extension, St. Aloysius Catholic College, Scott-street.
GLOUCESTER—Renovation of St. Mary de Crypt Church.
GODALMING—Church of England Schools, Moss-lane, Ecclesiastical Commissioners.
GOLCAR—Assembly, dining, and building rooms; alterations and additions to the Conservative Club—architect, Mr. A. Shaw.
GOLDER'S GREEN, N.W.—Development of 60 acres land for building, Hon. W. H. Appleton.
GOODMAYES—Congregational church, Rev. Davies Bull.
GORSEINON—Independent chapel, Trustees of Ebenezer Chapel.
GOSPORT—Institute in connection with Christ Church, Stoke-road (£2,000).
GOVAN—Electric lighting installation in sections during the next four years (£23,000), Town Council.
GRAVESEND—Arc lamps, etc., Electricity Committee.
GRAVESEND—Elementary schools, Education Committee.
GRIMSBY—Extensions to the cattle market, Town Council.
GUILDFORD—Technical institute and school. Mr. F. S. Tosswill, secretary, Education Committee.
HACKINGTON—Additions, St. Stephen's Schools (£868), Kent County Education Committee.
HADHAM—Two houses, Church End, Little Hadham, Mr. Minet.
HAMMERSMITH, W.—Additions, St. Peter's Girls' School, Mr. M N. Castelo; shop, 162, Uxbridge-road, Mr. W. C. Gordon; additions, Wood-lane railway station, Central London Railway, Messrs. Mott and Hay.
HAMPSTEAD, N.W.—Additions, central public library, Library Committee.
HAROLD WOOD — Alterations, The Grange, West Ham Borough Council.
HARROW—Eight houses, Dorset-road, Mr. J. Emes; offices, Northolt-road, Harrow and Stanmore Gas Co.; two houses, Mr. W. H. Watts.
HARROW—Offices, Northolt-road. Plans passed by District Council.
HARTLEY—Additional classroom, etc., at the National School. Architects, Messrs. Colson and Nisbett.
HASTINGS—Additions to steam laundry, Bexhill-road, Messrs. T. Bradford and Co.; additions to house, Edmund-road, Olive Vale, Mr. A. H. Huckle.
HEREFORD—Secondary school, Aylestone Hill, City Council.
HEXHAM—Primitive Methodist church (£6,000), Trustees.
HIGH WYCOMBE — Elementary school, Spring-gardens (£6,898), Education Committee.
HOMERTON — Alterations, medical superintendent's house, Eastern Fever Hospital, Metropolitan Asylums Board.
HOUGHTON-LE-SPRING—House and shop, Messrs. Morton and Sons; two houses and shop, Mr. G. Bruce; two houses, Mr. M. Brown.
HOWDEN CLOUGH—Sunday school. Messrs. W. Hanstock and Son, architects, Batley.
HUDDERSFIELD — Eight houses, Deighton-road. Mr. J. Berry, 3, Market-place.
HULL—Town hall extensions, Hull Corporation.
HUNGERFORD—Elementary school, Berks Education Committee.
ILFORD — Ninety-seven houses, Mr. L. Verlyck, Adelaide-chambers, Ilford; stable, South Essex Laundry Co., Roden-street.
ISLINGTON, N.—Extension of electricity mains (£320), Electricity Committee.
KEADY—Elementary school and parochial hall. Architect, Mr. H. C. Parkinson.
KELK—Alterations and additions to Council school, East Riding County Council Education Committee.
IPSWICH — Additions and alterations, St. John's Home (£538), Guardians.
JARROW—Public bath (£6,000), Town Council.
KENFIG HILL—Twenty-four houses, Pwll-y-Gath Building Club, Mr. R. O. Clark.
KIDDERMINSTER—Alterations to the old chapel at the cemetery, Joint Burial Committee.
KIDDERMINSTER—Mortuary chapel, Mill street, Governors of the Infirmary.
KILBURN, N.W.—Theatre of varieties, Messrs. T. H. Kingerlee and Sons.
KING'S LYNN—House, Wyatt-street, Mr. Roberts; cart-shed and storerooms, Creswell-street, Mr. E. Backham.
KING'S SUTTON—Elementary school, Northamptonshire Education Committee.
KINGSWAY, W.C.—Buildings, Messrs. Barlow and Roberts, 14, Red Cross-street, S.E.; buildings, Messrs. J. Smith and Sons, South Norwood.
KINGTON—Town hall, Urban District Council.
KIRKHAM—Council school, Elementary Education Sub-Committee.
KIRKINTILLOCH — Extensions, Lenzie Academy (£5,000), School Board.
LAUDER — Public sanitary conveniences, Under-Back-road, Town Council.
LEICESTER—Technical and art schools (£14,000), Education Committee.
LESLIE—Block of houses, Mansfield, Mr. T. Whitaker.
LEYTON—Alterations, etc., schools, Urban District Council.
LICHFIELD—Additions to house, Lombard-street, Mr. Baxter; two houses, Gaia-lane, Mr. J. R. Deacon.
LICHFIELD—Children's homes, Wissage, Board of Guardians.
LIMERICK—Technical school (£5,000), Town Council.
LITTLE HULTON—Three houses, Greenheyes, Mr. J. Bridge.
LLANISHEN—Baptist chapel, Trustees.
LOANHEAD—Thirteen houses, Clerk-street, Messrs Paterson, sanitary engineers, Edinburgh.
LOCHGELLY—Houses, Station-road. Mr. J. T. Scobie, architect, Dumfermline.
LONDON—Welsh mission hall, Ealing—architect, Mr. T. J. Evans; villas, Barnes, Messrs. C. Ellis and Co.; warehouses, etc., Barbican, Messrs Patman and Fotheringham; six houses, Southgate, Mr. W. J. Edwards.
LONDON—Manufacture, supply, and delivery of tramway feeder pillars, London County Council.
LONDON, E.C.—Rebuilding Black Dog public house, Shoe-lane. Messrs. P. H. Rice and Son, builders, Stockwell-road, S.W.
LONDON, W.C.—Exeter Hall, Strand (£20,000), Evangelical Alliance.
LOWESTOFT—Five houses, May-road, Mr. A. E. Clarke; two houses, Blackheath-road, Messrs. Westgate Bros.; curing-house, North Beach, Mr. Butcher; house, Royal-avenue, Mr. G. Fitt.
LUTON—Railway mission hall, Mr. A. Cole.
LUTON—Elementary school, Beech-hill (£2,649), Town Council.
LYDNEY—Enlargement, Council school (£1,200), Town Council.
LYDNEY—Elementary school (£1,186), Gloucester Education Committee.
LYNSTED—New offices in connection with the elementary schools, Kent County Education Authority.
MADDISTON—House, Mr. J. B. Bryce.
MAESTEG—Institute at Garth, Urban District Council.
MAIDENHEAD—Alterations at the Wesleyan infants' schoolroom (£600). Education Committee.
MALVERN—Additions to the abbey, Malvern Wells, Messrs. Berwick, Lechmere, and Co.
MANCHESTER—Car depôt, Princess-road, Manchester Corporation.
MANCHESTER—Electricity undertaking (£130,500), Town Council.
MIDDLESBROUGH—Alterations and additions, 17 houses, St. George's-terrace, Linthorpe-road.
MIDDLESBROUGH—Block of business premises, Messrs. W. Whitley Limited.
MIDLETON—Workmen's dwellings (£67,769), Rural District Council.
MORRISTON—Parish hall, Mr. C. S. Thomas, Wind-street, Swansea.
MOULTON—Improvements, Council school, Cheshire County Council.
MOUNT PLEASANT—Church in place of present iron structure, Joint Committee of the U.F. Presbytery and Mount Pleasant congregation.

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NAVAN—Offices (£5,000), County Council.

NETLEY—Alterations, etc., to the main hospital of the Royal Victoria Hospital in the Southern Command.

NORBURY—Business premises Messrs. L. Whitehead and Co., Portland place, South Lambeth, S.E.

NORTHALLERTON—Infectious diseases hospital (£950), Hospital Committee.

NORTHLEACH—Higher elementary school, Gloucester Education Committee.

OBAN—Post office, Commissioners of Public Works.

PENTRE—Vestry and classrooms, etc., Trustees of Hebron Welsh Baptist Chapel, Ton.

PERTH—Elementary school, Dunkeld-road, School Board.

PERTH—Extension, General Accident Assurance Corporation Buildings; architect, Mr. G. P. Young.

PERTH—Electric lighting wiring works, bells, etc., in connection with erection of the new Northern District school, Perth School Board.

PLATT BRIDGE—Engine-house, Urban District Council.

PONTSARN—Two villas in Penrhiwglais Field, Mr. H. C. Howitt.

PORTSMOUTH—Extensions, lunatic asylum (£9,500), Town Council.

PRESTON—Alterations and additions to Council school, East Riding County Council Education Committee.

PUTNEY—General hospital (£16,000), Hospital Committee.

RADCLIFFE—Fire station, Parsonage-street; extensions to electricity undertaking (£14,350), District Council.

RADYR—Villa, main road, Mr. J. Jenkins.

RAMSGATE—Hospital (£12,000), Hospital Committee.

RAWTENSTALL—Council school, Alder Grange, Town Council.

REDNAL—Public reading-room, Libraries Committee.

REDDING—Four houses and shop, Mr. T. Bain.

RHYMNEY—Repairing, etc., the Duke of Wellington Inn and the Tredegar Arms, Messrs. A. Buchan and Co.

RINGWOOD—House, Broadshard-lane, Mr. H. Barrow; house, St. Ives, Mr. H. Brewer; house, Burley, Mr. F. Milbourne.

ROCHESTER—Repairs at Troy Town School, £100; Gordon-road School, £100; Station-road School, £60; Borstal School, £40; St. Peter's School, £30; St. Mary's School, £20, Education Committee.

RUGBY—Boiler-house, Brownsover Mill-road, British Thomson-Houston Co.; two houses, Benn-street, Mr. Watford; alterations to premises, Regent-street, Mr. J. H. Liddington; four houses, Claremont-road, Messrs. Linnell and Son; house, Cromwell-road, Mr. G. Warner; lamp factory, Lower Hillmorton-road, Mr. J. Findlay; alterations to premises, Whitehall-road, Mr. C. H. Fuller.

RUTHIN—Renovation of the C.M. Chapel, Mr. T. Parry.

ST. ANNES—Electricity main feeder cable (£3,500), Council.

ST. ANNES—Villas, St. David's road, Mr. T. Seed; villas, Cambridge-road, Messrs. Keenan and Parker; six houses, Bromley-road, Messrs. J. Heap and Sons.

SALTCOATS—Pavilion, Town Council.

SALTNEY—Elementary school, Chester Education Committee.

SCUNTHORPE — Fire station and store (£3,000), Urban District Council.

SELLY PARK—Elementary school, Pershore-road, King's Norton and Northfield Urban District Council.

SHEFFIELD—Carriage storing shed, Midland Railway Co., Derby.

SHEFFIELD—Electricity lighting purposes (£20,000), Town Council.

SHERBORNE—Church hall, Digby-road, Trustees.

SITTINGBOURNE—Elementary school, Kent County Education Committee.

SKIPTON—Vestries and north aisle transept, parish church. Architects, Messrs. Austin and Paley.

SOUTHAMPTON—Extension of the tramways to the Royal Pier, Tramways Committee.

SOUTHGATE—Six houses, Mr. W. J. Edwards.

SOUTH SHIELDS—Extensions to workhouse at Harton (£10,000), Guardians

SOUTHWICK—St. Hilda's Church, Beaumont-street (£4,000), Churchwardens.

SPEETON—Alterations and alterations to Council school, East Riding County Council Education Committee

SPENNYMOOR—Elementary school, Durham County Education Committee.

SPENNYMOOR—House, Durham-road, Mr. W. Pattinson; workshop, St. Paul's-gardens, Mr. J. J. Maxey; abattoir, near King James-street, Mr. W. Huxley.

STANSTED — Alterations to house, Oakley-green, Mr. J. C. Waithman.

STEPNEY—Ampere-hour meters, demand indicators and time switches, arc lamp carbons, Electricity Committee.

STIRLING—Additions to house, Lower Polmont, Mr. J. Boyd; additions to Greenhill School, Falkirk Parish School Board.

SUNDERLAND—Two houses, Beechwood-street, Mr. M. A. Speight; five houses, Athol-park, Mr. R. Wilson; house, Canon Cockin-street, Mr. H. E. Robinson; two houses, St. Leonard-street, Mr. R. Oliver; two houses, Hastings-street, Mr. J. E. Parker; extension of St. Benets School, Mr. E. D. Webb; two houses, Henderson-road, Mr. J. Spain; additions to the Sunderland Workhouse, Guardians.

SUTTON—House and shop, Outram-street, Mr. W. Kirk; petrol store Hardwick-street, Freeman Oil Co.; two houses, Garden-lane, Mr. Fletcher.

TAUNTON—Shop, Albemarle-terrace, Mr. A. Fouracre.

TORONTO—Electrical construction department, City Council.

TREALAW—Sixteen houses, Miskin Manor Building Club.

TREHARRIS—Twenty houses, Quaker's Yard, Woodlands Building Club.

TURRIFF—Court-room and municipal offices, Town Council.

TWYNYRODYN—Additions, schools, Merthyr Tydfil Education Committee.

TYLDESLEY—Free library, Stanley-street, Urban District Council.

WALSALL—Eight houses, Sheridan-street, Mr. T. Hughes; additions to four houses, Bridgeman-street, Mr. W. H. Thompson; bakery, Shaw-street, Co-operative Society; temporary dressing-room, Midland-road, Messrs. Grapho and Jackson; additions to engine-house, Neale-street, Walsall Locks and Cart Gear Co.; barrelling house, Windmill-street, Messrs. M. Harvey and Co.; additions to house, Stafford-street, Misses Unit.

WALSALL—Erection and furnishing of the manual instruction, cookery, and laundry work centres at the Elmore Green Council School (£1,200).

WALLINGTON—R.C. church and presbytery, Rev. — Cafferata, Our Lady's Church, Sutton.

WANTAGE—Two pairs of villas, Priory-road, Mr. J. Trow.

WATFORD—Garage, The Priory, Langley-road, Mr. W. E. Newcombe.

WEALDSTONE—Shop and workshop, Messrs. Freeman, Hardy, and Wills, Newington Butts, S.E.

WELLINGBOROUGH—Office and showroom, Park-street, alterations two houses, Midland-road, Messrs. W. Fish and Co.

WEST AUCKLAND—Six houses. Sites given by Mr. M. H. Kellett.

WEST HAM—Underground convenience, Becton-road, Town Council.

WESTMORELAND (JAMAICA)—Sugar factory, Mirrlees-Watson Co., Glasgow.

WEYMOUTH—Alterations to shop, St. Mary-street, Mr. Jackson; house, High-street, Mr. J. Oliver.

WHITEHAVEN—Alterations to houses, Douglas Bourne; alterations to house, King-street; alterations to houses, John's-lane. Plans passed by Council.

WHITEHAVEN—Alterations to refuge buildings, Market-place. Architect, Mr. J. N. Singleton.

WHITEHAVEN—Elementary school (£3,918), Town Council.

WHITEFIELD—Wesleyan church, Trustees.

WIGAN—Workshop, Frog-lane, Messrs. J. Wood and Sons; motor garage, Arcade-street, Mr. H. H. Timberlake; house, Darlington-street, Mr. J. P. Hayes.

WIGAN—Machinery transferred from Pemberton electricity works to Bradford-place station, and extension of the latter (£36,500).

WILLINGTON — House, Chapel-street, Mr. Cottle; five houses, High-street; house, Crook-lane, Messrs. Strakers and Love.

WIMBLEDON—Thirty-three houses, The Crescent, Messrs. Ryan and Penfold, Wimbledon Park; enlargement of cottage hospital, Mr. A. S. Sheldon, town clerk; 35 houses, Mr. C. Barwell, Morden; laundry, Merton High-street, Messrs. Hooker and Webb, Croydon; church and parish-room, Mr. T. G. Jackson, 14, Buckingham-street, Strand, W.C.; shops and flats, Messrs. Thompson and Pomeroy; shop and showroom, Worple-road, Messrs. Whitehead Bros.; alteration and additions to building, Wimbledon Common, Mr. R. A. Hinds.

WINSCOMBE — Improvement, Sidcot Quakers' School (£16,000), Managers.

WISHAM—Engine-house connected to workhouse, Fylde Board of Guardians.

WITHERNSEA—14 houses, South Cliff, Mr. Brown.

WORMHILL—Elementary school, Peak Dale, to accommodate 320 children.

YARMOUTH—Additions, Middle-road, South Denes, Mr. W. B. Jarvis; additions, 33, Alpha-road, Southtown, Mr. R. Stanley; fishing premises, South Denes, Messrs. Slater and Co.; converting workshop into house, Queen Ann's-road, Mr. Teasdel; temporary shed, Upper Cliff-road, Mr. Watts; motor shed, factory, Messrs. Grout and Co.; additions to house, Pier Plain, Gorleston, Mr. R. A. Wightman; five houses, Kitchener-road, Mr. Trett; timber shelters, Riverside, Southtown, Messrs. Jewson and Sons; house, Nelson-road central, Mr. Bird.

YORK—Improvements, county hospital (£4,000), Hospital Committee.

PROVISIONAL PATENTS, 1908.

JUNE 1.

11833. Improvements in enclosed electric indicating fuses. James John Jennison, Elm Bank, Huckuall-road, Bulwell, Nottingham.

11857. Improvements in electrical signalling apparatus. Howard William Brunton, 88, Chancery-lane, London.

11895. Improvements in and relating to the manufacture of compositions suitable for electric insulating and other purposes. Frederick Walton, 7, Southampton-buildings, London.

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11870. Improvements in apparatus of the resonance type applicable for use in indicating or measuring the frequency of electrical alternations. Robert Hartmann-Kempf, Clun House, Surrey-street, London. (Date applied for under Section 91 of the Act, May 31, 1907, being date of application in United States.) (Complete specification.)

11871. Improvements in and relating to commutators for dynamo machines. Charles Algernon Parsons and Alexander Henry Law, 18, Southampton-buildings, London.

JUNE 2.

11932. New or improved automatic switch for producing changes of design in electrical illumination. Charles Thomas Pounsford and Frederick Thomas Love, 5, Ashcombe-gardens, Weston-super-Mare.

11933. Improvements in or connected with automatically operated or controlled electric signalling apparatus. Harry Storm and Thomas Simpson, 15, Water-street, Liverpool.

11944. Improvements in electrolytes for storage batteries. Alfred Wood Somers and Richard Joseph Crowley, Sunbridge-chambers, Bradford, Yorks. (Date applied for under Rule 13, May 9, 1908. An invention comprised in application No. 10078, dated May 9, 1908.)

11945. Improvements in or relating to surface-contact electric traction systems. Edward Albert Mitchell, 46, Lincoln's-inn-fields, London. (Date applied for under Rule 13, Jan. 31, 1908. An invention comprised in application No. 17552, dated July 31, 1907.) (Complete specification.)

11979. Improvements in and relating to electrical distributing systems. The British Thomson-Houston Company, Limited, and Edmund Basil Wedmore, 83, Cannon-street, London.

11986. Improvements in electric circuit controllers for railway signals and the like. Sidney Prescott Wood, Palace-chambers, Westminster, London.

JUNE 3.

12039. Improvements in electricity meters. George Hookham, 4, New Bartholomew-street, Birmingham.

12044. Improvements relating to electric transformers. Gisbert Kapp, 18, Southampton-buildings, London.

12050. Improvements in fuses fitted with indicating arrangements. Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Westminster. (Siemens-Schuckertwerke, G. m. b. H., Germany.) (Complete specification.)

12060. Improvements in means for controlling the electromotive force of dynamo-electric machinery. Howard Theophilus Wright, 47, Lincoln's-inn-fields, London. (Complete specification.)

12061. Improvements relating to the magnetic separation of materials. Thomas Barry, 46, Lincoln's-inn-fields, London.

12099. Improvements in and relating to the control of induction motors. Herbert Sefton-Jones, 322, High Holborn, London. (Clifford Hugh Douglas, India.)

12104. Improvements in the control of electrically-operated switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JUNE 4.

12105. Improvements in and relating to electric controllers. Ernest Schattner and Richard Amberton, Caxton House, Westminster.

12135. Improvements in telephones. Alexis Werner, 26, Upper Bedford-place, London.

12140. Improvements in and relating to wireless telephony and telegraphy. Alexander William Sharmann, 4, Buckingham House, 111, Trinity-road, Upper Tooting, London.

12142. Improvements in or relating to automatic cut-outs. Alfred Julius Boult, 111, Hatton-garden, London. (Electrical Manufacturing Company, United States.) (Complete specification.)

12152. Improvements in magneto-electric ignition apparatus for internal-combustion engines. Robert Frederick Hall, 24, Temple-row, Birmingham.

12170. Improvements in and relating to electric switches. Frederick Hagger Headley, Walter Henry Walton, and Edward Lawley-Pinching, 322, High Holborn, London. (Complete specification.)

12175. Improved switch for controlling electrical circuits. Thomas Joseph Rorke and Edwin Rorke, 7, Southampton-buildings, London. (Date applied for under Rule 13, Jan. 3, 1908. An invention comprised in application No. 12967, dated June 4, 1907.) (Complete specification.)

12183. Improvements in alloys useful as electric resistance conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JUNE 5.

12191. Improvements in electric cooking and heating apparatus. James Andrews Abbott, trading as Abbott Bros., 23, Merchants-quay, Dublin, Ireland.

12194. Improved method of supporting incandescent lamp filaments. Donald Murray, 3, Lombard-court, London.

12196. Pliers for rotating electric shade carriers. John Dugdill, 305, Oldham-road, Failsworth, near Manchester.

12211. Improvements in or relating to iron-clad electric switches and switch fuses. Vernon Hope, 55, Market-street, Manchester.

12225. Luminous electric lighting and bell switches. Emil Samuel Conradi, 19, Ebbsfleet-road, Cricklewood.

12229. Improvements in or relating to automatic cut-out apparatus for electric arc lamps. Joseph Bein, 205A, Pentonville-road, London.

12249. Improved electric motor giving reciprocating motion. Ernest Edward Pickard, 8, Quality-court, Chancery-lane, London.

12256. Improvements in electricity meters. Isaria-Zähler-Werke G. m. b. H., 46, Lincoln's-inn-fields, London. (Date applied for under Section 91 of the Act, May 11, 1907, being date of application in Germany.) (Complete specification.)

12258. Improvements in or relating to electric furnaces for the manufacture of steel. Adolphe Hugot, 31, Bedford-street, Strand, London.

12267. Improvements in and relating to asymmetric electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

12268. Improvements in shaft bearings. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

12275. Improvements in electrical heating apparatus especially applicable to flatirons and the like. William Eastman and Alan Warne, 38, Chancery-lane, London.

JUNE 6.

12280. Electric safety appliances. John Grice Statter, Norfolk House, Norfolk-street, Strand, London.

12296. Improvements in shunts for ammeters. Evershed and Vignoles, Limited, and Ernest Blacker Vignoles, Acton-lane Works, Chiswick, London. (Complete specification.)

12302. Improvements in or relating to magneto-electric ignition apparatus. Charles Frederick Caxton Wilkins and Muirhead and Co., Limited, 1, Imperial-buildings, East Croydon, Surrey. (Complete specification.)

12325. Improvements in or relating to electrical distribution. Joseph Lester Woodbridge, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, Oct. 2, 1907, being date of application in United States.) (Complete specification.)

12326. Improvements in or relating to regulating apparatus for induction motors. Manu Stern, 111, Hatton-garden, London. (Date applied for under Section 91 of the Act, June 12, 1907, being date of application in Germany.) (Complete specification.)

12336. Electric indicating meter for controlling the duration of telephone conversations. Hermann Roost, 65, Chancery-lane, London. (Complete specification.)

12340. Method of and apparatus for compounding or over-compounding alternators. The Phœnix Dynamo Manufacturing Company, Limited, and Robert Pohl, 322, High Holborn, London.

12352. Electric radiator for heating buildings or the like. Cornelius George Nobbs, Cornelius George Nobbs, jun., and James Edward Rosenthal, Birkbeck Bank-chambers, Southampton-buildings, London. (Complete specification.)

JUNE 9.

12364. Improvements in or relating to electrically-actuated pumps. Frank Roberts and Margaret Potter Roberts, 18, Seagate-road, Hunstanton, Norfolk.

12389. Improvements in and relating to oil switches and the like for alternating currents. Siemens Bros. Dynamo Works, Limited, and Max Kloss, Queen Anne's-chambers, Broadway, Westminster. (Complete specification.)

12390. Improved means for obtaining a smooth electromotive force curve in alternate-current dynamos. Siemens Bros. Dynamo Works, Limited, and Max Kloss, Queen Anne's-chambers, Westminster.

12398. Improvements in or relating to installations of electric lamps having metal filaments. William Dierman, 18, Southampton-buildings, London.

12447. Improvements in or relating to electric motors for vehicles. Carlo Riccardo Massone, 111, Hatton-garden, London. (Complete specification.)

JUNE 10.

12468. Improvements in apparatus for wireless telegraphy. Johann Sahulka, 55, Chancery-lane, London. (Complete specification.)

12470. New or improved adaptor for electric incandescence lamps. Francis Leonard Wright, 9, Warwick-court, Gray's-inn, London.

12498. Improvements relating to the control of electric motors. Henry Alexander Mavor and Mavor and Coulson, Limited, 46, Lincoln's-inn-fields, London.

12507. Improvements in telephonic or like calling apparatus. Charles Hustwick Ellison and Charles Mark Jacobs, Birkbeck Bank-chambers, Southampton-buildings, London. (Application for patent of addition to No. 18308/07.)

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12515. Improvements in and relating to compressors of the centrifugal type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JUNE 11.

12527. Improvements in and relating to variable motion gear for actuating magnetos, dynamos, and the like for electric ignition and other purposes. Edward Eugene-Brown, Gwydyr, Eardley-road, Streatham, London.

12532. Improvements in electrically-operated pumps or the like. Joseph Knight and Peter Ronald Keppie, 37, Moorfields, Liverpool.

12556. Improvements in carbons for arc lamps. Siemens Bros. Dynamo Works, Limited, Queen Anne's-chambers, Broadway, Westminster. (Siemens Schuckert - Werke G. m. b. H., Germany. (Complete specification.)

12563. Improvements relating to the electric ignition systems of internal-combustion engines. Robert Frederick Hall, 24, Temple-row, Birmingham.

12567. Improvements in electric bells. Carl Herrde, 1, Great James-street, Bedford-row, London.

12580. Improvements in and relating to alternating-current motors of the commutator type. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on June 25.)

1907.

10072. Electric motor control systems. British Thomson-Houston Company. (General Electric Company.)

10293. Trolley heads of electric tramcars and the like Collins, Hayes, and Watson.

12353. Receivers for wireless telegraphy. Austin. (Date applied for under International Convention, May 29, 1906.)

12496. Electric apparatus for communicating between one part of a vessel and another, and for analogous purposes. Sedgwick.

12495. Dynamometers and power indicators. Barr and Stroud.

12578. Self-regulating electrical machines for alternating or direct current. Heyland. (Date applied for under International Convention, May 30, 1906.)

12857. Ball and socket joints for gas, electric light, and other like fittings. Tonry.

12969. Devices for effecting electric synchronous working of two apparatus. Hellmann.

13032. Systems for electric railways. Eastwood.

14572. Means for electrically detecting the position of the switch tongues and locking bolts of railway points. Haywood, and McKenzie and Holland, Limited.

18013A. Contact arrangement and stand for electric incandescent lamps. Kessler and Jelich. (Date applied for under Rule 13, Aug. 8, 1907.)

18308. Telephonic and like calling apparatus. Ellison and Jacobs.

19073. Means for supporting electric lamps. Fusser.

19447. Electric automatic time switch mechanism. Moore.

19734. Electric arc lamps. Gross.

20119. Transmitters for wireless telegraphy. Marconi and Marconi's Wireless Telegraph Company.

21950. Telegraphic code appliances. Dotesio and Powell.

24753. Means for rectifying alternate currents. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

25350. Dynamo-electric machines of the homopolar type. Arenas y Garcia. (Date applied for under International Convention, Aug. 2, 1907.)

27379. Radio-telegraphy. Amalgamated Radio-Telegraph Company. (Seibt.)

27516. Electrical driving gear, more especially intended for motor road vehicles. Johnson. (Felten und Guilleaume-Lahmeyerwerke Akt.-Ges.)

1908.

4444. Electrical radiators. Dowsing.

4621. Manufacture of heat interchangers by an electrolytic process. Friedheim. (Date applied for under International Convention, March 4, 1907.)

5225. Electrodes for arc lamps. Allgemeine-Elektricitäts Ges. (Date applied for under International Convention, July 5, 1907.)

5610. Incandescent electric lamps. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, March 14, 1907.)

6050. Process for hardening tantalum. Siemens und Halske Akt.-Ges. (Date applied for under International Convention, March 26, 1907.)

7910. Pyrometers and thermometers of the thermo-electric or electrical resistance type. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.		Last price.
	£		£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	¼-⅜
—— Ord., 1,125,000	1	..	¼-⅜
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	23/32-27/32
—— Ordinary, Nos. 1 125,000	1	..	3/16-5/16
British Aluminium Co., Ordinary, 2,001-40,000	5	..	3-3¼
—— 7 per cent. Cum. Pref., 1-40,000	5	..	4-4¼
—— "A" 6 per cent. Cum. Pref., 1-20,000	5	..	4¼-4½
—— 4 per cent. Funding Certificates, 1-20,000	5	..	3¾-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100	..	104-108
—— 5½ per cent. Loch Leven Deb. (Reg.) Red., 1-3,000	100	..	97-100
British Insulated and Helsby Cables, Ord., 1-100,000	5	..	5¾-6¼
—— 6 per cent. Cum. Pref., 1-100,000	5	..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100	..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100	..	93-98
British Westinghouse Elec. and Manuf. 10 per cent. Pref., 275,001-475,000	3	..	7/16-11/16
—— 4 per cent. Mortgage Debenture Stock	100	..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1-105 731	2	..	0-¼
—— Non. Cum., 6 per cent., Pref.	2	..	5/16-7/16
—— 4½ per cent. 1st Debenture Stock	100	..	70-75
—— 4½ per cent. 2nd Debenture Stock	100	..	55-60
Callender's Cable, Debentures	100	..	107-109
—— Ordinary	5	..	9¾-10⅛
—— 5 per cent. Pref.	5	..	5¼-5⅝
Consolidated Electrical Co., Ordinary, 1-110,000	1	..	⅜-¼
Crompton and Co.	5	..	1¼-1⅝
—— 5 per cent. Debentures	—	..	92-96
Dick, Kerr, and Co., Ordinary, 1.250 000	1	..	1 1/16-1 5/15
—— 6 per cent. Cum. Pref., 1-305,000	1	..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100	..	101-104
Edison and Swan United, "A" Shares, 1-99 261	5	..	⅛-⅜
—— "A" Shares, 01-017,139	5	..	1⅛-2⅛
—— 5 per cent. Debentures	100	..	85-87
—— 4 per cent. Deb. Stock, Red.	100	..	78-81
Electric Construction, Nos. 1 to 112,100	2	..	¼-½
—— 7 per cent. Cumulative Pref.	2	..	1¼-1⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	63-67
Electrolytic Alkali Co., Ordinary, 1-202,218	1	..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red	100	..	75-80
General Electric Company (1900) 5 per cent. Cum. Pref.	10	..	7⅞-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	87-90
W. T. Henley's Telegraph Works, Ordinary	5	..	10¼-11⅛
—— 4½ per cent. Preference	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	104-106 xd
India Rubber, Gutta Percha, and Telegraph Works	10	..	15¼-16⅛
—— 4 per cent. Debentures	100	..	98-100
National Electric Construction Co., 1-170,000	1	..	⅜-⅝
Parker, Thos., Limited, Ordinary	10	..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5	..	—
Telegraph Construction and Maintenance	12	..	30-32
—— 4 per cent. Bonds	100	..	102-104
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10	..	7¼-8¼

Electric Lighting and Supply.—

Name.	Amount paid.		Last price.
	£		£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5	..	4⅝-5¼
Bournemouth and Poole, Ordinary	10	..	10¼-11
—— 4½ per cent. Cum. Pref., 7,501-15,000	10	..	9¼-10⅜
—— 6 per cent. Cum. Second Pref., 15,001-22,500	10	..	10¼-11
—— 4½ per cent. Debenture Stock, Red.	100	..	102-105
Bromley (Kent) Electric Light and Power Co.	5	..	4¼-5
—— 4½ per cent. 1st Debenture Stock, Red.	100	..	94-97
Brompton and Kensington, Ordinary	5	..	6¾-7¾
—— 7 per cent. Preference	5	..	6¾-7¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5	..	5¼-5¾ xd
Cambridge Electric Supply Company, £10 Ord.	8	..	12½-13½
Canadian General Electric Co., Common Shares	$100	..	88-90
—— 7 per cent. Cum. Pref. Stock	$100	..	109-111
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100	..	98-101 xd
Charing Cross, West End, and City Electric Supply, Ord., 1-60,000	5	..	3⅜-4⅛
—— 4½ per cent. Cum Pref., 1-80,000	5	..	4¼-4⅝
—— 4 per cent. Debenture Stock, Red.	100	..	95-98
—— "City Undertaking," 4½ p c Cum. Pref., 1-40,000	5	..	3⅜-4⅜
—— ditto (1905) 40,001-80,000	5	..	4⅛-4⅜
Chelsea Electricity Supply	5	..	5-5¼
—— 4½ per cent. Debentures	100	..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000	..	—
City of London, Ordinary	10	..	9¼-10½
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 4½ per cent. Debenture Stock	100	..	124-127
—— 4½ per cent. 2nd Deb. Stk., Red.	100	..	102-105
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1,630	50	..	50-53
Cordoba Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100	..	90-92
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5	..	2¼-3
—— 5 per cent. Preference, 1-50,000	5	..	3¾-4¼
County of London Elec. Supply, Ordinary	10	..	7⅞-8¼
—— 6 per cent. Cum. Pref.	10	..	10¼-11
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100	..	107-110
—— 4½ per cent. 2nd Debentures Prov. Certs	100	..	88-91
Edmundson's Electricity Corporation, Ordinary, 1-80,000	5	..	⅛-⅜
—— 6 per cent. Cum Pref.	5	..	⅛-1
—— 4½ per cent. First Mort. Deb.	100	..	6:-73
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	—	..	83-86 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5	..	2¼-2⅝
—— 5 per cent. Debenture Stock, Rd.	100	..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red.	100	..	90-93
Folkestone Electric Supply, Ord., Nos. 1-10 000	5	..	4¼-4½
—— 5 per cent. Cum. Pref., Nos. 1-10,000	5	..	5-5¼
—— 4½ per cent. First Deb Stock, Red.	100	..	94-97
Hove Electric Lighting, Ord., 1-13,000	5	..	6-6¼
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. stock, Red.	100	..	95-98
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red.	100	..	90-93
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1	..	⅜-½
Kensington and Knightsbridge Elec. Lt., Ord, 1-21,000	5	..	7-8
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100	..	96-99
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¼-10⅛

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Name.	Amount paid.	Last price.
	£	£
London Electric, Ordinary	3	¼-1⅛
—— 6 per cent. Pref.	5	4¼-4⅜
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	83-92
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs.), all paid	100	85-90
Metropolitan Ordinary, 100,001-200,000	5	4¼-5
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4¼-5
—— 5½ per cent. Mortgage Debenture, Red.	100	85-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000	—	82½-83½ p.c.
Mexican Light and Power Co., Capital Stock	$100	60 61
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	87-88
Midland Electric Power Dis., 4½ p.c. 1st Mort. Deb.	—	96 99
Newcastle-upon-Tyne Electric Supply, Ordinary, 1-57,009	5	5¼-6
—— do., 57,010-87,500	5	5¼-6
—— do., 75,001-87,500 (issued at £22 prem., 16s. paid	5	5¼-6
—— 5 per cent., Pref., 1-57,009	5	5⅞-6⅛
Notting Hill Electric Lighting	10	11¼-12¼
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5⅜-6⅛
—— 4 per cent. Debenture Stock	100	94-98
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120 507	1	27/32 31/32
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	¼-1
—— 5 per cent. Debenture Stock, Red.	100	96-98
Rosario Electric Co., 6 per cent. Cum. Pref., 1-20,000	5	4⅜-5⅛
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4⅜-5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¼-⅜
—— 4 per cent. Debenture Stock	100	70-74
South London, Ordinary	4	2¼-2⅜
South Metropolitan Electric Light and Power, Ord.	1	⅜-⅝
—— 7 per cent. Cum Pref.	1	1 1-1 5/16
—— 4½ per cent. 1st Mort. Deb.	100	99-102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7¼-8¼
—— 7 per cent. Pref.	5	6¼-7¼
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1-2
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅛-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	87-90
Westminster, Ordinary	5	7¼-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4⅛-5⅛

Electric Tramways.—

Name.	Amount paid.	Last price.
	£	£
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,007	5	6¼-6½
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	8¼-8⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	141-146
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk., Red.	100	104-107
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. Shares, 1-10,000	10	—
—— 5 per cent Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	¼-⅜
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	⅜-½
Birmingham and Midland Trams., 4½ p.c. 1st Db. Stk., Red.	100	95-96
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	10¼-10⅜
—— 4½ per cent. Deb. Stock, Red.	100	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	4 3/16 4 7/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼ 5⅛
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	98-103
British Columbia Electric Railway Co., Ord Def.	100	125-130
—— Ord. Pref.	100	108 112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	107-111
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	99-102
—— 4½ per cent. Vancouver Power Deb.	100	101-104
British Electric Traction, Ord. 1-300 000 & 60,001-90,000	10	1¼-1⅜
—— 6 per cent. Cm Pf., 30,0001-60 000	10	4¼ 4⅜
—— 5 per cent. Perpetual Debenture Stock	100	92-97
—— 4½ per cent 2nd Deb. Stock	100	74-78
Bueno Ayres and Belgrano Trams.	5	4⅜-4⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅜ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅜ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	95-99
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	101-105
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	100-104
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, Ord., Nos 1-137,610	5	5⅝ 6⅜
—— 5 per cent. Cum. Pref., Nos. 1 20,000	5	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	103 106
Cape Electric Tramways, Nos. 1-480,000	1	3.16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4¼-4⅜ xd
—— 4 per cent 1st Mortgage Deb., 1-3 000 (1917)	100	97-100
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5	5 9/16-5 13/16
—— 4 per cent. Deb. Stock, Red. 1905	100	99-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	88-91 xd
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	12¼-13¼
—— 5½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p.c. Deb. Stk., Red.	100	93-96
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	82-87
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14¼
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	¼-⅜
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	85-89
—— 6 per cent. "B" Deb. Stock	100	69-73
Kidderminster and District Lighting and Traction, Pref.	5	10-10¼
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £296,500 2nd Mort. Deb. Stock	—	—
—— £83,350 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1⅛
—— 6 per cent. Cum. Pref., Nos. 1-426,553	1	1-1⅛
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	90-95

Name.	Amount paid.	Last price.
	£	£
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7¼-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	81-86
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5	4¼-5
——½ per cent 1st Mort. Deb. Stock, Red.	100	85-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	11/16-13/ 6
—— ½ per cent. Deb. Stock, Red.	100	95-98
Mexico Trams. Co., Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	82½-90½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort Bonds, 1926 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., 601-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	¼-⅜
Oldham, Ashton, and Hyde Tramway, Ordinary	10	2
—— 5 per cent. Cum. Pref.	10	8⅜-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk.	100	103-106
Potteries Electric Traction, Ordinary, 1-245.000	1	¼-½
—— per cent. Cum. Pref., 300,001-545 000	1	⅜-½
—— per cent. Debenture Stock	100	95-96
Provincial Tramways Co., Ordinary, 1-24.912	10	4⅜-5⅛
—— per cent. Cum. Pref., 1-10,000	10	9¼-10¼
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5	5¼-5⅜
——4½ per cent 1st Mort. Deb. Stock, Red.	100	97-99
Sao Paulo Tramway, Light, and Power Co.	$100	132-137
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-12,000	$500	96-98 p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 per cent. Cum. Pref., 19,571-169,570, Prov. Certs.	1	⅜-1
—— 4 per cent. Deb Stock, Red. 1940	100	77-81
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	77-82
Yorkshire (West Riding) Elec Tram. Co., Ord., 70,001-110,000	5	¼-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	3¼-3⅝
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid	Last price.
	£	£
Central London, Ordinary	100	79-82
—— 4 per cent. Pref.	100	90-92
—— ,, ,, deferred	100	61-64
—— 4 p c Deb. Stock (Prov. Script Certs., fully paid)	100	103-106
City and South London, Consolidated Ordinary	100	39-41
—— 4 per cent Debenture Stock	100	100-103
—— 5 per cent. Pref. Stock '91	100	113-116
—— ,, ,, ,, '96	100	112-115
—— ,, ,, ,, '01	100	110-113
—— ,, ,, ,, '05	100	105-108
Liverpool Overhead, 5 per cent. Pref.	10	10-10¼
—— Ordinary, 1-50,000	10	3⅜-4¼
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent Profit-sharing Secured Notes	—	39-43
—— Deposit Receipts	—	39-43

Telegraphs and Telephones.—

Name.	Amount paid.	Last price
	£	£
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	84-87
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-88,000 and 53,001-78,000	$1,000	89-92
Anglo-American Telegraph Co., Ordinary	100	58-62
—— 6 per cent. Preferred Ordinary	100	104-106
—— Deferred Ordinary	100	1½-1 ¼
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44,000	5	7-7¼
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	84-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	7¼-8¼ xd
—— 10 per cent. Preference, 1-6,000	10	15⅜-16⅜ xd
Direct Spanish Telegraph Co., Ordinary	5	3-3¼
—— 10 per cent. Cum. Preference	5	8-9
—— 4½ per cent. Debs., 1-600	50	100-103
Direct United States Cable Co.	20	13¼-14
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100¼-102¼
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	100¼-102¼
—— 4 per cent. Reg. Mort. Debs. (Mauritius Subsidy), 1-8 000, 1913	25	99¼-101¼
Eastern Extension, Australasia and China, 1-300,000	10	12⅜-13¼
—— 4 per cent. Mort. Deb. Stock, Perp.	100	100¼-102¼
Eastern Telegraph Co., Ordinary Stock	100	131-136
—— 5½ per cent. Preference Stock	100	83¼-86¼
—— 4 per cent. Mortgage Debenture Stock	100	100¼-102¼
Great Northern Telegraph Co. (of Copenhagen)	10	28-30
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100	100¼-102¼
Indo-European Telegraph Co.	25	53-56
Marconi's Wireless Telegraph Co., Nos. 256,128-284,190	1	⅜-½
Monte Video Telephone Co., Ordinary, 1-72,680	1	29/32-1 1/32
—— 5 per cent. Preference, 1-86,492	1	15/16-15/16
National Telephone, Preferred	100	108¼-110¼
—— Deferred Stock	100	113-115
—— 6 per cent. Cum. First Pref.	10	10¼-12¼
—— 6 per cent Cum. Second Pref.	10	10¼-12¼
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5⅝
—— 5½ per cent. Deb. Stock, Red.	100	99¼-101¼
—— 4 per cent. Deb. Stock, Red.	100	102¼-103¼
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref.	1	1¼-1½
Pacific and European Tel., 4 p.c. Guar. Debs., Red., 1-1,000	100	99-102
United River Plate Tele. Co., Ordinary, 1-100,000	5	6⅜-6½
—— 5 per cent. Cum. Pref., 1-40,000	5	5-5⅛
—— 4½ per cent. Debenture Stock, Red.	100	100¼-102¼
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10¼
West Coast of America, 1-30,000 and 53,001-53,008	2½	1 5/16-1 9/16
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	99-102
West India and Panama Telegraph Co., Ordinary	10	⅜-½
—— 6 per cent. Cum. 1st Preference	10	8¼-8⅜
—— 6 per cent. Cum. 2nd Preference	10	8-9
—— 5 per cent. Debs., Red., 1-800	100	101-104
Western Telegraph Co., 1-207,930	10	13⅜-13⅝
—— 4 per cent. Debenture Stock, Red.	100	100¼-102¼

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pass'nger	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	June 10	1,426	1,476	- 50	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0·98	11·39	4,987	6·54
Ayr Corporation	,, 13	270	256	- 16	—	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 13	3,080	2,490	+ 590	+16,379	4¼	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 14	1,172	1,042	+ 130	+ 631	23·53	23·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 6	6 651	5,931	+ 720	—	56½	56½	,, 31	18,557	5,352,093	215,345	·87	16·2	9,228	—
Blackburn Corporation	May 20	1,123	1,349	- 225	+ 97	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12·64	2,309	8·02
Blackpool Corporation	June 11	1,973	784	+1,194	- 237	17½	17½	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams.	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·796
Bolton Corporation	,, 14	2,496	2,161	+ 335	+ 1,051	42	42	March 31	111.294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 10	2,068	1,566	+ 502	- 701	29¼	24½	,, 31	83,663	13,503,610	1,765,098	1·48	11·37	2,860	7·28
Bradford Corporation	,, 6	4 879	4 487	+ 342	- 600	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10 79	2,421	—
Brighton Corporation	,, 14	1,209	856	+ 353	+ 101	17·191	17·191	,, 31	50,652	10,759,310	1,798,505	1·09	10·49	2,844	7·4
Bristol Tramway Company	,, 12	7 002	5,104	+1,898	—	53½	51½	,, 31	265,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 13	1,460	1,261	+ 193	—	19½	19½	,, 31	62,699	11,967,458	1,205,83	1·31	12·48	5,825	8·21
Burton Corporation	,, 14	318	289	+ 29	—	9⅝	8½	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,820	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,266	6
Carlisle Tramways Company	June 13	198	189	+ 9	+ 25	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 13	7,223	5,812	+1,411	+ 1,515	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62 29a	55,357	35·22a
Charing X, Euston, & Hamp. Ry	,, 13	3,970	—	—	—	7⅞	6¼	—	—	—	—	—	—	—	—
City and South London Railway	,, 14	3,119	3 059	+ 50	+ 6,221	9	6¼	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	May 6	181	195	- 14	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	June 11	520	483	+ 32	- 377	15¼	15¼	Dec 31	25,032	5,966,364	891,988	—	6·74	—	4·78
Croydon Corporation	,, 12	1 972	—	—	—	12 c	12 c	March 31	64,065	13,514,918	1,802,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 12	293	268	+ 25	- 26	7·23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	,, 6	219	216	+ 3	- 201	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	,, 12	190	134	+ 66	+ 139h	6¾	6¾	—	—		—	—	—	—	—
Dublin U.T.	,, 12	6,244	6,157	+ 87	- 1,681	54¼	48¾	—	—		—	—	—	—	—
Dundee City Tramways	April 8	1,144	1 195	- 51	—	22	22	May 15	57,672	15 554,905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	June 13	1,0 8	905	+ 173	- 471	14	14	March 31	47,140	15,049,240	1,052,151	·74	10 49	3,636	7·14
Glasgow Corporation	,, 13	17,078	18,102	- 1,024	- 5,422h	177½	169	May 31	887,381	224,063,098	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 10	399	275	+ 124	+ 77	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 13	5.415	4,500	+ 915	+35,911	9¼	9	—	—	—	—	—	—	—	—
Halifax Corporation	May 5	1,490	1,515	— 25	—	52·574	37	,, 31	77,996	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	June 13	2,072	1,648	+ 424	+ 676	35½	35	,, 31	81,196	15 252,150	1,804,745	1·22	10·79	2,770	5·94
Hull Corporation	,, 13	2 589	2,478	+ 111	- 66	26	26	,, 31	121,186	29,151,543	2,956,406	1	9·84	—	—
Ilford Corporation	May 2	410	449	- 39	—	10½	10½	,, 31	26,499	6,586,754	615,117	·89	9 58	2,225	6 5
Ilkeston Corporation	June 10	188	131	+ 57	+ 60	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	May 6	249	256	- 7	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7 55	1,73	4 95
Lancashire United Tramways	June 10	1,501	1 330	+ 171	+ 1 235	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 6	6 837	6 474	+ 363	+ 529	96½	96½	March 31	327,794	73,024,853	7,358,185	1·06	10·69	3,352	5 58
Leicester Corporation	,, 13	2,770	2 331	+ 438	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 6	11,328	10,983	+ 340	- 2,255	104	104	Dec. 31	563,793	122,094,528	12,115,934	1 108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 14	1,607	1,513	+ 94	- 705h	9 25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	May 30	35 692	30,810	+4 882	+ 25 122	98	98	March 31	1378,014	314,227,090	30,130.297	1·05	10 98	—	8·56
Lowestoft Corporation	,, 23	174	219	- 45	—	3½	—	Sept. 30	11,009	2,622,922	343,190	1 03	7·9	2,156	6 39
Maidstone Corporation	June 11	284	205	+ 79	—	3¼	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2.956	6·2
Manchester Corporation	May 23	15,519	17,869	- 2,320	+ 4,837	172	161	,, 31	719,673	143,264,501	15,523,459	1·19	11·12	4,556	7·03
Metropolitan District Railway	June 13	9,026	8 623	+ 403	+22 508	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 14	16,984	15,948	+1 036	+ 3,793	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 13	156	155	+ 1	- 1·6	2¾	2¾	March 31	7,709	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 13	3,929	4 050	- 131	- 4,075	59⅛	57¼	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 6	701	1,504	- 803	- 1,015	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10 01	1,525	6·87
Oldham Corporation	May 3	1,894	1,871	+ 23	- 321	35⅔	35⅔	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·2·9
Portsmouth Corporation	June 6	2,108	1 763	+ 240	—	28½	28½	,, 31	98,911	20.668.825	2,199,823	1·15	10 79	—	—
Reading Corporation	,, 11	8 4	618	+ 186	—	13½	13½	,, 31	32,661	8,130,179	918,825	·95	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,745,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	,, 1	4,951	4,304	+ 647	- 1,539	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	
Sheffield Corporation	,, 7	5,810	5,641	+ 169	- 1,017	65½	65¾	March 25	276,907	73,966,299	6,804,656	898	9 767	4,174	
Southampton Corporation	May 6	1,079	932	+ 147	+ 202	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7·7
Southend-on-Sea Corporation	June 10	599	377	+ 222	+ 214	9	9	,, 31	20,076	4,431,728	390,538	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 14	1,470	1,445	+ 25	- 2,595	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6·37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 11	448	93	+ 355	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 13	1,117	844	+ 273	+ 482	12 68	12·43	‡ ,, 31	42,810	8,312,592	890,906	1·23	11·53	3,376	—
Warrington Corporation	—	—	—	—	—	6½	6¼	,, 31	19,204	4,965 296	429.785	—	10·724	1,989	6·95
West Ham Corporation	,, 4	2,346	2,169	+ 177	- 1,862	14·7	14·7	,, 31	122,881	35,102,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 10	1,334	837	+ 497	—	20	20	,, 31	43,823	9,276,023	966,133	—	10·886	2,159	6·095

* 1905-6 figures. ‡ 1907-8 figures. † And 38 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures

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THE

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THE TONGUE IN THE CHEEK.

The London County Council and its tramway accounts form an agreeable text for a cynic's comment. In our issue of March 27 last we referred to the laughable report of Messrs. Peat and Pixley on this subject. We say laughable advisedly, because it was to be a report on commercial lines, yet when it was issued it was seen to be nothing of the sort, as it suggested things to be done which are utterly unknown in commercial circles. What a blessing it is to be an expert, to be asked to report, to get a large fee, and in the end the frothy, wordy report really says nothing but "pay your capital account off a little quicker"; for, after all, and whatever is said to the contrary, the capital account of a tramway system is measured by its cost. The Finance Committee of the London County Council and the Highways Committee also have reported upon this famous report. We cannot deal with the whole of these lengthy documents, but come at once to the real gist of the whole matter. Messrs. Peat and Pixley, it will be remembered, put forth the novel doctrine that the Council ought not to include in its capital account the outlay on both horse and electric traction, saying "this principle is not sound because there are practically no existing assets to represent the horse system of traction so far as it has been displaced." The outlay on the displaced system is, they say, "loss." Fancy any sane commercial man saying that the cost of a slum area was not part and parcel of the capital when the slum buildings had been replaced by other structures. What does the speculator in buildings do? He buys the slum property, sells what of the materials he can, and the balance added to the expenditure on the new buildings is his capital account. He reckons his charges or rents according to the total expenditure, and not upon a part of it. So the London County Council or any other human commercial in tramways charges the public using the tramways in their fares to provide the revenue for the purpose of extinguishing the capital account, paying its interest, and maintaining the equipment. If by any chicanery the capital account is paid off in too short a period, the users during that period are unnecessarily overcharged. We have seen it stated that the policy—rather, the politics—of the present London County Council is by any means to disparage the tramways, to raise fares, in order to be able to say, "We told you so." The Finance Committee says that, "in adopting this advice the Council will assume an obligation of a more drastic character than that usually applied to commercial undertakings." It is not only "more drastic" than those usually applied," it does not exist and never has existed in commercial undertakings. Of course, in municipal affairs you can come upon the rates, but there is no analogue to this in company work. Can anyone tell us of any company that divides its expended moneys into two parts—capital and losses—paying off its losses quicker than it pays off its capital? If such there be, we should like to know of it, and to see how the matter is arranged. The only possible analogue seems to be when a sum is borrowed from bankers or elsewhere, and paid off out of revenue. However, the Finance Committee, though recommending the plan, evidently do not believe it to be commercial doctrine. It is not. Just consider for a few moments a question or two and a few figures. A. has nothing to do with B.'s business except, perhaps, to purchase something at B.'s shop now and again, and C. never purchases. Is it commercial practice for B. to give C. something out of the profits of his business, or to A., except value for money spent? The analogy is not quite true in considering municipal matters, because C. lends his name and may have to con-

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tribute to any loss of B. Still, this will do for future consideration, that if C. is to get anything on account of something that probably won't happen, how much? It is always assumed that C.—that is, the ratepayer—is to reap a benefit and that A. is to pay it. We are exceptions to the rule, and maintain that the ratepayer is not to expect large sums from profits in aid of rates. Go a little further. The total debt charges of the London County Council tramways are, 1908 9, £406,421. In 1915-16 they will be £68,204 less, in 1924-5 they will be £131,819 less. Who is to get the benefit of these lessened charges—the traveller or the ratepayer; and if the latter, why? We assume that revenue in 1908-9 will be enough to pay all charges, and that the rates pay nothing. It is not expected that revenue will decrease as the system becomes more perfect; hence, unless fares are reduced, there will be larger and larger surpluses paid by users. It may be held that the larger surplus should be used to pay off the capital more quickly—it may be put to aid the rates. We think it should be used in the reduction of fares. At any rate, it will be seen that the committee supporting the suggestion for paying off more quickly are proposing to use the surpluses for this purpose They do not propose to commence the increased paying for some six years—from March 31, 1914. Another case of troubling posterity, for the present London County Council will have ceased to be long ere that date. The whole thing looks to be what some people dub it—merely a political move.

ELECTRICAL CONTRACTORS AND REGISTRATION.

Electrical contractors have been straining every effort to bring about an improvement in the status of their trade by ensuring that each of their number is fully qualified to carry on such work, and is in no sense what may be termed a jerry contractor. Those contractors who are imbued with the sense of the importance of their work, and of the personal responsibility entailed, who are jealous of the reputation which their industry should bear, and zealous in their endeavours to make that industry synonymous with the highest efficiency, are, through their association, carrying on a work the importance of which is, perhaps, insufficiently recognised, but which, we venture to believe, will impress itself more deeply upon all who are engaged in electrical engineering as its progress continues. It is to be hoped that electrical contractors will not let slip the opportunity which presents itself of raising the status of their industry to a high pitch and maintaining it at that. For the class of work which now falls to the lot of the electrical contractor is of a more highly technical and complicated nature than the work which the contractor in the early days had to carry out, and the rule-of-thumb methods by which the latter was guided will not serve his successor in these days, when the installation of intricate apparatus and complicated wiring demands scientific treatment. The solution of the problem is in no way facilitated by the easy way in which any plumber, or gasfitter, or ironmonger, or sanitary engineer, or even house decorator (who has probably had no training in the work, and who certainly can show no adequate qualifications), may style himself "electrical engineer," and be prepared to carry out installations which, more often than otherwise, are unsatisfactorily performed. The difficulty has been overcome in Wellington, New Zealand, by the registration of electricians and wiremen, and the account from the pen of a valued contributor which appears in another part of this journal should be productive of no little discussion in contractors' circles. We do not suggest that the municipalities or other bodies in this country should register contractors. But there is no denying the fact that something must be done by the contractors themselves to rescue the industry from those who are unqualified and from the incompetent, otherwise another and outside body might step in.

THE CIVIL ENGINEERS.

The demolition of the existing premises of the Institution of Civil Engineers, which Parliament has sanctioned in order to make way for new public offices, has a peculiar interest for all of us. The premises have for years past been the scene of the meetings of the Institution of Electrical Engineers, and much regret will be felt that the building, which was erected within the last ten years at a cost of £30,000 or £40,000, will soon be no more. It seems extraordinary that at the time of the erection of the buildings in Great George-street there was not sufficient foresight to warn the Civil Engineers not to spend too much money on the building, as the land might be required for public purposes. This, however, is no concern of ours. The Civil Engineers do not seem to come at all badly out of the deal. They receive £40,000 for the old building and obtain a site on the south side of Great George-street, at the corner of Prince's-street, which is larger than the old, but for which they pay the Government exactly the same price per foot as they received for that which they surrendered. We suppose it is now too late to suggest a joint home for the various engineering societies, similar to that which has been established in the United States through the munificence of Mr. Carnegie. This establishment, though founded by the Mechanical Engineers, the Electrical Engineers, and the Mining Engineers, extends a welcome to all engineering institutions, and provides ample accommodation for meetings and discussions. But our confrères across the Atlantic can boast of another privilege which is here absent. Their Engineers' Club is an excellent meeting place for engineers for other than professional purposes, and, as a social centre, it effectively fosters a spirit of fraternity among its habitues, and tends to strengthen the bonds of friendship between them. At none of our institutions can we boast of anything approaching this. Indeed, it is impossible for two members of an institution to meet at the institution rooms on any evening, or before or after a lecture, to have a friendly chat or discuss any matter over a convivial cigar.

THE NOTTINGHAM ELECTRICITY WORKS.

Next week will see the gathering together of all the leading municipal electrical engineers in the historic town of Nottingham for the annual convention of the Incorporated Municipal Electrical Association. This year Mr. H. Talbot is the president of this association, and those engineers visiting Nottingham will be interested to see the two large central stations for which he has been responsible in every respect. When in 1894 it was decided by the Corporation that they would make electric lighting a municipal undertaking, Mr. Talbot was selected to design the works and to buy for the Corporation the plant and mains necessary to meet the then demand. It is nearly 14 years ago since the supply was first given, and the curves we reproduce below show clearly that the undertaking has progressed steadily with financial returns commensurate with the increase in the size of the undertaking. We have looked back to our issues for Feb. 23 and March 2, 1894, for the complete description of the first station, and it is interesting to note that the first plant consisted of Siemens dynamos

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coupled to Willans engines, and that the cables were supplied by Callender's Bitumen, Telegraph, and Waterproof Company, Limited. The great feature of the Nottingham undertaking is that having selected these three contractors and proved the value of the materials they supplied, the Nottingham Corporation have obtained practically the whole of the rest of the plant and cables from the same contractors. An examination of the balance-sheets and the analysed cost of production show that this course had been more than justified by the results obtained, and we feel sure that these contractors have given the Corporation first attention and reasonable prices in return for the steady flow of orders. The central stations at Nottingham do not require, in consequence, any extended description. There is a wonderful uniformity not only in the type of a plant, but also in the size of the units. Thus, in the first station there are still at work the first generating units installed. These are small, and are now mostly used for balancing purposes. Next in order, as shown in the accompanying illustration (Fig. 1), are four units of the Siemens bipolar type of 220 kw. output. These machines represented standard English practice for a number of years, and are about the upper limit to which the bipolar dynamo could be built. The next step to multipolar machines was made when larger units of 440 kw. were required. There are nine Siemens machines of this size in the Talbot-street works (Fig. 2), all driven by Willans engines. Again, when the electrification of the tramways necessitated the building of the St. Ann's power station, the same size units were adhered to, and there are in this station nine more Siemens-Willans combinations of 440 kw. The only variation in these 18 generating sets lies in the fact that six of them have not the dynamos wound for traction purposes. The engines are all interchangeable, and the staff have not to handle a variety of types both of engines and generators. The question of the spare parts is greatly simplified owing to this uniformity, and the accompanying curves show how low the item for repairs is.

We feel sure that Mr. Talbot and his committee have had laid before them from time to time, when renewal orders have been under consideration, tenders which would

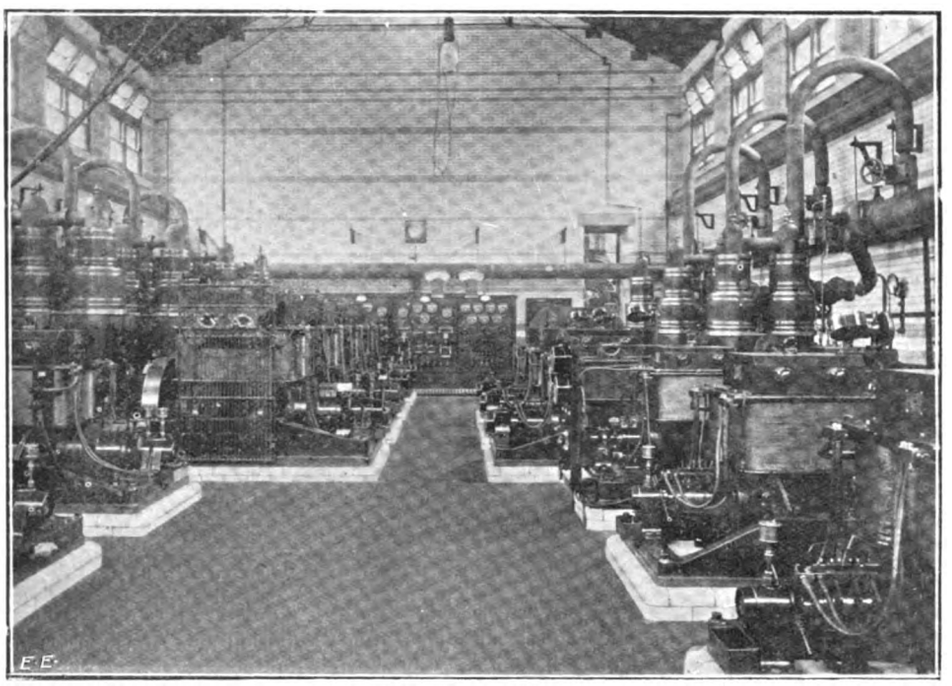

FIG. 1.—View of the First Engine Room at Talbot Road, Nottingham, showing the Siemens-Willans Steam Dynamos.

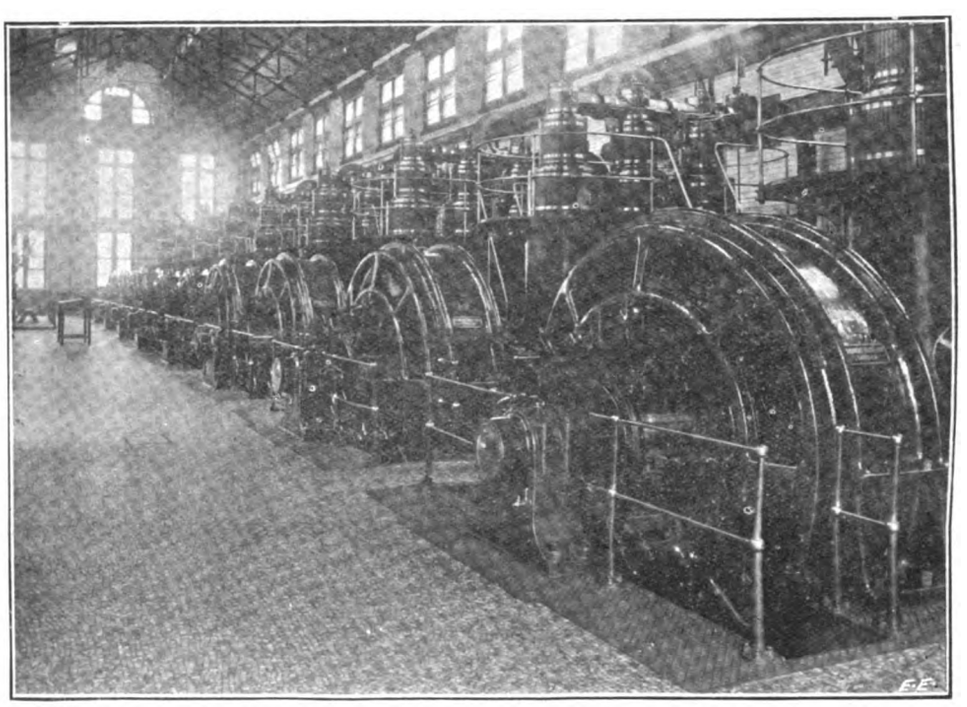

FIG. 2.—View of the Second Engine Room at Talbot Road, with Nine Siemens-Willans 440-kw. Sets.

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have provided plant equally as good as that obtained at a slightly lower figure. It speaks volumes for the confidence of the Corporation in their electrical engineer to see that they have taken his advice, and preferred uniformity of plant rather than a slight saving in first cost and a museum of electrical machinery. The same steadfast policy is seen in looking through the records of the commercial side of the undertaking. Thus, taking the charges made for electricity, in September, 1894, when the supply was

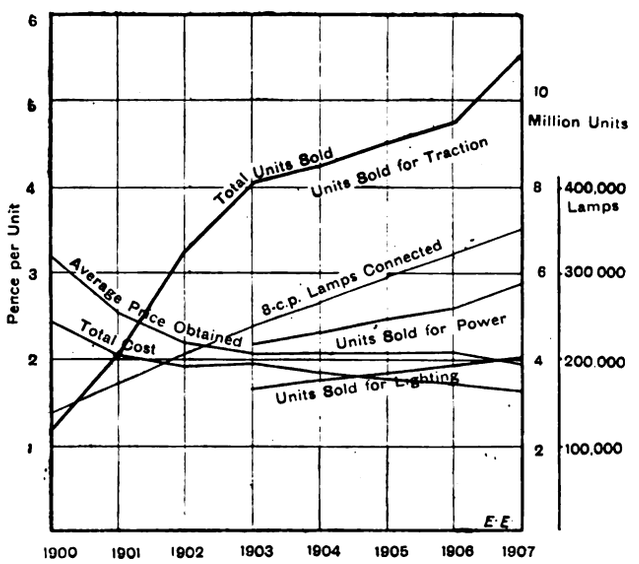

FIG. 3.—Curve showing the Total Output from the Nottingham Electricity Works for the last eight years, and how this output has been consumed.

inaugurated, the charge was 6d. per unit, with a reduction to 4½d. per unit for electricity used in the daytime.

In July, 1897, the maximum demand system of charging was inaugurated in order to encourage long-hour consumers. The charge for 365 hours per annum of the maximum demand was 6d. per unit, and all electricity used above this 4d. per unit. Churches were supplied at a flat rate of 5d. and power consumers 3d. per unit. In July, 1896, the period for the higher charge on the maximum demand system was increased to 400 hours, and the price reduced

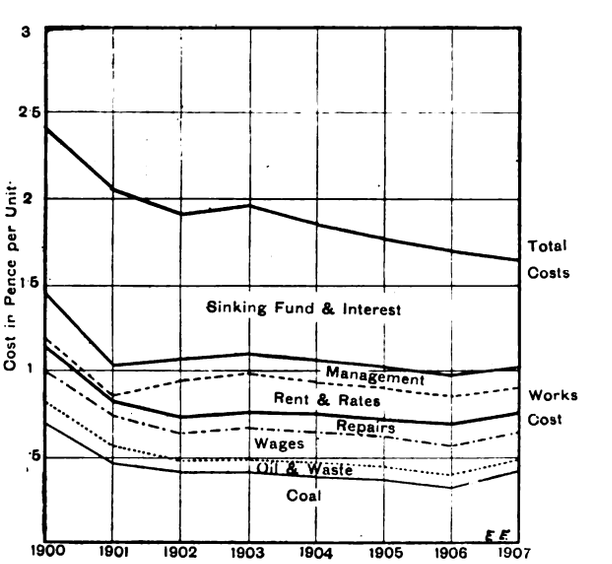

FIG. 4.—Curve showing the Total Cost per Unit Sold from the Nottingham Electricity Works for the past eight years.

to 4d. per unit. Excess consumption was charged at 2d. per unit. At the same time the charge for power was reduced to 2d. per unit for an average consumption of under four hours per day and 1d. per unit after.

The next change, made in July, 1900, was to increase the price for the first period under the maximum demand system to 5d. per unit, and to reduce the charge for power to 1½d. The last change, made in July, 1901, adhered to this figure for the lighting supply—*i.e.*, 5d. per unit for the first 400 hours per annum and 1½d. per unit afterwards. With this method of charging some of the largest lighting consumers obtained electricity at an average charge of 1·92d. per unit. At the same time the charge for power was reduced to 1½d. per unit. These rates apply equally to all. Thus, the public lighting and private lighting pay the electric light department on an exactly similar basis. Of course, the public lighting with the above maximum demand system of charges gets the advantage of the longer hours' use. The average price paid by the Corporation for the public lighting is 2·23d. per unit, as against 3·21d., which is the average for the private supply for lighting. Again,

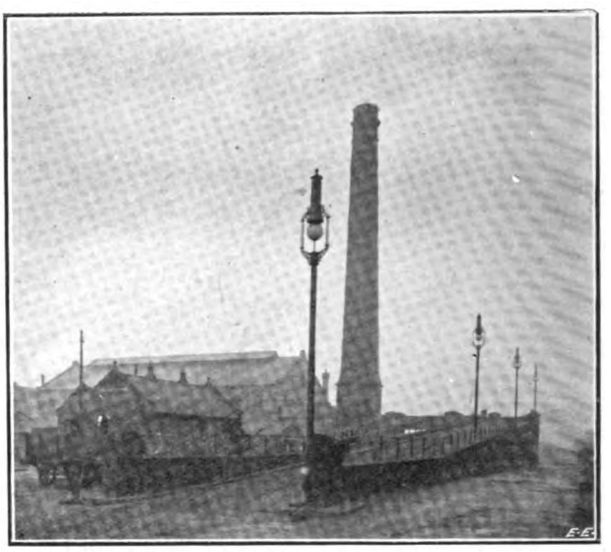

FIG. 1.—General View of the Refuse Destructor.

the tramways and the private power user are treated equally, with the result that there is not that opportunity for cavilling at the charges which is frequently found in other places. The curves (Fig. 3) show how the total output of the station has varied from year to year, and for the last five years we give other lines below which show how much of the electricity sold goes respectively to the tramways, power consumers, and the lighting. For the year in question the tramways took 5,294,979 units, the power consumers 1,709,208 units, and the lighting consumers

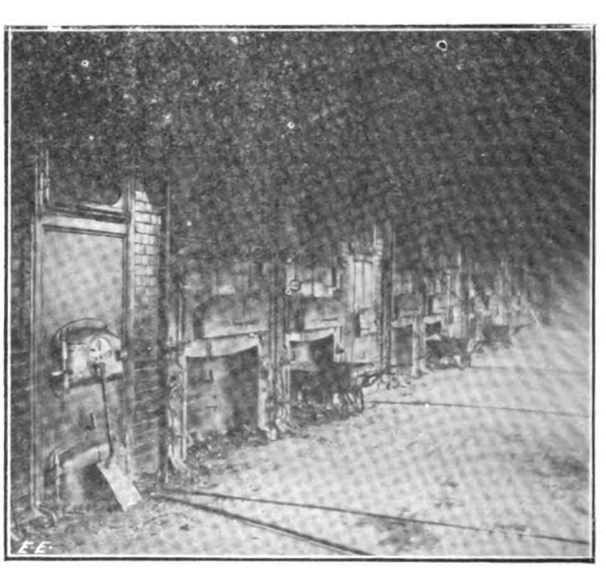

FIG. 2.—View of Destructor Cells.

4,112,648 units. The next curves (Fig. 4) give the detailed cost per unit for a series of years, and show that these have been regularly brought down year by year. The only line which is an exception to this is that representing the coal cost, and here the price of coal is the disturbing factor. No engineer can keep his cost of coal per unit decreasing in face of a rise of 25 per cent. in the price of that commodity. Another feature in the annual accounts for last year is the liberal way in which depreciation and antiquation have been met. The total expenditure up to March 31 this year amounted to £450,945. 3s. 5d. The sinking fund account stands at £20,343. 8s., the repayment of loans

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account £79,678. 19s. 2d., and the reserve fund account at £43,926. 1s. 2d. We congratulate the Nottingham Corporation on the success of their electricity supply undertaking, which has fully justified the confidence which they have placed in their engineer, Mr. Talbot.

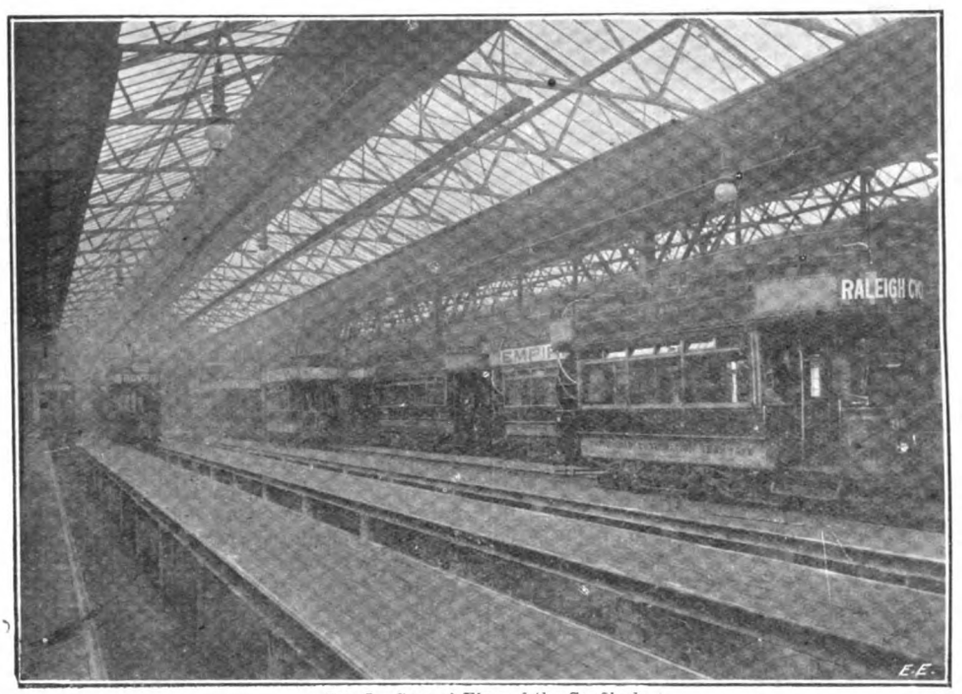

FIG. 3.—General View of the Car-Sheds.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The following is the programme for the thirteenth annual convention, which will be held at Nottingham from June 30 to July 3 inclusive. The meetings will be held in the University College. The accompanying photographs show some of the municipal works which will be open for inspection. Fig. 1 is a general view of the destructor station of the Corporation, from which a very considerable amount of electricity is obtained. Fig. 2 is a view of the destructor, which is of the Manlove-Alliot type. In the afternoon of Tuesday the car-sheds of the Corporation tramways will be open for inspection. Figs. 3, 4, 5, and 6 show various parts of these car-sheds, in which all the new tramcars required by the Corporation are assembled by Corporation employés under the supervision of Mr Aldworth. The programme for the first day (Tuesday, June 30) is as follows:

10.30 a.m. Meeting at the University College. The mayor (Mr. Councillor Spalding) and the sheriff (Mr. Councillor Carey) have kindly consented to be present and welcome the association. Presidential address by Mr. Herbert Talbot, chief electrical engineer, Nottingham. The following paper will then be read and discussed: "The Experiences of a Convener in the Establishment of an Electricity Undertaking," by Bailie Whiteman, convener of the Electricity Committee, Govan.

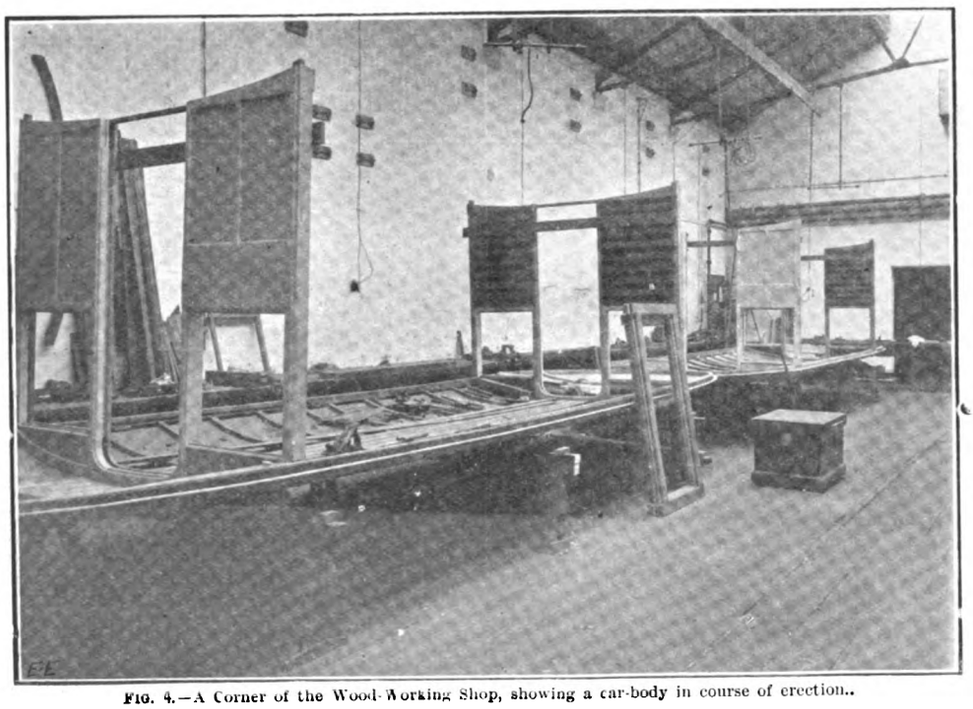

FIG. 4.—A Corner of the Wood-Working Shop, showing a car-body in course of erection.

12.45 p.m.—Luncheon at the Mechanics' Large Hall by kind invitation of the chairman (Sir John Turney, J.P.) and members of the Electricity Committee. Invitations to the luncheon are issued to members and delegates by the committee, and cannot be obtained of the secretary of the association.

2.30 p.m.—Special cars will leave the Mechanics' Hall for the Trent Bridge car-shed and repair shops, and will later

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take the members to the St. Ann's power station, where tea will be provided. The power stations and car-sheds will be open for inspection at all times during the convention.

The works of the Brush Electrical Engineering Company, Loughborough (14 miles from Nottingham), will be open for inspection during the convention, as will also the generating stations of the Derby Corporation.

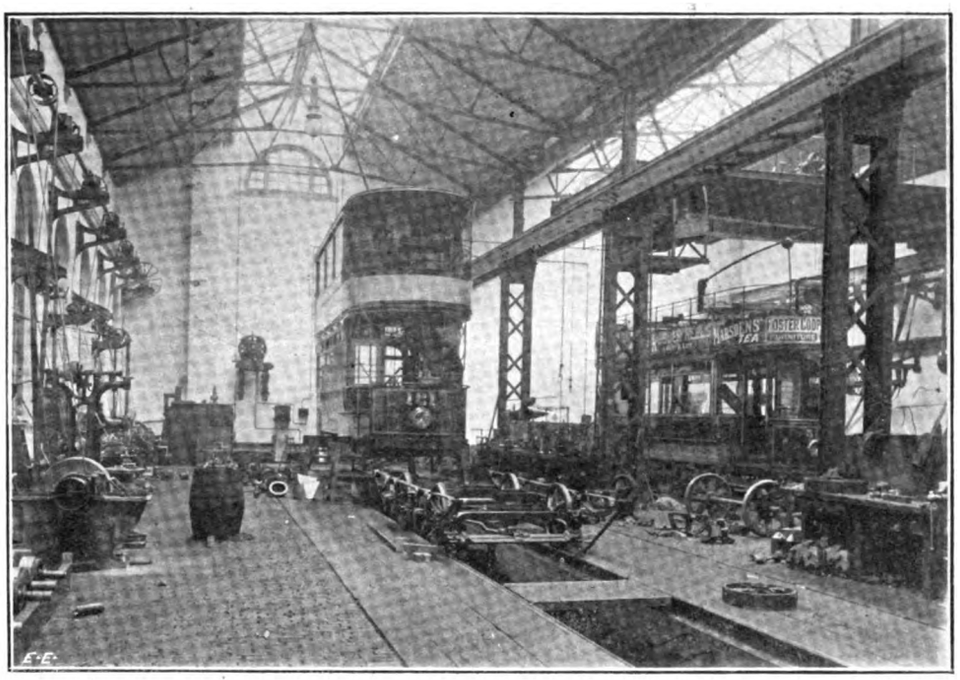

FIG. 5.—Part of the Fitting Shop in the Car-Sheds One of the cars is shown removed from its underframe.

Wednesday, July 1, will be devoted to a whole-day excursion to Dovedale. The cost, including railway and brake fares, luncheon and tea, will be 12s. 6d. per head.

Thursday, July 2, is the "big" day. At 10 a.m. the annual general meeting will be held, for which the following is the agenda: (1) Election of president for 1908-9. (2) Place of meeting for convention, 1909. (3) Election of officers and council for 1908-9. The following are the present officers and council (those marked thus * retire and are eligible for re-election; the remainder hold office for another year): president—H. Talbot*; vice-presidents—S. L. Pearce*, W. W. Lackie*; past-presidents—F. A. Newington, J. E. Edgcome, S. E. Fedden; hon. solicitor—Alderman G. Pearson*, hon. treasurer—J. E. Edgcome* (past-president); hon. secretary—H. Faraday Proctor* (past-president); council—Alderman Bruce, J. K. Brydges*, J. Christie, A. A. Day*, Alderman Dowson*, V. A. H. M'Cowen*, H. Richardson*, C. E. C. Shawfield, Councillor Sinclair*, Alderman J. P. Smith, Alderman Sir John Turney, Alderman Wilkinson*, G. Wilkinson, T. P. Wilmshurst. (4) Annual report of the council. (5) Balance sheet. (6) Any other competent business.

1 p.m.—Adjourn for luncheon, Victoria Hotel. (Table d'hote, 2s. 6d.)

2.30 p.m.—The following papers will be read and discussed: (1) "Some Considerations on the Design of a Generating Station," by Mr. H. Richardson, chief electrical engineer, Dundee; (2) "The Reconstruction of an Electric Lighting Scheme," with Observations on the Working of a Combined Steam and Water Power Plant, by Mr. C. M. Shaw, chief electrical engineer, Worcester.

The association dinner (members and their friends) will be held at the Exchange Hall, Nottingham, at 7.30 for 7.45 p.m. Evening dress. Tickets, 7s. 6d. each (exclusive of wine), may be obtained of the secretary before June 22, after which date the price will be 10s.

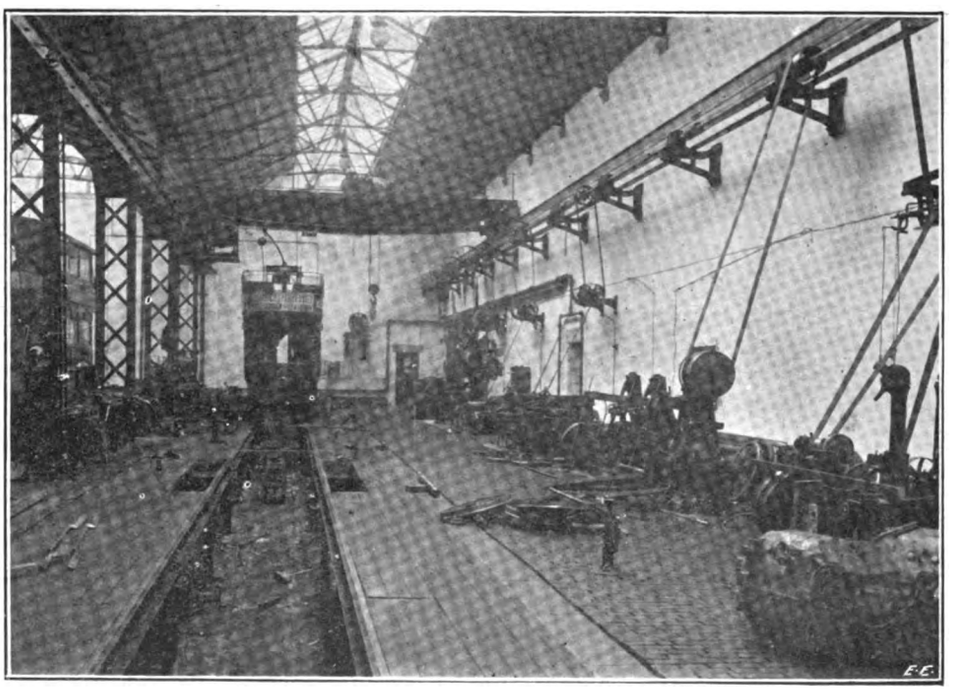

FIG. 6.—Another View of the Fitting Shop, showing some of the machine tools.

Friday, July 3, is the closing day of the convention, and the following papers will be discussed at the sitting, which commences at 10 a.m.: (1) "Alternating-Current Accumulator Sub-Stations," by Mr. A. M. Taylor, assistant electrical engineer, Birmingham; (2) "The Work and Equipment of a Testing and Standardising Department," by Mr. H. A.

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Radcliff, superintendent of the testing department, Manchester Corporation Electricity Works.

Mr. C. McArthur Butler is secretary, and his address is Staple Inn-buildings, Holborn, London, W.C.

THE REYROLLE EXTRA HIGH-TENSION SWITCHGEAR.

Iron-clad Solid System.

The design of central-station switchgear has been the hobby of a large number of electrical engineers, and there has been more variation shown in this department than in any other connected with the supply of electricity. In a good many instances the result of individual effort has been to give diversity in arrangement and construction without reducing either the fire risk, the risk to the life of the operator, or the security of the switchboard against self-destruction due to the failure of one component part. We know of several switchboards, some of them of the low tension type, which were shown to us with pride by the central-station engineer who designed them when the stations were opened, and which have since been cremated due to one or more of the supposed virtues in the design. When one comes to extra high-tension switchgear the problem is much more difficult, due to the fact that with these high voltages an arc once started is extremely difficult to extinguish and prevents access to the switchboard. With the recent Home Office inquiry in mind, one is apt to put the safety of the operator before every other consideration, but there is one other point which must not be overlooked, and which has been responsible for many failures in the past. We refer to the enormous amount of energy which is available in large supply systems, and which acts with almost explosive force when once a short-circuit has been established, even for an instant, between the high-tension conductors either inside or outside the supply station. Take, for example, a supply undertaking like that on Tyneside, with plant of over 20,000 kw. capacity running in parallel. All the generating sets running at high speed have considerable momentum, and the effect of a short-circuit may be likened to the bursting of the dam of a water supply. When the leak commences in such a dam it is comparatively easy to deal with, but when once the impounded water has commenced to destroy the dam no human agency avails to prevent the destruction of the countryside. The same thing applies to a high-tension switchboard, and the destruction of the Bristol switchboard some years ago is an instance of this. For example, if a fuse or automatic switch designed for, say, 2,000 kw. fails to break circuit with extreme rapidity when a short-circuit occurs, it may be called upon to break a current very many times greater than that which it is designed to interrupt. If it fails to do so, as was the case in Bristol, an electric furnace is set going in which the heat is sufficient to destroy the most refractory material. With the enormous currents circulating under these conditions the electromagnetic forces become abnormal. We believe that experiences at Carville have proved that the ordinary isolating switches have opened automatically under a short circuit, and that the sudden expansion of air due to the energy dissipated has been sufficient to blow out every window behind the switchboard and to burst the panels of the doors enclosing this space.

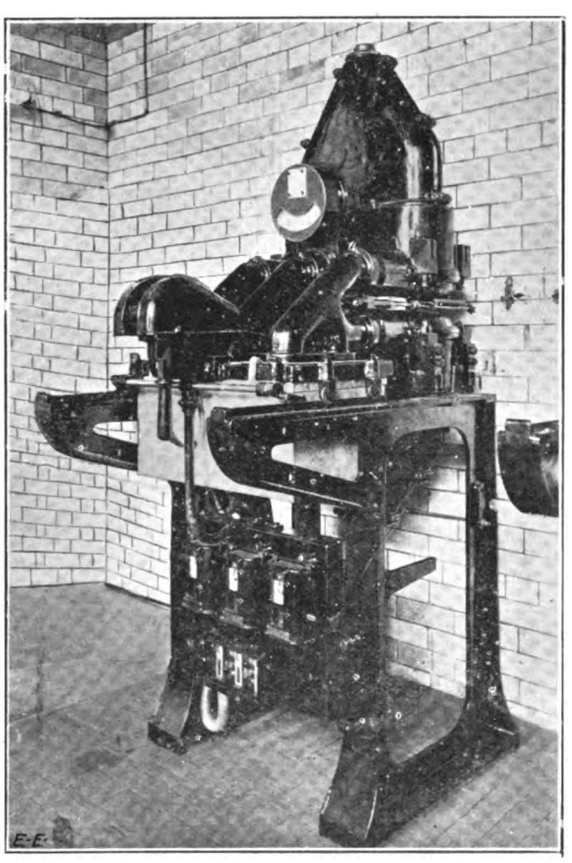

FIG. 1.—The Reyrolle Iron clad E.H.T. Switchgear, complete with Merz-Price Protective Device and Overload Tripping Gear. Switch closed.

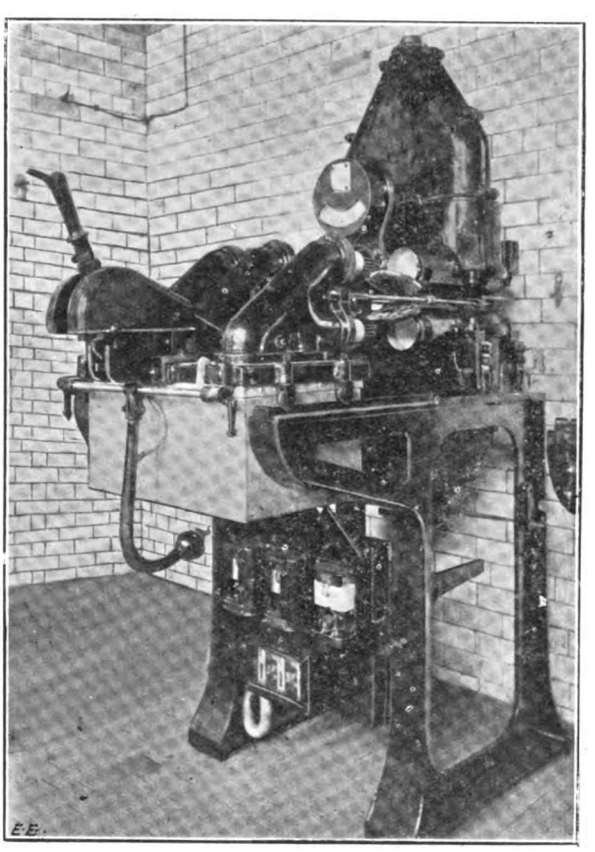

FIG 2.—The same Switch partially withdrawn to show the closing of the protecting cover over the high tension contacts. Switch open

With the above points in view we found it extremely interesting last week to inspect at the works of Messrs. A. Reyrolle and Co., Limited, at Hebburn-on-Tyne, the new iron-clad type of extra high-tension switchgear which this firm has standardised. They have been exceptionally fortunate in the development of the switchgear in having the advice of Mr. Merz and his staff as to what was required, and his permission to install the first of the new switchgear for continuous trial in sub-stations of the Newcastle-on-Tyne Electric Supply Company. The results of these trials and the practical suggestions of the operating staff have enabled Messrs. Reyrolle to put on the market switchgear which we think is capable of meeting the demands of all, including the supply engineer, the Home Office inspectors, the fire insurance companies' regulations, and last, but not least, we think that this switchgear will safely handle electric circuits through which the full power of stations like Carville may circulate. In the design and mechanical construction of this switchgear the makers naturally place first those considerations which give freedom from life and fire risks. Next comes reliability of action, without which the switchboard is useless to the supply engineer dealing with large powers. Extending these conditions in detail

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Messrs. Reyrolle laid down the 12 following points for consideration, and it is remarkable how fully the switchgear we inspected fulfils them:

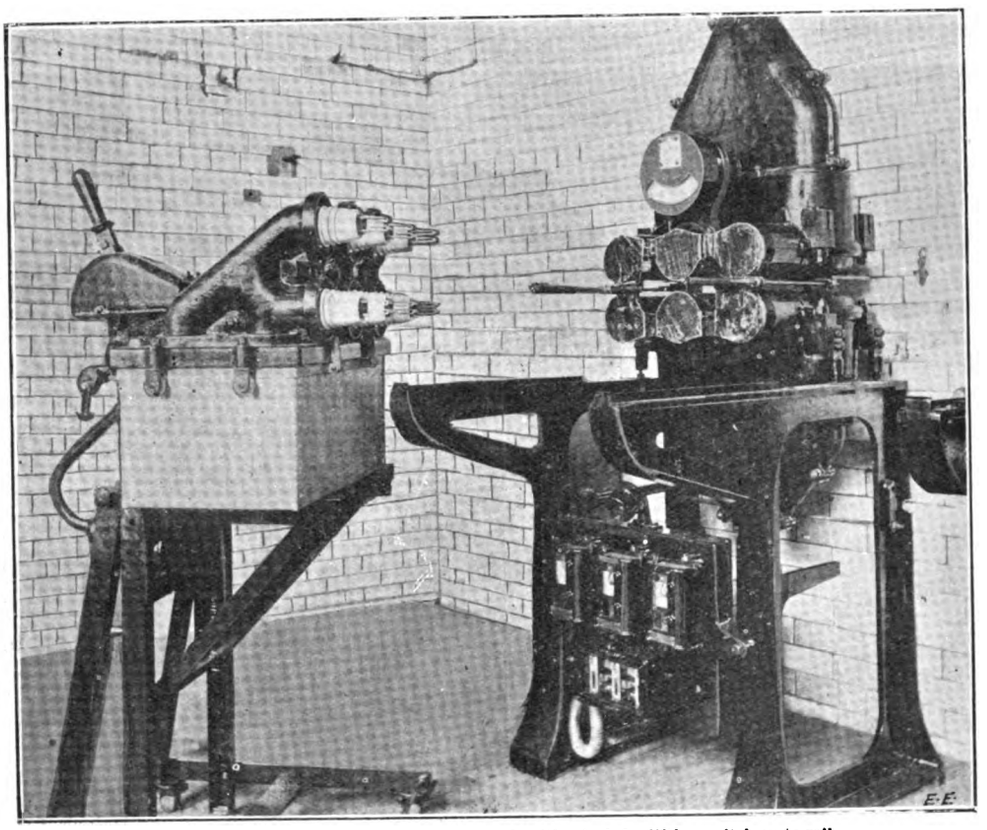

FIG. 3.—Switch removed on Portable Stand, with winch for lifting switch on to rail.

1. Accidental contact with metal whilst alive must be impossible.
2. The insulation must be able to withstand any excessive pressure that is liable to arrive even under abnormal conditions.
3. The design should not allow dust, dirt, moisture, or vermin to diminish the insulation.
4. Fire risks must be reduced to a minimum.
5. There should be a minimum amount of cleaning necessary to maintain the gear in a good condition.
6. Parts requiring inspection and cleaning must be readily and absolutely detached from the gear to enable such operation to be carried out with safety.
7. The sectional area of conductors must be such as to carry without deterioration the maximum overload to which they are liable.
8. Moving parts, such as switch mechanisms, must be situated where they can be observed, and chance of switches sticking must be reduced to a minimum.
9. Automatic protection to be included which will isolate the faulty section without interference with healthy sections.
10. The construction to be mechanically strong in order to resist rough usage and accidental impact.
11. The switches must be capable of breaking, without disturbance to other parts, the maximum power which may instantaneously pass through the switch when acting under the worst fault conditions.
12. The simplest construction is required consistent with economy in operation and maintenance costs.

Over and above these requisites for a switchgear there comes the commercial element of cost. This is a point which it is not usual to deal with in a technical paper, but one must remember that unless the finished product can be supplied at a reasonable price its merits have little chance of being proved practically. Messrs. Reyrolle, after giving due attention to the above points, so arrange the mechanical and electrical design of their gear as to evolve a line of standard parts which can be combined in various ways to meet all the requirements existing on extra high-tension networks. These parts are manufactured absolutely to gauge, so as to secure interchangeability and to facilitate easy extension without any departure from uniformity in detail. We propose first to describe a standard switch panel such as can be placed in a sub-station to control an incoming feeder and to pass the current on to an outgoing distributor, and then to refer briefly to some other typical panels.

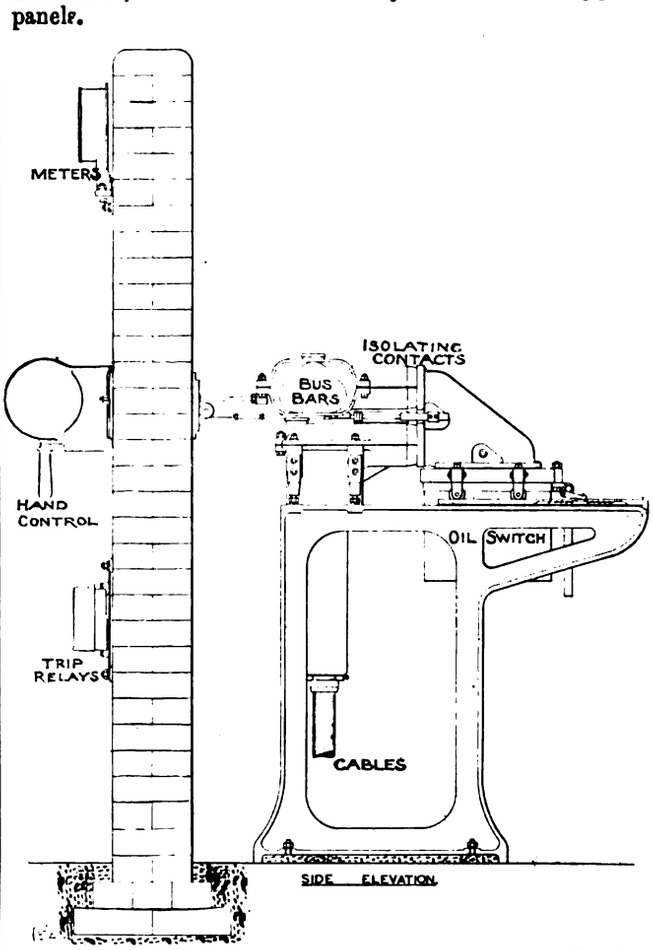

FIG. 4. Section of Reyrolle Switchgear, showing control from outside sub-station. The ratchet and teeth on the stand are clear y seen.

Fig. 1 shows this unit complete with its switch closed. The feeder entering from below passes into the cast-iron trifurcating box, which can just be seen between the

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opening in the framework on the right-hand side. In this the three-core cable is divided up, and each core passes through a current transformer of the type to be described hereafter for serving the Merz-Price patent protective gear. After passing through the centre of these transformers, the high-tension conductors are carried through a right-angle turn into the lower horizontal contacts, which are contained in porcelain-lined orifices clearly shown in Fig. 2. In this view the high-tension oil switch is partly withdrawn from these connections, and the cast-iron lids which come forward with the switch are shown in the act of closing the ends of the openings. Fig. 3 shows this switch completely removed and these openings closed off so as to give complete protection against accidental shock. Each lid can be padlocked so as to prevent the switch being connected again to these contacts when anyone is working on the cables connected with the upper end of this line of switchgear. From the upper contacts the high-voltage connections pass again through current transformers, and are then connected on to the three-core outgoing cable. The great feature in this part of the work is that the whole of the space between this high-voltage metal and the earthed

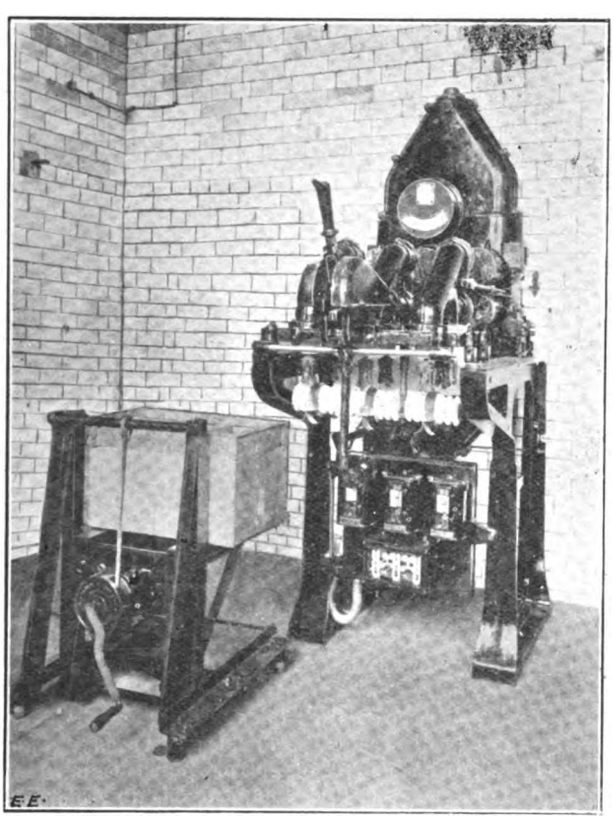

FIG. 5.—Reyrolle Switch with oil-tank removed to show contacts and their insulation.

outer casing is filled in solid with a special insulating compound. There is thus no lowering of the insulation with time due to dust being carried in by air currents. The lids which close up the open ends of these horizontal openings are made cup shape to prevent the ingress of dust, and so are the sockets round the switch contacts.

Assuming, now, that this line of switchgear is as shown in Fig. 3, and that it is wished to make connection between the cable and the outgoing distributor, the oil switch which is seen on the portable carriage is brought round over the rails until the two wheels on each side are directly over these. The winch is then turned to lower the switch, and the latter is ready to be pushed forward. The first movement in the forward direction is effected by hand, and this causes the lids protecting the contacts first to open and then to slide back, as shown in Figs. 2 and 1. The final closing of these contacts is done by means of the ratchets, which can best be seen in Fig. 4. These ratchets on either end of the bar in front of the main switch are worked by the lever which is seen hanging down in Fig. 2. This lever is a tube used to carry the tripping-coil leads and cannot be worked when the switch is closed, which prevents any attempt either to put the switch into its working position or to withdraw it unless the oil-immersed contacts are first broken. This lever and ratchet serve, with the pawl in one direction, to completely close the horizontal contacts between the switch and the connections above referred to, and with the pawl in the other direction to withdraw the switch. When the switch has been moved in to the full extent, the ratchet arm is connected by means of a bayonet-jointed socket to the relay contacts, as shown in Fig. 1.

The oil switches have been designed especially for this type of switchgear, and are arranged to deal with the severest conditions met with in practice. This switch can be seen with the oil reservoir removed in Fig. 5. The design throughout is very liberal, and the automatic brake is extremely rapid and certain in action, owing to there being no other moving elements than a lever pivoted on a pin (Fig. 6). The oil-switch contacts are built up of several independent contact fingers in parallel, each having its separate tension spring, while easily renewable sparking contacts are provided on the fixed and moving elements. The handle gear is of the free-handle type, and when glancing along a line of switches it is easy to see which switches are on and which off. The construction above described ensures that when the switch is closed the live contacts and their insulators are completely enclosed and protected by cast iron, so that it is impossible for anyone to make accidental contact with a live conductor. The tripping device is of the simplest construction, so as to secure reliability in action. It is of the electromagnet

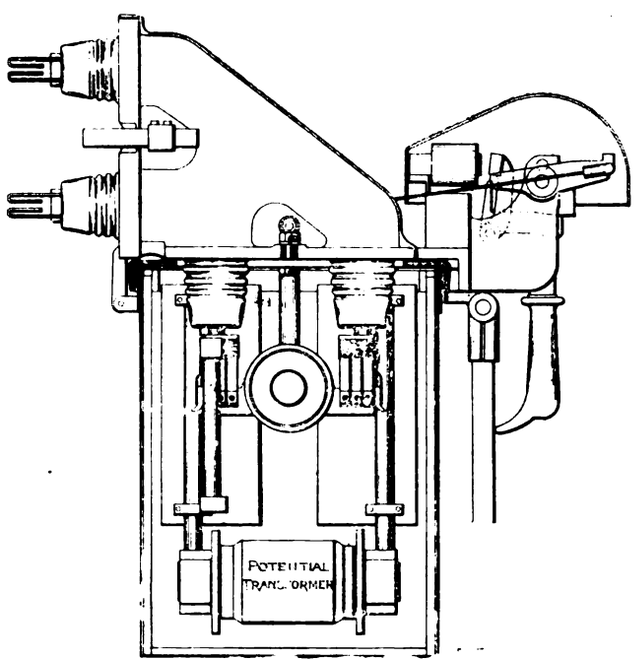

FIG. 6.—Section of Reyrolle 6,000-Volt Oil Switch, showing tripping gear.

and armature hammer type, and can be supplied suitable for either battery or transformer current tripping.

(To be continued.)

THE ELECTRICAL WORKER IN WELLINGTON, NEW ZEALAND.

We have received a most interesting communication from a friend who holds a position of responsibility and influence in an important electricity undertaking in New Zealand, which throws much light on the position of electrical workers in that colony. In view of the efforts that are being made by electrical contractors in this country to raise the status of their industry and the efficiency of their work, we think our correspondent's views will be read with no little interest.

The rapid development of the electrical industry in Wellington, where the Corporation control the supply of electrical energy for power and lighting, has resulted in the City Council enacting a by-law with the object of preventing unqualified persons engaging in the carrying out of

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installation work, thereby raising the standard of electrical workmanship within the confines of the city. The new law requires that all persons engaged in installation work in Wellington must be the holders of licences which will only be granted to applicants who satisfy the city electrical engineer that they are qualified to carry out the work. The by-law discriminates between electrical fitters and wiremen; the respective qualifications are included in the schedule attached to the by-law. The following are the qualifications required: (A) for a master fitter's and journeyman fitter's licence, and (B) for a wireman's licence:

A.—Every person applying for a master or journeyman fitter's licence shall present evidence: (*a*) that he is of the full age of 21 years, and has worked with some reputable electrical engineering firm at electrical fitter's and wireman's work for at least five years, or at electrical fitter's or wireman's work for two years, if he has, in addition, worked at mechanical engineering or plumbing for three years, and shall satisfy the electrical engineer of his fitness to carry out the work of an electrical fitter; (*b*) that he holds the journeyman fitter's certificate of the Wellington Technical School or the wireman's and ordinary grade certificate of the City and Guilds of London Institute, and the fitter's certificate for practical work and testing of the Wellington Technical School, or other certificate approved by the electrical engineer, and shall have served at least three years to the trade with some reputable electrical engineering firm.

B.—Every person applying for a wireman's licence shall present sufficient evidence: (*a*) that he is of the full age of 19 years, and has worked at least three years at electrical fitter's or wireman's work with some reputable electrical engineering firm, or at electrical fitter's or wireman's work at least two years, if he has in addition worked at mechanical engineering or plumbing for at least two years, and shall satisfy the electrical engineer of his fitness to carry out the work of an electrical wireman; (*b*) that he holds the wireman's certificate of the Wellington Technical School, or the wireman's certificate of the City and Guilds of London Institute, or other certificate approved by the electrical engineer, and that he has worked at least two years with some reputable electrical engineering firm at electrical fitter's and wireman's work.

The licence fees are for a master fitter 20s. per annum, and for a journeyman fitter or wireman, 1s. per annum.

As all installation work in Wellington must be carried out according to the rules of the council of the Fire Underwriters' Associations of New Zealand, and as the Corporation's own tests and regulations are stringently enforced, the additional advantage of the effect of the by-law should leave little to be desired in the quality of insulation work.

Another form of legislation has come into force almost simultaneously with the by-law, and it is to be hoped that it will also prove beneficial to the industry. It could hardly be expected in this land of advanced labour legislation that electrical workers would remain unorganised and neglect to follow the general custom of forming a union. Fortunately, the employers in Wellington were able to come to an agreement without much contention, and their agreement was approved and embodied into an award by the Court of Arbitration. The following are some of the principal clauses:

Wages.—Competent electrical fitters shall be paid not less than 1s. 6d. per hour and competent wiremen not less than 1s. 4d. per hour.

Hours of Labour.—Forty-five hours shall constitute a week's work. The working hours shall be between the hours of 7.30 a.m. and 5 p.m. on five days of the week, and between the hours of 7:30 a.m. and noon on one day of the week.

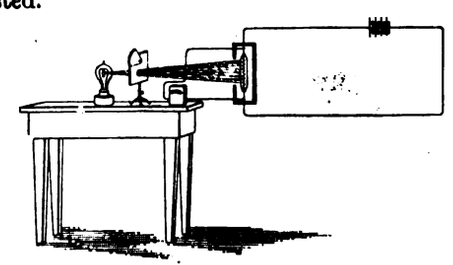
Assistants.—The proportion of assistants shall be one to every journeyman or working employer. Every assistant after having worked not less than three years at the trade shall be deemed to be an improver. At the termination of the period of three years the assistant shall be entitled to and shall receive from the employer a certificate showing that he has served his term, and should the employer, before the expiration of the said term, wish for any reason to dispense with the services of any assistant, he shall give him a certificate for the time actually served. Such certificate shall entitle the assistant to payment by any future employer of the wages herein provided for assistants according to the time actually served by the assistant at the trade. Every employer who engages an assistant shall be deemed to have undertaken the duty of teaching him the trade as carried on by the employer, which duty shall be enforceable under this award. The following shall be the minimum rates of wages for assistants: for the first year, 7s. per week; for the second year, 12s. per week; for the third year, £1 per week. Any assistant who has worked at the trade for a period of three years may be employed as an improver at not less than 9d. per hour for the first 12 months, and 1s. per hour for a further period of 12 months. No improver shall be employed where less than two journeymen are employed.

Chargemen.—Any journeyman who is placed in charge of work on which three or more journeymen, wiremen, or fitters are employed, shall, in addition to the ordinary wages, receive 1s. per day.

Workers engaged in the electrical industry in the United Kingdom may be inclined to envy the wages and conditions of their Colonial cousins, but they must bear in mind that the cost of living is close on double that obtaining in the Old Land.

SELENIUM PHOTOMETER.

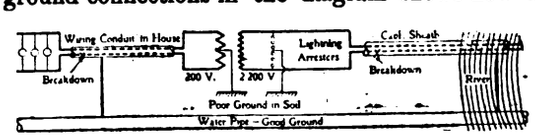
Mr. William J. Hammer recently obtained two patents relating to the use of selenium in photometry, the claims of which seem to be very broad. The leading claim of one patent is as follows: "The new art of measuring light which consists in causing the light to be measured to vary an ascertainable physical quantity and measuring the extent of the variations." The claims of the other patent cover apparatus for applying the light-measuring method suggested.



The accompanying illustration, which appeared in the *Electrical World* of New York, shows diagrammatically one of the proposed arrangements of apparatus. A voltmeter indicates the change produced in the resistance of a selenium cell when the light to be measured falls upon it The selenium is enclosed in a vacuum to exclude moisture, and thereby to eliminate the polarising E.M.F. that may be produced by electrolytic action when moisture is present. Moreover, by the use of the vacuum the deleterious effects of gases produced by heating are avoided. The tube is preferably made of quartz in order to admit certain rays that are excluded by glass.

DANGER OF A POOR GROUND CONNECTION ON THE SECONDARY OF A TRANSFORMER.

While it is common practice to ground the secondaries of service transformers as a protection against danger incident to breakdown between the high and low tension windings, it may often occur that if this connection is not carefully made and is not of low resistance, it will introduce an element of danger. The arrangement of circuits and ground connections in the diagram shows how actual



danger to life and also a fire resulted from a poor ground, when with either a good one or none at all there would have been no trouble. In this particular case the neutral of the lighting circuit and the middle point of a two-pole lightning arrester were grounded at the same pole to two plates which had been buried in the same hole in the earth. The resistance between these two ground plates was very low, but the resistance between them and the good ground of the water-pipe system and the river was comparatively high. The 2,200-volt mains were carried across the river in metallic-sheathed cable, and the house wiring was placed in metal conduit connected to the water system. When by accident the cable in the river became grounded on one side of the 2,200-volt circuit, a potential of

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2,200 volts was placed on one side of the lightning arrester. This arrester then broke down and connected the ungrounded side of the 2,200-volt circuit to the lightning arrester ground plate, which practically meant that both ground plates were raised to a potential of nearly 2,200 volts above that of the river and the water system. The resistance between the plates and the water-pipe system and river was high enough to prevent the flow of sufficient current to materially lower the potential delivered to the terminals of the transformer. The result, therefore, was that the two ground plates and the lightning circuit were at a potential of nearly 2,200 volts above the water-pipes and also of the conduits of the house wiring. This was the cause of the breakdown which started a persistent arc that resulted in a fire. If the earth connection of the 2,200-volt circuit had been much better, or if there had been none at all, there would have been no trouble. If, however, in conjunction with this trouble there had been a breakdown between the high and low tension windings of the transformer, the only absolute safety would have been in a very low resistance and effective earth connections for the secondary circuit; no earth connection or ground whatever would have meant both a life and fire danger.—*Electrical Journal* (R. P. Jackson).

INSTITUTION OF ELECTRICAL ENGINEERS.

A special general meeting of members, associate members, and associates of the Institution will be held in the lecture theatre of the Medical Examination Hall, Victoria-embankment, W.C., on Tuesday, June 30, at 5.30 p.m., for the purpose of considering, and, if approved, of passing the following resolution: "That the purchase of the lease of the site and building known as the Medical Examination Hall, situate on the Victoria-embankment, London, W.C, now the property of the Royal College of Physicians of London and the Royal College of Surgeons of England, for the sum of £50,000, be sanctioned and approved, and that the Council be authorised to sell such of the investments of the Institution and to make such other financial arrangements (including the disposal of the site in Tothill-street now owned by the Institution) as the Council may consider necessary for the above purpose."

The illustration produced herewith shows the building which it is proposed to acquire. The theatre is rather small, but the Council are of opinion that it can be enlarged and improved without very serious expense. By kind permission of the Royal Colleges the lower part of the building will be open to members at 5 p.m. on June 30, the day of the meeting.

MANCHESTER ELECTRICAL EXHIBITION.

A meeting of the general committee was held in Manchester on Tuesday, the 16th inst., in the offices on the exhibition site, Platts Park, Fallowfield. Satisfaction was expressed at the progress which has been made in the erection of the huge building, the skeleton of which is now complete, and enables one to gather an idea as to the ample space provided for exhibitors. The management reported that very satisfactory support was being received from all branches of the industry. Already over 100 spaces have been let, representing a total of between 140 and 150 individual exhibitors. That the importance of this exhibi-

Facade of Medical Examination Hall, Victoria Embankment.

tion is now generally recognised is evinced by the fact that Dr. Edward Hopkinson (of Messrs. Mather and Platt), Mr. Rushton (of Messrs. Dobson and Barlow), and Mr. W. T. Stubbs (of Messrs. Joseph Stubbs and Sons), have each accepted a seat on the general committee as representing the allied engineering trades.

Schemes for the decorating and lighting of the building inside and out were discussed, and the management were instructed to prepare plans and estimates for the same. Special arrangements are being made with the railway companies all over the country for cheap fares and excursions to Manchester during the progress of the exhibition, and, generally, the scheme bids fair to be the most important event in the engineering trade that has occurred during the past 20 years in Manchester or the North of England. A further general committee meeting is fixed to be held in the exhibition offices on Tuesday, July 7 next, by which time it is hoped that the buildings generally will be sufficiently advanced for the Press inspection.

The management propose arranging for a demonstration of wireless telegraphy between the exhibition buildings and some important town within a radius of, say, 50 miles of Manchester. This will doubtless prove a very great attraction to those visiting the exhibition. Numerous other attractive demonstrations of electricity are also being arranged for, full details of which we shall hope to furnish

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our readers with later. The various members of the Gas and Oil Engine Manufacturers' Association, recognising the important bearing which the exhibition will have in the engineering world, have decided to arrange for a number of complete working exhibits of special plants as applied to the generation of electricity.

THE TELEPHONE SERVICE IN FRANCE.

In Paris the agitation caused by the inefficiency of the telephone service continues to find expression in the Press and in public meetings of protest. The Association of Telephone Subscribers, organised four years ago to voice the complaints of the exasperated telephone users, has recently circulated a petition to Parliament calling the attention of the Government to the many defects of the present telephone service, and praying either for a complete reorganisation of the telephone branch of the French Post Office, or, failing that, for the return of the telephone service to private enterprise, from which it was taken by the Government nearly 20 years ago.

The new central battery exchange in the Passy district of Paris has increased the volume of public complaint against the telephone service. Owing to the mistaken policy of the French Administration in maintaining in service the old instruments at the subscribers' stations, which are of a variety of types and are not adapted to central battery working, the service of the new exchange is even worse than that of the old.

The interest of Parliament having been aroused by the intensity and persistence of the public complaints against the telephone service, a parliamentary committee of members of the Chamber of Deputies for the various divisions of Paris last week invited the council of the Association of Telephone Subscribers to attend the committee, with a view to giving detailed information regarding the existing difficulties with the telephone service. At this meeting the Association of Telephone Subscribers was represented by the Marquis de Montebello, president; Mr. Archdeacon, vice-president; and Mr. H. Laws Webb, consulting engineer to the association. The parliamentary committee, presided over by M. Georges Berry, consisted of some 15 members representing various divisions of Paris, who gave a sympathetic hearing to the case for the telephone-using public. M. de Montebello explained that the principal difficulties arose from the fact that the telephone service is at present operated merely as a branch of the Postal and Telegraph Administration, and he urged that for efficient working it was necessary to organise the telephone service as a separate department in all respects. A complete reform was necessary not only in the technical methods of the Telephone Administration, which had been allowed to fall far behind the times, but also in the selection and training of the staff, in the general business administration of the department, and in its financial management. Mr. Archdeacon followed along the same lines, and gave examples of the disorganisation at present existing among the staff of the telephone branch of the French Post Office, and quoted figures showing the greatly higher development of the telephone in the other principal European countries, and the more favourable tariffs for telephone service which are offered to the public of other countries. Mr. Laws Webb explained to the committee the essential difference between the telephone service and the postal and telegraph services, and pointed out that for an efficient city telephone service uniformity of plant and special training of the staff are essential requisites. He confirmed the arguments of Messrs. de Montebello and Archdeacon to the effect that no serious progress could be made with the service in France until the service was placed in charge of a separate telephone department, with a special staff and organisation devoted exclusively to telephone work.

The committee asked numerous questions of the deputation, and several members made short speeches, in which, while strongly opposing the suggestion that the French telephone service should be handed back to private enterprise, they stated that they fully agreed with the views of the deputation that the telephone branch of the French Post Office should be entirely reformed, and should be organised and conducted on the same lines as a commercial concern. Members of the committee themselves complained very forcibly that they were unable, as matters were now conducted, to obtain any figures or information giving precise data of the results of the telephone branch of the French Post Office. The administration did not know itself what it was doing so far as finance was concerned. The committee unanimously promised to support the Association of Telephone Subscribers, and to take the matter up actively in Parliament with the object of securing the appointment of a special commission of members of the Chamber and representatives of the telephone subscribers for the purpose of making a thorough investigation of the difficulties under which the French telephone service now labours.

CITY AND GUILDS OF LONDON INSTITUTE.

Department of Technology.

There has just been published (John Murray) the programme for the session 1908-9 of the department of technology. The programme contains regulations for the registration, conduct, and inspection of classes and examination of candidates in technological subjects. The list of subjects in which examinations are held covers a very wide range, but we can only deal here with those subjects which are likely to appeal to students of electrical engineering. Several alterations of minor importance have been made. Thus in the examinations in Section 38, "Wiremen's Work," the syllabus for the final examination has been somewhat simplified, the special drawing examination having been merged in the written examination. The revised syllabus of "Electrical Engineering" is now included in the programme. Some of the regulations have been slightly amended, particularly in regard to the conditions of issue of certificates in the honours grade. In this grade, first and second class certificates will be issued to those candidates only who have passed, in addition to the institute's examination, certain examinations of the Board of Education. The certificates so issued will be full technological certificates. Among the subjects in which examinations will be held are: telegraphy and telephony, electric wiremen's work, electrical engineering, electro-metallurgy, etc.

Much useful information is contained in the programme. In addition to the contents which we have noticed above, the dates of all examinations are given, the syllabus and course of instruction in each subject, the conditions of written and practical examinations, requirements for full technological certificate, and a useful list of text-books and works of reference complete a full volume.

COMPANIES' MEETINGS AND REPORTS.

PULFORD BROS.

The tenth annual meeting of the shareholders of Pulford Bros., Limited, electrical engineers, was held at the registered offices of the Company, Liverpool, on the 22nd inst. Mr Egerton G. Pulford was elected chairman, and reported that the year's trading had again been most successful, and showed an increased turnover. It was resolved that the usual dividend of 25 per cent., free of income tax, be paid for the year ended March 31 last, and that the balance of profit be carried to reserve fund.

BRITISH ELECTRIC TRACTION.

The report of the British Electric Traction Co. for the year ended March 31, 1908, states that the subscribed share and debenture capital of the Company remains the same as at March 31, 1907—viz: £1,333,010 in ordinary shares of £10 each; £1,614,370 in 6 per cent. cumulative preference shares of £10 each; £1,473,653 in 5 per cent. perpetual debenture stock; £528,936 in 4½ per cent. second debenture stock—total, £4,949,969. The amount standing at the credit of reserve account is £567,420. 7s. 11d. The question of utilising the reserve to write down the assets appearing on the opposite side of the balance-sheet has been considered, but in the opinion of the directors no good purpose would be served by adopting this course at present. In addition, reserves have been made out of profits against loss or depreciation of specific assets, of which reserves a balance of £41,116. 19s. 10d. is unappropriated. These, however, are not the only reserves, inasmuch as the various associated companies have created depreciation and reserve funds of their own, which amounted at Dec. 31, 1907, to £902,728. The associated companies have recently on the recommendation of this Company adopted resolutions with a view to increase their provision against depreciation and also to define more clearly the purposes of their reserve funds. The resolutions are to the effect that the companies should make mini-

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mum provisions before payment of dividends for (1) permanent-way renewals, (2) redemption of capital, and (3) general depreciation purposes. Some of the companies have acted on these resolutions in respect of their accounts for the past year, and endeavours will be made to give full effect to them in future years. During the past year a satisfactory reduction has been made in the liabilities of the Company, which on March 31, 1907, amounted to £278,550, while at the corresponding date this year they amounted to only £59,193. Of the latter amount £46,623 was in respect of debenture interest accrued at March 31, 1908, since paid. It will thus be seen that the liabilities have been reduced during the year by £219,357. The smallness of the amount considered in relation to the magnitude of the assets points to the Company being in a strong financial position.

The chief item in the balance-sheet is investments and undertakings, and consists of shares and debentures in associated tramway, electricity supply, manufacturing, and other companies, consols, and sundry securities and undertakings. It is made up as follows:

Consols of the par value of £200,000, standing in the books at	£196,373	18	5
Debentures in various companies of the par value of £395,251, standing in the books at	378,558	14	1
Shares in various companies of the par value of £4,485,590, standing in the books at	4,289,398	1	7
	£4,864,330	14	1
Capital expended at Barrow, Brighton, and Mumbles	143,372	3	5
	£5,007,702	17	6

Investments standing in the books at £3,275,178 were revenue-earning during the past year, and produced an average return of 4·7 per cent. Investments standing in the books at £1,589,152 did not earn any revenue during the past year. This figure is £103,483 less than in the preceding year. The total investments are less this year by £103,669 than at March 31, 1907, securities to the amount of £243,776 having been sold during the year at a profit of £10,882, and securities standing in the books at £140,107 having been added. The amount of sundry debtors and debit balances has been further reduced during the past year. At March 31, 1907, the amount stood at £631,632, as compared with £545,801 at March 31, 1908. The expenditure on promotion of Acts of Parliament, light railway orders, and other rights and powers, surveys, negotiations, etc., in connection with schemes which may not be proceeded with has been written down to £17,528. 15s. 7d. The amount is being written down annually by 20 per cent. Stock stands at £10,341. 7s., and represents the stock of cars on hire to the associated undertakings, electrical equipments, paving setts, and general stores, and is being gradually reduced by sales. Provision is made annually for any depreciation in value. The item lands and buildings stands at £19,930. 16s. 8d., and shows an increase upon the preceding year of £8,067. This increase arises out of the expenditure on the new office building, which it is proposed to transfer to the British Electrical Federation. Furniture stands at £3,098. 13s., which it is also proposed to transfer to the federation during the current year. Goodwill stands at £1,000, and is the balance of a larger amount.

Turning to profit and loss account, the gross profits for the year 1907·8 amount to £250,539. 3s., and the expenses, including £73,682 interest on the 5 per cent. debenture stock and £23,802 interest on the 4½ per cent. debenture stock for the year, amount to £144 829. 9s. 1d., leaving a balance of £105,709. 13s. 11d. Adding the amount brought forward from preceding year of £13,115. 0s. 9d., there remains to be dealt with £118,824. 14s. 8d. The gross profits include £49 954, profits on the Bombay undertaking, which have been fully explained in previous reports, and also £10,882 net profit on sale of investments. The expenses include £17,500, an amount reserved to meet depreciation of undertakings worked by the Company (apart from investments), buildings, doubtful debts, and expenditure on undertakings not proceeded with. The directors have given the question of the distribution of the balance of profit their earnest consideration. They recognise the desirability of paying the full dividend on the preference shares. They feel, however, that this question is at present governed by the importance of making further provision for depreciation, and by the advisability of keeping ample funds in hand to assist the Company to enter upon new enterprises when opportunity offers. Every effort is being made to increase the income on the existing investments; meanwhile, the other available source of increased profits is from the initiation and development of new undertakings. Some further comments on the general position and prospects of the Company—which present several favourable aspects—are made in the concluding paragraphs of this report. But on the question of the dividend the directors are unanimously of opinion that in advising the preference shareholders to agree to a postponement of a part of their dividend they are recommending a course which will materially strengthen the position of the Company, and which, by improving the prospects of increased profits, offers future compensation to both classes of shareholders for their present sacrifices. The directors, therefore, recommend that the full dividend on the preference shares at the rate of 6 per cent. per annum be paid for the six months ended Sept. 30, 1907, being at the rate of 3 per cent. for the financial year. This will absorb £48 431. 2s. Of this there has already been paid the dividend up to Aug. 15, 1907, and it is proposed that the balance of 1s. 5½d. per share be paid forthwith. They further recommend that there be added to general reserve (increasing the same to £602,420) £35,000, and that there be carried forward to next account £35,393. 12s. 8d. The directors consider that a dividend on the preference shares at the rate of 3 per cent. may be regarded as a minimum distribution for the current financial year, and they propose that this shall be paid in two equal instalments on Aug. 15 and Feb. 15 next, and they hope that increased profits will in the near future enable the arrears of preference dividend to be paid off. In comparing the amounts received by way of dividends and interest on investments it must be remembered that the investments were £103,669 less at March 31, 1908, than they were at March 31, 1907.

The weather during the greater part of the year was very unfavourable, and the traffic receipts upon most of the tramways and light railways in which the Company is interested are adversely affected by wet and cold weather. The number of passengers carried last year was slightly less than in the year 1906, notwithstanding the increase in the number of miles worked. This reduction was due partly to the unfavourable weather and partly to the fact that several miles of tramways in the city of Birmingham reverted to the Corporation at the end of 1906, and that the new lines opened in various places do not as yet equal in density of traffic the routes which have been lost. The traffic on the lines which have been in operation for some time is, however, on the whole developing satisfactorily. In the last report it was pointed out that between 1901 and 1906 the average fare per passenger had been reduced from 1·38d. to 1·22d., as a result of the general demand for lower fares and increased facilities, and that the difference of ·16d. per passenger represented a sum of £201,223 on the number of passengers carried in 1906 by the associated companies. Efforts were made during the past year to improve the position of the undertakings by increasing the fares, by shortening the fare stages, and by eliminating unremunerative services. The increases of fares were not made till the second half of the year, and it will necessarily take some time before the full effects of these changes can be ascertained. Meanwhile, the directors regret that owing to the causes above referred to the average fare for the past year has fallen to 1·21d. per passenger. Another matter which has an important bearing on the profits made by the associated tramway undertakings is the price paid for the electrical energy for working the cars. This is a very large item in the working expenses, and in many cases, where the local authority owns an electricity supply station, an obligation has been placed upon the Company to take current at what is now a high price, the local authority supplying other and much smaller consumers at considerably lower prices. Where, however, the companies have been free to make the best arrangements for purchase or to generate their own current, the cost is less. The matter is receiving the attention of the directors, with a view to securing better terms from the local authorities.

The associated companies have, when the circumstances have been favourable, undertaken the supply of electricity in the districts served by their tramways, with a view to securing additional business for their power stations, and the economies ensuing from combined administration. The results of this policy have proved satisfactory to the public, to whom it has meant a more general provision of electrical energy at more favourable prices than would otherwise have been commercially possible, and the improving results of the combined undertakings have prompted the directors to encourage this policy where the views of the local authorities admit of it. With few exceptions the separate electricity supply undertakings have now passed the pioneer stage, and are more than covering expenses, and their returns are steadily improving. Where these undertakings are situated in districts suited to industrial development, they are beginning to feel the benefit of the tendency of the manufacturing trades to leave the more congested and heavily-rated districts; and more recently the new Patents Act is causing foreign firms to make inquiries as to suitable sites, with a view to establishing factories in this country, in districts affording electrical services.

A federation of all the companies and undertakings associated with the Company was formed in July, 1907 (in succession to the Advisory Committee for associated companies formed in 1902), for the purpose of co-operation and joint action in matters of common interest. About 60 undertakings have thus been federated for co-operative purposes, and a council has been constituted, consisting of the chairman or managing director of each of the federated undertakings. The directors have reason to believe that the results of the formation of the federation will be to increase the efficiency and economy of operation, and to strengthen the hands of the associated companies in dealing with opposing interests. Among the more important matters dealt with by the federation are the following: It has been agreed to provide joint head office accommodation for all the federated companies, and a building is in course of erection over the Holborn Station (Kingsway) of the Great Northern, Piccadilly, and Brompton Railway, which will be ready for occupation in the autumn of the present year. Arrangements have been made for the collective purchase of stores on behalf of all the companies, and transactions to the extent of about £150,000 per annum are already being made to the advantage of the companies concerned. A mutual fund for the insurance against third-party accidents was established by the companies in 1905, and this has been transferred to the federation, which has also taken charge of all other insurance matters on behalf of the federated companies. The disbursements in respect of third-party claims amounted in 1905 to £22,699, in 1906 to £19,278, and in 1907 to £17,663 (uncompleted). Even the largest of these amounts represents an economy upon the payments formerly made to insurance companies, notwithstanding that the volume of traffic was then much smaller than it is now. Parcels delivery systems have already been established on several tramways and light railways. The business is being gradually extended to centres of other federated tramway companies, with every prospect of fair profits being earned. The council of the federation has also appointed expert officers to advise the companies in regard to rates and assessments, automobile matters, books and forms, and other like questions. The inspecting officer, formerly in the service of this Company, has been taken over by the federation, and the undertakings of the federated companies are periodically inspected with a view to the particular and general benefit of all the companies. The federation has been constituted on the basis of making no profit, and the expenses are distributed among the various companies in proportion to the services required by each.

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The directors regret that owing to the constant pressure put upon tramway companies to reduce fares and to increase facilities, the important services rendered by the associated companies to the public are not adequately rewarded. As a result, also, of the legislative and municipal burdens placed upon electrical enterprise in this country, and of the severe competition of foreign producers with English manufacturers—a competition which has reduced prices of electrical apparatus to such an extent that profits have practically vanished—electrical undertakings are not as remunerative in this country as might be expected, and consequently many of the assets of this Company have suffered severe depreciation in value. Nevertheless, the directors are of opinion that the market price of the Company's share and debenture capital are lower than the circumstances warrant, and is in a measure to be ascribed to the prevalent industrial depression and to the general stagnation on the stock and share market. The Board of Trade return of tramways shows that the net results obtained by the associated companies compare favourably with other similar undertakings; indeed, the associated companies show on an average a better net result in relation to capital expenditure and gross receipts than the average of other tramway undertakings in the country whether worked by companies or by local authorities, particularly having regard to the fact that the lines worked by local authorities are to a much greater extent in the large cities where the traffic is heavy, while most of the lines worked by companies are on interurban and rural routes where the traffic is much lighter. Where companies have not been restricted in carrying out comprehensive electric traction enterprises the undertakings have proved of great public utility, but the restrictions and the impositions to which the industry has been subjected have arrested its development, and very little expansion can be expected in this country under either the Tramways or the Light Railways Acts until the conditions under which these undertakings can be promoted and operated are improved. That there is a scope for the construction of further light railways in this country is generally admitted and is emphasised in the report of the Light Railway Commissioners, in which it is also confirmed that "proposals for new lines are now infrequent owing to the various difficulties in carrying them to a successful completion," and "that an improvement could be effected enabling the construction of many much needed lines by an amendment of some of the provisions of the Light Railways Act, 1896." While it is undeniable that the extensive business which has been established is thoroughly successful from the public point of view, and provides facilities which are of great benefit to a large section of the community, the directors regret that the results are not more profitable to the shareholders, but they are able to assure the shareholders that no efforts are spared by the management to increase the profits while properly serving the public. The directors are also satisfied that the staff is efficient and that the work of the companies is done with due economy. Furthermore, the strong financial position of the Company and the wide experience of electrical enterprises which it is able to command, place the Company in a favourable position for entering upon new undertakings when the general industrial and financial conditions of the country enable this to be done with prudence and with prospect of fair and reasonable reward. In the meanwhile the directors are giving consideration to some of the proposals for electrical enterprise submitted to them from countries where the conditions for the investment of capital are more favourable than in this country, and, although such proposals require extensive examination before commitments can be made, the directors are hopeful that they will be able in the near future to employ the resources of the Company to the further advantage of the shareholders. The directors who retire this year are Sir Charles Rivers Wilson and Sir Charles Fremantle, who, being eligible, offer themselves for re election.

LEAMINGTON AND WARWICK ELECTRICAL.

The report of the Leamington and Warwick Electrical Co. for the year ended Dec. 31, 1907, states that the capital expenditure during the year amounted to £2,293, of which £426 was incurred in connection with the reconstruction and equipment of the electric tramways and £1,866 in connection with the power station and equipment for the supply of electricity. The amount owing to the British Electric Traction Co. for advances in connection with the reconstruction and equipment of the tramways and power station, etc., is £28,233, which it is proposed to repay as soon as arrangements have been made for issuing a portion of the authorised debenture stock. In the meantime interest at the rate of 4½ per cent. is being paid on the loan. The working accounts show a net credit balance of £4,731 from tramways and electricity supply, and sundry receipts amount to £68. Deducting therefrom the administration and general expenses, amounting to £1,421; payments to the superannuation fund, £9; interest on loans, £662; and £350 provision for renewals, there remains a balance of £2,356. To this has to be added the sum of £1,257 brought forward, making a total amount available for distribution of £3,613. The directors recommend to place to depreciation and reserve account (raising it to £4,300) £300, to place to a sinking fund £350, and to pay a dividend at the rate of 4 per cent. on the ordinary shares for the year, leaving to be carried forward £139. Before arriving at the profit the directors have debited the profit and loss account with a sum of £350, which has been placed to a provision for renewals account. This, with the further sums of £650, which they now recommend should be placed to other reserves, is double the amount so provided last year. The tramways have been satisfactorily operated during the past year, but owing to the inclement weather during the summer the receipts show a falling off of £615. The expenses of operation, however, show a reduction of £407. The upply of electricity has progressed during the year. The expenses of his department, however, have been exceptionally heavy during the past year owing to trouble experienced with some of the plant at the power station, which necessitated an extensive overhaul of the plant. This resulted in a loss of £240 on the year's working. The Company is now deriving the benefit of the alterations carried out last year, and the cost of generation of electricity is rapidly being reduced. The directors anticipate that the sale of current will this year leave a fair profit.

INDIAN ELECTRIC SUPPLY AND TRACTION.

The report of the Indian Electric Supply and Traction Co. for the year ended Dec. 31, 1907. to be presented at the meeting on the 29th inst., states that up to June 30, 1907, expenditure was debited to capital account, and on July 1, 1907, the revenue account was opened. The capital expenditure has proved to be in excess of the estimates, partly owing to the plague, which delayed completion of the works, and partly because revenue has not come in to meet the debenture interest so soon as was expected. It will be necessary, in the early part of next year, to raise further capital to pay off the indebtedness incurred, and to provide for extensions of the Company's mains, which are required for the developments of the undertaking. In the meanwhile arrangements have been made for the financial requirements of the Company, including interest on the construction debenture stock, to the end of this year. The result of the first half-year's working has been a loss of £6,681, including payment of interest on construction debenture stock, amounting to £3,750. The working loss is mainly due to the tramway, the returns from which have fallen far short of the expectations formed of them. The directors have to regret that serious illness has deprived them since December last of the guidance of their chairman, Mr. J. G. B. Stone, but his recovery, now practically complete, gives them assurance of his early return. Their colleague, Sir Walter Lawrence, found it necessary in July, 1907, on public grounds, to resign his directorship.

MONTREAL LIGHT, HEAT, AND POWER.

The report of the Montreal Light, Heat, and Power Co. for the year ending April 30 last, submitted at the annual meeting on 3rd inst. at Montreal, shows gross earnings 3,792,218dol. and operating expenses, renewals, etc., 1,651,656dol., leaving net earnings 2,140,562dol. Of this fixed charges absorbed 493,095dol., leaving net profits 1,647,467dol. After deducting dividends amounting to 1,020,000dol. there remains a surplus from the year's operations of 627,467dol. Gross earnings and net profits, as also surplus earnings, show substantial and satisfactory increases over the previous year—the latter notwithstanding an increased dividend disbursement during the year of 170,000dol. The surplus for the year—627,467dol.—added to surplus earnings from previous years' operations, brings the total surplus as at the close of the year to 1,732,314dol., out of which the following appropriations—aggregating 318,422dol—have been made: depreciation, 268,422dol.; insurance fund, 50,000dol.

LIENS REGISTERED.

Pure Lubricating Oil Co., Limited (London).—£4,000 5 per cent. debentures, created Jan. 28 and dated May 6, 1908. Charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Fountayne Lamp and Engineering Co., Limited (London).—Issue on June 2 of £300 5 per cent. debentures, part of series created May 28, 1908, to secure £3,000. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

Electric Light Insurance and Maintenance Co. (1904), Limited (London).—Issue on May 27 of £2,440 5 per cent. debentures, part of series created May 11, 1908, to secure £2,500. Charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

La Capital Traction and Electric Co., Buenos Ayres, Limited.—A trust deed dated May 20, 1908 (supplemental to two trust deeds dated Dec. 21, 1900, and Nov. 11, 1907, securing £800,000 debentures), has been registered. Property charged: the company's undertaking and assets, present and future. Trustees: W. Trotter, Basildon House, E.C., and R. Fleming, 2, Princes-street, E C.

Lancashire Dynamo and Motor Co., Limited.—Issue on June 3 of £500 5 per cent. first mortgage debentures, part of series created by resolutions of March 4 and June 24, 1907, to secure £75,000. Charged on two plots of land in Trafford Park, Manchester, containing about 10,946 and 5,300 equare yards respectively, with the premises and machinery thereon and the company's other assets and undertaking, except uncalled capital. Trustees: E. F. Shepherd, 55, King-street, and A. Tongue, 86, King street, Manchester. Total amount previously issued of same series, £68,000.

Anglo-Argentine Tramways Co., Limited.—A trust deed dated June 2, 1908, to secure £565,000 4 per cent. debenture stock, with power to issue further debenture stock rank *pari passu* therewith (limited to such a sum as will not require more than £180,000 to be provided for interest thereon and an annual payment to a sinking fund sufficient for its redemption upon the basis prescribed in the trust deed on June 30, 1968), has been registered. Property charged: the company's undertaking and property, present and future, including uncalled capital, subject to prior indentures securing £266,600 6 per cent. debenture stock. Trustees: Law Debenture Corporation, 41, Threadneedle-street, E.C.

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

JANDUS REGENERATIVE ARC LAMP.

SIR,—We notice that in the article on p. 879 of your last issue, reprinted from the *Electrical World*, it is stated that the Jandus regenerative lamp is intended mainly for street, open space, and workshop lighting; and a deduction is drawn therefrom that the annoyance from fumes and gases has not yet been overcome.

May we point out that the lamp is perfectly enclosed, and, therefore, no fumes or gases escape. The lamp may be used in the smallest room, but the large amount of light generated is far too great for ordinary requirements. It is the great candle-power of the lamp that fits it more particularly for open spaces and large buildings.—Yours, etc.,

THE JANDUS ARC LAMP AND ELECTRIC CO., LIMITED.
(A. Denman Jones, Works Manager.)

LONDON ELECTRIC POWER BILLS.

Committee's Decision.

The House of Lords Committee over which Lord Cromer has presided gave further consideration this week to the London Electric Supply Bill—the one promoted by the existing companies.

Following Mr. J. Conacher (an abstract of whose evidence we gave in our issue of the 19th inst) came Mr. J. B. Braithwaite, chairman of the City of London and County of London Electric Supply Companies, who gave evidence in support of the Bill. He admitted that there was no precedent for the clause fixing the price for distributors at £4. 10s. per kilowatt and ½d. per unit, but he justified it by the exceptional condition of electrical supply in London and the necessity for a unified system. He explained that while the undertakings of the companies would be purchasable under the terms of the Act of 1888, the bulk supply undertaking of the joint committee would be purchasable in 1932 by repayment of capital at par with compensation for the estimated profit over the next 20 years. If the purchase took place in 1952, there would be no compensation for profit. Before the District Bill was heard of the engineers of the companies had been considering a scheme for the supply of London, and the conclusion to promote the present Bill was arrived at.

Mr. W. F. Fladgate, chairman of the Charing Cross, West-end, and City Electric Supply Company, declared there was, in his opinion, no need to raise £1,000,000 at once; £200,000 would be sufficient to begin work.

The greater part of the present week was occupied by counsel's speeches on the two Bills which the committee had had under consideration, and on Wednesday the committee sat specially to give its decision on these two Bills—the London and District Electric Power Bill and the London Electric Supply Bill.

In announcing the committee's decision, the chairman (Lord Cromer) said, with regard to the London and District Electric Power Bill, that the Bill might proceed on the assumption that the clause in substitution of Clause 75, the full text of which the committee had not seen, was satisfactory. The committee stipulated that a larger amount of capital by one-fifth should be subscribed than was provided for in the Bill (Sections 9 and 10), and that the £600,000 to be subscribed in the first instance should be actually paid up within 12 months. A sub-section involving certain payments to the renewal fund was also imposed upon the promoters. The chairman suggested that one way to do this was to provide that when a certain rate of interest accrued it should be obligatory to pay a certain sum into the renewals fund. The committee also intimated that they intended to consider a representation which had been made by the Smoke Abatement Society against allowing the company to be exempt from the common or statutory law in the event of black smoke being emitted from their generating stations.

In the case of the London Electric Supply Bill, the committee struck out the proposal to set up a joint committee of the eight companies interested in the Bill, and gave the companies power to unite their mains and supply in bulk to each other.

The Westminster and Kensington Electric Supply Company's Bill—the third Bill of the group—was down for consideration yesterday (Thursday) morning.

ELECTRICAL CONTRACTORS' ASSOCIATION.

At the annual meeting of this association held last week, Mr. E. C. Wallis, of Leeds, was elected president for the ensuing year.

The out-going president, Mr. A. Rashleigh Phipps, reported that during the past year a considerable amount of interest had been shown throughout the country in the general affairs of the association. Nearly 100 new firms had applied for and been elected to membership. New branches had been formed in Dundee, Aberdeen, Leicester, Birmingham, and Cheltenham. The financial position had been considerably improved, and the Law and Parliamentary Committee had been successful in getting the clauses amended in nearly a dozen Corporation Bills. A large amount of publicity had been given to the doings of the association by the trade journals, for which he expressed the best thanks of the association, and negotiations had been entered into with the kindred association for a more intimate connection. He hoped that the ensuing year would be equally fruitful of results, and stated that the Central Board would be shortly considering the question of registration and examination of workmen, and of the formation of other branches throughout the kingdom.

PUBLICATIONS RECEIVED.

Transactions of the North-East Coast Institution of Engineers and Shipbuilders. Vol. xxiv., Part 7. Newcastle-on-Tyne: Andrew Reid and Co., Limited.

"SWITCHBOARD MEASURING INSTRUMENTS," by John C. Connan. London: E. and F. N. Spon, Limited, 57, Haymarket, London, W. 5s. net. This short volume deals with the design and construction of measuring instruments for continuous and polyphase systems, the substance of which has been collected from reviews, magazines, and papers read before learned societies.

"Catalogue" of Lewis's Circulating Library, revised to end of 1907. 500 pp., demy 8vo. Price, 5s. net, or 2s. net to subscribers. This catalogue relates to books in the circulating library of Mr. H. K. Lewis, 136, Gower-street, London, W.C., and contains a classified index of subjects, with the names of those authors who have treated upon them. The range of subjects is very wide, and includes all branches of engineering, science, and general technology.

FORTHCOMING EVENTS.

Incorporated Municipal Electrical Association. — Tuesday, June 30, to Friday, July 3, inclusive, annual convention at Nottingham.

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BUSINESS NOTES.

LIGHTING AND GENERAL.

Nelson.—The electrical engineer's report for the past month shows that the total number of units generated was 75,286.

Burton-on-Trent.—The Town Council have decided to install Osram lamps, at a cost of £12, for illuminating the town hall clock.

Farnworth.—The Local Government Board will hold an enquiry on July 7 into the Council's application for sanction to borrow £7,000 for electric lighting purposes.

Westinghouse Electricity Co.—It is reported from Pittsburg that Mr. J. P. Morgan's syndicate has purchased the Westinghouse electric concern for 40 million dollars.

Aberdeen.—The Town Council has agreed to the conditions proposed by the District Committee for the laying down of feeder cables at the electrical sub-station at Cults.

Buxton.—The Urban District Council have decided to put down an extra cable from Leek-road to Robertson-road in order to meet the requirements of prospective consumers.

Tantalum Lamps.—It may interest our readers to know that Messrs. Siemens Bros. Dynamo Works Limited are advertising their tantalum lamps in the *Journal of Gas Lighting*.

St. Austell.—The Urban District Council have accepted a quotation from the electric light company for lighting the whole town on other nights than Fridays and Saturdays for 25s. per night.

Wigan.—The Corporation Electricity Committee have decided to apply to the Local Government Board for sanction to the borrowing of £2,000 for the purchase and laying of cables in the Ince district.

Mansfield.—It is estimated that the Corporation electricity undertaking will show a profit of over £700 for the year, and a large portion of this sum is to be handed over to the relief of the rates.

Huddersfield.—The electrical engineer has reported to his committee that in June the number of consumers was 2,722 and lamps connected 206,541, increases respectively of 20 and 6,985 over the previous month.

Southampton.—The Electricity Committee recommend that notice be given the South Stoneham Rural District Council that the Borough Council intend applying for a provisional order authorising the supply of light within the rural district.

Electric Firing Gun.—The Paris *Journal* states that M. Pouteaux, a French chemist and engineer, has invented a mitrailleuse which is destined to revolutionise modern artillery. The machine works by electricity, without powder or other explosive, and can fire 1,200 bullets per minute.

Swaffham.—For some little time a movement has been on foot in Swaffham to obtain a telephone service in the town. This effort was recently furthered by the Urban District Council, which at its last meeting decided to ascertain from headquarters various details as to conditions, costs, etc.

Coulsdon.—The Croydon Rural District Council have agreed to the erection of overground telephone wires in 15 roads at Coulsdon, provided the poles do not exceed 9½in. diameter on the ground line, and that overground wires be allowed in four roads at Beddington on the same condition.

Maesteg.—At the last meeting of the District Council a letter was read from Messrs. Gibbins and Chaumpler, Central-buildings, Liverpool, forwarding a plan for a proposed generating station at Maesteg, and expressing a hope that the Council would accept a tender from them for the proposed work.

Axbridge.—At the meeting of the Board of Guardians a report was read from the Sphere Electrical Co., Bristol, as to the condition of the generating plant at the workhouse and infirmary. The effect thereof was that the plant was capable of another season's work, but that at the expiration of such period certain repairs would be necessary.

Cleckheaton.—The official report of the gas undertaking of the District Council for the year ended March 31 last shows a net profit of £2,570. 19s. 10d. This is a decrease, for in the preceding year the net profit was £3,791. 17s. 7d. The electricity undertaking yielded a net surplus of £99. 7s., compared with a deficit of £193. 4s. 4½d. in 1906-7.

Stoke.—At the Electricity and Destructor Committee meeting the electrical engineer stated that during May 37,300 units had been sold, an increase on the corresponding period of last year of 149 per cent., and that the number of consumers on the books was 373, representing a total of 15,643 32-watt lamps for lighting and heating and 623½ h.p. in motors.

Heaton Moor.—The Manchester central group of telephone exchanges has been extended to include Heaton Moor and Eccles, thus abolishing the 1d. junction fee hitherto payable for communications between these places. On July 1 a further extension will be made to include Sale and Urmston, and the concession will apply to these places.

Southport.—Mr. Samuel Hardman, elective auditor of Southport, has issued a report on the finances of the borough, in which he strongly complains that the lowering of the candle-power of gas is a distinct disadvantage to consumers for cooking, heating, and motive power, and contends that the price of gas should be reduced to net cost to the consumer.

East Ham.—The engineer having reported the receipt of a further application from the National Telephone Co. for permission to erect an ornamental telephone pole in Merlin-road on the Wanstead Park Estate, for which privilege they are prepared to pay an annual rental of 21s., the Electricity Committee are recommending that the application be acceded to on these terms.

Arc Lamps, Limited.—This firm have now removed their works from Camden Town to their specially built factory at St. Albans. They wish to notify their clients that in order to facilitate the securing of spares, Messrs. Frampton and Paine, of 29, Old Queen-street, Westminster their sole selling agents for London and the South of England, hold a stock of carbons, globes, and other spare parts.

Halesowen.—On the 22nd inst. the Electric Lighting Provisional Orders Confirmation (No. 1) Bill was before the Lord Chairman of Committees in the House of Lords. Among the orders to which this Bill will give parliamentary sanction is that granted by the Board of Trade to Halesowen. There was no opposition to the Bill, and after formal evidence had been given it was ordered to be reported for third reading.

Liquidations.—The *London Gazette* announces that a general meeting of the Electric Traction Construction and Equipment Co. will be held at 5, New-court, Lincoln's-inn, W.C., at 3 p.m. on July 21 for the purpose of receiving the liquidator's report. A general meeting of the Rand Central Electric Works will be held at 120, Bishopsgate-street Within, London, E.C., on July 21 at 12 noon for the same purpose.

Amble.—At the monthly meeting of the Amble Urban District Council the lighting of the town was discussed. A letter was read from the Amble Gas Co. offering to supply gas at 5s. per 1,000 cubic feet, or for a total sum of £250 per annum. The Council offered to accept a tender of £225 per annum. Councillor Wanless gave notice of motion that he would propose a scheme at the August meeting to supply the town with electric light.

Beckenham.—The Council, after having made experiments with new metallic-filament incandescent electric globes, have decided to give notice to the two gas companies supplying the public street lamps that after Sept. 29 next they may change over completely from gas to electricity. The Council own their own electric light works, but, with the exception of one street lighted with arc lamps, have not hitherto tried electricity for street-lighting.

Tewkesbury.—A Bill to confirm a provisional order of the Board of Trade under the Electric Lighting Acts, 1882 and 1883, granted to the Corporation of Tewkesbury, for the amendment of the Tewkesbury Electric Lighting Order, 1906, came on the 23rd inst. before Lord Onslow (Chairman of Committees of the House of Lords) as an unopposed measure. Proof of the preamble having been given, the Bill passed this stage, and was ordered to be reported to the House for third reading.

Southend.—The Local Government Board, writing with reference to the application of the Corporation to borrow £26,990 for additional plant, etc., said they understood the Council withdrew that part of the application relating to £8,706 for additional generating plant. As regarded the remainder of the application, the Board authorised the borrowing of £18,344 for the purchase of property in Boston-avenue, new condensing plant, and meters. The electrical engineer has been authorised to extend the existing cable in Elderton-road in a northerly direction at a cost of £49.

Gelligaer.—A letter was read at the last meeting of the Rural District Council from the General Post Office in reply to the Council's request for more telephone facilities at Tirphil. The letter stated that the result of inquiries made on the subject did not lead the postal authorities to think they would be justified in having a call office there. Some discussion took place on the letter, and it was eventually resolved to ask the postal authorities to reconsider the matter. In the course of the discussion, the clerk stated that private telephones were not supposed to be used by the outside public.

Wolverhampton.—At the last meeting of the Town Council Councillor Gough Allen presented the report of the Electricity Committee relative to additional boilers, induced draught, and coal conveying plant at the works in the Commercial-road, and the recommendation that a loan of £6,000 should be applied for to cover the cost. He said the scheme was an evidence of the progress the committee were making. The proposed extensions were imperative, and it was necessary that the work should be put in hand at once. Councillor Grout seconded the adoption of the report, which was adopted without further discussion.

Oxford.—The Drapers' Company have granted a sum of £22,000 for the building and all the accessories of an electrical laboratory which is to be presented by them to Oxford University, and have instructed Mr. T. G. Jackson, the company's architect, to carry out the work. In a convocation to be held on Oct. 20 next it will be proposed that the University accept the munificent offer and express its grateful appreciation of the company's generosity. It will also be proposed that the University should consent to the extension of the museum for 20 yards on the north side should this be found necessary for the accommodation of the proposed new laboratory.

Belleek.—A communication of more than usual interest and importance came before the members of the Lough Erne Drainage Board at their last meeting, when a letter was received from a Belfast gentleman who wished to know whether the Board would be disposed to encourage the development of electrical energy at Belleek by the use of the falls, and, if so, on what terms the necessary rights could be obtained. This is not the first time the Board has been approached on this subject, as at least two other companies have been making inquiries on the subject with a view to the possibility of establishing an electric power station between Belleek and Ballyshannon.

West Ham.—The Electricity Committee are recommending the Town Council to apply to the Local Government Board for sanction to a loan for that part of the electrical engineer's estimate shown for the current year and the year ending March 31, 1909, amounting to £51,600, as follows: amount required to March 31, 1908—excess over last application, £7,045; generation, £12,300; distribution, £4,600; amount required for the year ending March 31, 1909—generation,

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£18,005; distribution, £9,750—total, £51,600; and that the balance of the estimate for the year ending March 31, 1910, in the sum of £20,325, be considered at a later date, if necessary, with the view to a subsequent application to the Board.

Maldens and Coombe.—The Parliamentary Committee of the Urban District Council have reported that they had an interview with the London Electric Supply Co. on the system to be adopted by them as undertakers for the supply of energy under the Maldens and Coombe Electric Lighting Order, 1907. The proposal was to supply the current for transforming stations. The committee recommended that the Board of Trade should be notified that the Council would require the undertakers to lay all cables within the district in conduits, except in such cases where the local authority agreed to dispense with that requirement, and in such case the cables should be protected by steel armour and laid directly in the ground. This has been agreed to by the Urban District Council.

Blandford.—At the last meeting of the Council, Councillor Hicks said they would all agree that the price charged for gas was very exorbitant, and that the gas company had treated them in a shameful manner. He moved that they approach the electric light company which had power to come to the town, and ask what their charge would be for installing the light. This need not cost the Council a penny, because if the company had taken the interest to get powers to come there they would have enough interest in the matter to see how much it would cost and let the Council know. Councillor Gould seconded, holding that it would be a benefit to the town at large if they could get some electric light company to come there. Competition was necessary to get any advantage at all. The motion was agreed to.

Greenock.—At the monthly meeting of the Corporation the Electricity Committee reported that Messrs. Russell and Co. had made application for a supply of electricity to their spar yard at Bogston. It was agreed that an effort should be made to obtain the current from a tramway feeder cable, and an application had been made to the tramways company and the Board of Trade for necessary permission. It was reported that a letter had been received from the Secretary to the Admiralty regarding a supply of electricity to the torpedo factory at the Battery Park, and requesting that in view of the special rate quoted the Corporation should forego the minimum payment asked for on condition that the agreement cover a period of 14 years. The letter was remitted to the provost and convener with power to accept.

Welsh Electric Lighting Orders.—Bills to confirm certain provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, relating to Carmarthen, Bridgend, and Llandaff and Dinas Powis, yesterday came before Lord Onslow, chairman of committees, House of Lords, as unopposed measures. The object of the order as regards Carmarthen is to allow Messrs. J. B. Saunders and Co., electrical and mechanical engineers, of Westminster, to supply electricity in the borough of Carmarthen. Power is given to enable the local authority to purchase at the end of 16 years, subject to six months' notice. The Bridgend order enables the Urban District Council to extend their area of supply. The Llandaff and Dinas Powis order gives the local Council additional powers for the supply of electricity. Proof of preamble having been given the Bills passed this stage, and were ordered to be reported for third reading.

Coatbridge.—At a meeting of the burgh Electricity Committee the clerk submitted an application by the Clyde Valley Electrical Power Co. to alter the line of cable which they obtained permission from the Town Council to lay through the burgh so as to allow them to carry the same to the works of the Coatbridge and Airdrie Electric Supply Co., with whom they have contracted to give a supply of energy, by the following route—viz: from Whifflet-street along Dundyvan-road, Henderson-street, Buchanan-street, Ross-street, Bank-street, East Canal-street, Water-street, Church-street, Churchlane, St. John-street, Crichton-street, Sunnyside-road, and thence into Burnbank-street; as also a plan showing the proposed new route. The committee, having considered the application, agreed to recommend that it be granted subject to the provisions of the Clyde Valley Electrical Power Act, and that it be remitted to the burgh surveyor to adjust with the company the details as to the position, depth, etc., at which the cable will be laid in the respective streets, and thereafter to obtain from them a plan showing the completed arrangement.

Manchester.—The decision of the Corporation Electricity Committee to install a 6,000 kw. Zoelly turbine in the Stuart-street power house is extremely interesting. The new turbine will be the largest Zoelly turbine in Great Britain, if not, indeed, in the world, and will be as large as the biggest of its rivals which have already been installed in this country. So far the fight has always lain between the Parsons and the Curtis types of turbine, with heavy odds on the former. The adoption of the simple-impulse type of turbine as represented by the Zoelly marks a victory for that type of great importance, and all engineers will watch with interest to see if the result justifies the change. The makers of the new turbine, Messrs. Howden and Co., are new comers in the turbine field, but they have successfully built one smaller turbine for the Powell Duffryn Colliery, in South Wales, and they have given excellent guarantees for the new turbine. The chief advantage expected from the Zoelly turbine is reliability and freedom from blade stripping. This turbine was originally made by Messrs. Escher, Wyss, and Co., of Zurich, Switzerland. It is now being made in this country by Messrs. Howden, Mather and Platt, and John Musgrave and Sons.

Battersea.—The Electric Lighting Committee have had under consideration the question of the lighting of the roads and the supply of electrical energy to houses on the Battersea Rise House Estate. The electrical engineer has prepared a scheme for both public and private lighting, and has submitted plans showing the position of the mains and lamps. The scheme provides for laying distributing mains in the various thoroughfares, a feeder from Northcote-road to the estate, 10 additional arc lamps along Clapham Common West Side and 37 lamp columns fitted with brackets similar to those on the Heathfield Estate, but with Osram metallic-filament lamps of 100 c.p. each for the side streets, the total estimated cost being £5,362. Negotiations are in progress with the various builders who contemplate erecting houses on the estate, and one of the builders, Mr. George, has already undertaken to wire 60 houses for electric light. It is proposed that the mains shall only be laid in the various parts of the estate as they become developed, so that the expenditure may not be incurred until the mains are actually required, and they recommend that the scheme prepared by the electrical engineer be approved and adopted by the Council and that the necessary work be carried out at an estimated cost of £5,362.

Hastings.—The Corporation Electricity Committee have considered the desirability of utilising electric current generated at the Corporation electricity works for the lighting of the whole of the public lamps in streets in which electric mains are laid. A report from the borough electrical engineer showed that there were at present 480 gas lamps (469 of which were ordinary 50 c.p. incandescent lamps and 11 of which were fitted with more than one burner), which were situate within 60ft of the electric mains, and could be lighted by electricity. The committee are prepared to supply current to the whole of these lamps, and to undertake similar services with regard thereto as are undertaken by the gas company—*i.e.*, the lighting, cleaning, and extinguishing of the lamps, and the renewal of the lamps when requisite at the same annual cost for each class of lamp as is at the present time charged by the gas company—and have, therefore, recommended the Council to give a standing instruction to in future supply current to all public lamps in the streets under which electric mains were laid (and which lamps may be within a distance of 60ft. from the main) on the terms above mentioned, and refer the consideration of cost to the Finance Committee to report in due course on the matter of defraying the expense of fitting the existing gas lamps for electric lighting. The Council have agreed to the recommendation.

Metropolitan Asylums Board.—At the last meeting the Hospitals Committee reported that they had had under consideration the question of the principle of lighting the North-Eastern Hospital by electricity, together with a letter from the engineer of the North Metropolitan Electric Power Supply Co., furnishing particulars of that company's charge for the supply of the electricity required. The engineer-in-chief (Mr. Hatch), whom they had consulted in this matter, had furnished them with figures comparing the actual cost of gas lighting at this hospital for the last two years with the probable cost of lighting by electricity, and he estimated that the total cost of electric light and gas (a small quantity of which would still be required for cooking, heating, and emergency burners) would amount to £700 per annum, compared with the present annual expenditure of £1,200 per annum, showing a saving of £500 per annum in favour of electric light. Electric light had the advantage over gas in that the light could be more favourably arranged, which was especially important in the case of the wards; it was also more convenient, more hygienic, was attended with less risk from fire, and was generally accepted as the most suitable light for institution purposes. They approved of the terms (less than 2d. per unit) on which the North Metropolitan Electric Power Supply Co. were prepared to supply electricity, and were also of opinion that electricity should be installed in the whole of the hospital and not in the permanent buildings only. They recommended accordingly. The engineer-in-chief estimates that the cost of installing electric light throughout the hospital would be approximately £4 500.

Stock Exchange.—The Stock Exchange Committee have appointed special settling days as under: July 1—Newcastle-upon-Tyne Electric Supply Co.'s provisional certificates for a further issue of 50,000 ordinary shares of £5 each (issued at £6 per share), fully and partly (£3) paid, of which £2 is capital and £1 premium Nos. 87,501 to 137,500, and 50,000 5 per cent. preference shares of £5 each, fully and partly (£2) paid, Nos. 87,501 to 137,000. July 8—United River Plate Telephone Co.'s further issue of 20,000 ordinary shares of £5 each, fully paid and partly (£1) paid, Nos 100,001 to 120,000. July 14—Marconi's Wireless Telegraph Co.'s further issue of 10,000 ordinary shares of £1 each, fully paid, Nos. 384,191 to 394,190. The committee have also ordered the undermentioned securities to be quoted in the official list: Marconi's Wireless Telegraph Co.'s further issue of 10,000 ordinary shares of £1 each, fully paid Nos. 384,191 to 394,190; Mexico Tramways Co.'s 600,000dol. additional general consolidated first mortgage 50-year 5 per cent. gold bonds, Nos. 12 561 to 13,200 and 14,001 to 14,200 for 500dol. each, and 32,201 to 32,250, 33,001 to 33 500, 33,751 to 34 750, and 35,251 to 35,500 for 100dol. each; Newcastle-upon-Tyne Electric Supply Co.'s provisional certificates for a further issue of 50,000 ordinary shares of £5 each (issued at £6 per share), £3 paid, of which £2 is capital and £1 premium, Nos. 87,501 to 137 500, and 50,000 5 per cent. preference shares of £5 each, £2 paid, Nos. 87,501 to 137,500; Rio de Janeiro Tramway, Light, and Power Co.'s 250,000 shares of 100dol. each, and a further issue of 564,000dol. first mortgage 30 year 5 per cent. gold bonds, Nos. 29,362 to 29,489 of 500dol., and 34,990 to 35,000, 55,236 to 58 000, and 73,001 to 75,224 of 100dol. each; United River Plate Telephone Co.'s further issue of 20,000 ordinary shares of £5 each, £1 paid, Nos. 100,001 to 120,000.

Newcastle (Staffs).—Major J. Stewart, R.E., conducted a Local Government Board enquiry at the Town Hall, Newcastle, last Friday, in reference to the application made by the Town Council for sanction to borrow £700 for the laying of electricity mains in Brampton and Sidmouth-avenue. It was stated that of the loans already sanctioned, but not yet raised, £5,090 was for electrical purposes, but the amount had been borrowed temporarily. The total loans sanctioned for electrical purposes amounted to £8,615, of which £3,525 had been raised. Mr. F. Marlow, representing the town clerk, said he understood that the application had been brought about by the demands

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that had been made by the residents in Brampton and Sidmouth-avenue for electric lighting. He pointed out that this was one of the best residential districts in the borough. The present yearly income from gas for the whole of the area mentioned was £375, and the income from gas from the people who have promised to adopt electric lighting was £116. It was estimated that the income from electric lighting for these people would be £140. He thought the present promises to take up electric lighting were sufficient warranty for the expenditure in that district. He understood the electrical undertaking was at present working at a loss, but he thought if this extension was sanctioned it would probably result in reducing this loss, and they would certainly get a profit from the transaction. Mr. A. J. C. de Renzi, the electrical engineer, said he had canvassed the whole of the residents. About 40 of the residents of the area contemplated being supplied with electric lighting, and he had obtained eight actual promises to have the electric light. The places to be lighted included a church. He had been in charge for two years. Of the £700—cables were estimated to cost £579, services £100, and contingencies £20. 10s. All the houses in that district were occupied by wealthy people, and, in fact, it was about the best district in the town.

Lowestoft.—The Corporation of Lowestoft having applied to the Local Government Board for a loan of £1,661 for the electric lighting undertaking—£1,000 for free wiring and £661 for fixing mechanical stokers to three of the boilers at the works—the usual inquiry was held at the town hall on Friday last by Mr. W. A. Ducat, the inspector appointed for the purpose. There were present Councillor C. Y. Fry (chairman of the Electric Lighting Committee), Mr. G. A. Bruce (resident electrical engineer), Mr. R. Robertson (borough accountant), and Mr. Saunders (chief clerk tramways department). The town clerk informed the inspector that the estimated population of the borough was 35,655; its rateable value to the general district rate £131,550, and to the poor rate £141,584; the district rate was 5s. in the £ per annum, and the poor rate 4s. 2d., a total rate of 9s. 2d. in the £. The loan indebtedness £120,658 to the general district fund, £75,420 electricity fund £74,935 to the tramways fund, £11,527 borough fund, £36,975 education fund—total indebtedness, £317,515. Mr. Bruce explained that they desired to use the mechanical stokers with two or three objects. They would save them much additional stoking, and would enable them to use a lower grade of coal, and get equally satisfactory results. The coal would be put into hoppers, and two men would be able to deal with more boilers and get even better results than at present out of the lower class of coal than they actually did with the higher grade coal, which now cost them so much money. The mechanical stokers would enable them to get more steam, and so carry a heavier load. The plans had been approved. With regard to free wiring, they had a considerable number of customers for current coming on who were anxious to take advantage of the system. They had now ten coming on, and had only £60 left of their £1,000. The inspector having ascertained that there was no opposition to the application, the inquiry closed. It lasted exactly seven minutes. A Bill to confirm a provisional order made by the Board of Trade under the Electric Lighting Acts of 1882 and 1888 relating to Lowestoft came on the 22nd inst. before Lord Onslow (Chairman of Committee of the House of Lords) as an unopposed measure. The object of the Bill is to amend the electric lighting powers given to the Lowestoft Corporation in 1898. Proof of preamble having been given, the Bill passed this stage and was ordered to be reported for third reading.

TRACTION.

Hobart Electric Tramway Co.—The directors announce a dividend of 1s. per share, free of income tax.

Provincial Tramways Co.—The directors announce an interim dividend of 3s. per share upon the ordinary shares.

Bilbao.—A concession has been granted to the Compañia del Tranvia Urbano de Bilbao for the construction of an electric tramway in the town of Bilbao.

South Shields.—After protracted negotiations between the South Shields Corporation and the Jarrow Electric Traction Co., a through service of cars has now been established whereby the people of the Mid-Tyne district can reach the coast at South Shields without changing cars.

Buenos Ayres and Belgrano Electric Tramways Co.—Receipts for the week ending June 17, 1908, were £3,495; corresponding period, 1907. £3,649—decrease, £154. Aggregates from Jan. 1, 1908, £91,207; aggregates from Jan. 1, 1907, £90,735—increase, £472.

Newcastle.—The traffic returns for the week ending June 20 show that passengers were carried to the number of 815,475, the revenue reached £3,700, and the car average was 11·43, against the corresponding week of last year, when there were 891,750 passengers, £4,048 in revenue, and a car average of 11·67.

Morecambe.—On July 1 the electric trains will commence to run between Morecambe and Lancester on the Midland Railway, when a very extensive train service will be inaugurated. There will be 35 trains in each direction daily, commencing with a workman's train at 5.30 a.m. Intending passengers would do well to consult the time-tables.

Shrewsbury.—The Town Council have decided to make application to the Light Railway Commissioners, under the provisions of the Light Railways Act, 1896, for the insertion of a clause in the North Shropshire Light Railway Order, 1907, authorising the Shrewsbury Town Council, if they so think fit, to advance to the North Shropshire Light Railway Co., either by way of loan or as part of the share capital of the company, or partly in one way and partly in the other, any sum not exceeding the sum of £500.

Bury.—The tramways manager reported to the Tramways Committee that the average receipts on the Bury sections during the last four weeks had been 10·18 per car mile, and on the Radcliffe sections 8·07 per car mile. It was decided to extend the hospitality of the committee to the members of the managers' section of the Municipal Tramways Association on the occasion of their visit to Bury on July 10.

Bradford.—A tramway accident which had a fatal termination occurred on the Queensbury section of the Bradford tramways on the 19th inst. The 3.35 car from Queensbury to Bradford was passing Littlemore, which is just above Horton Bank Top, when a little girl suddenly ran in front of the car. The driver promptly applied the brakes, but the girl was knocked down, and the front wheel passed over her, severing one leg just above the ankle and badly crushing the other. The injured girl was put into the car and driven direct to the Bradford Royal Infirmary, where she died shortly after admission.

Nottingham.—At a public meeting held on Monday the following resolution was adopted: "That the electors of the city of Nottingham hereby approve of, and consent to, the promotion of a Bill entitled 'A Bill to further extend the time limit for the purchase of lands and for the construction and completion of the tramways and works authorised by the Notts and Derbyshire Tramways Act, 1903; to provide for the transfer to the Corporation of Nottingham of certain of the powers of that Act; to authorise the Corporation to construct additional tramways, and a tramroad and street improvements, and for other purposes.'"

East Ham.—The Borough Electricity Committee have received a letter from the Board of Trade transmitting an order sanctioning the borrowing of the sum of £9,560 for the electrification of the tramways in Romford-road as follows: £8,930 for permanent way, repayable in 30 years; £630 for electrical equipment, repayable in 20 years; and are recommending that the treasurer be authorised to negotiate for the raising of the sum of £9,560, and also the loan required for the paving of the margins of the roadway as soon as the sanction of the Local Government Board to the borrowing thereof is received, on the best possible terms.

Wigan.—At a meeting of the Buildings, etc., Committee of the Corporation, the surveyor suggested that an official letter be sent to the Wigan Tramways Committee insisting on the regulation speed for cars to enter all loops. The wear and tear of the permanent way was aggravated by the excessive speed at the approaches. A letter was read from the town clerk of Wigan stating the question of providing a waiting-room at Bryn Cross was receiving the attention of the Tramways Committee. It was resolved to call the attention of the Corporation to the excess of speed laid down by the Board of Trade which the tramcars are permitted to enter the loops.

Shoreham.—Tramcars and tram horses were offered under the hammer at Southwick on the 19th inst., following the discontinuance of the service of horse trams between Hove and Shoreham. The majority of the animals will exchange their sphere of usefulness from that of the tramway service for work on the land, for farmers were well represented at the sale, there being a demand for horses for agricultural purposes at the present time. This being so prices were satisfactory, but it was otherwise in the case of the tramcars. These vehicles, the first cost of which was very considerable, went for £5 or thereabouts, a remarkable illustration of the transient character of things in this era of change and progress.

Ealing.—At the last meeting of the Town Council a letter was read from the Commissioner of Police with reference to the complaints which had been received in respect of the noise of tramcars, and stating that similar complaints had been received from most of the councils in the locality. Inspections were proceeding, and a detailed account of the inspection at Ealing would be sent as soon as possible, but it had been found up to the present that the noise was in nearly every case due to the condition of the track rather than the cars. The town clerk reported that he had forwarded the commissioner the numbers of certain cars which were particularly noisy. The Highways Committee, taking into consideration the necessity for prompt action in the matter, recommended that the mayor be requested, with the town clerk and borough surveyor, to see Mr. Nield, M.P., with a view to prevailing upon him to bring the matter to the notice of the House of Commons. This was agreed to.

Swansea.—Tramway enterprise for the convenience of Swansea Valley is likely soon to have a desirable consummation. The first section, constructed by Glamorgan County Council to connect Swansea tramways with the Swansea Valley, is likely to be opened shortly for passenger traffic. Early this week a small party, comprising Mr. Day (Messrs. Case and Day, Cardiff, who are acting as consulting engineers to the County Council), Mr. James (manager), and Mr. Johnston (engineer to the Swansea Tramways Co.), with Mr. Prussman (Swansea borough electrical engineer), with his chief assistant (Mr. Benson), made a trial trip in one of the tramway company's cars, with a view to the final preparations for the inspection by the officials of the Board of Trade. The carrying through of the line through Clydach to Pontardawe and Ystalyfera and the upper part of Swansea Valley points to a much-desired boon and benefit in the interests of those thriving and rapidly increasing localities.

Bradford.—At the last meeting of the Bradford Tramways Committee the report and balance-sheet for the year ended March 31 last were submitted. The report, presented by the general manager (Mr. C. J. Spencer), stated that the results of the year's working could fairly be compared with those for the previous year. The total revenue for the year from all sources, excepting bank interest, was £243,148, an increase of £5,637 on the previous year. The increased car mileage run this year had not quite earned the same amount *pro rata* with last year's increased mileage. The receipts per car mile for traffic and sundry revenue amounted to 10·591d., as against 10·732d. last year. Summed up, however, the whole matter was that with an increased

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car mileage of 3 per cent. an increase of 2·3 per cent. had accrued in receipts. The number of passengers carried was 47,839,569, as compared with 46,728,977 last year, an increase of 1,110,592 On an average calculation the population served had been carried 141 times.

Southend.—The town clerk laid before the Tramways Committee at the last meeting the Commissioners' decision upon the application to vary the Southend and Colchester Light Railway Order, whereby they express their willingness to extend for three years the time for constructing the light railway from Prittlewell to Burnham, subject to the conditions that the deposit of £3,250 provided by the order of 1904 should be made within 12 months and the works substantially commenced within 18 months from the date of the commencement of the amending order, and, further, with the addition of a grant of mutual running powers for the Corporation and for the company between Southend and Rochford. A letter was read from the Board of Trade referring to the breakage of axles that had occurred on the tramways from 1906 and up to the end of April last, suggesting that a stronger type of axle be substituted for those at present in use. The engineer reported as to the cars on which the majority of breakages had taken place, and it was ordered that all axles fitted to cars in the future be 4in. in diameter instead of 3¾in. as heretofore, at an estimated extra cost of £2 per axle.

Glasgow.—Lieut.-Colonel H. A. Yorke's report to the Board of Trade as to the result of his inquiry into the accident that occurred on Jan. 3 to a tramcar belonging to the Glasgow Corporation while it was on the journey from Springburn to Mount Florida, by which two persons were killed and 10 injured, was issued on the 19th inst. Lieut.-Colonel Yorke says that, owing to the death of the motorman Dolan, the driver of the car, and the absence of any direct evidence as to what happened at the front end of the car, it is impossible to say with certainty how it was that Dolan lost control of it, or why he failed to stop at the two important places on the route. "There seems," says Colonel Yorke, "to be only two ways of accounting for the occurrence. Either Dolan was driving carelessly, or even recklessly, and allowed the speed of the car to increase too rapidly before he took any steps to check it, or else some portion of the magnetic track brake gear, which he should have been using, must have failed him. The tramcar to which this accident occurred, and most of the tramcars belonging to the Glasgow Corporation, are fitted with only two sand-boxes—one at each end of the car. This means that sand can be applied to only one rail at a time, so that when the rails are greasy, and the efficiency of the braking appliances is of the utmost importance, it happens that the brakes, of whatever description, only do good work on one side of the car, which, in other words, means that when the rail conditions are at their worst only half the brake power is available. This seems to be a very unsatisfactory arrangement, and I strongly recommend that the Glasgow Corporation should take early steps to fit all their cars with four sanders, two at each end."

PERSONAL.

The Grays Urban District Council have resolved to increase the salary of Mr. E. D. Long, the electrical engineer, by £25 per annum.

Mr. Geo. L. Collins has been appointed manager of the Ontario Light and Traction Co. of Canandaigua, New York, in succession to Mr. R. M. Searle.

Mr. N. C. Draper has resigned his position as general manager of the Eastern Wisconsin Railway and Light Co. to take up the position of district manager of the Ohio Electric Railway, with headquarters at Zanesville, Ohio.

The Government authorities having purchased the lease of the premises of Messrs. Bramwell and Harris at 5, Great George-street, Westminster, the firm have taken new offices at 11, Great George-street, which they will occupy at the end of the present month.

The fourth annual dinner of the Faraday House Old Students' Association was held at the Queen's Hotel, Leicester square, on June 18, with the president of the association (Mr. Gerald W. Partridge, engineer-in-chief of the London Electric Supply Corporation) in the chair. The company included Mr. W. M. Mordey (president of the Institution of Electrical Engineers), Mr. Robert Hammond, Major O'Meara, Mr. Hugo Hirst, and Mr. Philip Dawson, who proposed the toast of the evening, "Faraday House and its Old Students." As is usual at these gatherings, beyond this toast there were no other speeches, the dinner being followed by an excellent smoking concert.

APPOINTMENTS VACANT.

Engineer Fitter, St. Patrick's College, Maynooth. Applications to Mr. S. Sharp, 34, Great George-street, London, S.W. See advertisement in last issue.

Charge Engineer, Bristol Corporation, Avonmouth sub-station. Salary, 25s. per week, rising to 35s. Applications to the city electrical engineer, Mr. H. Faraday Proctor. See advertisement in last issue.

Head of the Physics and Electrical Engineering Department, Northern Polytechnic Institute, Holloway, London, N. Salary, £300 per annum. Applications by June 29. See advertisement in issue of June 12.

Electrician, to take charge of electric light and fan installation at Egmore Station, Madras, for the South Indian Railway Co. Salary, 120 rupees per mensem, rising to 150 rupees. Applications to Electrical Engineer, South Indian Railway, Trichinopoly.

CONTRACTS FOR ELECTRICAL SUPPLIES.

Rome.—Tenders are invited by the Italian Government Railway for electrically equipping the Valtelina line.

Madrid.—The Public Works Department invite tenders for the construction of light railways. Tenders by Oct. 31.

West Ham.—The West Ham Hospital Committee invite tenders for the installation of electric light in the old building.

Viana del Bollo (Spain).—Tenders are invited for a concession for electrically lighting the town. Tenders by July 15.

Pontypridd.—The Urban District Council invite tenders for the supply of six double-deck tramcars. Tenders by June 30.

Lisbon.—Tenders are invited for the construction of railways at St. Thomas for the Colonial Railways. Tenders by July 22.

Bukarest.—Tenders are invited by the Roumanian State Railways for the supply of rails, points, and crossings. Tenders by June 29.

South Australia.—Tenders are invited by the Railway Department for the supply of 40 tons of firebar iron. Tenders by July 7.

Italy.—The Municipality of Volterra invite tenders for the construction of a railway from Volterra to the Cecina-Volterra Railway.

Belfast.—Tenders are invited for the annual supply of iron castings, as bends, branches, tees, etc. Tenders to the Town Clerk by July 2.

Bangkok.—Tenders are invited for fishplates, fishbolts, bearing plates, etc., required for the Royal Siamese Railways. Tenders by Oct. 1.

Brussels.—The Société Nationale des Chemins de Fer Vicinaux invite tenders for the doubling of the line at Auderlecht. Tenders by July 1.

Paddington.—The Guardians invite tenders for the installation of new boiler and seatings at the infirmary in Harrow-road. Tenders by July 1.

Rome.—Tenders are invited by the Italian Government Railways for the erection of an electric supply station at Rimini. Tenders by June 30.

St. Annes.—The Urban District Council invite tenders for laying a feeder cable. Particulars from the Electrical Engineer. Tenders by June 27.

Leipzig.—Tenders are invited for the supply of 18 Cornish boilers and superheaters for the municipal electricity works. Tenders by July 10.

Canterbury.—Tenders are invited for painting the lamp brackets at per 100 and the columns at per 100 for the Electric Lighting Committee.

Chatellerault (N. France).—Tenders are invited for the supply of 2,000 incandescent electric lamps for the National Arms Factory. Tenders by July 6.

Salford.—Tenders are invited for rewiring the Royal Technical Institute. Particulars from Mr. M'Cowen, borough electrical engineer. Tenders by July 1.

Madrid.—The Public Works Department invite tenders for the option of constructing a railway from La Carolina to Vado del Castano Tenders by July 8.

Rochdale.—The Electricity Committee invite tenders for the supply of coal. Particulars from the Borough Electrical Engineer. Tenders to the Town Clerk.

Newport (Mon.).—Tenders are invited for the supply of continuous and alternating current prepayment meters. Particulars from the Electrical Engineer.

Brussels.—The Société Nationale des Chemins de Fer Vicinaux invite tenders for the construction of a line from Olloy to Ognies. Tenders by June 30.

Odessa.—The Town Council invite applications for a concession for the installation and working of an electric station in Odessa. Tenders by Sept. 14.

Glasgow.—The Corporation invite tenders for one or two motor first-aid machines required for the fire department. Tenders to the Town Clerk by June 30.

Fulham.—The Guardians invite tenders for British-made vertical high-speed engine and a 20-kw. steam dynamo. Particulars from the Clerk. Tenders by July 2.

Canterbury.—The Town Council invite tenders for the annual supply of coal to the electricity works, Northgate-street. Tenders to the Town Clerk by June 29.

Salford.—The Education Committee invite tenders for heating and ventilating of the Halton Bank Council School, Pendleton. Tenders to the Town Clerk by July 6.

London, S.W.—The London County Council invite tenders for the supply of petrol-driven motor (escape) vans for the London Fire Brigade. Tenders by July 7.

Stanislau.—The Municipality invite tenders for the establishment of an electric tramway system, also for the erection of a generating station. Tenders by Aug. 31.

Bradford.—The Corporation invite tenders for the electric light installation at the new nurses' home and isolation block, City Hospital, Leeds-road. Tenders by July 7.

Blois.—Tenders are invited for the construction and maintenance for 50 years of public tramways. Particulars from the Prefecture de Loir-et-Cher. Tenders by July 15.

Ferndale (Wales).—Tenders are invited for the erection of a new bakery and stores, with engine-rooms for suction gas and electric producing plant and foundations for same, for the Ferndale Industrial Co-operative Society. Tenders to Mr. J. Jenkins, secretary, by July 1.

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Victoria.—The Postmaster General invites tenders for the supply of telegraph and telephone material required during the year ending June 30, 1909. Tenders by Aug. 4.

Brussels.—The Société Nationale des Chemins de Fer Vicinaux invite tenders for the exploitation of a line from St. Nicholas to Kieldrecht-Doel. Tenders by July 19.

St. Pancras.—The Borough Council invite tenders for additions to their low-tension switchboard at the King's-road generating station. Tenders by July 13. See advertisement.

Lowestoft.—Tenders are invited for the annual supply of coal to the Corporation electricity station. Particulars from the Borough Electrical Engineer. Tenders by July 3.

Auckland.—The Auckland Harbour Board require tenders for electrical capstans, etc. Particulars from the McArthur Engineering Co., Silk-street, Cripplegate, London, E.C.

Malvern.—The Urban District Council invite tenders for the supply and erection of 50-kw. steam alternator, exciter, etc. Tenders to Mr. Whatley, clerk to the Council, by June 29.

Rio de Janeiro.—The Public Works Department invite tenders for the construction of railways from St. Luiz to Casius and for the supply of rolling-stock. Tenders by July 1.

Pontypridd.—The Urban District Council invite tenders for the supply of coal to the electricity works. Particulars from Mr. Teasdel, engineer and manager. Tenders by June 29.

Treeton.—The West Riding Education Committee invite tenders for the installation of heating apparatus at the Treeton Provided School, near Rotherham. Tenders by July 3.

New South Wales.—Tenders are invited for the supply, delivery, and erection of a branching metallic multiple magneto switchboard at the Moeman Telephone Exchange. Tenders by Aug. 12.

Dublin.—Tenders are invited for the annual supply of machinery oils for the Corporation electricity supply works. Particulars from the Town Clerk. Tenders by June 29. See advertisement.

Gravesend.—The Electricity Committee invite tenders for the supply and erection of yellow flame arc lamps, columns, etc. Tenders to the Town Clerk by June 27. See advertisement in last issue.

Stepney.—The Electricity Supply Committee invite tenders for the supply of about 12,000 tons of coal for the electricity works. Tenders to the Chairman of the Electricity Supply Committee by June 29.

Melbourne.—Tenders are invited for the supply of 5 060 yards of insulated copper cables. Tenders to Messrs. McIlwraith, McEacharn, and Co. Proprietary, Billiter square-buildings, London, E.C., by July 3.

Toronto.—Tenders are invited by the Hydro-Electric Commission for the supply of transmission cables to be laid from Niagara Falls to St Thomas. Particulars from the chairman, Mr. Adam Beck. Tenders by July 15.

West Wretham.—Tenders are invited for the purchase of the lead, copper, brass, scrap, and wrought iron at Wretham Hall. Tenders to Mr. P. Ashburnham, Estate Office, West Wretham, Thetford, by June 30.

Woolwich.—The Borough Council invite tenders for the equipment of their Globe-lane generating station with coal-handling plant. Specification from the Borough Electrical Engineer. Tenders by July 23. See advertisement.

Aberdeen.—Tenders are invited for the various works required in heating, electric lighting, etc., of alterations and additions at the south-west portion of the main buildings of the Aberdeen Royal Asylum. Tenders by July 8.

Tunstall (Staffs).—The Urban District Council invite tenders for lighting the public streets for one or three years from Aug. 1. Further particulars from Mr. A. R. Wood, surveyor, Town Hall, Tunstall. Tenders by July 1.

Stepney.—The Electricity Supply Committee invite tenders for the annual supply of arc lamp carbons, ampere-hour meters, demand indicators, and time switches. Tenders to the Town Clerk by June 29. See advertisement in last issue.

Gravesend.—The Electricity Committee invite tenders for the supply of approximately 2,500 tons of rough small coal required between July 1, 1908, and June 30, 1909, for the electricity works. Tenders to the Town Clerk by June 26.

Spain.—The Direccion General de Obras Publicas invite offers for the construction and working of an electric tramway from La Coruna to Burgo. Particulars from the Commercial Intelligence Branch of the Board of Trade. Tenders by July 31.

East Greenwich.—The London County Council invite tenders for the manufacture and delivery of high-tension main switchgear and low-tension auxiliary switchgear to be erected at the East Greenwich generating station. Tenders to the Clerk by July 7.

London, S.W.—The London County Council invite tenders for the supply and delivery of (*a*) lanterns and lantern accessories, compressed gases, gas cylinders, etc.; (*b*) corks. Tenders to the Clerk of the Council, County Hall, Spring-gardens, S.W., by June 30.

Dublin.—The Lighting Committee invite tenders for the supply and erection of sub-station switchboards, transformers, and accessories; also for boiler plant, etc. Specification from the City Electrical Engineer. Tenders by July 13. See advertisement.

Bramby and Frodingham.—The Urban District Council invite tenders for fixing telephone between their offices and water-pumping station, about five miles. Particulars from Mr. J. Green, Council Offices, Frodingham, Doncaster. See advertisement in last issue.

Edinburgh.—The Edinburgh and Leith Corporations' Gas Commissioners invite tenders for the supply of about 2,000 to 2,500 tons per annum of sulphuric acid over a period of one, two, or three years. Particulars from Mr. Herring, general manager. Tenders by June 29.

Ealing.—The Town Council invite tenders for the supply of best cylinder oil, crank-chamber oil, paraffin, engine oil, best rope waste, and stoneware pipes required at the electricity works. Tenders to Mr. J. Douglas Knight, the borough electrical engineer and manager, by June 27.

New South Wales.—Tenders are invited for the supply of the following for the Postmaster-General's Department: 69 tons wire (hard-drawn copper, 300lb. per mile), 1 ton tape, binding copper (200lb. per mile), 15,000 insulators (best white porcelain, large). Tenders by Aug. 5.

Melbourne.—The Postmaster-General invites tenders for the erection of wireless telegraphy stations at Cape York, Thursday Island, Goode Island, Port Moresby, and Freemantle. Particulars from the Australian Commonwealth, Victoria-street, Westminster. Tenders by Aug. 26.

Stratford.—Tenders are invited for the electric lighting of the old portion of the hospital, for the Committee of the West Ham and East London Hospital, Stratford, E. Specifications and particulars can be had from Mr. A. W. Scrivener, secretary, to whom tenders must be delivered by June 27.

Ossett.—The Yorkshire Electric Power Co. invite tenders for the various works required in the erection of a sub-station. Plans may be seen and quantities obtained on personal application at the office of Mr. J. W. Burrows, architect, Birstall and Mirfield. Tenders to be delivered to the Architect by June 26.

Spain.—The Public Works Department, Madrid, will shortly invite tenders for the installation of a new submarine telegraph cable from Cadiz to Teneriffe, thence to Gran Canaria, Palma y Gomera, from the latter island to Hierro, from Gran Canaria to Fuerteventura, and from thence to Lanzarote. Estimate, £172,420.

Adelaide.—The Postmaster-General invites tenders for the supply of telephone and telegraph instruments, switchboards, telephone line material, six tons sulphate of magnesia, one ton sal-ammoniac, crushed, etc. Particulars from the Australian Commonwealth, 72, Victoria-street, Westminster. Tenders by July 1.

Edinburgh.—Tenders are invited for the installation of electric lighting and power in the new engineering laboratory, Heriot-Watt College, for the George Heriot's Trust. Specifications from Mr. John Anderson, superintendent of works. Tenders to Mr. Peter Macnaughton, S.S.C., clerk, 20, York-place, Edinburgh, by July 3.

Western Australia.—The Postmaster-General invites tenders for 650 telephone wall sets, 150 telephone table sets, 800 protectors, 90 extension switch and bell sets complete, 30 switchboards for 4 lines, 20 ditto for 6 lines, 5 ditto for 12 lines, 5 ditto for 24 lines, 20 telephone wall sets for party lines, 10 ditto. Tenders by Sept. 7.

Shillong.—The Government of Eastern Bengal and Assam are considering the question of the lighting of the station of Shillong by electricity, and invite applications for a licence for the introduction of a suitable scheme. Applications should be addressed to the Secretary to the Government of Eastern Bengal and Assam, Public Works Department, Shillong.

Johannesburg.—The Municipal Council invite tenders for the supply of an hydraulic tyring machine. Particulars from the Council's agents in London, Messrs. E. W. Carling and Co., St. Dunstan's-buildings, St. Dunstan's-hill, on payment of 10s. Tenders to the Town Clerk, Municipal Offices, Plein-square, Johannesburg, Transvaal, by July 29.

Pontypridd.—The Urban District Council invite tenders for the annual supply of stores, including oil and colourmen's sundries, engineers' stores, brushes, ironmongery and stores, leather goods, rubber, and engine packings, etc. Particulars from Mr. P. Willoughby, engineer and surveyor. Tenders to Mr. J. Colenso Jones, clerk, Municipal Buildings, Pontypridd, by June 29.

London, E.C.—Tenders are invited for the supply of brass and other fittings and materials for railway carriages, steel cotters, twist drills, phosphor copper, tool steel, and other miscellaneous stores for the locomotive and carriage department as per specification to be seen at the Company's Office, for the Madras and Southern Mahratta Railway Co. (Madras Section). Tenders by June 29.

Camberwell and Lewisham.—The London County Council invite tenders for the roadwork and platelaying required for the construction, on the underground conduit system of electric traction, of the authorised tramways from Dulwich Library (Lordship-lane) to Forest Hill, Camberwell, and Lewisham. Particulars from Mr. Fitzmaurice, chief engineer of the Council. Tenders by June 30.

Accra (Gold Coast).—Tenders are invited for the construction of a railway of a length of about 39 miles, from Accra to Mangoassi, in the Gold Coast Colony, for the Crown Agents for the Colony. The line has been surveyed by engineers employed by the Colonial Government, and plans, sections, type drawings, specifications, quantities, draft form of contract, and form of tender may be seen by intending contractors at the office of the Crown Agents in London. Tenders by Sept. 10.

Christiania.—The Commercial Intelligence Branch of the Board of Trade are informed by his Majesty's Consul at Christiania that the Norwegian naval authorities at Horten have issued a call for tenders for the supply of a number of copper and brass tubes and plates. Copies of specifications and conditions may be inspected by British manufacturers on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C. Tenders by July 4.

Copenhagen.—The Commercial Intelligence Branch of the Board of Trade have received from his Majesty's Consul at Copenhagen copies of the conditions and specifications relating to a call for tenders by the Danish State Railways for the supply of 117,500 kg. of bar iron, 3,000 kg. of angle iron, 2,100 kg. of shaped iron, 71,000 kg. of fire-bars, 421 iron plates, and 400 iron casings. Tenders to be delivered

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at Maskinafdalingens Kontor, Gl. Kongvej, 1 D. 3 Sal., Copenhagen, by June 30.

RESULTS OF TENDERS.

Worksop.—The Urban District Council have accepted the tender of E. Green and Son for a fuel economiser for £250.

Ealing.—The Oliver Arc Lamp have secured an order for the street-lighting of Ealing with their "Oriflamme" flame lamp.

Leyton.—The Oliver Arc Lamp have received the contract for lighting the streets with their "Oriflamme" flame lamp.

Cheltenham.—The Lighting Committee have accepted the tender of the British Thomson-Houston Co. for the annual supply of meters.

Dundee.—Messrs. Chamberlain and Hookham have been awarded the contract for the supply of meters to the electricity department for £525.

Wantage.—The Guardians have accepted the tender of Kent and Son for a new installation of electric bells at the workhouse for £3. 7s. 6d.

Penrhyndeudraeth (Wales).—The Guardians have accepted the tender of O. D. Jones, of Borthygest, for the erection of a new boiler-house at the workhouse.

Cape Town.—The tender of G. Findlay and Co., of Cape Town, has been accepted for a Waygood electric passenger elevator at the new premises of the Bank of Africa.

Bradford.—The Corporation have accepted the tender of J. R. Williams and Co., Liverpool, for the supply of tramway tickets for period of not exceeding three years.

Bradford.—The Corporation have accepted the tender of Roberts Bros., North-parade, for an electric lighting installation at the town hall extension for the sum of £1,420

Sheffield.—The Tramways Committee have accepted the tender of Burnley and Son for the supply of coal for use at Kelham Island power station during 12 months ending June 30, 1909.

Bradford.—The tender of the Bradford Electrical Engineering Co., at £46, has been accepted for the installation of an electric lighting main cable at the union workhouse, Horton-lane.

Ardwick.—Messrs. Royce have received a repeat order from Messrs. Galloways, Manchester, for two 40-ton three-motor electric overhead cranes and gantries for their boiler works at Ardwick.

New South Wales.—The Public Works Department have accepted the tender of Simpson Bros., Sydney, for supply and erection of pumping machinery for Mittagong water supply for £987.

Seaforth.—Messrs. Royce, Limited, have received a repeat order from Messrs. Farnworth and Jardine, Seaforth, Liverpool, for one five-ton three-motor electric overhead crane and steel gantry.

West Australia.—The Postmaster-General has accepted the following tenders: J. M. Ferguson, Limited, Perth, 500 fuses at 3½d. each; Unbehaun and Johnstone, Perth, 6 relays non-polar at £1. 8s. 9d. each.

Sutton.—The Metropolitan Asylums Board have accepted the tender of Edmundson's Electricity Corporation for wiring and fitting for electric lighting the Belmont Laboratory, Sutton, Surrey, for £194.

Belfast.—The tender of Hind Bros. and Co. has been accepted for the supply of five iron latticed-built electric light masts 70ft. high from the ground line, with suitable base, for the Belfast Harbour Commissioners.

Walsall.—The tender of Willans and Robinson, of Rugby, has been accepted by the Electric Lighting Committee for the supply and erection of condensing plant, including surface condenser, air-pumps, cooling tower, and water purifier.

Emsworth.—The Urban District Council have accepted the offer of the National Telephone Co. to install a system of magneto-alarm bells to various firemen's residences, connected up with the captain's residence, at £8 a year for five years.

New Westminster (British Columbia).—The contract for the first section of the Westminster-Chilliwack electric car line has been awarded to Messrs. Boyd and Craig, of Vancouver. The approximate cost is 100,000dol. (about £20,416 13s.).

Victoria.—The State Rivers and Water Supply Commission have accepted the tender of the Weymouth Proprietary, Limited, for the supply, delivery, and erection (complete) of pumping plants at Nyah and White Cliffs for the sum of £18 062. 2s.

Western Australia.—The Mines Department have accepted the following tenders: Saunders and Stuart, Brush motor £80, Pearn electric sinking pump £103. 10s.; General Electric Engineering Co, 3,000 yards 7-18 cable at £15. 10s. per mile.

Crayford.—The Metropolitan Water Board have accepted the tender of the Baker Oil Separator Co. for the provision of two oil separators at the Crayford pumping station for the purpose of extracting the oil from the exhaust steam of Nos. 2 and 3 engines for £115.

Gravesend.—The Town Council have accepted the following tenders: Tudor Accumulator Co., storage battery £1,295, and £112 for maintenance; Switchgear Co., switchboard £295, and £21 for regulating switches; A. E. Tong, erection of sub-station at Northfleet, £724.

East Ham.—The Board of Trade sanction having been received to the borrowing of £9,560 for the electrification of the tramways in Romford-road, the Electric Lighting and Tramways Committee recommend that a contract be entered into with Griffiths and Co. for the electrification of this track when ready.

Calgary.—The Electric Light Committee have accepted the tender of the Robb Engineering Co., of Amherst, Nova Scotia, for a cross-compound engine for 20,226dol. (about £4,887. 5s.), and that of the Allis-Chalmers and Bullock Co., of Montreal, for a generator, exciter, etc., for 15,980dol. (about £3,242. 12s.).

Bristol.—The Electrical Committee have accepted the following tenders: Jones and Horsfield, boiler and pipe covering at Avonbank, £238; Princess Royal Colliery Co., coal for Temple Back station for one year, £1,640; Oliver Arc Lamps, alternating-current and direct-current flame arc lamps, £1,358; Sykes and Sugden, joint and junction boxes (one year), £387.

Heywood (Lancs.).—The Town Council have accepted the following tenders: T. Hill and Sons, boiler, etc.; Whipp and Bourne, switchboard; Blakeley and Wild, extensions at electricity works; Browett. Lindley, and Co., engine, dynamo, condensers, etc.; British Insulated and Helsby Cables, tramway feeder cable; Liverpool Hennebique Ferro-Concrete Contracting Co., cooling tower.

Toronto.—The Gutta Percha and Rubber Manufacturing Co. have secured the contract for a supply of hose for the high-pressure fire system as follows: 4,000ft. of 3½in. eureka four-ply cotton rubber-lined hose, 3,500ft. of 2½in. paragon three-ply cotton rubber-lined hose, and 500ft. of 2in. eureka mill. cotton rubber-lined hose. The Canadian Rubber Co., of Montreal, will supply 1,500ft. of 2½in. Keystone wax and gum treated fire hose.

London.—The London County Council have received the following tenders for the supply of motors, transformers, etc., at the central car repair depot:

Electric Construction Co., Wolverhampton*	£427 10 0
British Westinghouse Electric and Manufacturing Co., London, W.C.	468 0 0
General Electric Co., Birmingham	595 18 0

* Recommended for acceptance.

Southend.—The Electricity Committee have accepted the tender of Pass and Sons to purchase the lead plates and lead oxide from the dismantled Hart battery at £67, less 12s. for cartage to the railway station. The electrical engineer has reported that Ferranti, Limited, with whom the Corporation have a running contract for the supply of meters, have agreed to make the following reductions on the price of the 50, 75, and 100 ampere meters supplied to the Corporation: 50 meters from 57s. 6d. to 54s. each, 75 to 100 from £3. 5s. to £3. 3s.

Queensland.—The following tenders have been accepted for supplies to the Postmaster-General's Department: Lead-covered cable—3,814 yards 208 pair L.C. cable at £490 per mile, 320 yards 78 pair L.C. cable at £240 per mile, 858 yards 39 pair L.C. cable at £140 per mile, 652 yards 26 pair L.C. cable at £115 per mile, British Insulated and Helsby Cables, Melbourne; 3,492 yards 104 pair L.C. cable for £464. 19s. 3d. (total price), Western Electric Co., Sydney; 5,280 yards 52 pair L.C. cable at £176 per mile, W. T. Henley's Telegraph Works Co., Melbourne; 220 yards 13 pair L.C. cable at £74 per mile, C. E. Bernays, Brisbane.

Metropolitan Asylums Board.—The Board have accepted tenders from the following firms for the annual supply of electrical accessories: General Electric Co.; British Insulated and Helsby Cables; W. T. Henley's Telegraph Works; Edison and Swan United Electric Co.; Callender's Cable and Construction Co.; India Rubber, Gutta Percha, and Telegraph Works Co.; Siemens Bros., and Co.; Pryke and Palmer; G. Braulik; Stirling Telephone and Electric Co.; Connolly Bros.; Sunbeam Lamp Co.; Cryselco, Limited; H. G. Mayer and Co.; A. P. Lundberg and Sons; Galsworthy, Limited; J. Tucker and Co.; Heap and Johnson; London Electric Wire Co.; G. McLellan and Co.; Macintosh and Co.; Davies, Kent, and Stewart.

London.—The London County Council have received the following tenders for the wiring and fitting for electric lighting of the Hackney car-shed:

Jenkins and Cawte, Chard	£702 4 4
A. C. Smith, Engineers, Lincoln, Limited, Lincoln	775 2 0
Perry and Co., London, S.W.*	911 0 0
S. J. Suter and Wood, London, W.	961 0 0
W. G. Cannon and Sons, Southwark, S.E.	1,010 16 2
Pinching and Walton, London, E.C.	1,014 19 10
Comyn, Ching, and Co., Long-acre, W.C.	1,099 8 1
G. Weston and Sons, London, E.C.	1,158 8 9
G. E. Taylor and Co., London, E.C.	1,189 13 6
Cross and Cross, Westminster, S.W.	1,209 0 0
H. J. Cash and Co., Westminster, S.W.	1,245 0 0
Tilley Bros., Shoreditch, E.	1,397 16 10

* Recommended for acceptance.

Southend.—The following tenders have been received for the laying along Southchurch Beach-road of about 1,500 yards of single tramway track with loops (rails and setts will be provided by the Corporation), for the Corporation:

S. G. Smith, 4, South-place, E.C.	£2,626 15 3
R. C. Brebner and Co., Edinburgh	2,621 11 6
R. Dykes, Bedford Park, Chiswick	2,192 14 4
W. Muirhead and Co., 35, Queen Victoria-street	2,045 8 9
Fry Bros., Greenwich, S.E.	2,010 19 5
J. Mowlem and Co., Westminster, S.W.	1,969 0 0
W. Griffiths and Co., London, E.C.	1,966 11 7
W. Ball and Co., Leyton	1,940 12 3
Scammell, Lawson, and Co., Gracechurch-street	1,936 17 3
G. J. Anderson, Poplar, E.	1,901 10 11
G. Trentham, Birmingham	1,791 0 0
R. W. Blackwell and Co., Westminster (accepted)	1,720 17 0

Southend-on-Sea.—The Corporation have received the following tenders for the supply and delivery of about 150 tons of rails, B.S. section: Hammer and Co., Cannon-street, E.C., No. 1 B.S. section (90lb.) £7. 14s. per ton, fishplates £9. 17s.; Craven, Lee,

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and Booth, Chester-road, Manchester, £10 and £11; P. and W. McLellan, Trongate, Glasgow, £6. 4s. 9d. and £7. 19s. 9d.; W. Scott, Limited, Hunslet, Leeds, £7. 5s. and £10. 10s.; Stalwerks Verbands, Dusseldorf, £8 15s. and £9. 5s.; Cargo Fleet Co., Middlesbrough, £7. 1s. and £9. 1s.; H. Gielgud, agent for Société Anonyme des Acieres, Belgium, £6. 2s. 6d. and £8. 2s. 6d. (accepted); Lorain Steel Co., King William-street, E.C., £6. 2s. 6d and £7. 12s. 6d. The Council have resolved to accept the tender of E. Allen and Co., Sheffield, at £445, for the provision of the bonds and crossings required for the tramway extension, and also their tender, at £95, for the necessary bends and crossings required for the improvement of track being carried out at the Cricketers' Corner.

Greenwich.—The London County Council have received the following tenders for the manufacture and supply of two electrically-driven centrifugal pumps to be erected at the Greenwich generating station:

Dick, Kerr, and Co., London, E C. (accepted)	£3 320	0	0
General Electric Co., Birmingham	3,333	6	0
British Electric Plant Co., Alloa, N.B.	3,335	10	0
Drysdale and Co., Glasgow	3,358	0	0
Worthington Pump Co., London, E C.	3 375	0	0
General Electric Co. (alternative tender)	3,375	7	0
British Westinghouse Electric and Manufacturing Co., London, W.C.	3,379	17	0
Worthington Pump Co. (first alternative tender)	3 406	0	0
Dick, Kerr, and Co. (alternative tender)	3,415	0	0
Electric Construction Co., Wolverhampton	3,501	0	0
Worthington Pump Co. (second alternative tender)	3 530	10	0
T Parker, Limited, Wolverhampton	3,706	0	0
J. Cochrane, Barrhead, near Glasgow	3.757	10	0
Gwynnes, Limited, London, E.C.	3,865	0	0
Greenwood and Batley, Leeds (alternative tender)	4,004	10	0
Greenwood and Batley	4,074	10	0
Entwistle and Gass, Bolton	4,312	0	0

West Ham.—The Electric Lighting and Tramways Committee have received the following tenders for the supply of a 3,000-kw. turbo-generator:

Electrical Co.	£11,470
Richardsons-Westgarth—Brown-Boveri	9,675
Richardsons-Westgarth—Parsons	9,400
Electric Construction Co.—Richardsons-Westgarth	9,400
Richardsons-Westgarth—Electric Construction Co.	9,300
Willans and Robinson—Dick-Kerr	9,182
Howden—Dick-Kerr	8,865
Howden—Westinghouse	8,750
General Electric Co.—Richardsons-Westgarth	8,745
Richardsons-Westgarth—Dick-Kerr	8,520
Howden—Siemens	8,500
Parsons—Parsons	8,181
Richardsons-Westgarth—Siemens	8,175
Electric Construction Co.—Parsons	7,704
Parsons—Dick-Kerr	7,491
General Electric Company—Parsons	7 319
British Westinghouse*	6,100

* Recommended for acceptance. The contract to provide for delivery in five months with two years' maintenance, and to contain clauses giving to the Council the option of purchasing a further similar turbo generator within two years for the sum of £6,800.

OPENINGS FOR CONTRACTORS.

ABERBARGOED—Passenger station, Brecon and Merthyr Railway Co.

ABERDARE—Two houses, Gospel Hall-terrace, Mr. R. Charles; workshop, High-street, Mr. W. Humphreys.

ABERDEEN—Dwelling-houses, University-road, Whitehall-road, and Rubislaw Den South and fish curing works Raik-road, Mr. James M. Davidson; fish-curing works, Poynernook-road, Messrs. Allan and Dey.

ABERDEEN—House, Pocra Quay. Mr. R. Nicol, harbour engineer.

ABERFAN—House, Angus-street, Mr. R. E. Rees.

ABERGAVENNY—Two houses, Pontsarn. Architect, Mr. Pritchard.

ABERYSTWYTH—Hostel (£40,000), Montgomeryshire County Education Committee.

ABERYSTWYTH—Four houses, Dinas Powis, Messrs. Edwards Bros.

ACTON—Elementary school, Acton Education Committee.

ALFORD—Town lighting. Mr. T. N. Loy, clerk, Alford.

ALMONDSBURY—Council school, Gloucester Education Committee.

ALNWICK—Houses, Christon Bank, Messrs. Young.

AMMANFORD—Church (£6,000). Architect, Mr. W. Jenkins, Llandilo.

ANNFIELD PLAIN—Nine dwelling-houses, Sabin-terrace, Mr. T. Lubbock; four dwelling-houses, Northgate-street, Mr. J. Bulmer; three dwelling-houses, Flint-hill, Mr. R. Thompson.

ANTWERP—Fire station (£24,685), Consul-General at Antwerp.

ASHBOURNE—Houses, Sandybrook-road, Messrs. Bagshaw and Sons.

ASHFORD—Houses, Queen's-road, Mr. C. J. Epps.

ASHTON—Swimming and slipper baths (£6,000), District Council.

ASPULL—Houses, Hall-lane, Mr. V. Abbott.

ASTON—Elementary school at Swallownest, near Sheffield, West Riding Education Committee.

AYLESBURY—Alterations to stores, Secretary to Co-operative Society.

BANGOR—Hostel in connection with college (£25,000), Joint Committee of Carnarvonshire and Anglesey County Council,

BANNOCKBURN—Alterations and additions to house, Old-road, Mr. D. Crockart; house and offices, St. Ninians Parish Council; two semi-detached houses, Station-road.

BARGOED—Higher elementary school, Glamorgan Education Committee.

BARROWFORD—Two houses, two shops, Gisburn-road, Mr. J. Farnum.

BASINGSTOKE—Additions to premises, London-street, Mr. McLennan; motor showroom, Winchester-road, Mr. J. Mares.

BATLEY—Elementary school, Field-lane, Education Authority.

BATTERSEA, S.W.—Motor-house. Architects, Messrs. Bartlett and Ross, 8, Breams-buildings, W.C.

BATTERSEA, S.W.—Offices for J. Crucible Dixon Co. Messrs. F. and H. F. Higgs, builders, Loughborough Junction.

BEDLINOG—Two houses, Mr. E. Powell; house and workshop, Mr. D. Davies.

BEN RHYDDING—Wesleyan schools, Messrs. Garside and Pennington.

BERKHAMPSTEAD—Two houses, Highfield-road, Mr. H. Grundy.

BILSTON—Elementary school, Bull Holes, Education Committee.

BILSTON—Catholic church, Presbytery.

BIRKBY — Baptist church and schools, Messrs. Garside and Pennington.

BIRKENHEAD—Additions, aged and infirm block, and extensions, nurses' home, Hospital Committee.

BIRKENSHAW—Sunday school, United Methodist Church (£1,600), Trustees.

BLACKBURN—Higher elementary school, Blakey Moor, Education Committee.

BLAENGARW—Forty-six houses, Mr. P. Morris.

BLANTYRE—Police station, Victoria-street.

BLISWORTH—School and teacher's residence, Northamptonshire Education Committee.

BONT—Elementary school, Montgomeryshire Education Committee.

BRENTWOOD—Villa residence, Westbury-road, Mr. W. Green.

BRIXHAM—House, Berryhead-road, Mr. C. Hellyer.

BROADSTAIRS—Houses, St. Peter's Park-road, Messrs. Harvey and Co.

BROMLEY—Laundry, Cowper-road. Messrs. E. Peill and Sons, contractors, Southlands-road.

BRONDESBURY, N.W.—Houses, Teignmouth-road. Mr. G. Bridge, builder, Teignmouth road, N.W.

BROUGHTON (YORKS)—Improvements and enlargements at Broughton Schools, near Stokesley. Messrs. J. M. Bottomley, Son, and Wellburn architects, Middlesbrough.

BRYNMAWR—Twenty houses. Mr. H. B. Jones, architect.

BRYNNA—Thirty houses near Llanharan, Brynna Building Club.

BURGHEAD—Church. Mr J. Wittet, architect, Elgin.

BURNHAM OVERY—Alterations, etc., Burnham Overy, Walpole St. Andrew Cross Keys, and Wiggenhall St. Mary Magdalen Schools, and enlarging classroom and offices at Snettisham School, Norfolk Education Committee.

BURNLEY—Baths, North-street, Mr. G. H. Pickles.

BURY—Weaving-shed, Vulcan Cotton Spinning and Manufacturing Co.

CAERPHILLY—Twenty-one houses, Van-road, Mr. J. H. Phillips, Cardiff

CARDIFF—Rebuilding Globe Hotel, Castle-street, Messrs. James and Morgan.

CARDIFF—Bottling store, Anglo-Bavarian Brewery Co.

CARLOW—Carnegie Library, Libraries Committee.

CARNARVON—Alterations and improvements, public slaughter-house, Sanitary Committee.

CATCLIFFE—Repairs and improvements to Catcliffe Provided School, near Sheffield, West Riding Education Committee.

CHADDERTON—Town hall, Belton-place (£1,200), Council.

CHARD—Wesleyan church at Wambrook, Trustees.

CHARLESWORTH—Rope works, Messrs. J. Booth and Sons.

CHELMSFORD—Baptist Church to be lighted by electricity, King Edward's-avenue (£6,000), Trustees.

CHESTERFIELD—Slaughter-house purposes (£400), offices for health and highways department (£850), fire brigade purposes (£2,800), Corporation.

CHIPPING NORTON—Alterations and additions, school buildings, Governors, Chipping Campden Grammar School.

CHRISTCHURCH—Improvements to the Board-room, Board of Guardians.

CHURCHDOWN (GLOUCESTER)—Alterations and additions to teacher's house at Council schools. Mr. R. E. Phillips, architect, Midland Bank-chambers, Gloucester.

CLAPTON, N.E. — Dwelling-houses, Clapton Common. Mr. J. Hamilton, architect, 23, Wormwood-street, E.C.

COCKFIELD—Alterations and additions, two Church of England schools. Messrs. Clark and Moscrop, architects.

COLCHESTER—Enlarging Colchester Grammar School (£3,600), Essex Education Committee.

COLNE—Weavers' institute. Architect, Mr. Pilling.

CORSTORPHINE—Police station, Midlothian County Council.

COVENTRY—Extension, electricity undertaking (£35,000), Council.

COWDENBEATH—Elementary school, Mr. J. Ross, Beath School Board.

COWIE—Shop and hall, Mr. Easton; alterations and additions to the manse of Buchlyvie.

CRANBROOK—Two semi-detached villas. Mr. W. Brooks, architect.

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CROYDON—Secondary school, Croydon Education Committee.

CWMAMAN—Two dwelling-houses, Glynhafod-street, etc., Glynhafod Building Club.

CWMNANTYCOED—Six houses near the Gorsedd Circle, Mr. N. Moss.

DARLINGTON—Public conveniences, Town Council; school, Harrogate-hill, to accommodate 420 scholars, Town Council.

DARTFORD—Extensions, Bow Arrow Hospital. Mr. R. Marchant, architect, 28, Theobald's-road, W.C.

DENNYLOANHEAD—Hall, Managers of the Church of Christ.

DEWSBURY—Additions to workhouse, Messrs. Holtom and Fox.

DOLLAR—Additional accommodation, Fever Hospital, Town Council.

DORCHESTER—Extension isolation hospital, borough surveyor.

DOVER—House, Shepherdswell, Mr. Maynard.

DOVER—Convenience (£2,770) and shelter (£175), sea-front, Town Council.

DUBLIN—Technical school, Bolton-street, Mr. J. Ryans, Chatham-row.

DUNDEE—Villa, Adelaide-terrace, Mr. James P. Ross; cottage, Americanmuir-road, Mr. Richard G. Murray; store, Bellefield-street, Messrs. Urquhart, Lindsay, and Co.; alteration, property, Brook-street, Mr. Christopher Malloy; lavatories, Commercial-court, Messrs. Mitchell and Smith; villa, Craigie Strips-road, Mr. Godfrey Shepherd; additions, works, Erskine-street, Messrs. Ogilvy and Smith; store, Park-wynd, Mr. Wm. A. Martin; laboratory, Park-wynd, Council of University College; alterations, property, Shore-terrace, Dundee, Perth, and London Shipping Co.; workshop, Larch-street, Messrs. Urquhart, Lindsay, and Co.; alterations, property, Yeaman's-alley, Mr. Alex. Matthew; semi-detached cottages, East Haddon-road, Misses A. and J. Reid.

DUNCHURCH—Restoration of church, Ecclesiastical Commissioners.

EAST HAM—Twenty-one houses, Montpelier-gardens, Mr. F. Hamlett; alterations, house, Woodstock-road, Mr. R. T. Gordon; eight houses, St. Olave's-road, Mr. W. Jameson; vicarage, Browning-road, Mr. W. Bucknall; house, Little Ilford-lane, Mr. R. T. Gordon.

EAST HAM—Extensions, hospital (£7,950), Borough Council.

EASTHAM—Block of houses, Mr. Townsend, Cheshire.

EDINBURGH—Extension, George Watson's College (£6,000), Governors.

EDINBURGH—Installation of electricity at Heriot-Watt College, Mr. J. Anderson.

ELLAND—Temporary secondary school, West Riding Education Committee.

ELTHAM—Twenty-two houses, Page Estate, Mr. W. Brake, 10, Spencer-gardens; surgery and waiting-room, Mr. H. Webb, 47, Shooter's-hill-gardens; stationmaster's house—Mr. W. F. Blay, builder, Dartford.

EPPING—House, High-road, Mr. E. Hills.

ESSINGTON—Pumping-house for electrically-driven pumps, Wolverhampton Town Council.

EVESHAM—Secondary school (£1,075), Education Committee.

FENCE HOUSES—House and shop, Station-avenue North, Mr. H. Lamb.

FERNDALE (WALES).—Bakery and stores, with engine-room for suction gas and electric producing plant, Ferndale Industrial Co-operative Society.

FERRYHILL—Secondary school, Higher Education Committee.

FRIERN BARNET—Twenty-two houses, St. John's-avenue. Mr. C. F. Day, builder, Regent's-parade, Finchley.

FRODSHAM—Pumping station, Runcorn Rural District Council.

FROSTERLEY—Parish hall, Mr. V. A. Rippon.

FYVIE—Creamery at the station. Architect, Mr. W. L. Duncan.

GAINSBOROUGH—Refuse destructor (£7,000), Urban District Council.

GELLIGAER—Isolation hospital, Hospital Committee.

GIRVAN—Town hall (£7,500), Market Cross, Town Council.

GLASGOW—Erection of third section of the Glasgow and West of Scotland Technical College, Governors.

GLASNEVIN—Enlargement of parish church, Messrs. W. M. Mitchell and Sons, Dublin.

GLOUCESTER—Council school, Deacon-street (£6,000), Education Committee.

GOLCAR—Conservative Club, alterations and additions, Mr. A. Shaw.

GORSEINON—Chapel, Trustees Ebenezer Chapel.

GREASBOROUGH—Erection of sanitary conveniences at Greasborough Provided School, near Rotherham, West Riding Education Committee.

GREENWICH—Houses, Wyndcliff-road—Mr. F. Barrett, builder, 25, Old Dover-road, Blackheath; houses, Foyle-road, Mr. C. Grimwood.

GUERNSEY—Target store. Mr. T. J. Guilbert, state surveyor.

HACKNEY, N.E.—Additions to 80, Cranwich-road. Messrs. Hodson and Whitehead, architects, 7, Finsbury-square, E.C.

HACKNEY, N.E.—Bottle factory, Messrs. Sharp Bros., 178, Glyn-road; workshop, Mortimer-road, Mr. Reynolds.

HAMPTON—Refuse destructor, Hanworth-road (£2,500), Urban District Council.

HANDSWORTH—Electric light undertaking (£22,300), Urban District Council.

HARLESDEN—Four houses, Palermo-road. Messrs. G. and J. Ball, builders, 1, Bramstone-road, N.W.

HARPENDEN—Additions, house, Mr. R. Lydekker; additions, houses, Carlton-road, Mr. W. Mardall; alterations, etc., house, Cravells-road, Mr. J. T. Borders.

HARRINGTON—Three houses at High Harrington, Messrs. L. Ferguson and Sons.

HARROGATE—Alterations to St. James's Hall, Cambridge-street, Mr. S. Carter; alterations and additions to house, Beech-grove, Dr. Wesley Smith; alterations to shops, Station-square, Mr. J. T. Hollins; additions to property, Station-square, Mr. R. Wray; additions to Balliol House, Clarence-drive, Mr. Johnson; alterations to shops, Oxford-street.

HARROGATE—New bandstand, etc., Town Council.

HARROW—Three houses, Harrow Weald, Mr. J. Taylor; three houses, and shop, ditto, Mr. W. Willing.

HARTLEY—Classroom at National School, Messrs. Colson and Nisbett.

HARTSHEAD—Sunday school (£800), Wesleyan body.

HASTINGS—Kursaal, Brisco Estate (£12,000), Hastings Corporation.

HENDY—Elementary school, Carmarthenshire Education Committee.

HENLEY—Mortuary, receiving ward, and room for lunatics (£600), Guardians.

HEPTONSTALL—Restoration of old church of St. Thomas-a-Becket at Heptonstall (£1,100).

HILLSBOROUGH—Workmen's dwellings (£12,424), Rural District Council.

HINCKLEY—New baths (£2,650), Urban District Council.

HINDLEY—Engine-house, Platts Bridge, Mr. O. P. Abbott, Council Offices.

HOUGHTON-LE-SPRING—Three houses, Lumley-street, Grasswell, Mr. J. H. Wood.

HOUNSLOW—Music hall to be known as the Hounslow Empire, District Council.

HUCKNALL—Seven shops, Mr. J. Allcock; villa, Mr. R. A. Wagg; two houses, Mr. W. Bamford.

ILFORD—Twelve houses and dairy—Mr. E. T. Dunn, architect, 7, Roding-street; four houses, Hamilton-avenue—Messrs. Webb and Neilson, agents; 13 houses, Mr. C. W. Duly, Cranbrook-road, Ilford; additions to school, Cranbrook-road, Mr. W. H. Carte; three houses and shops, Great North-road—Messrs. Woodrow and Helsdon, architects, 6, Raymond-buildings, W.C.

ILFORD—Extensions to infirmary, Urban District Council.

INCHBERY—Schoolhouse. Mr. J. Wittet, architect.

JALGAON—Office building (£680), Executive Engineer.

KENFIG—Twenty-four houses, Pwll-y-Gath Building Club.

KILPATRICK—Public Hall, Lanward Committee of Old Kilpatrick Parish Council.

KING'S NORTON—Secondary school (£2,270), Education Committee.

KINGSWAY, W.C.—Buildings—Messrs. Ford and Walton, builders, High-road, Kilburn; buildings—Messrs. Holland and Hannen, builders, Hyde-street, Bloomsbury.

KIPPEN—Houses at Boquhan Gates, Mr. S. Mitchell.

KNARESBOROUGH—Caretaker's house, etc. (£2,636), Harrogate Town Council.

LADYWELL—Secondary school (£20,000), Dover Education Committee.

LAHORE—Additions and alterations, Provincial Lunatic Asylum (£10,666), Panjab Government.

LANDPORT—Wesleyan Soldiers' and Sailors' Home (£12,000), Trustees.

LEEDS—Alterations to schools, Education Department.

LEIGH ON-MENDIP—Reading room in connection with St. Giles's parish, Vicar.

LINDFIELD—Village hall, Mr. and Mrs. Sturdy, Parkhill Park.

LIVERPOOL—Alterations to Westminster-road Congregational Church, Caretaker, 4, Hilda street, Kirkdale.

LLANDRINDOD WELLS—Photographic studio near the Congregational Chapel, Managers.

LLANDRIDOD WELLS—Public buildings (£1,000), Baveno-site, Urban District Council.

LLANELLY—Y.M.C.A. building (£6,000).

LOCHORE—Public-house, Mr. J. T. Scobie.

LONDON—Conveniences at Meath Gardens and bandstand, London County Council.

LONDON, N.—Extension, central library, Finchley-road. Mr. A. S Taylor, architect.

LONDON, N.—Rebuilding Crown Mills, Stamford Hill. Messrs. T. J. Marshall and Co., Campbell Works, Stoke Newington.

LONDON, S.E.—Shops, Kennington Park-road. Mr. E. Payne, architect, 11, John-street, Bedford-row, W.C.

LONDON, W.—Buildings, 125-6, Piccadilly—Messrs. Higgs and Hill, builders, South Lambeth-road; shops, etc., Princes-street—Mr. D. Prosser, builder, 23 5, Charlotte-street, Fitzroy-square, W.; rebuilding, 48, Lower Porchester-street, W., Mr. C. Foan, 6, Connaught House, Seymour-street, W.

LONG DITTON—Elementary school, Surrey Education Committee.

LONGSIDE—Additions and alterations in connection with Roba Public School and Kinmundy Public School, Longside School Board.

LOSSIEMOUTH—Chemical laboratory and classroom, public school; double house, Commerce-street, Mr. T. Main.

LOW BENTHAM—Elementary school, West Riding Education Committee

LOWESTOFT—Electric lighting purposes (£1,661), Town Council,

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LYTHAM—Vestries, St. Cuthbert's Church. Messrs. Wright and Sons, architects.

MACCLESFIELD—Sunday school, near King Edward-street Chapel, Trustees.

MACCLESFIELD—Alterations, St. James's School, Higher Sutton, Messrs. Whittaker and Bradburn.

MAESTEG—Thirty-five houses near the Heart of Oak, Plans Committee.

MALVERN—Extensions, electricity undertaking (£1,000), District Council.

MANCHESTER—Congregational Church House, Rev. H. W. Turner, Wilmslow.

MASHAM (YORKS)—New corridor, cloakroom, offices, and alterations to elementary schools. Messrs. Edmundson and Gowland, solicitors, Masham.

MAUBIN—Court house (£2,930), Burma Government.

MELTON MOWBRAY—Cattle market improvements (£2 500), Council.

MERTHYR—Two houses, Hanover-street, Mr. R. Lloyd; house, Graigberthlwyd, Mr. J. K. Williams; conversion of bakehouse at rear of lock-up shop, Victoria-street, Dowlais, Mr. T. Morgan; addition to shop premises at Mount Pleasant, Troedyrhiw, Mr. E. Phillips; temporary carpenter's workshop at the rear of Moy-road, Aberfan, Mr. D. T. Gibbon; 22 houses in Council street. Penydarren, Gellifaelog Building Club; extension to Darren View Forward Movement Hall, Merthyr, Trustees; alterations and additions, 17, 18, 19, and 20, Brecon-road, Mr. T. J. Price; 21 houses in Lloyd's-terrace, Penydarren, Camrose Building Club; 20 houses at Woodlands, Quaker's Yard, Woodlands Building Club; pair of semi-detached villas, the Walk, Penydarren-park, Merthyr, Mr. John Williams.

MERTHYR—Alterations, judges' court (£402), Town Council.

METHLEY—Repairs and improvements to Scholey Hill Provided School, West Riding Education Committee.

METHLICK—Public hall (£2,000).

MIDDLESBROUGH—Alterations and additions and converting into shops 17 houses, St. George's-terrace, Linthorpe-road. Mr. S. T. Wiggen, architect.

MILLOM—Additions, house, Salthouse-road, Mr. T. Trenwith; additions, house, Main-street, Haverigg, Mr. T. Brocklebank.

MIRFIELD—Elementary school (£10,000), Education Authority.

MURTON—Twenty houses, Mr. E. S. Wood.

NANTYFFYLLON—Additions to the General Picton Inn, Mr. E. E. Bevan.

NELSON—Public baths (£10,500), Town Council.

NELSON—Thirteen houses, Fir-street, Mr. Wm. Halstead; houses, Baldwick-street, Mr. Jas. Crowther; 19 houses, Hibson street, Messrs. T. and J. Edmondson.

NENAGH—312 additional houses (£58,657), Board of Guardians.

NETTESWELL—Additions, Non-Provided school, Managers.

NEWBIGGIN—Church hall (£700), Trustees.

NEWCASTLE ON-TYNE—Isolation wards, workhouse, Westgate-road.

NEWCASTLE—Ten houses, Little Benton-road South; two houses Sunningdale-avenue; two cottages, Delaval-gardens; and two semi-detached villas, Mooreside. Plans passed by Council.

NEWCASTLE ON-TYNE—New isolation wards at Workhouse, Westgate-road. Messrs. Newcombe and Newcombe, architects.

NEWCASTLE (STAFFS)—Laying of electricity mains in Brampton and Sidmouth-avenue (£700), Town Council.

NORBURY—Church, Warwick-road, Mr. W. S. Wetherley.

NORMANTON—Repairs and alterations to teachers' house in connection with the Central Provided School, West Riding Education Committee.

NORWICH—Parish hall, St. Catharine's Church, Messrs. Knox and Wells.

NORWICH—Isolation hospital block (£3,034), Town Council; additional accommodation for nurses at hospital, Town Council; swimming-bath (£2,880), Council.

NUNEATON—Council school, Coton, Education Committee.

OGMORE VALE—Two houses, Dunraven-terrace, Mr. J. Thomas.

OKEHAMPTON—Alterations at the union workhouse, Guardians.

OSSETT—House, sub-station, office, etc., Yorkshire Electrical Power Co.

OUGHTERSIDE—Alterations and additions, Council school, Cumberland Education Committee.

OULTON BROAD—Conversion of St. Mark's Infant School into special subjects centre. Mr. Watkins, secretary, County Hall, Ipswich.

OUNDLE—House, Glapthorne-road, Mr. Powell.

OXENHOPE—Alterations, etc., to Provided School, near Halifax, West Riding Education Committee.

OXFORD—Rebuilding of New Theatre, Mr. W. J. R. Sprague.

PARTICK—Balshagray Church, Broomhill-drive, Messrs. Stewart and Paterson, Glasgow.

PEGSWOOD—Extensions to shops, Pegswood Co operative Society.

PINNER—Six houses, Mr. E. Waterman.

PLUMSTEAD—Wheelwright shop, Messrs. Thomas and Edge, Anglesea-avenue, Woolwich; parish hall, Messrs. J. Dorey and Co., Brentford.

PLUMSTEAD—Two houses, Eaglesfield-road, Mr. W. West, Montrose Villa, Plum-lane; shop, Frederick-place—architects, Messrs. Church, Quick, etc., 22, William-street, Woolwich.

PLUSCARDEN—Alterations, etc., farm steading, Overtown. Mr. J. Wittet, architect.

PLYMOUTH—Transfer municipal secondary school from the technical school to North-road School premises, Education Committee.

POLLOKSHAWS—Additions to Shawlands Academy Public School, School Board of Eastwood.

PONTSARN—Two villas, Mr. W. J. Pritchard.

PORTLAND—Three houses, Chesil, Mr. W. Hodder; house, New-street, Mr. Stewkesbury.

PRESTBURY—Two houses, Presbytery Lodge of Oddfellows.

PRESTON—Elementary school, Education Committee.

RADCLIFFE—Extension, electricity works (£14,350), Rural District Council.

RAMSGATE—Wiring for electric light, East Cliff bandstand, Town Council.

RAWTENSTALL—Council school, Alder Grange, Mr. A. Brocklehurst.

REDCAR—Alterations and additions, Redcar Zetland Council School, Mr. J. C. Wrigley.

RHYL—Rebuilding Queen's Palace Ballroom, Sussex-street.

ROTHBURY—Parish hall. Architect, Mr. C. S. Errington.

SAFFRON WALDEN—Secondary school, Education Committee.

ST. ANNES—Shed at depôt, St. Andrew's-road North (£150), Urban District Council.

ST. ANNES—Town hall, South-promenade, Urban District Council.

ST. ASAPH—Church house, Messrs. Douglas and Minshull.

ST. PANCRAS, N.W.—Additional buildings, Camden School, Education Authority.

ST. AUSTELL—Offices Highcross street, Messrs. F. C. Jury and Son.

SALFORD—Reinstatement of warehouse, Dawson-street; reconstruction, back-to-back property, Hatherton-street, Adderley-street, and Drayton-street; alterations, offices of Irwell and Eastern Rubber Co., Woden-street and Mill-street; conversion of property of Manchester Bonding Warehousing Co., Clowes-street; remodelling sanitary accommodation, Broughton Flax Mills; alterations, Barbour Hall, Mount-street; two dwelling-houses, Tully-street, Broughton; extension, premises, John-street and Allen-street, Broughton; three dwelling-houses, Stanley-road, Merry Bower-road, and Marston-road, Broughton; studio, rear 213A, Broad-street, Pendleton; 24 dwelling-houses, Bridson-street, Derby-road, and Heywood street, Pendleton; 10 semi-detached villas, Moorfield-road and Caldy-road, Pendleton; construction, lavatories, Milton Hall, Milton-street, Pendleton; alteration, Oddfellows' Arms, Harrison-street; alterations to Dover Inn, Fenney-street, Broughton: alterations, bakehouse, Great Cheetham-street, Broughton; alterations, property, 326 to 338, Eccles New road, Pendleton; construction, girls' institute, Oldfield-road; remodelling insanitary property, Sussex-street and David-street, Broughton; shop fronts, Mellor-terrace, Lower Broughton-road, Broughton; construction, works, Meadow-road, Broughton; extension, dyeing works, Hodge lane, Pendleton; six semi-detached villas, Moorfield-road, Pendleton; eight semi-detached villas, Rivington-road, Pendleton; addition, "Erlsdene," Moorfield-road, Pendleton.

SARGHODA—Residence for the superintendent of Jhelum Canal Colony Circle (£20,666).

SARSFIELD—House, Mr. T. English, Templebraden, Limerick.

SCUNTHORPE—Fire station and stores yard (£3,000), Urban District Council.

SEAHAM—Two houses, Alfred street, Mr. H. Potter; four houses, Albert-street, Mr. Nicholson; four houses, Princess-road, Executors of the late Mr. C. Milrenna.

SELBY—Permanent secondary school, Urban District Council.

SEVENOAKS—Extensions to laundry, Sundridge, Sevenoaks Board of Guardians.

SHEFFIELD—Extension to Royal Infirmary, Messrs. Gibbs and Flockton.

SHEFFIELD—Alterations and additions, union offices, Westbar, Guardians.

SHEERNESS—Elementary school at the Halfday Houses (£3,000), Kent Education Committee.

SHIPLEY—Ten cottages, Dockfield, Urban District Council.

SILSDEN—Dyeworks. Mr. J. W. C. Atkinson, architect.

SKIPTON—Aisles to parish church, Messrs. Wright and Son, Lancaster.

SLIEVEMARGEY—Workmen's dwellings (£21,139), Rural District Council.

SLOUGH—St. Ethelbert's Church, Curzon-street, Mr. H. Street; two houses, Upton-road, Mr. H. Street.

SOUTHAMPTON—Council school, Eastleigh, Southampton County Council.

SOUTH BRENT—House, Binnemore Farm, Mr. H Bartlett.

SOUTHEND—Eleven houses and shop, London-road and Nelson-road, Mr. A. D. Martin; house, Princes street, Mr. W. J. Lincoln; additions, 19, High-street, Mr. W. Tyler Evans; alteration of stable into house, Old Leigh-road, Mr. T. P. Prior; alterations and additions, Ditton Lodge, Ditton Court-road, Mr. W. G. Adams; lobby, pantry, and cycle house, rear of Alma House, Leigh-road, Mr. Charles May; conversion of two houses into shops, Leigh-road, Mr. T. Brand; house, Southchurch Beach-road, Mr. T. Cooper; house, Recreation-avenue, Mr. A. E. Halliday; six houses and shop, North Avenue and Bournemouth Park road, Mr. A. O. Moore; eight houses, North-avenue, Westcliffe, Mr. W. Robinson; house and stable, Southchurch Beach-parade, Mr. W. Clark; house, Crowstone-road, Mr. J. A. King; two houses, Wenham-drive, Mr. S. Riley; house, Park-road,

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Mr. E. C. White ; three houses, Christchurch-road, Mr. J. Sears ; showroom, Clarence-street, Mr. J. C. Ingram ; three houses and stores, Gainsborough-drive, Mr. T. Wiggins ; house, The Leas, Mr. J. Bane ; two bungalows, Grassmead-avenue, Mr. A. E. Day ; one house in place of two, Winter-avenue, Mr. W. Dale ; four houses, Leigh-road, Mr. T. Brand ; three houses, Cranley-road, Mr. W. Jones, jun. ; two houses, Leigh-road, Mr. R. Alabaster ; conversion of two houses into one, Westcliffe-avenue, Mr. A. W. Robertson ; bungalow, Fairmead-avenue, Mr. J. W. Palmer ; house and shop, Westborough-road, Mrs. A. Osmont.

SOUTHEND—Lecture hall, Deacons of Chelmsford-avenue Congregational Church.

SOUTHMOLTON—Church hall (£600), Trustees.

SOUTHPORT—Extension, electricity plant (£910), Council.

SOWERBY BRIDGE—Secondary school at Albert-road. Messrs. Longbottom and Culpan, architects, George-street, Halifax.

STIRLING—Restoration, West Church (£2,348), Trustees.

STOCKTON—Enlargement of post office, H.M. Commissioners of Public Works.

STOKE NEWINGTON—Generating station for supply of electricity (£3,280), Borough Council.

STRATFORD, E.—Electrically lighting hospital, Committee, West Ham and East London Hospital.

STRICHEN—Additions to schools, Education Committee.

SUNDERLAND—Additions to workhouse, Messrs. Millburn, 20, Fawcett-street.

SUTTON—Seven shops, High-street, Mr. A. Linfoot, Birdhurst, South Croydon ; St. Andrew's Church, Rev. J. Maunders.

SWANSEA—Workmen's dwellings, Town Council.

TADCASTER—Two houses, Micklefield ; slaughter-house, Crossgates. Plans passed by Urban District Council.

THORPE SALVIN—Alterations and additions to Provided School, near Worksop, West Riding Education Committee.

THURLESTONE—Wesleyan church, Buckland, Mr. G. P. Perrott.

TORPHINS—House, Wester Beltie, Mr. W. Coutts.

TORQUAY—Shelter close to Princess Pier (£150), Council.

TRECYNON—Eight houses on site of the old stoneyard, Harriett-street, Mr. D. W. Price.

TREHARRIS—House, Perrott-place, Mr. J. Lewis ; workshop and office, Brynteg-terrace, Mr. F. Evans ; additions to house, Bargoed-terrace, Mr. R. Jones ; 26 houses in Windsor-road, Quaker's Yard Junction, for the Nantddu Building Co.

TREVERVA—Extension Wesleyan Chapel, Trustees.

TWICKENHAM—County schools and technical institution (£18,000), Middlesex County Council.

TYLDESLEY—Library, Stanley-street, Urban District Council.

WAKEFIELD—Alterations and additions, church and Sunday schools, Stanley-road, Trustees, Eastmoor Wesleyan Methodist Church and Sunday Schools ; two houses, Balne lane, Mr. W. W. Hunt ; additions, house, Balne lane, Mr. W. Green.

WANDSWORTH, S.W.—Infirmary buildings, Board of Guardians.

WARRINGTON—Public conveniences at the Market Hall (£469), Town Council.

WATFORD—Alterations, Aldenham-road, Mr. Chauvidon ; five houses, Vicarage-road, Mr. Edward Plested ; villa, Albert-road, Mr. S. Swain ; two houses, The Avenue, Nascot Estate, Mr. J. Tyler ; additions, cottages, Sheffield-place, St. Albans-road, Messrs. Foat and Riggall ; detached house, Mildred-avenue, Messrs. J. and J. Goss ; two houses, Sandringham-road, Mr. H Everitt ; additions, bank, High-street, Messrs. Lloyds ; two houses with shops, St. Albans-road, Mr. C. Brightman ; six shops, the Bridle Path Junction Estate, Mr. C. Brightman.

WEYBRIDGE—Public offices and a depôt, Urban District Council.

WEYMOUTH—Theatre near the Royal Hotel, Corporation.

WHETSTONE—Additions, All Saints' Church, Rev. H. Miles, M.A., The Vicarage, Whetstone.

WHITSTABLE—Shelter, Marine Parade, Urban District Council.

WILLESDEN, N.W. — Alterations, 308-10, High-road, Mr. W. Vincent, architect, West Park Estate, Kew Gardens ; three houses and laundries, Villiers-road, Mr. L. T. Wreford.

WILLESDEN, N.W.—Buildings on side of Wyndham House, Shootup-hill. Messrs. Oldrey and Sons, builders, 7, West End-lane, N.W.

WIMBLEDON—Additions, "Croylands," South Side. Messrs. Whitehead Bros., builders, Wimbledon Hill-road.

WINDSOR—Hospital, Hospital Committee.

WINDSOR—Conversion of 4, 6, 8, and 10, St. Leonard's-road into shops, Mr. C. Butler.

WIGTON—Works in connection with the laundry (£250), Guardians.

WINGATE—Villa, Salters-lane, Mr. J. W. Hays.

WISHAW—Temple, hall, etc., Stewarton-street (£2,500), Trustees of Lodge St. Mary.

WOODSETTS—Conveniences, etc., West Riding Education Committee.

WORSBOROUGH—Alterations and additions, Blacker-hill Infants' School (£480), Education Sub-Committee.

WORTHING—Convalescent home in connection with Guildford Hospital, Brighton-road.

WORTHING—Hotel, South-street (£45,000), Mr. S. E. Davies.

WREXHAM—Boiler-house, smithy, and workshops, etc. (£1,800), Guardians.

YARDLEY—Secondary school, Worcestershire Education Committee.

PROVISIONAL PATENTS, 1908.

JUNE 12.

12592. Improved push switch lampholder for electric light fittings. Geeorge Henry Ide, 152, Sherlock-street, Birmingham.

12614. Improvements in means for electrically operating tramway points, switches, and the like. Robert Hacking and Henry Walker Hill, 2, Church-gate, Nottingham.

12630. Pocket electric lamp. Paul Marcel Emile Bourgeois and Charles Henri Bourgeois, 65, Chancery-lane, London. (Complete specification.)

12634. Improvements in or relating to electrical conductors. Charles Albert Keller, Chancery-lane Station-chambers, London. (Complete specification.)

12644. Improvements in and relating to electric arc lamps. John Owen Girdlestone and Carl Frederik Grimur Thorkelin, 37, Warwick-road, Ealing, London. (Complete specification.)

12650. Improvements in electric motors. Johnson and Phillips, Limited, and Sydney Paterson, Birkbeck Bank-chambers, Southampton-buildings, London.

12651. Improvements in electric arc lamps. Johnson and Phillips, Limited, and Sydney Paterson, Birkbeck Bank-chambers, Southampton-buildings, London.

12654. Improvements in electric lamps. The London Import Company, Limited, and Bernard Pordes, 28, New Bridge-street, London.

12656. Improvements in and relating to arc lamps. Dagobert Timar and Carl von Dreger, 7, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 8, 1907, being date of application in Germany.) (Complete specification.)

12678. Improved electric cut-out. Giovanni Gaglio and Luigi Villani, 4, South-street, Finsbury, London. (Complete specification.)

12682. Improvements in and relating to arc lamps. Allgemeine-Elektricitäts Ges., 83, Cannon-street, London. (Date applied for under Section 91 of the Act, July 15, 1907, being date of application in Germany.) (Complete specification.)

12683. Improvements in controlling means for air brakes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

12684. Improvements in and relating to electromagnetic relays, especially applicable to the control of electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.) (Application for patent of addition to No. 16195/07.)

JUNE 13.

12690. Improvements in electric cables or wire conduits and the like. Herbert Samuel Smith, 11, Burlington-chambers, New-street, Birmingham.

12704. Improved method of and apparatus for controlling the voltage of dynamo-electric machinery, especially applicable to variable-speed generators. William Stansfield and John Joseph Hatt, 34, Castle-street, Liverpool.

12720. Improvements in the manufacture of incandescent electric lamp filaments and in apparatus therefor. Société Française d'Incandescence par le Gaz (Systéme Auer), 24, Southampton-buildings, London. (Date applied for under Section 91 of the Act, July 13, 1907, being date of application in France.) (Complete specification.)

12736. Improved method of and means for adjustably suspending electric incandescent lamps. Christoph Erhard Heldbek, 72, Cannon-street, London.

12738. Improvements in and relating to electromagnetic power velocity ratio devices, particularly applicable for driving automobiles and the like. Albert Henry Midgley and Charles Anthony Vendervell, 1, Queen Victoria-street, London.

JUNE 15.

12818. Improvements in or relating to primary batteries. Paul Gabriel Triquet, 72, Cannon-street, London. (Date applied for under Section 91 of the Act, June 13, 1907, being date of application in France.) (Complete specification.)

JUNE 16.

12841. Improvements in thermo-electric batteries. Johannes Marschall, 6, Bank-street, Manchester. (Complete specification.)

12881. Improvements relating to magneto-ignition devices. Eugene Victor Gratze, 118, Holborn, London.

JUNE 17.

12923. Improved point-shifting arrangements for electric tramways and the like. Joseph Patrick Tierney and John Malone, 44, Booterstown-avenue, Booterstown, co. Dublin.

12968. Improvements in the manufacture of filaments for electric glow lamps from refractory material in the colloidal state. Hans Kuzel, 322, High Holborn,

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London. Application for patent of addition to No. 28154/04.) (Complete specification.)

12974. Improvements in and relating to machines for forming porcelain ware. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (General Electric Company, United States.)

JUNE 18.

12987. Improvements in electrical socks. Gilbert Harwood Hooper and Horace Hugh Hooper, 57, Queen's road, Southend-on-Sea.

12991. Improvements in electric or gas pendants. Edward Charles Peck, 151, Victoria-road, Old Charlton, Kent.

12997. Improvements in magnetic compasses. Charles Batty and William Batty, 4, Clayton square, Liverpool.

13014. Appliance for handling electric bulb lamps in positions where ladders would otherwise be necessary. Austin Thomas Stace and Cecil Frederick Pallott, 1, Perrin-road, Acton, London.

13015. Improvements in and relating to electric incandescent lamps. John Gray, 83, Cannon-street, London.

13023. Improvements in electric detectors. Hugo Stephens, 28, Hester street, Northampton.

13025. Improvements relating to electric switches. Andreas Peter Lundberg, Gustaf Charles Lundberg, and Percival André Lundberg, Queen Anne's-chambers, Westminster. (Complete specification.)

13029. Improvements in metal filaments for electric incandescent lamps. Tom Wiseman Lowden and the Westinghouse Metal-Filament Lamp Company, Limited, Westinghouse Building, Norfolk-street, Strand, London.

13048. Improvod automatic cut-out for electrical conductors in tramway systems. Maurice George Newbould, 55, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

(To be published on July 2.)

1907.

12937. Compensated alternate-current series motors. Felten und Guilleaume Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, July 12, 1906.)

13129. Voltage-regulated system for the electric lighting and heating of vehicles. Grob. (Date applied for under International Convention, June 9, 1906.)

13147. Enclosed electric arc lamps. Brockie.

13190. Electrodes for electric arc lamps. Harrison and Hirst.

13432. Fusible electric cut-outs. Schattner.

13712. Regulation of dynamo-electric machinery. Parsons and Law.

13821. Coin-controlled telephones. Jentzsch.

14567. Electrically-operated electric switches. Eckstein, Heap, and Mellis.

15366. Electric controller regulators. Amberton and Schattner.

15367. Methods of producing refractory electric conductors, particularly metallic filaments. British Thomson-Houston Company. (General Electric Company.)

17390. Combined electric connection plug and socket and switch. Buckton. (Post-dated Jan. 24, 1908.)

18044. Monophase shunt electric machines. Felten und Guilleaume Lahmeyerwerke Akt.-Ges. (Date applied for under International Convention, Aug. 11, 1907.)

18187. Means for signalling the approach of tramcars at cross roads where overhead electric wires are employed. Bailey.

20824. Electric oscillographs. Irwin.

22082. Ignition systems comprising multiple induction coils with separate trembler or tremblers. Watson and Smith.

26084. Electric meter for continuous current provided with a permanent magnet and an armature arranged in the field thereof. Meyerling. (Date applied for under International Convention, Nov. 23, 1906.)

1908.

325. Induction ignition coils. Sanders and Greenberg.

4433. Starting and working of three-phase motors from a single-phase supply. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, June 28, 1907. Application for patent of addition to No. 1243/07.)

4692. Brush-holders for electrical machines. Siemens-Schuckertwerke Ges. (Date applied for under International Convention, March 2, 1907.)

5698. Electrical block apparatus or the like for railways. Siemens Bros. and Co. (Siemens und Halske Akt.-Ges.)

5783. Incandescent electric lamps. Howell. (Date applied for under International Convention, March 16, 1907.)

6757. Electric cables. Von Pindtershofen.

7125. Shuttle armatures for dynamo-electric machines. Firm Robert Bosch. (Date applied for under International Convention, March 14, 1908.)

9977. Electrical power transmission systems. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, June 8, 1907.)

COMPANIES' STOCK AND SHARE LIST.

Commercial and Industrial.—

Name.	Amount paid.	Last price.
	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-⅝
—— Ord., 1,125 000	1 ..	½-⅝
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	23/32-27/32
—— Ordinary, Nos. 1 125,000	1 ..	3/16 5/16
British Aluminium Co., Ordinary, 2 001-40,000	5 ..	3-3½
—— 7 per cent. Cum. Pref., 1-40 000	5 ..	4-4½
—— "A" 6 per cent. Cum. Pref., 1-20,000	5 ..	4½-5
—— 4 per cent. Funding Certificates, 1-20 000	5 ..	3¾-4¼
—— 5 per cent. 1st Mort. Deb. Stock, Red.	100 ..	104-108
—— 5½ per cent Loch Leven Deb. (Reg.) Red., 1-3 000	100 ..	97-100
British Insulated and Helsby Cables, Ord., 1-100 000	5 ..	5¾-6¼
—— 6 per cent. Cum. Pref., 1-100 000	5 ..	5¾-6¼
—— 4½ per cent. Mortgage Debentures	100 ..	102-105
British Thomson-Houston Co., 4½ per cent. 1st Mort. Deb. Stock, Red.	100 ..	93-98
British Westinghouse Elec. and Manuf. 10 per cent Pref., 275 001-475 000	3 ..	7/16-11/16
—— 4 per cent. Mortgage Debenture Stock	100 ..	45-50
Brush Electrical Engineering, Ordinary, Nos. 1 105 731	2 ..	0-¼
—— Non. Cum., 6 per cent., Pref.	2 ..	3/16-7/16
—— 4½ per cent 1st Debenture Stock	100 ..	70-75
—— 4½ per cent. 2nd Debenture Stock	100 ..	55-60
Callender's Cable, Debentures	100 ..	107-109
—— Ordinary	5 ..	9½ 10¼
—— 5 per cent. Pref.	5 ..	5¼-5¾
Consolidated Electrical Co., Ordinary, 1-110,000	1 ..	⅜-¼
Crompton and Co.	3 ..	1⅝-1¾
—— 5 per cent Debentures	— ..	92-96
Dick, Kerr and Co., Ordinary, 1 260 000	1 ..	¼-1⅛
—— 6 per cent. Cum. Pref., 1-305,000	1 ..	1-1¼
—— 4½ per cent. Debenture Stock, Red.	100 ..	101-104
Edison and Swan United, "A" Shares, 1-99 261	5 ..	¼-⅜
—— "A" Shares, 01-017,139	5 ..	1¼-2⅜
—— 5 per cent. Debentures	100 ..	85-87
—— 4 per cent. Deb. Stock, Red.	100 ..	78-81
Electric Construction, Nos. 1 to 112 100	2 ..	¼-⅜
—— 7 per cent. Cumulative Pref.	2 ..	1¼-1⅜
—— 4 per cent. Perp. 1st Mort. Deb	100 ..	61-65
Electrolytic Alkali Co., Ordinary, 1-202,218	1 ..	3/16-5/16
Ferranti, Limited, 5 per cent. 1st Mort. Deb. Stock, Red	100 ..	75-80
General Electric Company (1900) 5 per cent. Cum. Pref.	10 ..	7⅞-8¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	87-90
W. T. Henley's Telegraph Works, Ordinary	5 ..	10½-11¼
—— 4½ per cent. Preference	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	104-106 xd
India Rubber, Gutta Percha, and Telegraph Works	10 ..	15¼-16⅛
—— 4 per cent. Debentures	100 ..	98-100
National Electric Construction Co., 1-170,000	1 ..	⅜-½
Parker, Thos., Limited, Ordinary	10 ..	10-10¼
Peebles (Bruce) and Co., 6 per cent. Cum. Pref., 20,001-50,000	5 ..	—
Telegraph Construction and Maintenance	12 ..	30½-32½
—— 4 per cent. Bonds	100 ..	102-104
White, J. G., and Co., 6 per cent. Cum. Pref., 1-15,000	10 ..	7½-8¼

Electric Lighting and Supply.—

Name.	Amount paid.	Last price.
	£	£
Adelaide Electric Supply Co., 6 p.c. Cum. Pref., 1-10,000	5 ..	4¾-5¼
Bournemouth and Poole, Ordinary	10 ..	10½-11
—— 4½ per cent. Cum Pref., 7 501-15 000	10 ..	9¾-10⅛
—— 6 per cent. Cum Second Pref., 15 001-22,500	10 ..	10⅜-10⅝
—— 4½ per cent. Debenture Stock, Red.	100 ..	102-105
Bromley (Kent) Electric Light and Power Co.	5 ..	4½-5
—— 4½ per cent. 1st Debenture Stock, Red.	100 ..	94-97
Brompton and Kensington, Ordinary	5 ..	6¾-7¾
—— 7 per cent. Preference	5 ..	6¾-7¾
Calcutta Electric Supply Corp., Ordinary, Nos. 1-100,000	5 ..	5½-5¾ x 1
Cambridge Electric Supply Company, £10 Ord.	8 ..	12½-13¼
Canadian General Electric Co., Common Shares	$100 ..	90-92
—— 7 per cent. Cum. Pref. Stock	$100 ..	1 9 1 1
Central Electric Supply, 4 per cent. Guar. Deb. Stock	100 ..	98-101 xd
Charing Cross, West End, and City Electric Supply, Ord., 1-80,000	5 ..	3⅝-4⅛
—— 4½ per cent. Cum Pref., 1-80,000	5 ..	4⅛-⅝
—— 4 per cent. Debenture Stock, Red.	100 ..	95-98
—— "City Undertaking," 4½ p.c. Cum. Pref., 1-40,000	5 ..	3⅝-4⅛
—— ditto (1903) 40,001-80,000	5 ..	4⅛-4⅝
Chelsea Electricity Supply	5 ..	5-5⅛
—— 4½ per cent. Debentures	100 ..	101-104
Chicago Edison Co., 1st Mt. 5 p.c. 30-yr. Gld. Bds. Red., 1-1,2 0	$1000 ..	—
City of London, Ordinary	10 ..	9½-10¼
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 4½ per cent. Debenture Stock	100 ..	124-127
—— 4½ per cent. 2nd Deb. Stk., Red.	100 ..	102-105
City of Wellington Electric Light and Power Co., 5 per cent. Registered 1st Debs., Red., 1-1 630	50 ..	50-53
Corjubs Light and Power Co., 1st Mt. Stl. 5 per cent. Bds., Red., 1-1,000	100 ..	90-98
County of Durham Electrical Power Distribution Co., Ordinary, 10,001-50,000	5 ..	2½-3
—— 5 per cent Preference, 1-50,000	5 ..	3¼-4¼
County of London Elec. Supply, Ordinary	10 ..	7⅞-8½
—— 6 per cent. Cum Pref.	10 ..	10⅜-10⅞
—— 4½ per cent. Debentures Prov. Certs. All pd., Red.	100 ..	107-110
—— 4½ per cent. 2nd Debentures Prov Certs	100 ..	98-101
Edmundson's Electricity Corporation, Ordinary, 1-80,000	b ..	⅛-¼
—— 6 per cent. Cum Pref.	5 ..	½-1
—— 4½ per cent. First Mort. Deb.	100 ..	6 -73
Electrical Development Co. of Ontario, 5 per cent. 1st Mort. 30-year Gold Bonds, 10,751-15,750	— ..	83-86 p.c.
Electric Lt. & Traction Co. of Aust., 6 p.c. Cm. Pf., 1-30,000	5 ..	2½-2¾
—— 5 per cent. Debenture Stock, Red.	100 ..	84-88
Electric Supply Co. of Victoria, 5 per cent. 1st Mt. Deb. Stock, Red	100 ..	90-93
Folkestone Electric Supply, Ord., Nos. 1-10 000	b ..	4⅜-½
—— 5 per cent. Cum. Pref., Nos. 1-10 000	5 ..	5-5¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	94-97
Hove Electric Lighting, Ord., 1-13,000	5 ..	6-6½
Indian Electric Supply and Traction Co., 6 per cent. Construction Deb. Stock, Red.	100 ..	90-93
Isle of Wight Elec. Lt. and Pwr., 4½ p.c. Db. Stk., Red	100 ..	90-93
Kalgoorlie Electric Power and Lighting, 6 per cent. Cum. Pref., 1-150,000	1 .	21/32 25/32
Kensington and Knightsbridge Elec. Lt., Ord., 1-21,000	5 ..	7-8
Kensington and Knightsbridge and Notting Hill, 4 per cent. Debenture Stock, Red.	100 ..	97-101
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼

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Name.	Amount paid. £	Last price. £
London Electric, Ordinary	3	½-1⅛
—— 6 per cent. Pref.	5	4½-4¾
—— 4 per cent 1st Mortgage Debenture Stock, Red.	100	89-92
Madras Electric Supply Corporation 5 per cent. Construction Deb. Stock, Red. (Prov. Certs), all paid	100	85-90
Metropolitan Ordinary, 100,001-200,000	5	4½-5
—— 4½ per cent. First Mortgage Debenture Stock	100	107-111
—— 4½ per cent. Cum. Pref.	5	4½ 5
—— 3½ per cent. Mortgage Debenture, Red.	100	£5-90
Mexican Electric Light Co., 5 per cent. 1st Mort. Gold Bds. 1935, C 1-1,000 ($100), D 1-3,000 ($500), M 1-4,400 ($1,000	—	82½-83½ p.c.
Mexican Light and Power Co., Capital Stock	$100	60 61
—— 5 per cent. 1st Mort. Gold Bonds, Red., 1-4,000 ($500), 4,001-14,000 ($1,000)	—	87-88
Midland Electric Power Dis., 4½ p.c 1st Mort. Deb.	—	96 99
Newcastle-upon-Tyne Electric supply, Ordinary, 1-57,009	5	5½-6
—— do., 57,010-87,500	5	5½-6
—— do., 75,001-87,500 (issued at £2 prem., 16s. paid	5	5½-6
—— 5 per cent., Pref., 1-57,009	5	5½-5⅝
Notting Hill Electric Lighting	10	11¼-12¼
—— 4 per cent. First Mort. Debs. Nos. 1 500 (Reg.)	100	96-97
Oxford Electric, Ordinary, 1-96 and 40-14,310	5	5⅜-6½
—— 4 per cent. Debenture Stock	100	94-96
River Plate Electricity Co., Ord., 1-119,687 & 120,501-120 507	1	27/32 31/32
—— 6 per cent. Non-Cum. Pref., 1-100,000	1	¾-1
—— 5 per cent. Debenture Stock, Red.	100	96-99
Rosario Electric Co, 6 per cent. Cum. Pref, 1-20,000	5	4⅝ 5⅛
—— 6 per cent. Cum 2nd Pref., 1-15,000	5	4¾ 5¼
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	96 98
Shawinigan Water and Power Co., 5 p.c. Cons. 1st Mt. Bds.	—	102-104 p.c.
Smithfield Markets Electric Supply, Ord., 1-12,000	5	¾-⅞
—— 4 per cent. Debenture Stock	100	70-74
South London Ordinary	4	2¼-2⅜
South Metropolitan Electric Light and Power, Ord.	1	⅞-⅞
—— 7 per cent. Cum Pref.	1	1 1/16-1 5/16
—— 4½ per cent 1st Mort. Deb.	100	99-102
St. James's and Pall Mall, Ordinary, 101-20,080	5	7¼-8¼
—— 7 per cent. Pref.	5	6¼-7¼
—— 3½ per cent. Deb.	100	85-90
Urban Electric Supply Co., Ordinary, 8-30,007	5	1-2
—— 5 per cent. Cumulative Preference, 50 001 80,000	5	1⅞-2⅛
—— 4½ per cent. First Mort. Debenture Stock, Red.	100	87-90
Westminster, Ordinary	5	7¼-8
—— 4½ per cent. Cum. Pref., 110,101-138,251	5	4¼-5⅛

Electric Tramways.—

Name.	Amount paid. £	Last price. £
Anglo-Argentine, 6 per cent. Cum Pref., 1-260,007	5	6¼-6½
—— 10 per cent. Non-Cum. 2nd Pref., 260,008-280,007	5	8 7/16-8 11/16
—— Permanent 6 per cent. Debenture stock, 1888	100	141-146
Auckland Elec. Trams., 5 p.c. 1st Mor. Deb. Stk, Red.	100	104-107
Barcelona Tramways, Ord., 1-20,000	10	—
—— 5 per cent. Cum. Pref. shares, 1-10,000	10	—
—— 5 per cent. Deb., Red., 1-600	100	—
—— 4½ per cent. Red. Deb. Stock	100	—
Bath Elec. Tramways, Ld., Pref. Ord. Shares, 75,001-150,606	1	¼-⅜
—— 5 per cent. Cum. Pref. Shares, 1-75,000	1	⅜-½
Birmingham and Midland Trams., 4½ p. c. 1st Db. Stk, Red.	100	95-96
Blackpool and Fleetwood Tramroad	10	13⅜-13⅝
Bombay Elec. Supply and Trams Co., 6 per cent. Cum. Pref.	10	10¼-10⅜
—— 4½ per cent. Deb. Stock, Red.	100	94-96
Brisbane Tramway Invest., Ord., 1-75,000	5	4 3/16 4 7/16
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼ 5¼
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	99-103
British Columbia Electric Railway Co., Ord Def.	100	125-130
—— Ord. Pref.	100	108 112
—— 5 per cent. Cum. Perpetual Pref. Stock	100	107-111
—— 4½ per cent. 1st Mt. Debs., Nos. 1-6,250, of £40 each	40	98-102
—— 4½ per cent. Vancouver Power Deb.	100	101-104
British Electric Traction, Ord. 1-300,000 & 60,001-90,000	10	1⅛-1⅞
—— 6 per cent. Cm Pf., 30,0001-60 000	10	4⅜ 4⅞
—— 5 per cent. Perpetual Debenture Stock	100	92-97
—— 4½ per cent. 2nd Deb. Stock	100	76-77
Bueno Ayres and Belgrano Trams	5	4⅜-4⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	4⅝ 5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4⅝ 5⅛
—— 5 per cent. Deb. Stock, Red.	100	110-116
—— Prov. Cert., all paid	100	—
Buenos Ayres Electric Trams, 5 p.c. Deb. Stk., Red.	100	96-98
Buenos Ayres Gd. Nat. Trams. Co., 5½ per cent. Pref. Deb Bonds, Red., 1-1,500	100	101-105
—— 6 per cent. Deb. Bonds, Red., 1-2,275	100	100-104
Buenos Ayres Lacroze Trams. Co., Stg. 5 per cent. 1st Mort. Deb. Stock, Red.	100	91-94
Calcutta Tramways, Ord., Nos 1-137,610	5	5⅜-6⅜
—— 5 per cent. Cum. Pref., Nos. 1 30,000	5	5-5⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	103 106
Cape Electric Tramways, Nos. 1-480,000	1	3/16-7/16
City of Birmingham Tramways, 5 per cent. Cum. Pref.	5	4½-4⅜
—— 4 per cent 1st Mortgage Deb, 1-3 000 (1917)	100	97-100
City of Buenos Ayres Trams. Co. (1 04), 1-248,000	5	5 9/16-5 13/16
—— 4 per cent. Deb. Stock, Red. 1985	100	99-103
Colombo Electric Tramways and Lighting, 5 per cent. 1st Mortgage Debenture Stock, Red.	100	88-91
Cork Electric Tramway and Lighting Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	12⅜-13⅜
—— 4 per cent. Debentures	100	90-95
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	12¼-13¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	12¼-13¼
—— 3½ per cent. Mort. Debs., 1-3,000 Red	100	90-95
Hastings and Dist. Elec. Tram. Co., 4½ p c. Deb. Stk, Red.	100	93-96
Havana Electric Railway Consolidated Mort. 5 per cent. 50-year Coupon Bonds of 1952, 1-6957	$1,000	82-87
Imperial Tramways, Ordinary	all	18-19
—— 6 per cent. Cum. Pref.	all	14-14½
—— 4½ per cent. Deb. Stock	100	108-110
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	¾-1⅛
—— 4 per cent. 1st. Mt. Db Stock, Red.	100	58-63
Kalgoorlie Electric Tramways, 1-250,000	1	1/32-3/32
—— 5 per cent. "A" Deb. Stock	100	85-89 xd
—— 6 per cent. "B" Deb. Stock	100	64-75 xd
Kidderminster and District Lighting and Traction, Pref.	5	10-10½
Lancashire United Tramways, Limited, 5 per cent. Prior Lien Deb. Stock, Red.	100	91-94
—— £236,500 2nd Mort. Deb. Stock	—	—
—— £83,330 Deferred Deb. Stock (all fully paid)	—	—
Lisbon Electric Tramways, Limited, Ord., Nos. 1-594,188	1	1-1¼
—— 6 per cent. Cum. Pref., Nos 1-425,553	1	1-1¼
—— 5 per cent. Mort. Deb., 1-5,000 Red.	100	90-95

Name.	Amount paid. £	Last price. £
London United Trys. (1901), 5 per cent. Cum. Pref.	10	7¼-8¼
—— 4 per cent. 1st. Mt. Db. Stock, Red.	100	81-86
Madras Elec. Trams. (1904) 5 per cent. Deb. Stk., Red.	100	95-98
Manila Elec. R.R. and Lightg. Corp., 5 p.c. 1st Lien and Coll. Tr. Sinkg. Fund Gold Bonds of 1953, Red., 1-4,635	$1,000	86-90
Manx Elec. Railway Co., 5½ p.c. Cum. Pref., 301-21,635 and 436-25,000	5	4¼ 5
——½ per cent 1st Mort. Deb. Stock, Red.	100	£5-90
Metropolitan Elec Trams., Defd., 1,000,001-1 314,016	1	1/32-5/32
—— 5 per cent. Cum. Pref., 500,001-1,000,000	1	11/16-13/16
—— ¼ per cent. Deb. Stock, Red.	100	95-98
Mexico Trams. Co, Gen. Cons. 1st Mort. 50-year 5 per cent. Gold Bonds	—	£0½-91½ p.c.
Milwaukee Electric Rail and Light, 5 per cent. 30-yr. Con Mort Bonds, 1926, 1-5,500 and 7,001-8,000	$1,000	103-105
Montreal Street Rail., 4½ per cent. Sterling Deb., £01-2,000 1922	100	101-103
New General Traction, 6 per cent. Cum. Pref., 1-10,000 and 34,001-74,000	5	¼-½
Oldham, Ashton, and Hyde Tramway, Ordinary	10	½ 2
—— 5 per cent. Cum. Pref.	10	8¾-9
Perth Elec. Tramways (W.A.), 5 per cent. 1 Mrt. Deb. Stk	100	103-106
Potteries Electric Traction, Ordinary, 1-245,000	1	¼-½
—— per cent. Cum. Pref., 300,001-545 000	1	⅝-¾
—— per cent Debenture Stock	100	93-96
Provincial Tramways Co., Ordinary, 1-24,912	10	4¾-5¼
—— per cent. Cum. Pref., 1-10,000	10	9¼-10½
Rangoon Elec. Tramway and Supply Co., 6 p.c. Cum. Pref. 1-30,000	5	5¼-5⅜
—— 4½ per cent 1st Mort. Deb. Stock, Red.	100	98-100
Sao Paulo Tramway, Light, and Power Co.	$100	132-137
—— 5 per cent. 1st Mort Deb., Red. 1929, 1-12,000	$500	96 98 p.c.
South Metropolitan Electric Tramways and Lighting Co. 6 per cent Cum. Pref., 19,571-169,570, Prov. Certs.	1	¾-1
—— 4 per cent. Deb Stock, Red. 1940	100	77-81
Sunderland District Electric Tramways, 5 p.c 1st Mort. Debs., Red., 1-1 600	100	76-81
Yorkshire (West Riding) Elec Tram. Co, Ord., 70 001-110,000	5	¾-1⅛
—— 6 per cent. Cum. Pref., 1-46,261	5	3¼-3⅜
—— 4½ per cent. 1st Deb. Stock, Red.	100	84-87

Electric Railways.—

Name.	Amount paid £	Last price. £
Central London, Ordinary	100	75-78
—— 4 per cent. Pref.	100	90-92
—— " " deferred	100	56-59
—— 4 p c. Deb. Stock (Prov. Script Certs., fully paid)	100	103-106
City and South London, Consolidated Ordinary	100	39-41
—— 4 per cent Debenture Stock	100	100-103
—— 5 per cent. Pref. Stock '81	100	113-116
—— " " " '96	100	112-115
—— " " " '01	100	110 113
—— " " " '03	100	105-108
Liverpool Overhead, 5 per cent. Pref	10	10-10½
—— Ordinary, 1-50,000	10	3¾-4⅛
—— 4 per cent. Mortgage Debentures, Red, 1-1,700	—	94-96
Underground Electric Railways of London, 5 per cent Profit-Sharing Secured Notes	—	39-43
—— Deposit Receipts	—	29-43

Telegraphs and Telephones.—

Name.	Amount paid. £	Last price £
Amazon Telegraph Co., 1-25,000	10	2-3
—— 5 per cent. Debs., Red., within 1-1,069	100	85-88
American Telephone and Telegraph Collat. Trust 4 per cent. Bonds, 1-28,000 and 53,001-78,000	$1,000	90 93
Anglo-American Telegraph Co., Ordinary	100	59-62
—— 6 per cent. Preferred Ordinary	100	104-105
—— Deferred Ordinary	100	1¼-1⅝
Anglo-Portuguese Telephone Co., 5 per cent. 1st Mort. Deb. Stock, Red.	100	99-102
Chili Telephone Co., 1-44,000	5	7¼ 7⅜
Commercial Cable Co., Ster. 500-year 4 p.c. Deb. Stk., Red.	100	86-87
Cuba Submarine Telegraph Co., Ordinary, 1-16,000	10	7¼-8¼
—— 10 per cent. Preference, 1-6,000	10	15⅜-16⅜
Direct Spanish Telegraph Co., Ordinary	5	3-3¼
—— 10 per cent. Cum. Preference	5	8 9
—— 4½ per cent. Debs., 1-600	50	100-103
Direct United States Cable Co.	20	13⅜-14⅛
Direct West India Cable Co., 4½ per cent. Debs., reg. within 1-1,200, Red.	100	100½-102½
Eastern and South African, 4 per cent. Mort. Debs., within 1-3,000, 1909	100	101 103
—— 4 per cent. Reg. Mort. Debs. (Mauritius subsidy), 1-8 000, 1913	25	100-102
Eastern Extension, Australasia and China, 1-300 000	10	12⅜-13⅛
—— 4 per cent. Mort. Deb. Stock, Perp.	100	100½-102½
Eastern Telegraph Co., Ordinary stock	100	133-136
—— 3½ per cent. Preference stock	100	84½-86½
—— 4 per cent. Mortgage Debenture Stock	100	100½-102½
Great Northern Telegraph Co. (of Copenhagen)	10	£7½-29½
Halifax and Bermudas Cable Co., 4½ per cent. 1st Mort. Debs within 1-1,200, Red.	100	100½-102½
Indo-European Telegraph Co.	£5	54-57
Marconi's Wireless Telegraph Co, Nos. 256,128-284,190	1	7/16-9/16
Monte Video Telephone Co., Ordinary, 1-72,680	1	29/32-1 1/32
—— 5 per cent. Preference, 1-86,492	1	13 16-15/16
National Telephone, Preferred	100	108½-110½
—— Deferred stock	100	113-115
—— 6 per cent. Cum. First Pref.	10	10¾-12⅛
—— 6 per cent Cum. Second Pref.	10	10¼-12⅛
—— 5 per cent. Non. Cum. Third Pref.	5	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100	99½-101½
—— 4 per cent Deb. Stock, Red.	100	102½-103½
Oriental Telephone and Electric Company	1	1¼-1⅜
—— 6 per cent. Cum. Pref	1	1¼-1½
Pacific and European Tel., 4 p c. Guar. Debs., Red., 1-1,000	100	99-102
United River Plate Tele. Co., Ordinary, 1-100,000	5	6⅜-6½
—— 5 per cent. Cum. Pref., 1-40,000	5	5-5½
—— 4½ per cent. Debenture stock, Red.	100	100½-102½
Telephone Co. of Egypt, 4½ per cent. Deb. Stock, Red.	100	99-102
West African Telegraph Co.	10	10-10½
West Coast of America, 1-30,000 and 53,001-53,008	2½	1 3 16-1 7/16
—— 4 p.c. Debs., 1-1,500, guar. by Western Telegraph	100	99-102
West India and Panama Telegraph Co., Ordinary	10	⅜-½
—— 6 per cent. Cum. 1st Preference	10	8¼-8⅜ xd
—— 6 per cent. Cum 2nd Preference	10	8-9
—— 5 per cent. Debs., Red., 1-800	100	101-104
Western Telegraph Co., 1-207,930	10	13⅜-13⅝
—— 4 per cent. Debenture Stock, Red.	100	101-103

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line	Traffic Returns for week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile
	Ending	1908.	1907.	Week.	Current year.	1908.	1907.	Ending	Total receipts	Passengers carried.	Car miles run.	Receipts per Pas-s'nger	Car mile.	Mile o track.	
		£	£	£	£				£			d.	d.	£	d.
Aberdeen Corporation	June 17	1,017	1,513	- 95	— h	27½	27½	May 31	72,605	17,676,000	1,529,682	0 98	11·39	4,987	6·34
Ayr Corporation	,, 20	375	351	+ 24	—	8	8	,, 15	15,283	3,603,789	378,894	·97	9·28	1,917	5·35
Baker Street and Waterloo Ry.	,, 20	3,010	2,530	+ 480	+16,859	4½	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	,, 21	1,074	1,034	+ 40	+ 693	23·53	23·53	March 31	55,408	11,696,691	1,324,743	—	—	—	6·1
Birmingham Corporation	,, 13	7,444	6,075	+1,369	—	56½	56½	,, 31	18,557	5,252,088	215,345	·87	16·2	9,228	—
Blackburn Corporation	May 20	1,123	1,349	- 226	+ 97	23·80	23·80	,, 25	54,951	10,094,028	1,002,372	1·25	12·64	2,309	8·08
Blackpool Corporation	June 18	1,597	834	+ 763	+ 417	17½	17½	—	—	—	—	—	—	—	
Blackpool-Fleetwood Trams	—	—	—	—	—	16½	16½	Dec. 31	34,819	2,707,918	625,110	3·09	12 903	—	7·795
Bolton Corporation	,, 21	2,478	2,276	+ 193	+ 1,217	42	42	March 31	111,294	23,410,690	2,411,969	1·14	11·03	2,649	6·12
Bournemouth Corporation	,, 17	1,539	1,533	+ 6	- 695	29¼	24½	,, 31	83,663	13,503,610	1,765,088	1·48	11·37	2,860	7·28
Bradford Corporation	,, 13	5,807	4 901	+ 906	+ 306	98	95	,, 31	232,427	46,728,977	5,167,261	1·193	10·79	2,421	—
Brighton Corporation	,, 21	900	991	+ 9	+ 110	17·191	17·191	,, 31	50,652	10,759,310	1,798,105	1·09	10·48	2,844	7·4
Bristol Tramway Company	,, 19	4 727	5,007	+ 220	—	53½	51½	,, 31	266,769	46,902,257	6,178,886	—	—	—	—
Burnley Corporation	,, 20	1,150	1,218	- 68	—	19½	19½	,, 31	62,699	11,967,4:8	1,205,83	1·31	12·48	5,825	8·21
Burton Corporation	,, 21	257	276	- 39	—	9¾	8½	,, 31	15,576	3,383,527	421,317	1·07	8·87	1,768	6·14
Cardiff Corporation	Mar. 7	1,860	1,880	+ 40	—	32·62	†32·26	,, 31	106,550	24,438,164	2,624,504	1·04	9·74	3,256	6
Carlisle Tramways Company	June 20	175	180	- 5	+ 20	8·5	8·5	Dec. 31	10,254	2,790 699	350,417	—	—	—	7·96
Central London Railway	,, 20	7,091	5,466	+1,625	+ 3,140	6	6	,, 31	349,298	43,057,997	1,279,698a	1·85	62·29a	55,357	5 22a
Charing X, Euston, & Hamp. Ry	,, 20	3,240	—	—	—	7½	6½	—	—	—	—	—	—	—	—
City and South London Railway	,, 21	3,101	3,225	- 124	+ 6,097	9	6½	h June 30	82,456	10,048,780	—	—	—	—	—
Colchester Corporation	,, 16	302	206	+ 96	—	8	8	*March 31	10,588	2,457,553	320,788	·97	7·47	1,401	6·12
Cork E. T. and L. Company	,, 18	488	520	- 32	- 409	15½	15½	Dec. 31	25,032	5,966,364	891,998	—	6·74	—	4·78
Croydon Corporation	,, 19	1,972	—	—	—	12 c	12 c	March 3	62,065	13,514,918	1,502,408	1 08	9·76	3,125	6 67
Darwen Corporation	,, 19	233	254	- 26	- 47	7 23	7·23	—	—	—	—	—	—	—	—
Dover Corporation	,, 13	252	218	+ 34	— 168	4¾	4¾	,, 31	12,468	3,178,063	328,406	·94	9·11	2,625	—
Dublin and Lucan Electric Ry.	,, 19	136	138	- 2	+ 136h	6¾	6¾	—	—		—	—	—	—	—
Dublin U.T.	,, 19	5,420	6,506	+1,086	+ 2,745	54¼	48¾	—	—		—	—	—	—	—
Dundee City Tramways	April 8	1,144	1 195	- 51	—	22	22	May 15	57,672	15 554,905	1,162 792	·878	11·9	4,352	7·3
East Ham Corporation	June 20	876	959	- 83	- 518	14	14	March 31	47,140	15,049,240	1,062,151	·74	10·49	3,636	7·14
Glasgow Corporation	,, 20	18,081	17,675	+ 406	- 5,017h	177½	169	May 31	887,381	224,063,098	20,350,367	·95	10·47	5,035	5·21
Gloucester Corporation	,, 10	399	275	+ 124	+ 77	15	15	March 31	15,033	3,182,111	579,996	1·06	6·94	1,002	5·1
G.N., Piccadilly and Brompton.	,, 20	5,440	4,210	+1,230	+37,141	9½	9	—	—	—	—	—	—	—	—
Halifax Corporation	May 5	1,490	1,515	— 25	—	52·574	37	,, 31	77,996	18,893,242	1,624,275	—	11·52	—	8·65
Huddersfield Corporation	June 20	1,580	1,606	- 26	+19,567	35½	35	,, 31	81,196	15 252,150	1.804,745	1·22	10·79	2,770	5·94
Hull Corporation	,, 20	2,382	2,383	- 1	—	26	26	,, 31	121,186	29,151,543	2,966,406	1	9·84	—	—
Ilford Corporation	May 2	410	449	- 39	—	10½	10½	,, 31	26,499	6,586,754	645,117	·89	9 58	2,225	6 5
Ilkeston Corporation	June 17	124	143	- 19	+ 41	9	9	—	—	—	—	—	—	—	—
Kirkcaldy Corporation	May 6	249	256	- 7	—	7½	7½	May 15	13,702	4,640,618	466,919	·692	7 55	1,73	4 95
Lancashire United Tramways	June 17	1,518	1,241	+ 277	+ 1,488	39	39	—	—	—	—	—	—	—	—
Leeds Corporation	,, 13	7 281	6 726	+1,155	+ 1,554	96½	96½	March 31	327,794	73,024,853	7,358,185	1 06	10·69	3,352	5 58
Leicester Corporation	,, 20	2,159	2,301	- 142	—	42	42	—	—	—	—	—	—	—	—
Liverpool Corporation	,, 13	11,672	11,131	+ 541	- 1,713	104	104	Dec. 31	563,793	122,094,528	12.115,934	1 108	11 17	5,421	7·75
Liverpool Overhead Railway	,, 21	1,424	1,526	- 102	- 808h	9·25	6·65	June 30	77,568	10,957,148	1,102,809	—	—	—	—
London County Council	,, 6	36,708	31,521	+5,184	+ 30,307	98	98	March 31	1378,014	314,227,090	30,130 297	1·05	10 98	—	8·55
Lowestoft Corporation	,, 20	207	201	+ 6	+ 204	3½	—	Sept. 30	11,039	2,622,922	343,190	1 03	7 9	2,156	6·39
Maidstone Corporation	,, 11	284	105	+ 79	—	3½	2	March 31	5,913	1 186,566	157,050	1·14	8 6	2,956	7·2
Manchester Corporation	May 23	15,519	17,869	- 2,320	+ 4,837	172	161	,, 31	719,673	143,264,501	15,523,459	1 19	11·12	4,556	7·03
Metropolitan District Railway	June 20	9,379	7 993	+1,386	+23 894	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	,, 21	16,612	16,153	+ 459	+ 4,252	23½	23½	June 30	637,794	97,639,334	—	1·39	—	—	—
Nelson Corporation	,, 20	136	146	- 10	- 126	2¾	2¾	March 31	7,309	2,035,300	203,203	·86	8 64	1,892	8·69
Newcastle-on-Tyne Corporation	,, 20	3,700	4,048	- 348	- 4,422	59⅛	57½	,, 31	210,491	45,506,468	4,263,174	1·11	11·85	3,560	6·04
Newport (Mon.) Corporation	,, 13	968	846	+ 122	- 894	14½	14½	,, 31	32,421	7,760,403	772,753	1 03	10 01	1,525	6·87
Oldham Corporation	May 3	1,894	1,871	+ 23	- 321	35⅝	35⅝	,, 25	94,948	18,647,731	1,818,444	1·19	12·53	2,603	7·2·9
Portsmouth Corporation	June 13	2,634	1 916	+ 7 8	—	28½	28½	,, 31	98,911	20,668,825	2,199,823	1·15	10 79	—	—
Reading Corporation	,, 11	804	618	+ 186	—	13½	13½	,, 31	32,661	8,130,179	918,825	·96	8·53	2,476	4·77
Rochdale Corporation	—	—	—	—	—	20·9	20·9	,, 31	54,138	9,749,202	1,201,364	1·32	10·75	2,638	6 03
Rotherham Corporation	—	—	—	—	—	10	10	,, 31	26,916	5,743,298	618,211	1·12	10 45	2,691	7·38
Salford Corporation	,, 15	6,241	4,560	+1,681	—	—	—	—	—	—	—	—	—	—	—
Scarborough Tramways Co.	—	—	—	—	—	4·78 c	4·78 c	Dec. 31	7,779	1,537,845	228,235	1·21	8 2	1,640	
Sheffield Corporation	,, 14	6,588	5,537	+1,051	+ 33	65¼	65¾	March 25	276,907	73,966,299	6,804,656	898	9 767	4,174	
Southampton Corporation	May 6	1,079	932	+ 147	+ 202	18	18	,, 31	49,185	9,437,396	1,143,085	1·25	10·71	—	7 7
Southend-on-Sea Corporation	June 17	432	384	+ 48	+ 263	9	9	,, 31	20,076	4,431,728	390,538	1 07	12 33	3,155	6·75
Stockport Corporation	—	—	—	—	—	25	25	,, 31	50,127	8,617,127	1,248,656	—	9 464	—	4·849
Sunderland Corporation	,, 21	1,159	1,473	- 314	- 2,910	20	20	,, 31	72,396	17,483,132	1,535,425	1·006	11·261	3,687	6 37
Swindon Corporation	—	—	—	—	—	4½	4½	,, 31	9,300	2,675,221	224,417	·8	9 94	1,968	7·79
Torquay Tramways	,, 18	283	150	+ 133	—	5·16	—	—	—	—	—	—	—	—	—
Wallasey U.D.C.	,, 20	949	886	+ 63	+ 546	12 68	12·43	‡ ,, 31	42,810	8,312,592	890,906	1·23	11·53	3,376	—
Warrington Corporation	—	—	—	—	—	6½	6½	,, 31	19,204	4,965,296	429,785	—	0 724	1,989	6 93
West Ham Corporation	,, 18	2,146	2,329	- 183	— 4,129	14·7	14·7	,, 31	132,881	35,502,836	2,556,854	·789	10·96	4,407	6·79
Wolverhampton Corporation	,, 17	782	832	— 50	- 59	20	20	,, 31	43,823	9,276,023	965,133	—	10 886	2,159	6·095

* 1906-6 figures. ‡ 1907-8 figures. † And 88 miles of interlacing track. a Train mile. c Miles of route. h Half-year's figures.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

1631. Discuss and explain the blow-out action of the magnetic field on the electric arc.—L. D. L.

ANSWERS.

Question No. 1 022.—In a power-house with three-phase current, two 500-kw. three-phase transformers are run in parallel to raise the pressure from 3,000 volts to 10,000 volts. If required to add a 1,000-kw. transformer, what particulars are required by the designer so that the three transformers may run in parallel and each doing its proportion of the load. Give the tests necessary to get the above data.

Answer to No. 1,022 (awarded 5s.).—The necessary conditions for two transformers to share any given total load in proportion to their respective normal full-load outputs are that, when supplied with current at the same potential on their primary windings, the secondary terminal voltages should be the same with the transformers on open circuit, and also the same when each transformer is carrying its normal full load; in other words, the drop in volts between no load and full load must be the same in each case It follows, then, that at any intermediate load the terminal secondary voltages will be of the same value when each transformer is doing its proper proportion of the load. The voltage drop of the transformer for any given load depends entirely upon its reactance, and as the reactance is definitely fixed by design of the apparatus, it is only necessary to ascertain this reactance to be able to determine

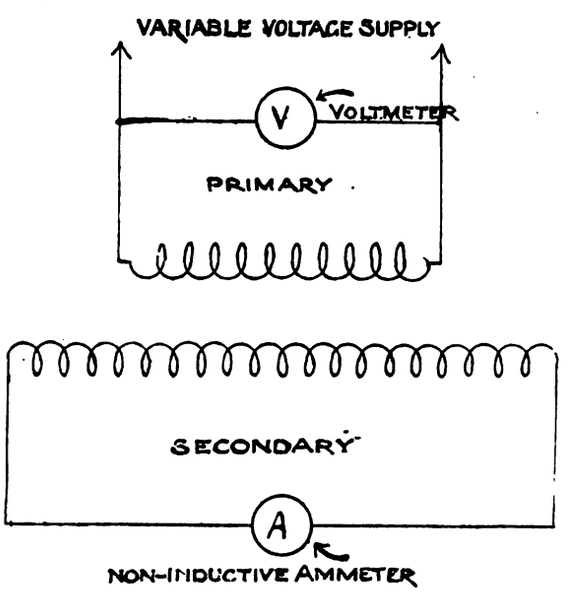


FIG. 1.

the voltage drop with any load. This can readily be done experimentally. The reactance of any circuit of resistance R, inductance L, and frequency f is given by the expression $\sqrt{R^2+(2\pi f L)^2}$, and the relation between the current and voltage applied to such a circuit is given by

$$C = \frac{E}{\sqrt{R^2+(2\pi f L)^2}},$$

where C and E represent current and voltage respectively. This gives us a simple method of obtaining the reactance of an alternating-current circuit.

The particulars of the 500-kw. transformers required by the designer of the 1,000-kw. transformers will be as follows: (1) Ratio of secondary terminal volts on open circuit to voltage applied to primary. This is readily obtained by taking simultaneous readings on primary and secondary voltmeters with secondary on open circuit. (2) Drop in volts on secondary between no load and full load. This is obtained by short-circuiting the secondary winding through a non-inductor ammeter and applying a voltage to the primary, which is adjusted until the normal full-load current is indicated in the secondary ammeter. This primary voltage is then noted Fig. 1 shows diagram of connections for this test. (3) Resistances of primary and secondary windings respectively. These are best obtained by passing a continuous current of known value through each winding separately, and measuring voltage drop across the winding. The resistance is then obtained by inserting values obtained in equation

$$R = \frac{E}{C}$$

where E = volts across winding, C = current flowing in winding, and R = resistance of winding.

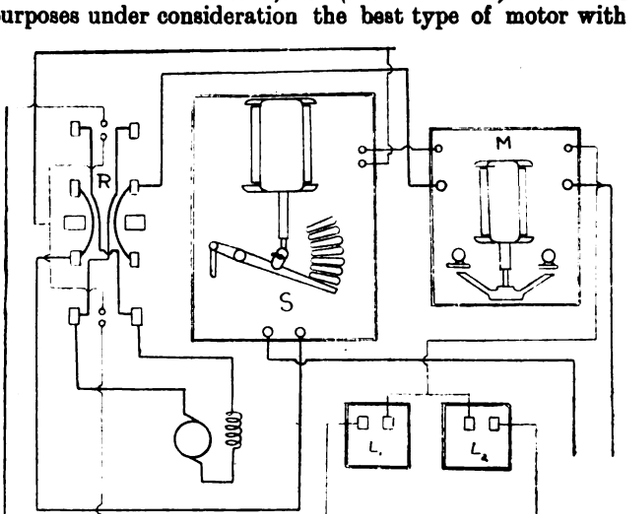
It may not readily be seen how the second experiment gives us the drop in the transformer at full load. Referring to equation

$$C = \frac{E}{\sqrt{R^2+(2\pi f L)^2}},$$

we have now obtained values for C = the secondary full-load current and E = the primary volts required to send this current through secondary. We have also determined R = the sum of resistances of primary and secondary windings (from third experiment). We can, therefore, obtain the value of L; f being the frequency of the primary and, of course, the secondary circuits. It is a simple matter now to calculate the reactance $\sqrt{R^2+(2\pi f L)^2}$ of the transformer. We see from the above equation that a voltage, E, is required to drive a current, C, through the reactance $\sqrt{R^2+(2\pi f L)^2}$—that is to say, in driving this current, C, through the reactance there will be a drop of E volts. Now the voltage, E, is measured on the primary and the current, C, on the secondary, and if the transformer had a ratio of transformation of unity, the value E obtained would give the drop in transformer (with load C) direct; but it is obvious that when the transforming ratio is other than unity this value E must be increased in the case of step-up transformer and decreased in case of step-down transformer in proportion to the transforming ratio. In the present instance it will readily be seen that if the transformer had a ratio of 10,000 to 10,000 volts, or unity, a greater voltage than E would be required on the primary to give the full-load current on the secondary. In order, therefore, to obtain the actual drop in the transformer, we must increase the value E obtained in proportion to transforming ratio, or $E \times \frac{10,000}{3,000}$.—ERG.

Question No. 1,023.—A travelling truck weighing 11 tons travels 25ft. Sketch and describe the best arrangements, size, type of motor, and starter, also automatic arrangements for cutting off the current when the truck reaches each end. It must be controlled a distance of 20 yards from the truck, and overhead mains cannot be used.

Best Answer to No. 1,023 (awarded 10s.).—For the purposes under consideration the best type of motor with



which to equip the truck would be a series-wound motor, owing to its excellent starting properties, the brake horse-power being, say, 30 at a voltage of 500. In the system about to be described the motor brushes would be directly connected to slippers or sliding contacts, which would make contact on the two insulated third rails, these two third rails being treated as the terminals of the motor. The controlling apparatus essentially consists of a solenoid main switch, M, and solenoid starting switch, S, reversing

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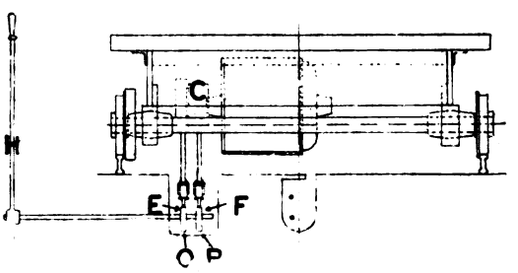
switch, R. At each end of the track would be a limit switch, L_1 and L_2, which would be operated by a suitable tappet fixed in a convenient position on the truck. The first operation would be brought about by switching in the change-over switch. This would close one of the controlling circuits, the spools of the solenoid, main switch, and solenoid self-starter would be excited, plungers drawn up, and thus current would be switched on the line by the solenoid main switch, and resistance gradually cut out automatically by the solenoid self-starter, thus allowing the motor to slowly start up. On approaching the end of the track the tappet on the truck would engage the limit switch, L_1, and the controlling circuit would be opened, thus de-energising the spool of the main switch, which would open the main circuit and stop down the motor automatically, a brake being applied by the same action. The next operation would be the change over of the reversing switch, when the motor would start up in opposite direction and the cycle of operations repeated. The chief advantage of this system lies in the fact that it is practically fool-proof, all the various parts being interlocked with one another; the only manual operation necessary would be the changing over of the reversing switch, an operation which calls for no particular intelligence on the part of the operator. Again, the main switch would only be broken at the main switch, and this being provided with powerful magnetic blow-outs and renewable carbon contacts minimises the evils experienced with heavy sparking.—T. Y. P.

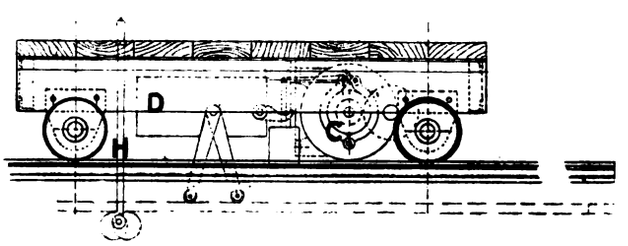
Answer to No. 1,023 (awarded 7s. 6d.).—The question does not state what speed the truck is required to travel at, so we will assume that it travels 100ft. per minute, and the diameter of the track wheels is 10in Assuming 40lb. per ton for amount of power required to move truck,

$$\text{B.H.P.} = \frac{11 \times 40 \times 100}{33{,}000} = \frac{44{,}000}{33{,}000} = 1{\cdot}3 \text{ b.h.p}$$

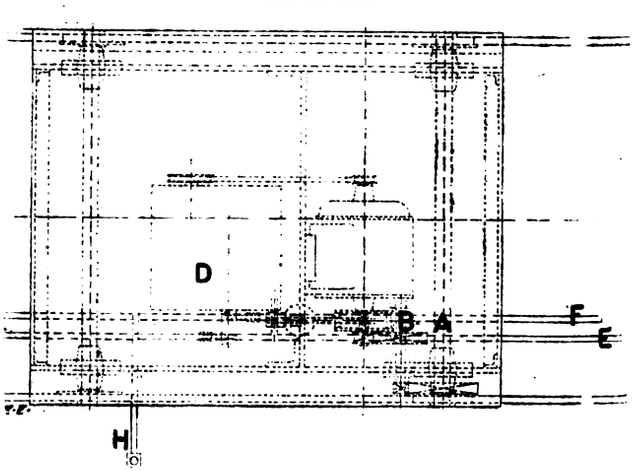
So that if we adopt a standard series-wound 2·b h.p. motor, 500 r.p.m., we will have a motor which will allow for the track not being dead level. Between the motor and the truck axle we will require a set of reduction gear to give us 38 r.p.m. on the truck axle, which equals a ratio of $\frac{500}{38} = 13{\cdot}1$ to 1. Spur wheel on the truck axle, A, to have 48 teeth four diameter pitch, and 2¼in. wide; pinion on second motion shaft, B, 12 teeth; wheel on second motion shaft to have 40 teeth four diameter pitch; pinion on motor shaft 12 teeth. The pinions in both cases being made from forged ·4 carbon steel blanks, and the spur wheels by means of ·4 carbon steel rings forged from the solid, without welds, and shrunk on to cast-iron centres. On the motor shaft a cast-iron brake drum will be required, 10in. diameter and 4in. face, to take a mechanically operated brake, C. The starting switch, D, is bolted to the under side of truck, and is operated by means of two rocking rails, E and F (similar to those used on the railroads for signal interlocking), which come into contact with rollers on the levers on the starter. The rocking rails, E and F, are worked by means of the lever, H (which may be any distance away), a length of 1¼in. diameter shafting, and two cams, O and P. If the lever, H, is moved downwards on the right-hand side, the rocking rail E is lifted up, and the mechanical brake, C, is lifted clear off the drum, and the reversing switch moved over; then the main switch (inside the starting switch) is put in. Once the main switch is put in, the circuit being made through the motor and resistance, the motor will start running. The resistance switch is geared up to the motor shaft by means of a 1in. belt, the resistance switch being moved round by means of a ratchet wheel and pawl, worked by means of an eccentric, step by step. When all the resistance is cut out of circuit the pawl is lifted clear, and another pawl holds the resistance switch in the "on" position. To stop the motor, the lever, H, is moved to a vertical position, which allows the rail E to fall: the resistance switch then returns by gravity to the position in which all resistance is in circuit. The main switch next comes out by means of a strong spring and gravity; the brake shoes then grip the brake pulley, and pull the truck up in some two or three feet. If the lever, H, is moved downwards on the left-hand side, the direction of the motor is reversed by means of the reversing switch, and the truck runs in the opposite direction. By these means, instead of providing automatic cut-out switches at the ends of the track, the rocking levers are cut short, so that when the truck has travelled far enough in either direction the rollers on the end of switch levers run off the end of the same and allow the starting switch to return to the "off" position and the brake to come on. To start the truck back on the return journey, the lever, H, is moved over into the opposite position, the rocking rail, which is not cut short at that end, comes into contact with the switch lever roller, and thus starts the motor running.



Front Elevation.



Side Elevation



Plan

The current will have to be picked up by means of collector shoes and, say, two No. 5 S.W.G. hard-drawn high-conductivity copper wires.—C. G.

Question No. 1,024.—Discuss the use of equaliser rings. Give diagrams of connections and best method of making the same.

Best Answer to No 1,024 (awarded 10s.).—The use of equalising rings has been found to be almost essential in the case of multipolar machines above about 100 kw. with parallel (or lap) wound armatures. Without them the armature may be seriously unbalanced—*i.e*, unequally loaded—at the different sets of brushes, owing to slight inequality in the fluxes from the different poles, and this gives rise to sparking at certain brushes and to "bucking" (violent rapid fluctuations in flux due to armature reaction, and leading to serious mechanical vibration, and eventually to flashing over at the commutator). By fitting a few equalising rings, each of which is connected to the winding at a number of exactly equidistant points equal to the number of pairs of poles—*i.e.*, to points separated by a number of conductors equal to $\frac{\text{total conductors}}{\text{number of pairs of poles}}$ — the inequalities of the flux are rectified by internal currents, which, though adding somewhat to the heating of the armature, do not cause sparking. The action of the rings can be followed by means of a simplified diagram, such as

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Fig. 1, in which the armature winding is represented by the outer circle, whilst the inner circle represents an equalising ring. Suppose that, owing to reduced air-gap or to increased number of turns, the pole N_1 gives more flux than pole N_2—*e.g.*, 1 megaline against ·8 megaline—the flux of N_1 will divide up equally between S_1 and S_2, ·5 megaline going to each, as shown by the dotted lines. From N_2 ·4 megaline goes to each S pole, the total fluxes from the four poles being 1, ·9, ·9, and ·8 megalines respectively. The voltages induced in the four quadrants will be as represented by the arrows, quadrant C B being least, quadrants A B and C D being greater as ·9 : ·8, and quadrant A D greater as 1 : ·8.

If the machine is on open circuit and the equalising connections occupy the position shown, a current will circulate inside the armatures in the circuits C B A E F C and C D A E F C. If the machine is loaded an actual current may not circulate, but a corresponding increase in the current in quadrants A D and A B and decrease in quadrants C D and C B will occur instead. Quadrants A D and A B carry currents in the normal direction and equal in amount, and, therefore, assuming that the brushes are neutral, the flux from N_1 to S_1 is neither weakened nor strengthened. The currents in C D and C B are both in the reverse direction from the normal and equal in amount, so that the flux from N_2 to S_2 also is not affected. The flux from N_1 to S_2, however, is *weakened*, because quadrant C D carries current in the same direction as quadrant D A—*i.e.*, the effect is the same as if the brushes were given a large forward lead In the same way the flux from N_2 to S_1 is *strengthened*. With this particular position of the ring connections, therefore, a definite equalising action occurs—*i.e.*, the ring currents tend to weaken the strong pole and to strengthen the weak pole, and thus rectify matters.

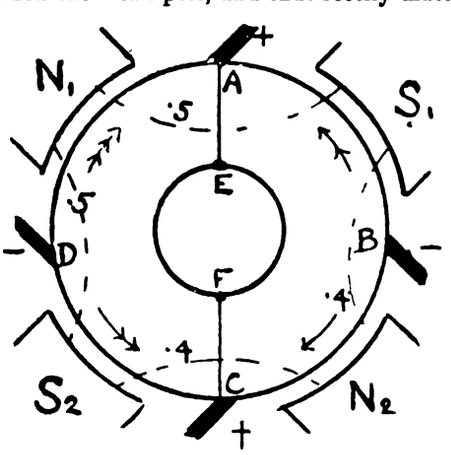

FIG. 1.

By using a number of rings, each connected to the winding at as many equidistant points as there are pairs of poles, and distributing these points fairly evenly over the whole winding, there will always be one or more rings in approximately the position shown in Fig 1, and the equalising action will go on more or less continuously. When no rings are provided, the same sort of equalising action goes on, but over the brushes and through the brush connectors, thus causing sparking and also necessitating larger equalising currents, because the brush connectors only take the place of a single equalising ring, so that the equalising current is concentrated instead of being spread out over a number of rings. The equalising rings are perfectly fixed at the back end of the armature by cleats inside the winding support. The rings should be of cable or copper strip of about the same section as an armature conductor. The connections to the winding should be readily detachable—*i.e.*, they should be made with screws tapped into the back loops of the armature end connections rather than with solder. This point is important, because when the rings are connected, it is practically impossible to tell whether heavy equalising currents are passing on test, whilst if the rings can be disconnected it is a simple matter to adjust the magnet poles on test after the machine has been finally erected, so that very little, if any, magnetic differences shall exist. One way of carrying out this test is to disconnect the brush connections—*i.e.*, the heavy conductors which connect all the + brushes together and those which connect all the - brushes together—as well as the equalising rings, and to run the machine round fully excited. If the volts between the different + and - brushes all round are then read with a voltmeter, any inequality in pole strength will appear as an increased or decreased voltage. By shifting the magnets slightly so as to readjust the air-gap, or by taking a few shunt turns off certain poles, it is then easy to obtain the required equality of voltage, which will ensure the absence of any large equalising currents on connecting up the equalising rings.—Q.

Answer to No. 1,024 (awarded 7s. 6d).—The necessity of having equaliser rings on continuous-current armatures is due to the inequality in the distribution of E.M.F. in the armature winding. Suppose in a four-pole machine one of the poles is not excited to the same degree as the others. Consider the effect this will have on (1) a series-wound armature, (2) a parallel-wound armature.

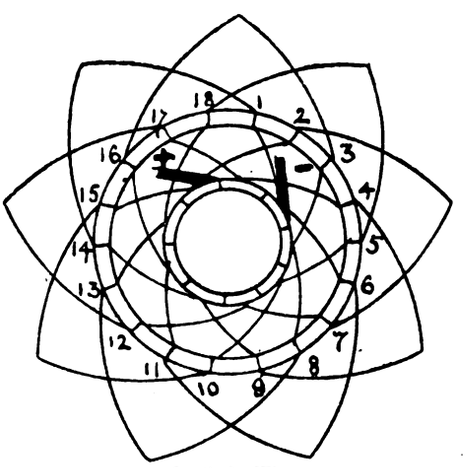

FIG. 1.—Series Winding.

Fig. 1 is a diagram of a series winding. Suppose the weaker pole is opposite the conductors 4, 5, 6, 7. In this winding there are only two circuits through the armature. The conductors 5 and 7 passing across the weak field will have a smaller E.M F. induced in them than those at the opposite side of the armature This will decrease the total E M F induced in that section. But the conductors 4 and 6 also have a smaller E M F. induced in them, and they belong to the other section of the winding Thus the E M.F. in this section will be practically the same as in the

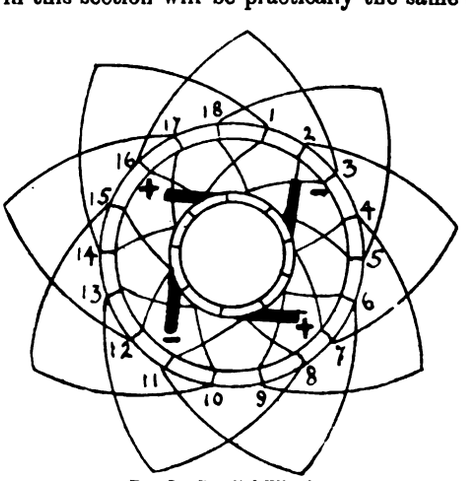

FIG. 2.—Parallel Winding.

other, and there will be no appreciable effect beyond a slight decrease in the terminal E.M F. Now consider the parallel winding. Here there are four circuits—1, 14, 17, 12; 16, 3, 18, 5; 11, 6, 9, 4, 7, 2; and 8, 13, 10, 15. If conductors 4, 5, 6, and 7 are passing across the weak field, there are only two of the groups represented, and the E.M F in these two groups will be less than that in the other two. There will thus be more current drawn from the latter two sections, which would cause greater heating losses, and sparking at the brushes of these two sections. To obviate this, those conductors in the winding which ought to be at equal potentials are connected to short-circuiting rings called equalising rings. Currents will then flow through these, which will tend to equalise the distribu-

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tion of current in the armature. Of course, these are not needed in the case of series-wound armatures, as such windings automatically equalise the distribution. There may be as many of these equalising rings are there are conductors per pair of poles in the armature, but more than ten are not needed for even the largest sizes The conductors to be short-circuited are distant from one another by twice the pole pitch.

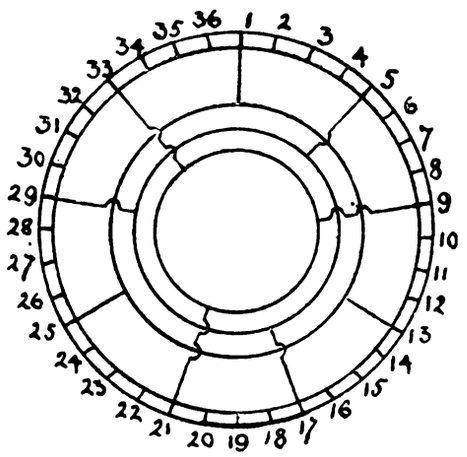


FIG. 3.

Fig. 3 is a diagram of the connections to equalising rings on a 36-conductor armature. Only three rings are shown, but there may be six. One of the best methods of making these connections is to have the rings clamped against the back of the commutator. The rings have lugs cast on them as in Fig. 4, the number of lugs depending on the number of conductors to be short-circuited—that is, equal to the number of pairs of poles. The connections from the armature to the commutator may then be passed through these lugs and connected thereto. Another

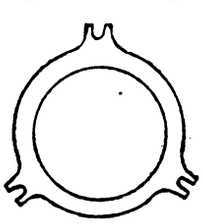


FIG. 4.

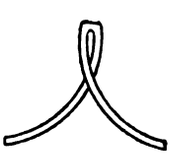
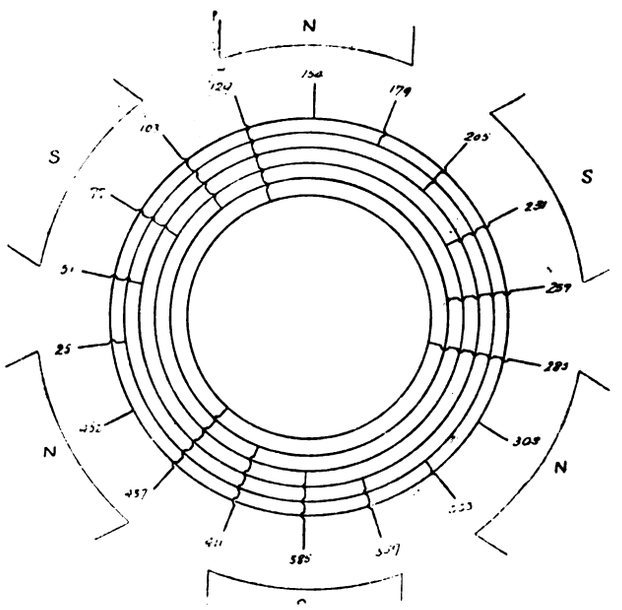


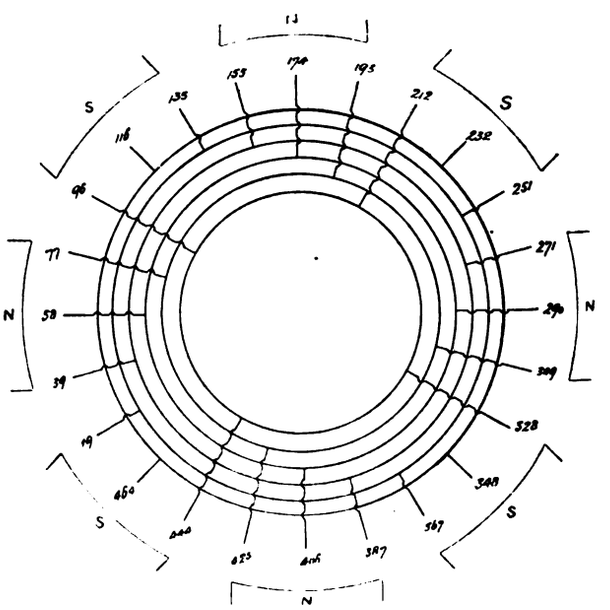
FIG. 5.

method used by the Oerlikon Company in some of their armatures does away with the rings altogether. Instead of connecting the armature conductors to the commutator by a single strip, a strip of copper of the shape shown in Fig. 5 is used. The middle part is connected to the armature conductor and the two ends to the commutator. The distance between them is equal to twice the pole pitch. In this way each conductor is connected through a commutator segment to the next conductor to it, which should be at the same potential, and thus the connection is made right round the armature.—J. H.

Answer to No. 1,024 (awarded 5s.).—In armatures with multiple-circuit windings cross currents are liable to be set up, which will cause sparking and undue armature heating. The chief cause of this trouble is the armature being out of balance—that is, the armature not being concentric in the field. For example, after a machine has been running for some time, the bearings will wear down a small fraction. The air-gap at the top will be widened and at the bottom reduced. As the air gap plays a very important part in the total reluctance of the magnetic circuit, the change will produce a diminution of flux at the upper poles and a corresponding increase at the lower poles. The E.M.F.'s will consequently be unequal, and the potential of the brushes in parallel on the collecting rings will differ. As these rings are of low resistance, a small difference of potential will cause heavy equalising currents to flow through them. Similar conditions are produced by faulty magnet castings, such as blowholes in the iron, also badly-excited field coils, turns short-circuited, etc. If two or more points of the armature winding which are at nearly equal potential are connected together by means of rings, this would equalise the amount of current collected at the various brush spindles, and so do away with the above mentioned trouble. The current produced in the rings will be an alternating current, for the potential difference between any two points will reverse as the armature revolves. These currents will tend to remove the cause of their production—namely, the difference of pole flux. Being an inductive circuit they will be out of step with the potential difference producing them, and then will tend to increase the compensating effect. The rings are usually made of insulated copper strip or cable, and are fixed at the back end of the armature in wooden cleats or in iron clamps and insulators. Often they are put inside the commutator. Any number of rings may be used.



Equaliser Connections, 6-Circuit Winding, 924 Conductors, 462 Commutator Parts.



Equaliser Connections, 8-Circuit Winding, 928 Conductors, 464 Commutator Parts.

The number of rings generally employed vary between four and ten, according to the size of the armature. It is not usual to fit equalisers on machines under about 70 kw. capacity. It will be seen that when designing an armature to be fitted with equalisers, the number of conductors chosen should be such that the number of poles is a factor of the number of conductors. The rings should be of as low resistance as possible without making them of undue size. It is advisable, where possible, to electrically balance the armature before connecting up the tappings. In double-current machines giving three-phase currents such connectors serve as equalisers, even though no three-phase current is being taken from the armature. The diagrams show equaliser connections for a six and eight pole winding.—H. T. A.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,032. Particulars are desired of best type of relays and main solenoids used in connection with electric lifts (push-button control) on board ship, especially with reference to the precautions adopted to prevent the circuit being broken by vibration, shock, etc. Also what are the voltages most commonly used in ships? — ALPHA.

1,033. Explain method of design of static balancers, for balancing on three-wire system.—W. H. J.

ANSWERS.

Question No. 1,025.—Owing to the installation of a new reversible booster, two 40-volt, 30-ampere motor-driven dynamos, formerly used for charging the regulating cells, are thrown out of use. It is proposed to use these for charging portable cells. As the cells to be charged vary from those in an electric landaulette of 100 ampere-hours to small ignition cells of 10 ampere-hours, the number of charging circuits must not be less than seven, so that large and small cells can be charged at the same time at different rates. One dynamo would be used entirely for charging the landaulette cells, and the charging rates required for the other cells are eight, five, four, three, two, one amperes. What is the most economical method of arranging the circuits? Both dynamos have field regulators giving 0-40 volts.

Best Answer to No. 1,025 (awarded 10s.).—A suitable system of connections is shown in Fig. 1. The switchboard

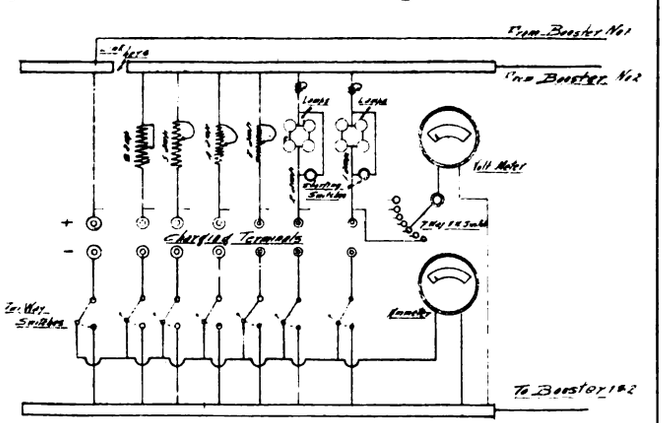
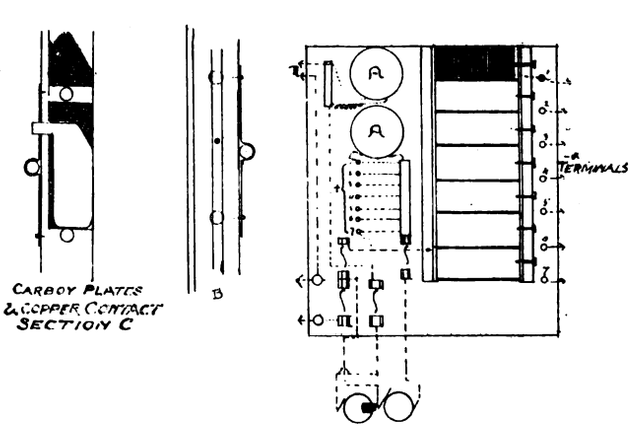


FIG. 1.

is provided with two main 'bus bars, the positive being on the top. This bar is split into two sections, and the boosters are connected as shown; their negative terminals both going to the lower 'bus bars and their positive terminals being each connected to one section of the top 'bus bar. The circuits are seven in number, and, taking them from the left, are as follows: No. 1 is connected straight to the left half of the top 'bus bar and through a two-way switch to the bottom 'bus bar. The others are connected to the right part of the top 'bus bars through suitable resistances, and to the lower 'bus bar through the two-way switches, as shown. For the 8, 5, 4, and 3 ampere circuits the resistances may be conveniently made of some cheap resistance wire, and should have a resistance of 5, 8, 10, and 13·3 ohms respectively; they can be wound on metal cylinders, which should be covered with thick asbestos sheet and should be provided with adjustable contacts to allow of their resistances being varied at will. For the 2 and 1 ampere circuits, as these would require resistances of 20 and 40 ohms respectively, it will be best to provide a number of lampholders connected in parallel, a small adjustable resistance of a few ohms being in series. The current may be adjusted by altering the number or size of lamps. A switch should also be provided to allow of the lamps being short-circuited, so that when the boosters are running on low volts the current may be regulated by means of the adjustable resistance. The two-way switches are provided to allow of an ammeter being inserted into any circuit and the charging current observed. These switches need not be an expensive type; the ordinary two-way tumbler switch would do up to the eight-ampere circuit, but for the large current circuit a larger size would have to be used. A voltmeter and multi-way switch is also shown.

In using the board, when the landaulette requires to be charged its cells are connected to the end circuit and No. 1 booster is run up, its voltage being regulated to suit the charging current required. At the same time No. 2 booster may be used for the other circuits, the booster being set to give the highest voltage required for any circuit, the resistance of that circuit being short-circuited, the resistance on the other circuits being adjusted to give the required currents. If necessary, all circuits may be connected to No. 1 booster by linking across the two top halves of the 'bus bar; also No. 2 booster may be used to charge the landaulette cells, or both machines may be run in parallel. At any time the $C^2 R$ losses are reduced to a minimum on the system as the booster may be set to give the voltage required on the largest circuit with all resistance cut out, and the other circuits will then have their minimum resistance in circuit. If only one or two of the small circuits are required when charging the landaulette, these may be charged from the same machine, and there will be no waste, as there would be if both machines were running.—E. V. C.

Answer to No. 1,025 (awarded 5s.).—To simplify matters and reduce cost of apparatus to a minimum, the arrangement shown in sketch may be employed. A slate panel is fitted with two externally shunted ammeters, one normally for use on the heavy current side, the other for the light. The shunt leads are terminated with plugs to fit into holes in the shunt resistance terminals, and then the meter can



be easily used on any circuit. The heavy current circuit is composed of a pair of clip fuses (Reyrolle pattern), on which the machine leads terminate, an ammeter shunt, and a Paul's carbon-plate resistance The other circuits are arranged on the other machine, the main leads, as before, terminating in clip fuses. From there one is carried to a 'bus bar to which are attached seven ammeter shunts, connected in turn to seven terminals; the other lead is carried to a 'bus bar forming a common connection to seven carbon resistances. The ammeter shunts can be easily made up in the test-room, out of resistance wire or strip, whilst the carbon resistances necessitate only a small expenditure.

There is one common terminal plate, into which glass rods are slipped. These rods support carbon plates, 3in. by 1in. by ⅛in., and when in position are fixed by a strip of brass, as shown in sketch B. Another set of glass rods prevent the

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carbons falling outwards, as shown in section C. The plate at the other end of the resistances is tapped for milled headed bolts, which screw up into a small plate of equal size to the carbon, but faced with red fibre. The connections from these resistances are taken from copper plates, which can be inserted anywhere in the length, thus varying the amount of resistance in use, whilst the thumbscrews form the final variation for current adjustment. If all circuits are wanted, it will be found most convenient to use both ammeters on the No. 2 machine circuits (this has to be borne in mind when obtaining the meters). The procedure would be to put on circuit 1 at, say, 4 amperes, 2 at 2½, thus 3 at 2, etc. When all are ready raise the main voltage, gradually checking out current taken on each circuit. A little practice will show the attendant what to allow so that all circuits will come up to the correct current.—R. M. MOBERLY.

Question No. 1,026.—Discuss theoretically the question of sparking in a direct-current multipolar generator when running under a varying load. Indicate the means adopted in design and construction to ensure sparkless running under these conditions. Size of generator, say, 150 kw., or larger.

Best Answer to No. 1,026 (awarded 10s.).—The space at my disposal is, I am afraid, very small to discuss a question which has received so much attention in the progress made in the design of direct-current machines. I shall, however, endeavour to point out a few causes of sparking which must be dealt with in the design of the machine (say, slotted drum-wound armatures, normally dimensioned "open slots"), and to lay out some theory referring to the more important points.

To produce sparkless commutation, at the time each commutator segment passes under a brush, and so short-circuits a coil, this coil must lie in such a field as to tend to produce an equal current in the opposite direction to the current which reactance tends to maintain. This can be done by advancing the brushes by an amount depending on the degree of field distortion, which is dependent on the load, or by the use of commutating poles. If the lead of brushes be set for full load, the machine will spark when running on light load, unless the reactance voltage is kept very low, and, therefore, the question to be studied in the design of the machine is to keep the reactance volts low. In a machine of the size stated (150 kw. or upwards) the reactance voltage should not exceed three to five.

With regard to the theory of reactance voltage. Inductance, which controls reactance, depends on the completeness of the iron circuit round each conductor—*i.e.*, on whether the conductor is surface wound, wound in open slots or in closed slots—since this determines the number of magnetic lines set up round the conductor by a given current flowing in it. Further, since a circuit of one turn has an inductance of one henry if, when one ampere is flowing round it, 10^8 C.G.S. lines are linked by the circuit; if the circuit consists of two turns, not only is the magnetising force doubled, but so also is the number of turns. This increases flux links. Hence the inductance of a circuit increases as the square of the number of turns it contains. It is, therefore, necessary to keep the convolutions per segment at one, if this is possible.

By the well-known reactance formula for any alternating current, if L = inductance in henries, N = frequency, C = current in conductor, then 2π L N = reactance in ohms, and

$$2\pi \text{ L N C} = \text{reactance volts} \quad . \quad . \quad . \quad (1)$$

In a commutating dynamo, during the time a segment is under the brush, the current in the coil connected to that segment goes through half a complete cycle—*i.e.*, from a maximum value in the one direction to a maximum value in the opposite direction. If D = diameter of commutator, b = breadth of brush in inches, R = speed (revolutions per minute), then peripheral speed of commutator = $\frac{\pi \text{ D R}}{60}$ inches per second, and time taken for one point on commutator to pass under one brush—that is, time of half a cycle—= $\frac{b \times 60}{\pi \text{ D R}}$ seconds.

$$\therefore \text{ frequency of commutation} = \text{N} = \frac{\pi \text{ D R}}{2 \times 60 \times b} \quad . \quad (a)$$

To find an expression for L (self-induction). Maximum number of turns short-circuited by one brush = $n = \frac{b - 1 \text{ mica}}{\text{pitch of bars}}$, where pitch of bars = 1 segment + 1 mica. The conductors which are being short-circuited in any one gap come from one positive and one negative brush, hence there are 2 n short-circuited turns contained in any one gap. Let us consider the inductance of any one of these 2 n turns. The flux is produced by 2 n turns, but linked by one turn; hence the inductance of one turn is 2 n times as great as if it were acting alone. Let K = flux set up in one turn, per ampere in that turn, and per inch length of armature, then self-induction = l K 10^{-8} henries, where l is the length of armature between end plates, in inches. Also the mutual induction of one turn with relation to 2 n turns simultaneously undergoing commutation = 2 n l K 10^{-8}. If there are T armature turns per commutator bar (instead of one as assumed above), inductance will be T^2 as much—*i.e.*, inductance = 2 n l K T^2 10^{-8}. This expression gives the inductance of the windings between two adjacent commutator bars in a two-pole machine. For a multipolar machine with wave-wound armature it must be multiplied by the number of pairs of poles = t. (For a multipolar lap-wound machine t = 1.) We then get:

$$\text{L} = 2 \, n \, l \, \text{T}^2 \, t \, \text{K} \, 10^{-8} \quad . \quad . \quad . \quad . \quad (b)$$

Substituting expressions (a) and (b) in equation (1) we get:

$$\text{Reactance volts} = \frac{2\pi \times \pi \text{ D R} \times 2 \, n \, l \, \text{T}^2 \, t \, \text{K} \, 10^{-8} \times \text{C}}{2 \times 60 \times b}$$

(Note that increasing b does not alter the value of R.V., because n increases in the same proportion.)

If for n we write $\frac{b}{\text{pitch of bars}}$ instead of $\frac{b - \text{miea}}{\text{pitch of bars}}$ and if B = number of segments, we get:

$$n = \frac{b}{\pi \frac{\text{D}}{\text{B}}} = \frac{b \text{ B}}{\pi \text{ D}};$$

and if S = total convolutions on armature = B T,

$$\therefore \quad \text{T}^2 = \frac{\text{S}^2}{\text{B}^2}.$$

Substituting these values for n and T^2 we get:

$$\text{Reactance volts} = \frac{4\pi^2 \text{ D R } b \text{ B } l \text{ S}^2 \, t \text{ K C } 10^{-8}}{\pi \text{ D B}^2 \, 120 \, b}$$

$$= \frac{\text{C S}^2 \, t \, l \text{ R K}}{\text{B}} \, 0{\cdot}105 \times 10^{-8}.$$

K (flux per ampere per inch length) is a constant which must be decided upon by the designer, and is usually put as 20.

$$\text{R.V. then becomes} = \frac{\text{C S}^2 \, t \, l \text{ R } 2{\cdot}1 \times 10^{-8}}{\text{B}};$$

i.e., the *reactance voltage* between two commutator bars undergoing commutation is directly proportional to the current in each conductor, the square of the total number of armature convolutions, the number of poles, if series-wound armature (t), the length of armature between end plates, and the speed; and is inversely proportional to the number of commutator bars It is independent of the commutator diameter and thickness of brush.

The armature reactance field is at right angles to the field due to the poles, and can be reduced in various ways by putting reluctance in the path of the cross-magnetisation: (1) either by cutting a slot in the pole-piece, as in Fig. 1, reducing the pole flux very little, but decreasing the cross-magnetisation enormously; (2) by boring out the pole-pieces to larger radius than armature + clearance, as in Fig. 2; (3) sometimes cross-pieces of copper are placed in pole-pieces (Fig. 3).

To limit field distortion due to armature reactance: (1) keep flux density in teeth and pole shoes high, with large air-gap; (2) keep armature ampere-turns per inch periphery down to from 300 to 350 (in turbo-generators the tooth density is kept *low*; about 13,000 to 14,000 lines per square centimetre instead of 21,000 to 22,000)—also the winding should be as symmetrical as possible; (3) if machine be lap-wound, "multipole" equalising rings should be used.

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In addition to the reactance voltage, which cannot be eliminated, although, as before stated, it should be kept as low as possible, there are several points in the constructions which, if not attended to carefully, may cause bad sparking—viz.: (1) Inequality in air-gap, or in magnetic circuit due to bad metal. (2) Unsymmetrical assembly of commutator segments or brushes. (3) Incorrect brush tension (should be 1½lb. to 2lb. per square inch) for carbon brushes (4) Inexact alignment of brushes. All brushes should reach each copper segment at the same instant. (5) Insufficient brush surface (less than, say, 1in per 29-30 amperes), due to their not being properly bedded. This is frequently the case with new machines, and will cure itself. (6) High-voltage machine should have high-resistance brush (hard

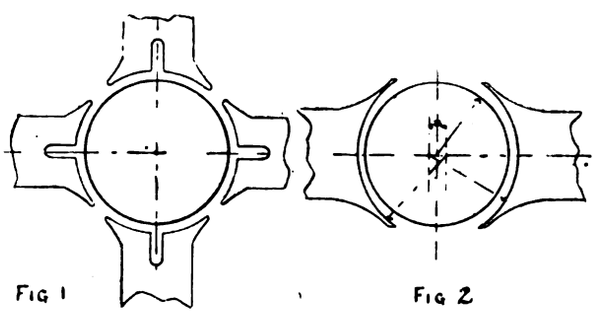

FIG 1

FIG 2

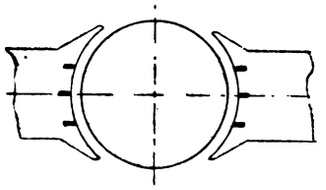

FIG 3

carbon) and low-voltage machine low-resistance brush (soft carbon), but copper brushes for turbo-generators, on account of wear of commutator, due to high speed. (7) Unsuitable copper and mica in commutator. (8) Eccentricity of commutator. If the surface is good and the brushes good this will, however, have little effect, unless the eccentricity is very marked. (9) Rising of commutator bars, due to clamp ring being slack. (10) Inequality of speed of prime mover. (11) Insufficient rigidity in shaft. (12) Want of balance of rotating parts.

I trust these are the points which your correspondent had in mind when asking the question, and not the design of inter-poles, as a machine of this size should not require these except under very special conditions.—R. P.

Answer to No. 1,026 (awarded 7s. 6d.).—The commutation process in a direct-current machine consists in reversing a current in an armature coil of one or more turns in a short interval of time. If the coil had only ohmic resistance the reversal could be obtained, however short the interval might be, by the application of a small reversing voltage just in excess of the ohmic C × R drop in the coil. In practice, the C R effect is completely screened by the fact that the coil always has some self-induction—*i.e.*, a current flowing in the coil sets up a magnetic flux through the coil—so that the reversal of the current sets up a voltage of self-induction or reactance voltage, always acting in opposition to the change of the current and proportional to its rate of change—*i.e*, inversely proportional to the length of time that each coil is short-circuited by the brush. Various approximate methods of calculating the average value of the reactance voltage for a given machine at a given load have been devised (see Hobart's "Electric Motors"), and experience has shown that a really good machine cannot be obtained if the reactance voltage is allowed to exceed the low value of three or four volts. The commutation problem consists in introducing into the coil whilst it is short-circuited by the brush a reversing voltage whose average value is just in excess of the average reactance voltage. This reversing voltage can be introduced (1) by shifting the brushes so that the short-circuited coil is cutting a part of the main pole flux of the right direction and amount; (2) by producing a separate small flux of the right direction and amount by means of reversing or commutating poles placed between the main poles; or (3) by the use of carbon brushes. Method 1 is now practically obsolete, as it involves varying the brush position for every change in load so as to obtain the required increase in flux with increase in load. Method 2 is the most effective at present available It is already employed in all cases of special difficulty, such as steam turbo-generators, variable-speed motors, etc, and is gradually coming into use for ordinary conditions also, as it enables the whole machine to be cheapened considerably. The commutating poles are narrow poles covering two or three slots, and extending over from one half to the whole armature breadth. They are series woun l with a number of ampere-turns on each pole slightly in excess of the armature ampere-turns per pole (about 1¼ × armature ampere-turns), so as to enable a flux in the right direction (which is opposite to that in which the armature tends to produce flux) to be forced into the armature at the commutating points. As the iron of the commutating poles is kept well below saturation, the series winding ensures the practical proportionate rise of the reversing voltage with the reactance voltage, since both are proportional to the output current of the machine, thus producing satisfactory commutation at all loads. The third method (carbon brushes) is by far the most widely adopted at the present time because of its simplicity and great effectiveness in all ordinary cases. Methods (1) and (2) come under the heading of "flux commutation," whilst this third method is based on an entirely different principle, known as "resistance commutation." The reversing voltage in this case is obtained by an automatic increase in the current density under the toe of the brush over the current density under the heel of the brush as soon as the reversal of the current in the short-circuited coil does not proceed at the required rate—*i.e.*, is not half completed when half the brush is passed, three-quarters completed when three-quarters of the brush is passed, and so on. Such differences in current density result in an excess of voltage drop under the toe over that under the heel, and this excess is always a correct reversing voltage. Its possible value is only limited by the permissible rise in current density under the toe of the brush before glowing or burning away of the carbon occurs. Reversing voltages of at least two or three volts are safely obtainable in this way with ordinary carbons. A numerical example will make the action clear.

Suppose the brush has a contact area of one square inch, a contact resistance per square inch of ·03 ohm, and the current from the brush is 40 amperes—*i.e.*, the current in the coil has to be changed from + 20 amperes to − 20 amperes, and the normal current density under the brush is 40 amperes per square inch At the instant shown in

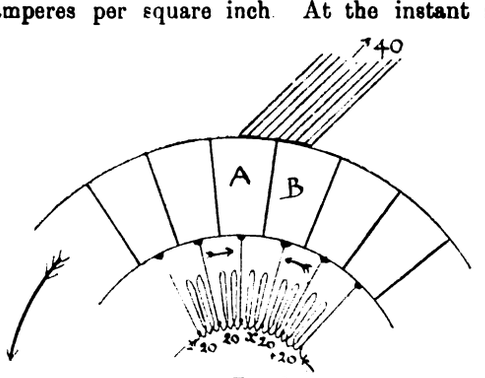

FIG. 1.

Fig. 1 the coil between A and B has completed half the commutation period. If commutation has proceeded properly, the original + 20 amperes in the coil should have just died down to zero before commencing to rise to − 20 amperes. In this case the current in coil = x = 0, and the current flowing into the toe of brush = 20 amperes, and that into the heel of brush also = 20 amperes. Voltage drop to toe = ·06 × 20 = 1·2 volts and to heel = ·06 × 20 = 1·2 also, ∴ there is no net reversing voltage. If, however, commutation has been much delayed, so that x, instead of being zero, is still, say, 10 amperes, the current into the toe = 30 amperes and into the heel = 10 amperes, ∴ voltage drop to toe = ·06 × 30 = 1·8

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and to heel = ·06 × 10 = ·6, or there is a net reversing voltage acting round the coil from A to B of 1·8 − ·6 = 1·2 volts, and this has been attained at the expense of an increase in the current density under the toe of the brush from 40 amperes per square inch to $\frac{30}{·5}$ = 60 amperes per square inch. In this way the greater the delay in the commutation the greater will be the reversing voltage, but also the greater the current density under the toe. Thus, supposing x is still + 10 amperes when three-fourths of the commutation period is completed, then the voltage drop to the toe of brush = ·12 × 30 = 3·6 volts and to the heel = ·03 × $\frac{4}{3}$ × 10 = ·4, giving a net reversing voltage of 3·6 − ·4 = 3·2 volts with a current density under the toe of $\frac{30}{·25}$ = 120 amperes per square inch. It will be clear from this that an actual reversing voltage is obtained merely by means of the brush contact resistance and without the aid of any flux.—Q.

Answer to No. 1,026 (awarded 5s.).—Briefly stated, the condition necessary for sparkless running is that at the instant when the coil passes from under the brush for the above condition there shall be a current in it generated equal in magnitude and sense to the current flowing in the coils which it is going to join. The coil must, therefore, be short-circuited in a field strong enough to generate in it an E.M.F. capable of causing such current to flow. Two factors have, however, to be considered: (1) a greater reversing field is required for an increase in load; and (2) the distortion in the field will increase with the amount of current generated (due to armature reaction) and the

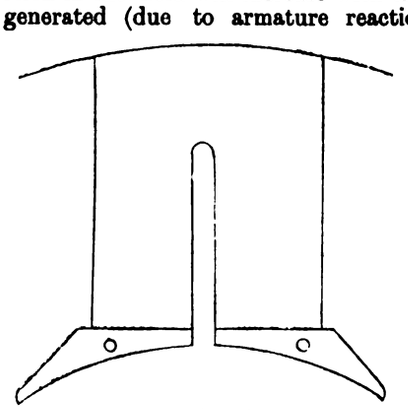


FIG. 1.

reversing field will be weakened. In order to remedy this, an increase in lead of the brushes is required. To obtain a fixed lead—*i.e.*, the same position of the brushes for various loads—various devices have been used. A device known as the pole-ring consists of a thin iron ring or cylinder within the bore of the magnets connecting all the poles together, thus forming a magnetic shunt of more or less reluctance. The effect of this ring is to reduce the distortion due to armature reaction, and so reduce the required shifting of the brushes with changes of load. The cross-section of the iron is made very small. When the machine becomes excited this ring becomes highly saturated, and produces a well graduated fringe of magnetism at each pole-tip.

Another simple method is to cut a deep slot about ½in wide, as seen in Fig. 1, in the centre of each pole. This greatly reduces distortion in the field from the leading to the trailing pole-tip by causing the trailing part of each pole to become more or less saturated when any difference in the flux from the two horns is set up by armature cross ampere-turns. Sparking may be set up also through lack of uniformity in the resistance of armature coils. We know that the current which will flow depends not only on the lines of force cut per unit time, but also on the resistance of the circuit; hence, if the resistance of any one coil is greater than the other, the current induced in this coil will be more than in the preceding one, and so give rise to sparking. Equalising connections may be used to prevent abnormal currents flowing through the brushes. This method, however, will be dealt with in detail in the *Electrical Engineer* in reply to Question No. 1,024.

Finally, for sparkless commutation to be possible without special devices, Mr. Swinburne has shown that the sum of the currents in the exterior conductors of an armature should be less than

$$92{,}000\ \frac{r \cdot l_a \cdot B}{R},$$

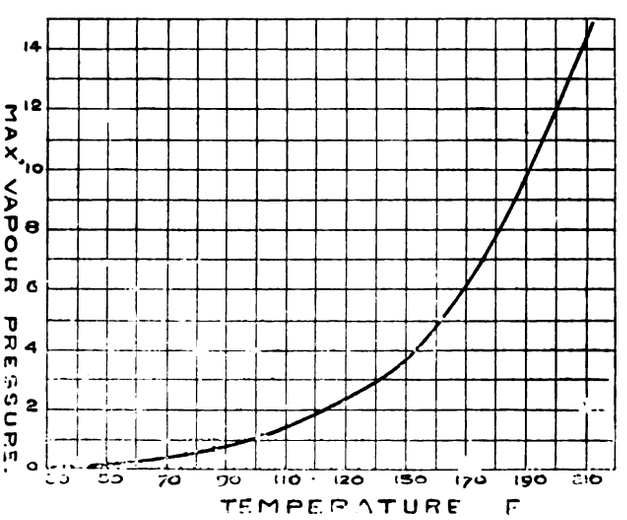
where r = radial depth of core in centimetres; R = external radius of core in centimetres; l_a = radial length of air-gap in centimetres; and B = maximum magnetic induction in armature; and Esson gives for Gramme armatures

$$A \cdot S = 288\ \frac{B \cdot l}{\phi} \times P,$$

where A = current in armature coils in amperes; S = number of coils round the armature; l = length of air-gap in centimetres; P = number of poles; and ϕ = angle subtended at the centre of the armature by the arc of one pole-piece.—OSCAR DINERMAN.

Question No. 1,027.—Explain fully why it is that feed pumps will not work satisfactorily if the supply water is hot and has to be raised any height. What is the best way to overcome the difficulty?

Answer to No. 1,027 (awarded 5s.).—The pump fails to draw hot water so well as cold because the vapour pressure of water increases with the temperature and limits the minimum pressure which it can produce. Consider a closed vessel partly full of water. This water will evaporate until the pressure reaches a certain limit which depends upon and increases with the temperature. When this pressure is reached evaporation ceases, the vapour is said



to be saturated, and the pressure is called the maximum vapour pressure, corresponding to the prevailing temperature. Suppose we have to deal with water at 140deg. F. The maximum vapour pressure at this temperature is 2·9lb. per square inch. A perfect pump would have no difficulty in dealing with any air that might be present, but it would be unable to reduce the pressure in the suction pipe below 2·9lb. per square inch, because as fast as it removed the existing vapour fresh would be formed; therefore, it could only draw water from 28·5ft. instead of from the vacuum limit of 34. Feed pumps are not, as a rule, good suction pumps at any temperature. Owing to the high pressures at which they work, the valves are made strong and heavy, and are often supplemented with springs. In consequence, the difference in pressure between pump barrel and suction pipe must be considerable before they will lift. Apart from this, the small size of the barrel, small lift of the valves, and slow speed render them unsuitable for dealing with large volumes of rarefied vapour. The remedy is to put the feed tank higher than the pump suction, so that the water will flow into the barrel by gravity. In marine practice, where the feed pumps have to deal with water up to 300deg. F., the heater is placed at the top of the engine-room, so that the pumps work under a head of 20ft or so. The curve shown gives the relation between maximum vapour pressure in pounds per square inch and temperature Fahrenheit for water.—J. P.

[Other replies to Question No. 1,027 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,034. Explain the action that takes place in a reverse-current relay, used on an alternating-current system, when set at a certain percentage of full-load current. Why do they not operate at this fixed point, whichever direction the current is flowing, for the system is alternating and constantly changing? Give clear connections of same. Is a relay in use which combines overload as well as reverse-current (any percentage) operations? If so, give connections and explain thoroughly the combined action.—SUB.

1,035. Show a method of estimating approximately the total works cost of a line of dynamos, from, say, 1 kw. to 300 kw., the calculations to be based simply on the kilowatt output in conjunction with the speed, and not from linear dimensions of the armature.—W. H. J.

ANSWERS.

Question No. 1,027.—Explain fully why it is that feed pumps will not work satisfactorily if the supply water is hot and has to be raised any height. What is the best way to overcome the difficulty?

Best Answer to No. 1,027 (awarded 10s.).—The cause of this difficulty is that when water is hot a comparatively slight decrease in pressure causes it to boil, and give off steam. The table gives the boiling points of water under reduced pressure.

Pressure (pounds absolute)	Temperature (deg. F.).
1	102
3	142
5	162
7	177
9	188
10	193

Suppose the feed water is at 180deg. F. If for any reason the pressure on the water as it enters the pump is less than 7lb. absolute, as the piston rises the pressure will be reduced, the water will boil, and the pump will be filled with steam instead of water. On the return stroke of the pump this steam is at less than atmospheric pressure, and has the full pressure of the pump applied to it. It is easily compressed, and the pump begins to knock itself to pieces without passing any water into the boiler. If the water has to be raised any height before entering the pump, the pressure on it, when entering the pump, is reduced. Since the feed water is presumably in an open tank—*i.e.*, open to atmospheric pressure—the pressure on water entering pump is given by 14·7lb. minus the pressure due to a head, H, of water. The value of this head may readily be calculated thus:

Consider a cubic foot of water standing on an area of one square foot. The weight of the water = 62½lb. and the depth = 1ft. ∴ the pressure on the bottom of tank $= \frac{62\frac{1}{2}}{12 \times 12}$ lb. per square inch = 0·433lb.; or a column of water 1ft. high gives a pressure of 0·433lb. per square inch. Hence the pressure on the water in the feed pump = 14·7lb. − (H feet × ·433) lb.

The remedies open for "S. E. T." to use are: (1) to cool the feed water more; (2) to put the pump nearer the level of feed water in tank—if possible, below the level; (3) to raise the water above the feed pump by auxiliary means.

The relative merits of the three solutions can only be considered when the particulars of the problem are known—*i.e.*, the temperature of the water, the height to which it is raised, and the possibility of changing the position of the pump. In some cases injectors might be used for the feed

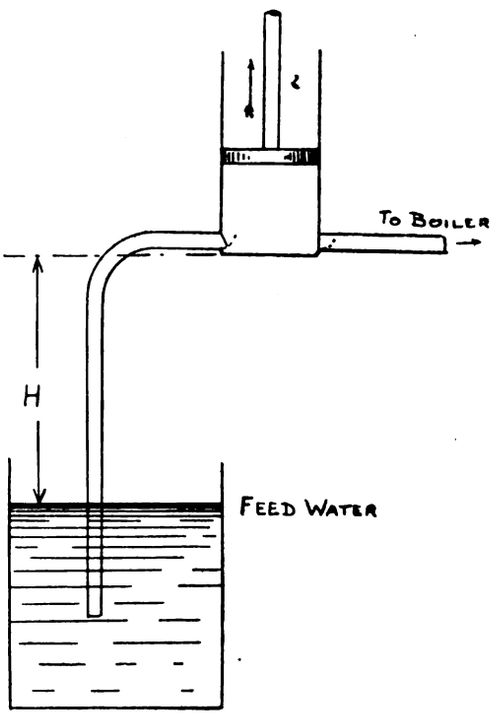

FIG. 1.

water, but it is almost certainly not so in this case, as the maximum temperature allowable for the feed water is 135deg. F. for low pressures and 105deg. F. for high pressures, while the height to which water can be drawn does not exceed 12ft. even with the larger sizes of injector.

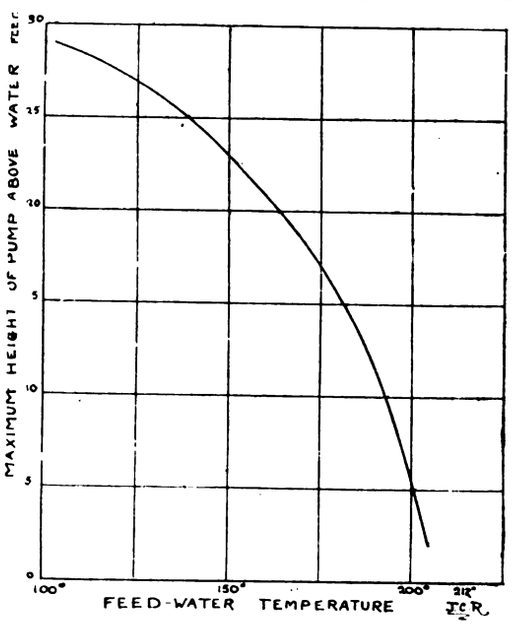

FIG. 2.

The following table giving the maximum height to which water can be raised at different temperatures has been calculated in the manner indicated, allowance being made for frictional losses in the pipes, etc.

Temperature of feed (deg. F.)	Maximum height allowable (feet).
100	29
120	27·5
140	25
160	21
180	15·5
200	6

These heights will be diminished by 40 or 50 per cent. if the pump has to work quickly, or even more if all pipe joints, valves, etc., are not airtight.—J. CAMERON RENNIE.

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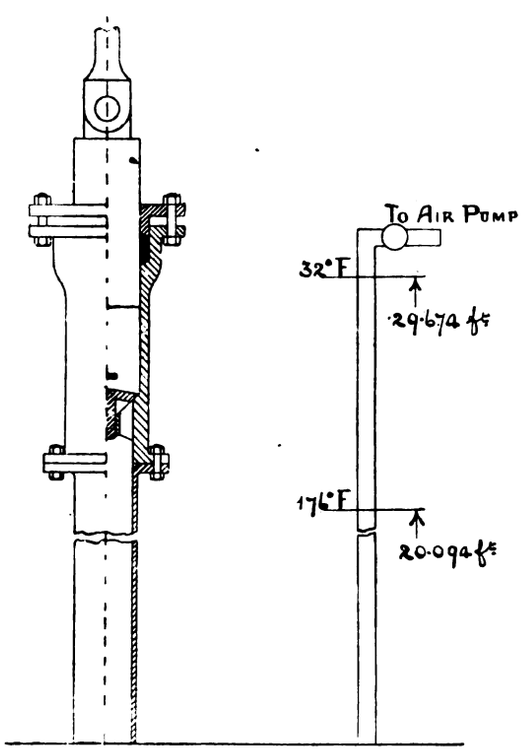
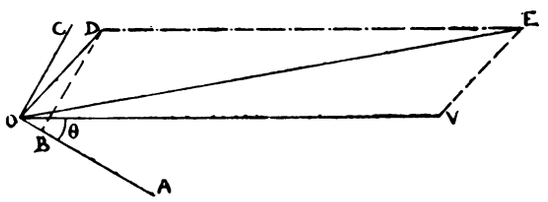
Answer to No. 1,027 (awarded 5s.).—In considering this question let us take the most unfavourable atmospheric conditions—that is, when the barometer reads 28in. of mercury. This means that in a tube which has been exhausted of air the outside pressure of the atmosphere will sustain a column of 28in. of mercury, or $\frac{28 \times 13{\cdot}596}{12}$ = 31·724ft. of water (13·596 is the specific gravity of mercury). Such an experimental tube is shown on the right-hand side of the figure; the tube is placed beside the diagram of pump in order to the more clearly bring out the cause why pump refuses to "draw." Unless water is in contact with its saturated vapour, evaporation is continually taking place, and this vapour exerts a pressure that is constant for any given temperature. Thus, if water is just boiling, its vapour exerts a pressure equal to that of the atmosphere or of the surrounding medium. As the temperature of the water decreases its vapour pressure decreases also, until at 32deg. F. it is only 1·81102in. of mercury. Vapour in contact with water in a closed pipe will be saturated, and, therefore, exert a pressure in accordance with the particular temperature. Suppose the hot water to be pumped has a temperature of 176deg. F., its vapour pressure will be



approximately equal to a column of water 11 63ft. When at 32deg. F. its vapour pressure will be about equal to 2·05ft. of water. Therefore, if water being pumped is at a temperature of 32deg. F., it will rise in an exhausted pipe to a height of 31·724 - 2·05 = 29·674ft., but if at a temperature of 176deg. F. will only rise 31·724 - 11·63 = 20·094ft. It will then be seen that although theory points to a possible height of 29ft. at 32deg F., at 176deg. F only 20ft. can be expected. These heights are marked on the diagram, showing that at the higher temperature water could not possibly reach the barrel of the pump. In practice these figures are considerably modified; it is impossible to have a perfectly airtight plunger, and friction in water passages must be considered. For a pump to work satisfactorily with *cold* water, lift should not exceed 25ft., and for all-round everyday work 15ft. is usually given as the maximum working distance. In practical language we say that the steam from hot water spoils the vacuum and prevents water reaching the pump barrel. The best procedure will be to have a force pump with hot water at same or a higher level than barrel of pump; water will then flow to the pump by gravity. All hot-water pumps should have valves of large diameter, with a corresponding small lift. It is considered impracticable to employ a suction pump for water above 130deg. to 140deg. F.—M. M.

Question No. 1,028.—In connection with a large three-phase power supply system the frequency at the generating station has lately been changed from 50 periods to 40 periods per second. The circuits consist mostly of induction motors supplied from step-down transformers (6,000 to 440 and 6,000 to 2 000). Neither motors nor transformers have been altered to suit the changed frequency, nor have the generators at the power station, and these latter have to be run very much over-excited in order to keep the voltage as high as desired at the reduced speed. What effect is this change of frequency likely to have on the power factor of the system? Give reasons.

Best Answer to No. 1,028 (awarded 10s.).—It will, perhaps, be well to first consider the alternators alone, and to entirely neglect the external circuit. In the diagram the vector O V represents the voltage across the alternator terminals, and the vector O A the current in the armature, which lags behind the terminal voltage by some unknown angle θ. Along the line O A we will lay off a length, O B, to represent the voltage required to overcome the resistance of the armature. At right angles to O A we may lay off a line, O C, to represent the reactance voltage.



The resultant of these two latter voltages—viz., O B and O C—gives the impedance voltage, O D. If we add this voltage to the voltage O V vectorially, we obtain the total voltage, O E, which must be generated by the machine. We will suppose that the machines have been running at 50 cycles, and that at a time when only one machine was at work its speed was decreased, and the field increased so as to to reduce the periodicity to 40 cycles and to maintain the correct voltage. The question which at present we have to decide is whether, neglecting the load, will the angle ϕ remain constant. The line O V we know to be the same, and the line O C, representing the reactance voltage, is given by

$$2 \pi n l c,$$

where n is the periodicity, l the inductance, and c the current. By the change we have made n has been decreased, but the number of lines have been correspondingly increased, so the line O C remains practically the same. Further, we know that the angle B O D is such that the tan of this angle is equal to

$$\frac{2 \pi n l}{R},$$

this angle being independent of the power factor of the load. Considering one machine, therefore, and neglecting the external load, this alteration cannot alter the angle θ. If we parallel another machine with the one already at work and still neglecting the external load, the power factor still remains unaltered by the increased excitation and reduced speed. It may be pointed out that over-exciting two machines an equal amount is a different thing to over-exciting one machine that is running in parallel with others while a constant 'bus-bar voltage is maintained. In the latter case, if we over-excite one of the alternators, the current will lag behind the E.M F. Conversely, if we weaken the field of one of the alternators an undue amount, the current will lead. In the case under consideration, however, the conditions are different, for all the alternators have been excited to maintain the voltage at reduced speed. From these considerations it will be seen the effect of reducing the periodicity will not alter the power factor if we neglect the external load. We will now consider the effect when the alternators are connected to an inductive load, such as transformers and induction motors. The induced E.M.F. in the primary windings of a transformer is given by the formula

$$\frac{4{\cdot}44 \, N \, n \, T}{10^8},$$

where N is the magnetic flux, n the periodicity, and T the number of turns. With the same voltage applied to the

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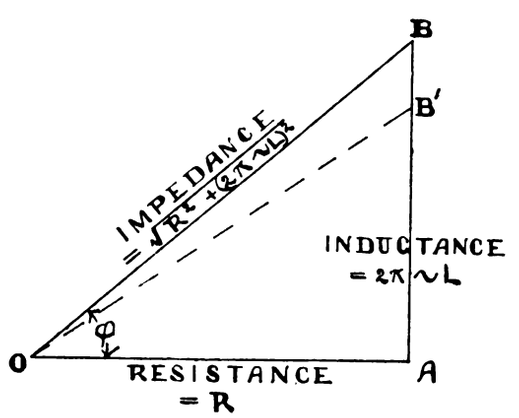
primary terminals as originally but at a lower periodicity means that we get a reduced back E.M.F., and more current must flow into the windings to provide the requisite flux for the secondary voltage, for the rate of change of the magnetic lines have now been reduced, and the magnetising current is, therefore, greater than before. Now, the magnetising current of a transformer is in phase with the magnetic flux whilst the induced pressure set up lags behind the magnetism, and, therefore, behind the current by 90deg., and as the induced pressure is exactly opposite in phase to the impressed pressure, it follows that the magnetising current is approximately in quadrature with the impressed E.M.F. It will be seen, therefore, that by reducing the periodicity the power factor will be somewhat reduced, for what applies to the transformers also applies to the motors. Further, it is evident that the efficiency of both motors and transformers will be lower than formerly.—CALCULUS.

Answer to No. 1,028 (awarded 5s.).—The power factor, or cosine of the angle of lag, will be altered by the reduced frequency; this is apparent from a graphical representation. In the figure A O B is angle of lag, therefore the power factor = cos ϕ

$$= \frac{R}{\sqrt{R^2 + (2\pi \sim L)^2}},$$

where R = resistance in ohms, ~ periodicity, and L = inductance in henrys. Now the only factor that has been altered is the periodicity (~), and this has been reduced from 50 to 40; therefore, under the new arrangement, A B will only have four-fifths of its former value. The inductance will then become some such value as A B', the



exact amount depending upon the relative values of the other factors. The angle A O B' being less than the angle A O B its cosine will be greater; consequently the power factor will be improved, becoming nearer unity. If generators can be sufficiently excited to give normal voltage at the reduced speed, the useful current will be the same, but total current will be less, owing to the reduction in the wattless component. Motors will then have approximately the same torque, but only run at four-fifths the previous speed. The total output of plant will be less in proportion approximately to the reduced speed of engines. Whether the alteration will result in an all-round improvement will depend on factors not given in the question. For instance, hysteresis losses will be less, as these vary directly as the periodicity. Taking into consideration the improved power factor and conveniences of running engines and generators at a lower speed, any decrease in total output may be more than balanced in other directions.—M. M.

Question No. 1,029.—In designing compound balancers with cross-connected fields, should the series ampere-turns only balance out the armature reaction of the machines, or should they have any compounding effect greater than this? If so, how much?

Best Answer to No. 1,029 (awarded 10s.).—As every central-station engineer knows to his discomfort, a shunt-wound balancer, or one compounded to overcome armature reaction alone, is not by any means automatic, and considerable hand regulation is necessary if a balance is to be maintained. The reason for this is found in the fact that it is the feeder voltage that he wants to balance, and not the station voltage, while it is this latter pressure which the balancer (if compounded for armature reaction alone) would balance. But as the load on the two sides of the system becomes unequal so the drop of volts in the feeder also varies, causing an unbalanced voltage at the feeding point even though the balancer maintains a true balance at the station. It, therefore, becomes necessary to compensate for this unequal drop in pressure, and to do this the balancer must be over-compounded Now, the current in the middle wire (the out-of-balance current) will be proportional to this inequality of volts drop, and on this fact depends one of the systems of winding for an automatic balancer.

There are two distinct methods of compounding, each having its advantages. Figs 1 and 2 show these diagrammatically. In both of these arrangements the fields are cross-connected. In Fig. 1 the series winding is on the

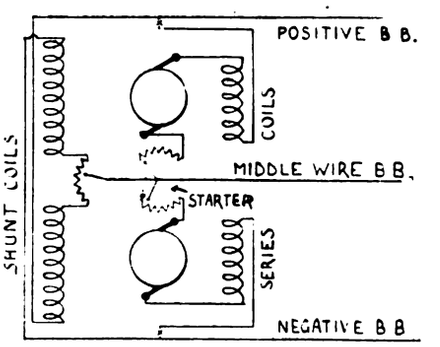


FIG. 1.

outer, and carries the whole of the current taken, or being produced by each machine of the balancer. This winding must be such as to compensate for armature reaction, and also the loss of volts between station and feeding point. This method is quite satisfactory, and is employed in many places with good results. Fig. 2 shows the better method of compounding. In this case the middle wire, instead of being brought straight through to the middle-wire 'bus bar on the switchboard, is carried to the balancer and wound round the field coils in such a direction as to enable the current flowing in it (the out-of-balance current) to produce a field in opposition to or in conjunction with the shunt coils according as the out-of-balance current is flowing in one direction or the other. Thus, if the positive side becomes the most heavily loaded, the current in the middle wire will flow in the direction of the arrow, and must increase the field of the positive machine and decrease that of the negative to such an extent as to compensate for armature reaction and feeder volts drop. Some engineers

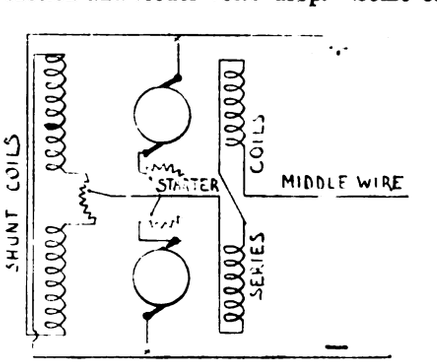


FIG. 2.

prefer to combine the two systems, having two series windings, but this, I think, introduces unnecessary complications and costs, and is better on paper than in the engine-room.—BALANCE.

Answer to No. 1,029 (awarded 5s.).—Speaking generally, in designing compound balancers with cross-connected fields the compound windings should do more than out balance the armature reaction of the machines. Consider first a shunt-wound balancer without cross-connected fields, and assume that the shunts are so adjusted that the machines give equal voltages when both sides of the system are loaded to the same extent. In this case the difference in pressure on the two sides of the system

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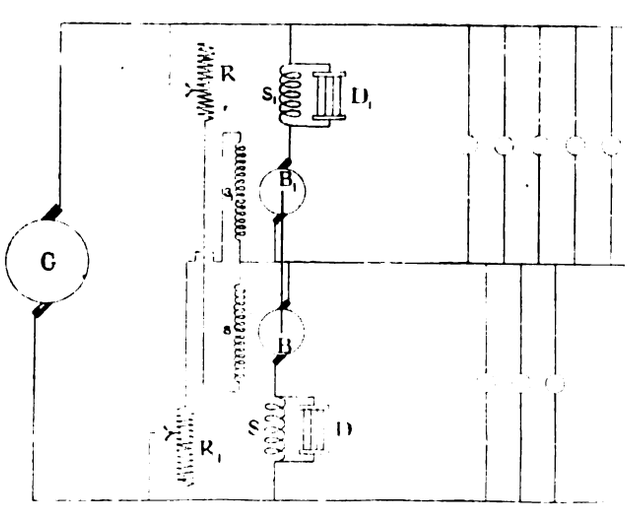
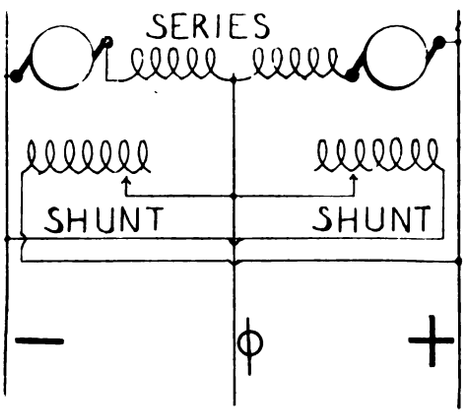
when the full out-of-balance condition exists is due to three things: (1) The ohmic drop in the armature windings. This tends to make the dynamo give low volts, and to make the motor run too slowly. (2) The armature reaction, which tends in the case of the motor to raise its speed and in the case of the dynamo to lower its volts, these two effects tending to cancel one another. (3) The drop in voltage on the heavily loaded side weakens the dynamo field. Suppose, now, we cross-connect the fields, the resistance drop remains the same, but any drop on the dynamo side weakens the field of the motor, and so raises the speed, and consequently the dynamo volts. It is evident from these considerations that, in order to maintain even the 'bus-bar volts at the correct value automatically by means of compound-wound balancers, the compound windings must not only compensate for the reaction of the armature, but also the C R drop in the armatures, taking into account the field windings being cross-connected as stated in the question. By suitably proportioning the series windings it is possible to entirely compensate for the drops in pressure due to the causes mentioned above, and, if necessary, also compensate for the drop in the middle wire due to the out-of-balance current. It is well known that in central stations it is the pressure at the feeding points which has to be balanced, and not the pressure at the 'bus bars, pilot wires being brought in from the various feeding points to the switchboard. To sum up, therefore, in practice, as, for example, a balancer used in a central station to maintain the proper voltage on the two sides of the network, the compound windings should first compensate the reaction due to the armatures; secondly, the C R drop in the armatures; and, thirdly, the C R drop in the middle wire. It is, of course, understood the series windings of both machines are connected in the same way as compound dynamos, so that when one machine acts as a motor, the series winding on that machine opposes the magnetisation due to the shunt, and so assists in increasing the speed while the field of the other machine which is acting as a dynamo is strengthened.—CALCULUS.

Answer to No. 1,029 (awarded 5s.).—With regard to armature reaction, it may generally be considered that the armature reaction of the booster acting as motor neutralises the armature reaction of the booster acting as generator. In the one case the generator tends to give a lower voltage, in the other the motor tends to run faster. There is, however, the C R drop in armature windings that can with advantage be met by compounding. As to whether the series winding should just keep the voltage normal, or whether over-compounding should be resorted to, will depend on the circumstances of each particular case.



There may be certain work connected to the supply, or the resistance of mains may be such that extra series turns will be advisable. In any case, the best procedure will be to over-compound each of the two boosters, and by means of a diverting shunt across the series winding regulate compounding to the best proportion. In the figure D D_1 are diverting resistances on series, S S_1 series winding, s s_1 shunt winding, R R_1 regulating resistances in shunt circuits. As shown, B is motoring and B_1 generating. The series on each booster is connected as in an ordinary generator; thus motor will have its field weakened, and, therefore, tend to run faster; generator to have its field strengthened, and, therefore, tend to an increased voltage. Opinions are somewhat divided as to advantages from compounding these balancers, but the addition of a diverting arrangement places another means of regulation in the hands of the station engineer.—M M.

Answer to No. 1,029 (awarded 5s.).—Compound cross-connected balancers are connected up as shown in the diagram. If the direction of the current flowing in the



shunt and series coils be traced out, it will be found that when one machine starts to work as a motor and the other as a dynamo that the series turns in the motoring machine *oppose* the shunt turns, thus causing the resultant field to be weaker and the machine to tend to run faster, so driving the generating machine at a higher speed and keeping up its volts, which are also further kept up by the series coils on the generating machine. So that this method of connection gives us an already weakened field on the motoring machine (due to its shunt being excited from the other and heavily loaded side), which is still further weakened by the series coils opposing it. Thus, if sparking on the motoring machine is to be avoided, then the *shunt* field must be so designed that when at its weakest—*i.e.*, when the load on the opposite machine is heaviest—it must be strong enough to keep the armature reaction within the sparking limits. As this field has also to overcome the weakening effect of the opposition of the series coils, it follows that the series coils must not be designed to produce any very great effect, or else the shunt coils will have to be proportionally strengthened in order to keep down the armature reaction on the motoring machine, thus using material for nothing, whilst the volts on the generating machine would tend to rise too high. The result is then that the shunt fields must be designed so as to always predominate the series fields and to do most of the work. All that is required of the series fields is that they allow the shunt fields to take care of the drop due to the resistance of the armature windings and the armature reaction, whilst not being called upon to quickly readjust the voltage on each side of the system. This quick adjustment the series coils supply by at once accelerating the speeding up of the motoring machine and strengthening the field, and so raising the volts of the generating machine. The series coils then are not used for overcoming the armature reactions, which must be done by the shunt coils; they are used to take the place of hand regulation, which is so very necessary with simple cross-connected shunt-wound balancers. The series coils should be designed so that the voltage on the heaviest loaded side is kept about 2 per cent. higher than that on the light loaded side at times of heaviest out of balance.—W. T. WARDALE.

THE WESTERN ELECTRIC COMPANY, North Woolwich, London, E., have issued two price-lists, which should be in the hands of our readers. One of these is an abridged price-list of "Non-Association" vulcanised electric light wires and cables, flexible cords, etc., while the other contains the "Association" prices for the same class of wires, as well as for electrolier wire, etc. The prices stated in the lists are net, but the discounts will be quoted on application.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,036. An 80-volt 50-kw. exciter commutator having a surface speed of 2,500ft. per minute gives sparking trouble, the fault being that the trailing end of one of the brushes becomes coated with copper. This causes sparking all round, with any kind of load, though when the brushes have been newly bedded the machine is sparkless on all loads. Different brushes are affected, the trouble not being traced to one or two only. State the reasons for the above, and the probable remedy.—A. R. C.

1,037. Explain the principles of construction of "slow-speed" continuous-current motors, taking as an example one, say, of 2 h.p. working at a creeping speed in a 110-volt circuit, as compared with an ordinary motor. Give such particulars as will make answer fully self-explanatory, such as dimensions of respective armatures and fields, amount and gauge of wire used, the ampere-turns, ohmic resistance, current consumed at full load, etc. Also mention the starters required for each.—RHEOSTAT.

1,038. Two or more three-phase transformers are connected in mesh on the primary to the same 'bus bars, the secondaries being star-wound and the neutral points not earthed. If a voltmeter be placed across phase 1 on one of them and phase 2 or 3 on the other, should the voltmeter give a reading? If not, explain why.—BETA.

ANSWERS.

Question No. 1,030.—With reference to three-phase motors, please explain the difference between the following statements: The intensity of the resultant revolving field is equal to 1·5 times the amplitude of one of the component alternating fields; and the resultant magnetomotive force of three phases is equal to twice the magnetomotive force of one phase.

Answer to No. 1,030 (awarded 7s. 6d.).—I take it that "A. D." does not think these two statements are in accordance with one other. If so, it may be stated at once that this is not the case, as they refer to entirely different circumstances. The first statement concerns a rotating vector of constant value, and the second concerns a scalar quantity following a sine law as regards its magnitude.

Let us consider the first statement. Assume we have a ring winding on a closed circular iron core with tappings at three equidistant points which are connected to a three-phase supply. To consider the field produced by each part, we must take into account the time phase of the current and the direction of the field as determined by winding. Taking coil *a b*, this will produce a field horizontal in direction and of value N sin $2\pi f t$, represented by O X in vector diagram. Coil *b c* will produce a field always in direction O Y and of value N sin $(2\pi f t + 240\text{deg.})$. Also, coil *c a* will produce a field in direction O Z and of value N sin $(2\pi f t + 120\text{deg.})$. Taking the horizontal components of these, we get

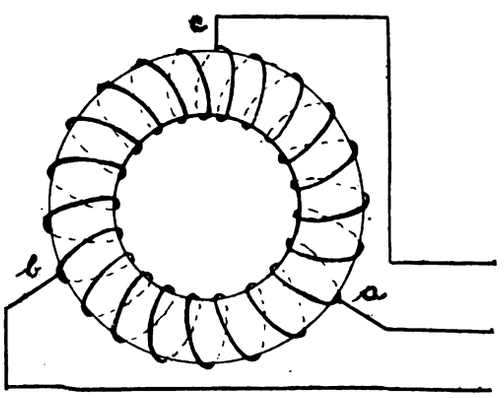
$$\text{N sin } 2\pi f t - \text{N sin } (2\pi f t + 120\text{deg.}) \cos 60\text{deg.} - \text{N sin } (2\pi f t + 240\text{deg.}) \cos 60\text{deg.},$$

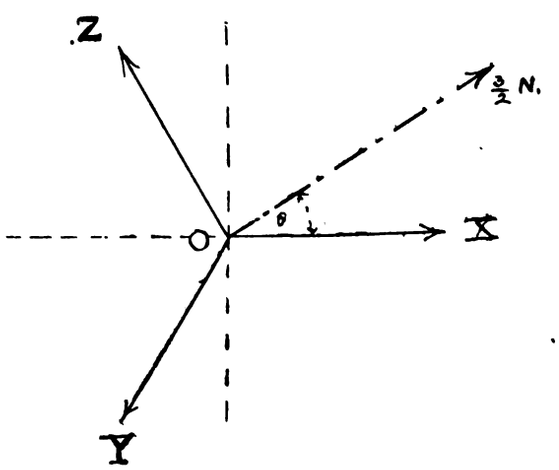
which equals $\frac{3}{2}$ N sin $2\pi f t$. Now, taking vertical components, we get

$$\text{N sin } 2\pi f t \cos 90^\circ + \text{N sin } (2\pi f t + 120^\circ) \cos 30^\circ - \text{N sin } (2\pi f t + 240^\circ) \cos 30^\circ,$$

which equals $\frac{3}{2}$ N cos $2\pi f t$—that is, there are *at the centre* of the ring two alternating fields of the same maximum value but differing in time phase by an angle (90deg.) which is the supplement of the angle of their directions (90deg.). Therefore, there will be at the centre a rotating or pivotal field equal in value to $\frac{3}{2}$ the maximum value of the field produced by any one phase.

Now, consider the second statement. Above we have combined a magnetic field at a point with other magnetic fields acting at the same point, but now we must consider a field in an air-gap whose value along the air-gap follows a sine law as closely as the windings and teeth will allow. The part between two points of zero field is one pole.





Consider the centre point of a pole. The ampere-turns producing it are less than three times the ampere-turns of one phase, because the currents are not at their maximum value at the same time, but it is greater than 1½ times, as in the first statement, because here we have three sine functions which are not acting at 120deg. apart in space, but acting along the periphery of a stator in a more or less circular direction, and the phases overlap. When one phase is at its maximum value, the total M.M.F. due to the three phases is $1 + \frac{1}{2} + \frac{1}{2} = 2$ that of maximum of one phase. Again, when this phase has value ·866 of maximum, another phase has value ·866, and the third phase zero—*i.e.*, total M.M.F. acting 1·732. The mean value for the M.M.F. is, therefore, taken at 1·9 or 2·0 times the M.M.F. of one phase.—F. CLARK.

Answer to No. 1,030 (awarded 7s. 6d.).—The two statements in this question will be best understood by referring to the figure, where O A, O B, O C represent the three alternating fields of the three-phase motor, which differ in phase by 120deg. from one another. The particular instant is chosen, for purposes of illustration, when O A = O B. In order to satisfy the three-phase relation, O A + O B + O C = O, it is evident that O C is twice the value of either O A or O B at the instant considered. Further, O C has its maximum value at this instant. O X is the resultant of the two alternating fields, O A and O B. As the windings which produce the three alternating fields in the motor are all connected in the same sense, the direction in space of the three fields must be the same. O X must, therefore, be reversed to bring it into the same direction as O C. Let O X_1 represent O X reversed. Adding O X_1

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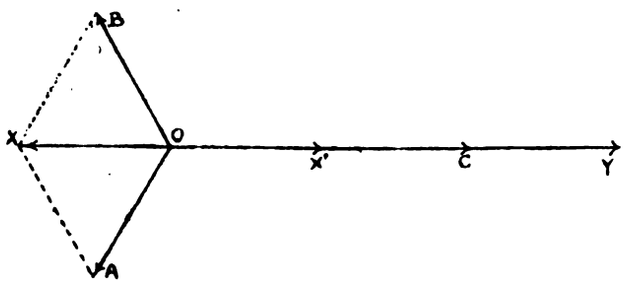
to O C, we obtain O Y as the resultant revolving field, which is evidently 1·5 times the value of O C. As stated above, O C has its maximum value at the instant considered.

Taking the second part of the question, referring to the magnetomotive forces of the three phases, it should be noted that M.M.F. is proportional to the ampere-turns of the phases, and consequently to the amperes, since the turns are constant. In the figure let O C represent the maximum instantaneous value of the amperes in one phase.



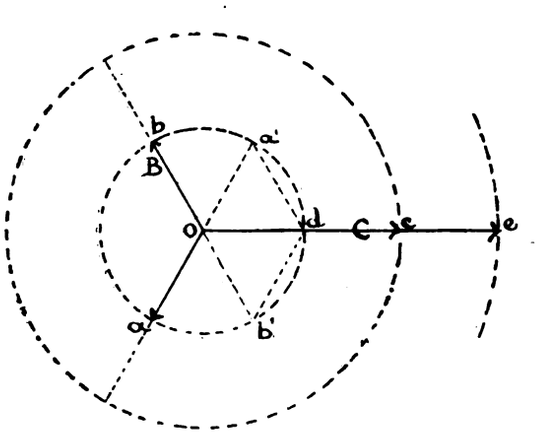
The R.M.S. value of the amperes = maximum value $\div \sqrt{2} = 0{\cdot}707 \times$ maximum value. O Y has already been shown to be the resultant revolving field, and has a value 1·5 times O C. In this case O Y represents the resultant M.M.F. of the three phases.

Now, R.M.S. value = 0·707 when maximum value = 1·0 and resultant value = 1·5.

$$\therefore \frac{\text{Resultant}}{\text{R.M.S}} = \frac{1{\cdot}5}{{\cdot}707} = 2{\cdot}12.$$

—B. R. S. L.

Answer to No. 1,030 (awarded 5s.).—The magnetising forces of the individual phases of a three-phase motor give a theoretical resultant magnetising force approximately 1·5 times the maximum magnetising force of any one phase. This value is based on the assumption that the three phases are spaced equidistant at an angle of 120deg. from one another, and carry sinusoidal currents differing in phase by 120deg. The vector diagram shows how the



above result is obtained, and in which it is assumed that the magnetising forces of the coils of the three phases A B C are of equal value. If we consider at any one instant when the currents in the coils of A and B are of equal value, then the current in coil C will be twice the value of that in either of the other two, in order to satisfy the three-phase relation. Thus the magnetising forces of coils A and B can be represented in magnitude and phase by the lines O *a* and O *b* respectively, while that of coil C will be represented in magnitude and phase by the line O *c*, this latter vector being twice the length of either of the other two. Now, the direction in space of the three magnetising forces is the same, for the armature coils of the machine are, of course, connected in the same sense; consequently the lines O *a* and O *b* must be produced to O *a'* and O *b'*, these two lines thus representing the magnetising forces of coils A and B in magnitude, phase, and direction. Their resultant is at once seen to be O *d*, so that the total resultant magnetising force is given in magnitude by the length of line O *c* plus the length of line O *d*—namely, O *e*—or, what is the same thing, the resultant magnetising force of the three phases is 1·5 times that of any one phase. Now, the above value of 1·5 is only theoretically correct, as it has been assumed that the three sine functions were compounded vectorially 120deg. apart; in practice, however, the coils are more in the order of a straight line as arranged on the periphery of the three-phase stator core, and, of course, the coils in each phase overlap one another. In view of this, the mean value of the resultant magnetising force is found to be about 1·9 times and an instantaneous maximum of about 2·7 times that of any one phase. The proof of these values can be obtained from any standard text-book on the theory of alternating-current motors. It should also be borne in mind when considering a three-phase motor that the magnetising effect of the stator is largely dependent on the currents in the rotor windings, as well as the stator currents.—K.

Answer to No. 1,030 (awarded 5s.).—The two statements referred to in this question are, of course, contradictory, since we may assume that the reluctance is the same at all points of the air-gap of an induction motor, and the flux is, therefore, proportional to the M.M.F. The first statement is true if it be assumed that the distribution of the winding is sinusoidal—that is to say, if we assume that with direct current flowing in the windings the curves showing the intensity of M.M.F. along the periphery of the stator would consist of three sine waves, as shown in

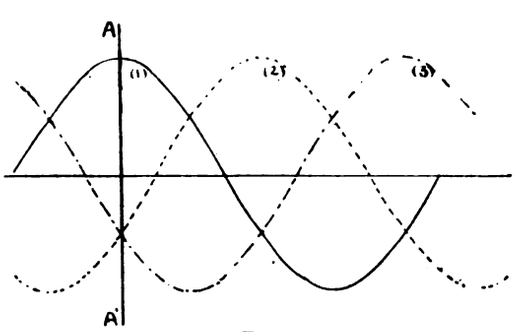


FIG. 1.

Fig. 1. Now, if we consider the ordinates at A A', the ordinates of phase 1 is the maximum, P N, while those of phases 2 and 3 are half the maximum, and in the opposite direction. But a glance at the "rotating" diagram of the currents (Fig. 2) shows that when current in phase 1 is a maximum currents in phases 2 and 3 are at half their maximum value, and in the opposite direction. Hence, if these currents are flowing in the (hypothetical) winding

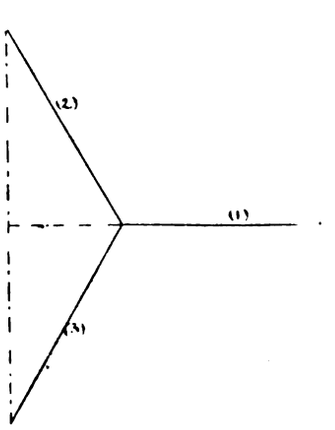


FIG. 2.

considered, then when the current in the first phase is a maximum the M.M.F. at A A' will consist of: (1) the maximum M.M.F. in phase 1; (2) $-\frac{1}{2}$ current in $-\frac{1}{2}$ winding = $+\frac{1}{4}$ M.M.F. in phases 2 and 3; of (1) maximum current in maximum winding = maximum M.M.F. in phase 1; (2) $-\frac{1}{2}$ current in $-\frac{1}{2}$ maximum winding = $+\frac{1}{4}$ M.M.F. in phase 2; (3) $-\frac{1}{2}$ current in $-\frac{1}{2}$ maximum

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winding = + ½ M.M F. in phase 3. The total M.M.F. is, therefore, 1·5 times that due to one phase only.

The second statement—that the M.M.F. is twice that due to one phase—refers to the case of windings consisting of equidistant conductors connected so as to give a M.M.F. diagram of the shape shown in Fig. 3 when continuous current is flowing in all three phases. In this case, if we consider the ordinates at A A', when the current in phase 1 is a maximum the total M.M.F. consists of (1) maximum current in maximum winding in phase 1; (2) – ½ current in – maximum winding = + ½ maximum M.M.F. in phase 2;

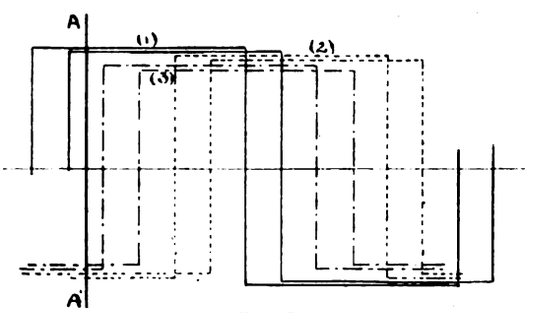

FIG. 3.

(3) – ½ current in – maximum winding = + maximum M.M.F. in phase 3. The total is, therefore, *twice* the M.M.F. due to one phase only.—J. P.

Question No. 1,031.—Discuss and explain the blow-out action of the magnetic field on the electric arc.

Best Answer to No. 1,031 (awarded 10s.).—The blow-out action of the magnetic field on the electric arc can be explained by a consideration of the "ether theory" of electricity and magnetism. The ether is an imaginary medium supposed to pervade all space, and capable of occupying with matter the same space at the same time. Its chief properties are: (1) imponderability; (2) incompressibility; (3) perfect elasticity. The ether theory states that electricity and magnetism are both manifestations of the ether: a current of electricity being ether in translation and magnetism being ether in rotation. Having, according to the theory, the same medium as a basis, it follows that electricity and magnetism are mutually convertible. This we now know to be the case since Faraday's great discovery of electromagnetic induction. Further, it was Faraday who gave the name "lines of force" to the lines along which the ether particles are assumed to set themselves, and around which lines as axes the particles are assumed to spin. In spinning on the lines of force as axis the particles are assumed to swell out circumferentially, thus increasing the pressure at right angles to the direction of the lines of force. The volume of the ether particles being assumed constant, it is evident that the pressure is decreased in the direction of the length of the lines of force—in other words, a line of force acts somewhat as a stretched elastic band, and tends to shorten itself. Returning to the question, we may, instead of the words "electric arc," read "a current-carrying conductor." The electric arc is composed of a stream of hot air and metallic particles joining the two points of an electric circuit, at which the said circuit has been broken, the said two points being originally in contact. The electric arc can produce around itself lines of force in the same way as a current-carrying conductor, and it is this property that is taken advantage of in blowing out the arc.

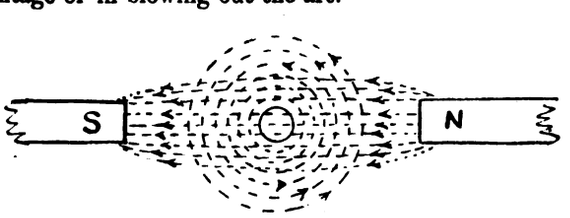

FIG. 1.

In Fig. 1 let the full-line circle represent a cross-section of the conductor standing at right angles to the plane of the paper. N and S are the north and south poles respectively of a magnet or of separate magnets. When there is no current in the conductor the lines of force pass from N to S, as shown by the straight and slightly curved dotted lines. More strictly speaking, we should say that these dotted lines indicate the axes upon which the ether particles spin. The arrows indicate the direction in which the lines are supposed to pass—*i.e.*, from N to S. The direction of rotation of the ether particles fixes up the direction of the arrows, but we will not consider that convention here. If a current flowed in the conductor removed a sufficient distance from the poles N and S or other magnetic field, the lines of force around the conductor would be represented by the dotted circles. Now let the conductor carrying a current be placed between N and S, as shown in Fig. 2, and suppose the current flowing

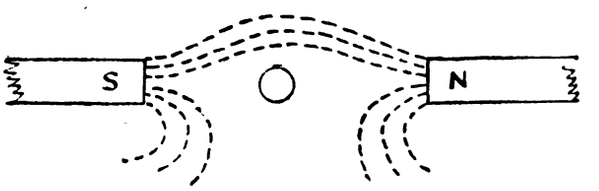

FIG. 2.

towards the observer. The direction of the circular lines of force (when conductor is away from N and S) is shown by arrows (Fig. 1). It will be seen in Fig. 2 that the lines of force due to current and the poles N and S are in the same direction at the top of the conductor but in opposite directions below the conductor. The effect of this is that the field is strengthened above the conductor and weakened below it, as shown in Fig. 2. Remembering that lines of force tend to shorten themselves in the direction of their length, it is evident that the conductor will experience a downward pressure, and that in the case of the arc it would be "blown out" downwards.—B. R. S. L.

Answer to No. 1,031 (awarded 5s.).—In considering the question of the action of a magnetic field on an electric arc, it is thought that the whole matter may be rendered clear as soon as one clearly appreciates how an arc is caused. As is perfectly well known, an arc is a flexible and extensible conductor formed across two points in an electric circuit when (*a*) the voltage between the points is sufficient to pierce the insulating layer separating them, or (*b*) when the points are brought into contact to start a current flow and then separated. After one has clearly appreciated the fact that an arc is really an exceedingly flexible conductor, one would naturally imagine that it would behave as all other conductors carrying current. Such, as a matter of fact, is found to be the case. For example, a field is set up by the current which is capable of acting on, or being acted on by, any other field situate near it, and the flexible conductor or arc tends to move. These and the like laws are perfectly well known as applied to ordinary conductors, and they need not be further dealt with here. As applied to the arc, what happens is that with a gentle field deflection of the arc takes place in a direction—with the magnet arranged for a cross flux—normal to its ordinary course; the arc, therefore, lengthens, and the voltage rises. If the field is increased, the deflection and voltage also increase, until the arc breaks or blows out. This blow-out action of the arc is largely used at the present day in connection with motor and like switch work, and also in connection with arc lamps of the Bremer type. Some years ago its action was proposed as a means for producing electric blow-pipes, but this has led to nothing practically. As a matter of fact, the idea of utilising the blowing or deflecting action is very old, and experiments were made on the matter by Davy between 50 and 60 years ago.

Although the electromagnetic action of the arc is now so much utilised, very little experimental data on the subject going right into the effects of fields of different strengths, etc., have been published. In fact, the most exhaustive experiments of which the author is aware are those due to Marling, which have not yet been published in English. These experiments were made on continuous-current arcs arranged vertically, a cross field being produced by a solenoid energised by accumulators. A number

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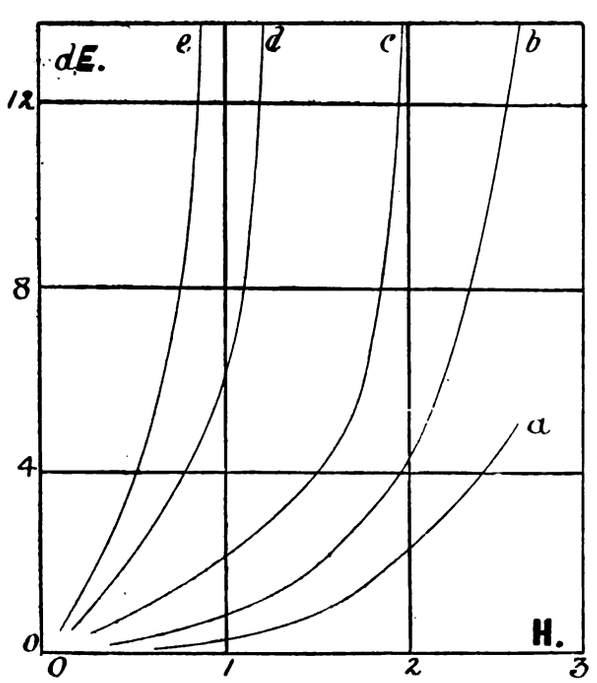
of series of experiments was undertaken with varying field strengths, voltages, and lengths of arc. From these the following set is selected as being typical of the results obtained. Measurements of length of the normal arc, etc., were made by measuring the length of the image of the same cast by a lens on a screen, and the lengths of the deflected arc by noting the increase in voltage due to the lengthening, and noting the corresponding value from curves. The arcs were formed between solid carbon electrodes of 8·2mm. diameter on a 220-volt circuit with a 20-ohm resistance in series. They were adjusted at various lengths for corresponding voltages. The magnet was 7·4cm. long, 9cm. outside diameter, 2cm. inside diameter, and had 465 turns capable of taking six amperes at a pressure of 16 volts. Table I. shows the results obtained from this set of experiments, E being the actual voltage and d E the increase due to deflection.

TABLE I.

H. Field in dynes per sq. cm.	E					dE				
	a	*b*	*c*	*d*	*e*	*a*	*b*	*c*	*d*	*e*
0	64·0	73·7	83·5	93·2	103	—	—	—	—	—
0·36	·2	·9	84·1	94·6	105	0·1	0·2	0·6	1·4	2·3
·73	·4	74·2	85·2	96·6	110	·2	·5	1·7	3·4	6·6
1·10	—	74·8	86·1	101	220	·4	1·1	2·6	7·7	117
·28	·8	—	—	107	—	—	—	—	13·5	—
·46	—	75·5	87·3	220	—	·8	1·8	3·8	127	—
·64	—	—	88·4	—	—	—	—	4·9	—	—
·82	65·6	76·6	90·6	—	—	1·6	2·9	7·1	—	—
2·00	—	—	220	—	—	—	—	136	—	—
·19	66·8	78·1	—	—	—	2·8	4·4	—	—	—
·55	68·8	84·4	—	—	—	4·8	10·7	—	—	—
·59	—	220	—	—	—	—	146	—	—	—

From the table and from the curves it will be seen that the voltage increase, and consequent lengthening of the arc, increases more or less slowly at first on an increase of field strength, but takes a fairly sharp turn, and then



increases suddenly to the full circuit voltage—that is, until it breaks. It will also be seen that the various points of change themselves lie on a curve indicating a relation between the action and the normal voltage.—L. R.

Answer to No. 1,031 (awarded 5s.).—If any conductor carrying a current be placed in a magnetic field, the conductor will tend to move across the field unless the magnetic lines composing the field are parallel to the conductor, and the direction of motion will be at right angles both to the conductor and to the magnetic lines. Similarly, if the flame of an electric arc (which may be considered as a current-carrying conductor of extreme mobility) is placed in a magnetic field, the arc will move across the field, and thus be distorted. The tendency is for the arc to travel across the magnetic lines until completely out of the field of the magnet, but this is opposed by the tendency of the arc to shorten itself—*i.e.*, to take the path of least resistance between the two electrodes. The actual result, therefore, is that the arc assumes a curved shape, travelling across the field until the forces tending respectively to shorten it and to stretch it are in equilibrium. The amount of the magnetic drag acting on the arc per centimetre length of arc when it is at right angles to the field is given by the formula

$$F = \frac{H\,C}{10},$$

where F = force in dynes per centimetre length, C = current in amperes, H = number of lines per square centimetre of field. If the arc is not at right angles to the direction of the lines composing the magnetic field, the component of the field normal to the direction of the arc must be substituted for H in the above formula. From this it is evident that the force acting on the arc for a given current and strength of field is greatest when the arc is at right angles to the magnetic lines, and diminishes for all other positions, becoming zero when the arc lies parallel to the magnetic lines.

The direction of the force acting upon the arc, and hence of its distortion, can be found by the ordinary right-hand rule for magnetic drag; or, with perhaps less liability to error, by considering the directions of the lines of force composing the field and those due to the current in the arc, bearing in mind the rule that lines in the same direction repel one another. Thus, Fig. 1 shows an arc with the positive electrode at the top, the direction of the current being downwards. If the N pole of a magnet be

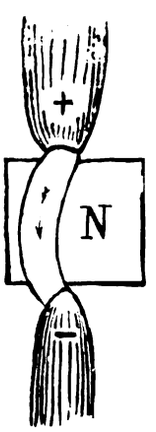


FIG. 1.

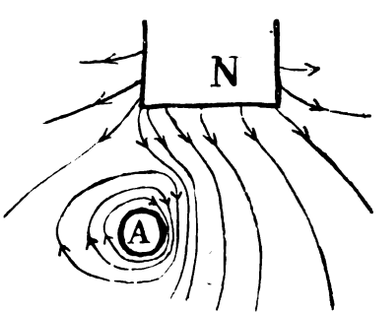


FIG. 2.

presented behind the arc, as shown, the arc will be distorted to the left. The reason for this is shown in Fig. 2, which is a plan of the arrangement shown in Fig. 1. In this figure the arc is shown in section at A, the direction of the current being away from the reader. The lines of force round the arc due to this current will be in a clockwise direction, and hence at the right of the figure will be repelled by the lines issuing from the N pole, the arc being moved towards the left.

If the magnetic field is sufficiently strong, the arc will be bowed and lengthened so much that the terminal voltage at the electrodes will be insufficient to maintain it, and it will be "blown" out. This action is practically instantaneous, and forms the principle of the magnetic blow-out which is used to reduce the arcing at the contacts of controllers, etc., to a minimum, also in lightning arresters and similar apparatus. In these cases the contacts or spark-gap are so arranged in relation to a solenoid that the arc, when formed, lies across a powerful magnetic field and is at once extinguished, as explained above. The solenoid is usually energised by the current traversing the arc, so that it is automatically cut out of circuit by the breaking of the arc.—A. H. B.

[Other replies to Question No. 1,031 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*.

QUESTIONS.

1039. Describe (preferably from personal knowledge) the precautions to be adopted when withdrawing lead-covered cables from earthenware ducts, the cable being 1·5 C.M.A., and covered with a jute serving. What is considered a safe strain or pull (expressed in pounds) to put on such cables' end?

1040. What are the advantages gained by using fractional pitch windings on induction motors, and how are these wound? Is it necessary to have open slots with such a winding?—M.

ANSWERS.

Question No. 1,031.—Discuss and explain the blow-out action of the magnetic field on the electric arc.

Answer to No. 1,031 (awarded 7s. 6d.).—In answering a question of this nature I think the best plan is to start from first principles. From careful study and investigation the following facts have been established: (1) the lines of magnetic strain which constitute the magnetic field repel one another when their direction is identical, and attract when their direction is opposite; (2) the lines always try to take the shortest path—*i.e.*, the lines tend to become straight; (3) when a conductor is subjected to an electric current a magnetic whirl is produced round it, this whirl having a definite direction according to the direction of the current in the conductor.

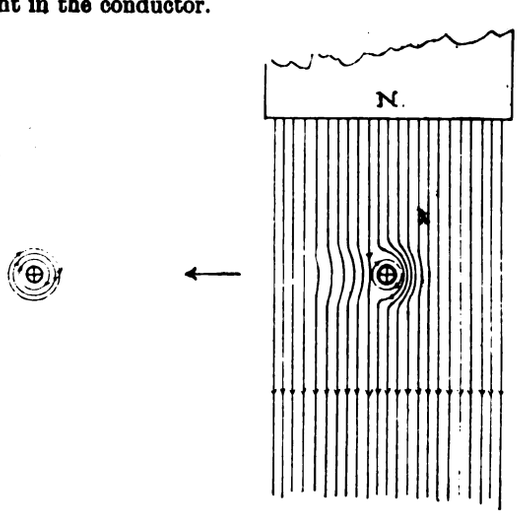

FIG. 1.

FIG. 2.

In Fig. 1 a conductor is represented with a current flowing in a downward direction, when a magnetic whirl having a clockwise direction will be produced. If, now, a magnetic field is superimposed (Fig. 2), the lines of strain on the right-hand side of the conductor travel in the same direction as the magnetic lines due to the current flowing in the conductor, and consequently they repel one another; whereas on the left-hand side, the lines from the two sources being opposite in direction attract one another. The lines of the superimposed magnetic field are, therefore, disturbed from their usual straight path, which they will immediately try to return to, with the result that the conductor tends to move in the direction of the arrow. It is found that the electric arc has the same property as a conductor carrying current—namely, that it produces a magnetic whirl round it. If we, therefore, superimpose a magnetic field at right angles to the axis of the arc it will tend to move it in a definite direction, and since the ends of the arc are, as it were, tied and its middle portion free, it will bow out, and with a strong enough field will be deflected to its breaking point—*i.e.*, blown out.

The next considerations are the applications of this principle, and I think, perhaps, the most important is its use in flame arc lamps. In this type of lamp, where inclined and impregnated carbons are employed, nearly the whole of the light is emitted from the arc itself; therefore, to increase its area, it is deflected by a magnetic field.

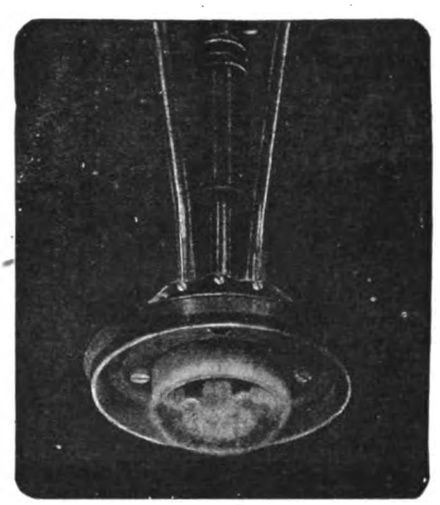

FIG. 3.

Further, when the carbons can feed no more, an additional field is introduced, and the combined strength of the deflecting and blowing-out fields immediately extinguish the arc; thus no damage is done to the lower portions of the lamp by the arc gradually getting higher and higher as the carbons consume away. In the illustration (Fig. 3) the lower portion of the well-known Union "Excello" flame lamp is shown. The long shunt coil above the base-plate is one of a pair which deflect the arc, and the small series coil above this is one of the pair which aid in the extinguishing. The magnetic field set up by the coils is either from front to back, or *vice versâ*, the complete magnetic path being through the iron rod shown, and iron cross bar, and a similar iron rod at the other side. Some further and very beautiful illustrations of the flame arc may be seen in Mr. Andrews's paper read before the Institution of Electrical Engineers on April 6, 1906 (vide *Journal* of the Institution of Electrical Engineers, vol. 37, No. 179).

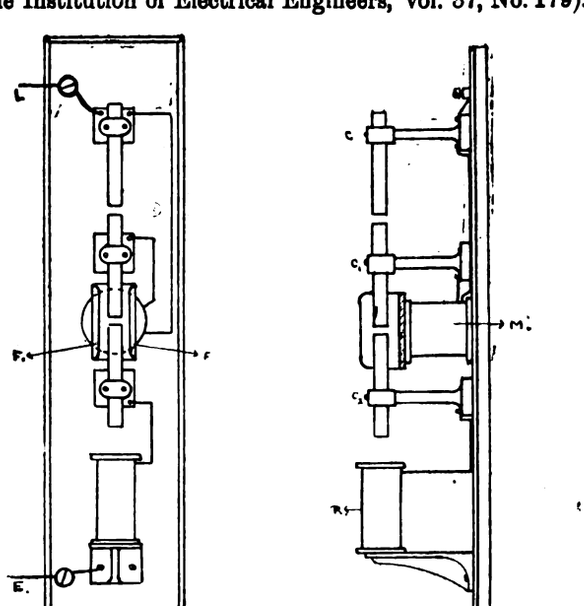

FIG. 4.

Another useful application is for low-tension switchgear carrying large currents, by suitably arranging two iron plates so that they will be on either side of the arc, springing from one sparking tip to the other, and by arranging for the current flowing through the switch to produce a magnetic field between the iron plates, the arc will at once be extinguished.

Amongst other uses of the principle I will mention the lightning arrester. In Fig. 4 two spark-gaps are shown

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between the three pieces of carbon rod, c, c_1, c_2. The latter are held in position by three clamps, and are, consequently, easily adjustable to suit the potential of the mains. A magnet coil, m, is connected in parallel with the top gap, and so, when the arrester operates, a magnetic field is produced between the iron faces, F and F_1, causing the arc across the lower gap to be extinguished. To prevent excessive current passing when the apparatus comes into action, an inductionless resistance, R, is inserted in the earth lead.—H. W. C.

Question No. 1,032.—Particulars are desired of best type of relays and main solenoid used in connection with electric lifts (push-button control) on board ship, especially with reference to the precautions adopted to prevent the circuit being broken by vibration, shock, etc. Also what are the voltages most commonly used in ships?

Best Answer to No. 1,032 (awarded 10s.).—The chief problem in connection with the construction of lift controllers for marine work consists in designing all the switches and solenoids so that they shall be unaffected by vibration, and should not rely on gravity more than necessary for actuating the "break." Most of the types of switches in use for lifts in buildings would not be suitable for this kind of work, as they usually rely on the pull of the solenoids to maintain contact.

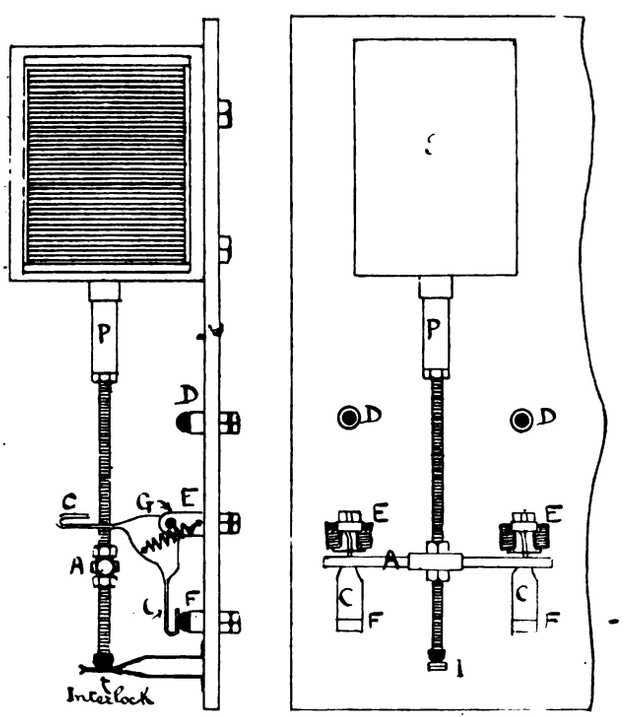

FIG. 1.

When subjected to severe vibration the contacts would be liable to jump and become burnt. A suitable type of main switch is that shown in Fig. 1. Two solenoids, S S, one of which is energised at a time by the controlling circuit, operate plungers, P P, to which are attached the cross-bars, A A. These cross-bars are made of fibre or other insulating material, and are each arranged to strike two hinged contacts, C, which can make contact either between D E and D_1 E_1 or between E F and E_1 F_1 respectively. The hinged contacts are held in either position by the springs, G. It will be observed that the efficiency of the contact is independent of the force which the solenoids exerts on the plunger, and depends only on the strength of the spring. The switch has also a simple quick-break action, as the cross-bar can be allowed considerable movement before striking the hinged contacts. Small contacts are provided at the bottom on which the plunger falls when the controlling circuit is broken, and constitute a simple form of electrical interlock to prevent both solenoids from lifting at once. The rheostat may be operated by a worm gear and magnetic clutch driven off the motor, or it may be driven by an arrangement of ratchet and pawl. In the former case means must be provided to allow the motor to start in either direction, either by having a rheostat with two sets of contacts or by some other means. If a ratchet and pawl is employed, the starter will move the same way whether the lift is moving up or down.

The simplest form of starter is shown in Fig. 2. This consists of a solenoid working against an air or oil dash-pot, and is the type most commonly used. It has the merit of cheapness, but is not so good as one driven by the motor itself.

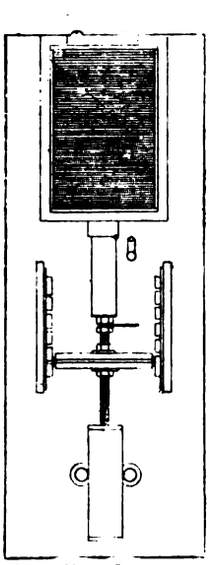

FIG. 2.

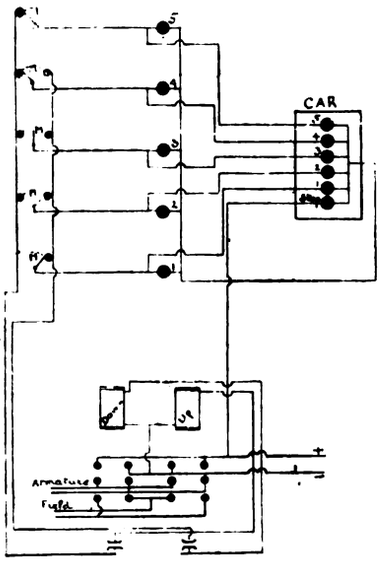

FIG. 4.

The "Jensen" controller, made by Messrs. Congdon and Co., of Manchester (Fig. 3), combines the reversing switches and rheostat, and is very suitable for this class of work. To describe it fully would occupy too much space, as the mechanism is somewhat complicated. Briefly the mode of working is as follows: Two solenoids are placed side by side, and plungers work in the top and bottom of each. The two top plungers are short, and are connected over a yoke by a chain. This yoke operates the reversing switch, the circuit being broken when the switch is in a vertical or mid position. The two lower plungers are

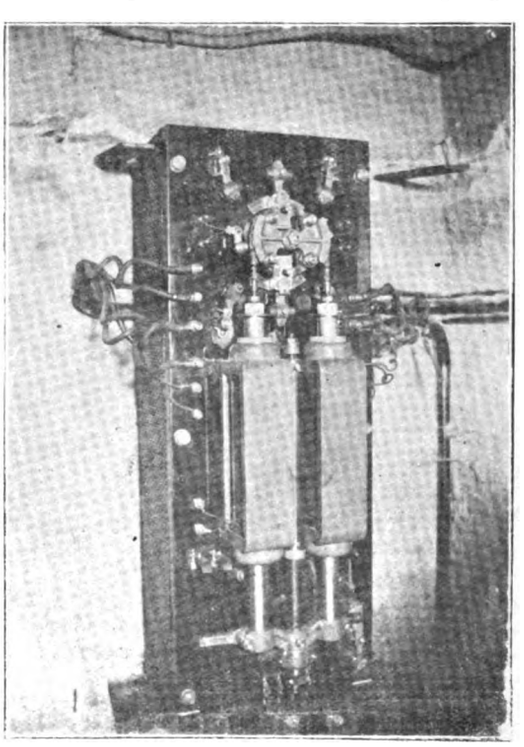

FIG. 3.

rigidly connected together, and hold the carbon brushes of the rheostat. The movement of these lower plungers is checked by an air dash-pot placed between the two. The action is as follows: When one of the coils is energised, one of the top plungers is drawn in, causing the other top plunger to lift out of the coil, and throwing over the reversing switch. This starts the motor. The bottom plungers then commence to lift, checked by the air dash-pot,

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and cut out, step by step, the armature resistance. When they have risen a short distance, a switch is opened which puts both coils in series, thus cutting down the controlling current without decreasing the pull on the plungers. The lower plungers continue to rise until all resistance is cut out.

A diagram of connections for use with separate reversing switch and rheostat is shown in Fig. 4 with a simple form of push-button attachment. Referring to this diagram, it will be seen that the change-over switches, M, are operated by the cam, O, on the car, and determine the direction of travel. In the diagram the car is shown at the third floor, so that the switch, M, at that floor is in the "off" position. Pushes 1, 2, 3, 4, and 5 on the floors, and also in the car, are, when the lift is in motion, locked either "in" or "out" by small electromagnets which have not been shown.—M. D. S.

Question No. 1,033.—Explain method of design of static balancers, for balancing on three-wire system.

Best Answer to No. 1,033 (awarded 10s.).—As the principle of the static balancer has been previously discussed in these columns*, we may, therefore, confine our remarks to the methods of design. Static balancers may be built for any number of phases, the object of increasing the number of phases being to obtain a more uniform distribution of the out-of-balance current in the armature winding of the generator, and thereby reduce the local heating to a minimum. It is usual, however, to limit the number of phases to six, as beyond this figure the increased cost of the balancer, slip-rings, etc., is not compensated for by the small reduction in the armature heating. The slip-rings are connected to the armature winding in the same way as for a rotary converter, as shown in Table I., which also gives the ratio of voltage at the commutator to that between adjacent slip-rings. The frequency of the alternating E.M.F. between the slip-rings is given by

$$\frac{\text{R.P.M.} \times \text{number of poles}}{120} \text{ cycles per second.}$$

This alternating E.M.F. when applied to the terminals of the static balancer will produce a magnetising current, the effective value of which (for a single-phase balancer) is given by

$$\frac{E_r}{\text{total impedance of balancer}},$$

where E_r is the effective voltage between the slip-rings.

TABLE I.

—	Number of slip-rings.	Effective voltage between adjacent slip-rings.*	Effective voltage between neutral and each terminal of balancer.	Total number of tap from armature to slip-rings for two-circuit winding.	Total number of taps from armature to slip-rings for multiple-circuit winding.	Number of taps per slip-rings for multiple-circuit winding.
Single-phase balancer ...	2	70·7	35·35	2	2 p†	Equal to number of pairs of poles.
Two-phase balancer	4	50	25	4	4 p	
Three-phase balancer ...	3	61·2	35·3	3	3 p	
Six-phase balancer (diametrical connection)	6	70·7	35·35	6	6 p	

* Voltage at commutator taken as 100 volts.
† p = number of pairs of poles.

Since the ohmic resistance of the coils of a static balancer is negligible when compared with the reactance, the magnetising current will equal

$$\frac{E_r}{2\pi \sim L},$$

where $\sim$ is the frequency in cycles per second, and L the inductance in henries. The inductance may be calculated from the formula:

$$L \text{ (henries)} = 4\pi\mu n^2 \left(\frac{a}{l}\right) \times 10^{-9},$$

where a l represent the cross-section and mean length of magnetic circuit respectively, μ the permeability of the magnetic core, and n the number of turns on the coils. An alternative method, which may be adopted for estimating the magnetising current, is to treat the balancer windings as one side of a transformer, and deduce the wattless and energy components of the magnetising current from standard curves giving the saturation and energy losses in sheet iron. The magnetising current is then given by:

$$\sqrt{(\text{wattless component})^2 + (\text{energy component})^2}.$$

In this method the flux in the magnetic circuit is estimated from the formula:

$$M = \frac{E \times 100}{4\cdot44\ T\ .\ N},$$

by assuming a value for T. M = flux in megalines, E = voltage per phase, T = number of turns per phase, and N = cycles per second.

The number of turns, T, on each phase of the balancer are limited by conditions of cost, regulation, and heating. Considering the regulation of a static balancer—*i.e.*, the difference in voltage between the heavily-loaded and the lightly-loaded sides of the system—it may be shown that this difference in voltage, in the case of a single-phase balancer, is given by

$$\frac{C}{2}\left\{r + \frac{2}{3}R\right\}\dagger$$

where C is the out-of-balance current, r is the resistance of each leg of the balancer, and R the resistance of the armature winding between brushes. The regulation, therefore, fixes the resistance of the balancer, while the number of turns is limited from considerations of cost and heating, since, in order to limit the temperature rise to about 40deg. C., the radiating surface of each coil must be approximately $\frac{C^2}{2}\ .\ r$ square inches.

As the value of T is limited, we must work the iron forming the magnetic circuit at a high permeability, in order to obtain a minimum magnetising current—that is, the magnetic circuit must be worked below saturation, at a density of about 5,000 to 6,000 lines per square centimetre. In order that this low density may be maintained when the out-of-balance current circulates through the windings, the magnetisation due to the out-of-balance current must be neutralised. This is accomplished in the case of single and two phase balancers by connecting the windings of each leg in such a manner that the magnetisation due to the direct current in one leg is neutralised by that in the other (Fig. 1). A similar arrangement may be

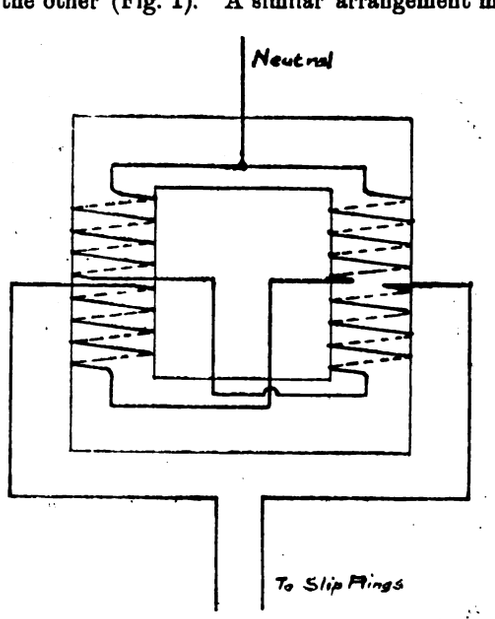

FIG. 1.—Connections of Coils in Single-Phase Static Balancer to obtain no Magnetising Effect due to Out-of-balance Current.

adopted for a six-phase balancer, but cannot be applied to a three-phase balancer. In this case, however, Dr. Steinmetz has proposed that extra turns be wound on each

* See the *Electrical Engineer*, Jan. 6, 1905, p. 1, and June 21, 1907, p. 853A

† "Static Balancers," by C. C. Garrard, *Electrical Review*, vol. lx., pp. 985 and 1,060.

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leg in the opposite direction to the main winding and connected in series with the middle wire (Fig. 2), such that the resultant magnetisation due to the out-of-balance current is zero. If the magnetisation due to the out-of-balance current is not neutralised, then the flux in the balancer will be considerably increased when working at its rated load, and this increased flux will not only cause a larger magnetising current to circulate from the slip-rings, but will also increase the iron loss, and thereby cause a greater temperature rise in the balancer.

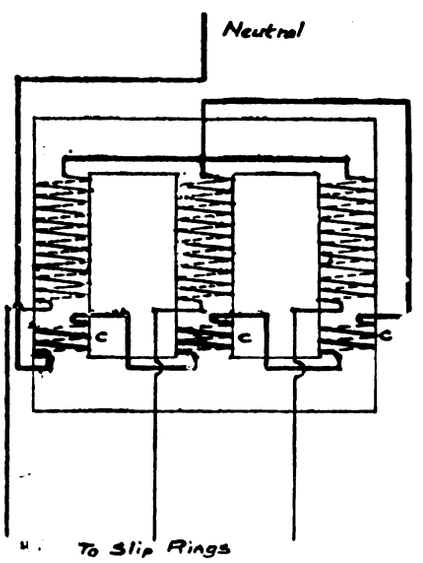


FIG. 2. - Three-Phase Static Balancer with Neutralising Coils (C).

The increased flux, due to the direct-current magnetisation, will also cause a greater leakage flux, which will generate eddy currents in any solid metal—*e.g.*, the containing case—in the vicinity, and will be manifested by an increase in the apparent iron loss of the balancer. It is principally due to this fact that three-phase static balancers are not much used, since they would require to be fitted with Steinmetz's neutralising winding, whereas a two-phase balancer would be free from this defect and would be slightly cheaper than a three-phase one.—THREE-WIRE.

Answer to No. 1,033 (awarded 7s. 6d.).—In designing a balancer the first consideration is as to the type to be used, either a static transformer, enclosed ventilated, or totally enclosed oil cooled, or a ring revolving on the armature shaft. With the former two or more rings will be required, according to the number of phases, whereas with the latter one ring suffices. The saving in the number of rings employed and the reduced amount of material necessary owing to better ventilation due to the balancer revolving in the air should about balance the extra cost of longer shaft, etc., and increased labour. If appearances are to be taken into account, a transformer fixed on the bed-plate is to be preferred, and this is the general practice. Having decided the type, the number of phases should next be settled. The more phases used the more uniform will be the distribution of the out-of-balance current, and the less the local heating in the armature. It is not usual to use more than two or three phases. The voltage and number of rings can be found from Table I., the voltage at the brushes being taken as 100. The frequency depends on the number of poles and speed of the generator

$$\sim = \frac{P \times R.P.M.}{120},$$

where P = number of poles. The out-of-balance current will probably be 15 to 25 per cent. of the total generator current. We have now all that is necessary for the design of our balancer.

TABLE I.

	Voltage between rings.	No. of rings.
Single phase	70·7	2
Two or four phase	50	4
Three phase	61·2	3
Six phase	70·7	6

The magnetising current should be kept as low as possible; therefore, the inductance, L, and the permeability, μ, must be high and the flux density in the core low.

$$\text{Inductance} = L = 4\pi\mu N^2 \left(\frac{a}{l}\right) 10^{-9},$$

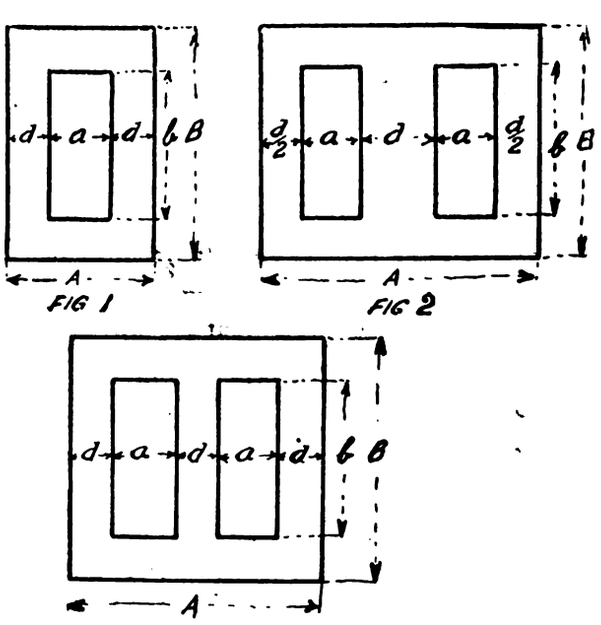
where N = number of turns in coil, a = cross-section of core (net), and l = length of magnetic path. The magnetising current = $\frac{\text{E.M.F.}}{2\pi \sim L}$, neglecting the copper resistance, which should be kept low.

The proportion of the iron part of the balancer cannot be given in hard-and-fast rules. If the cores are made short, the yokes must be made correspondingly long in order to allow sufficient winding space. On the other hand, if the cores are made long and thin we get a long magnetic path, and consequently a large magnetising current. Good proportions (Kapp) are given in Figs. 1, 2, and 3 (see Table II.) for single, two, and three phase respectively. For two-phase two single-phase transformers may be used or a three-limbed transformer, as in Fig. 2, in which case the area of the central limb must be made $\sqrt{2}$ times the area of either of the outer limbs. For three-phase Fig. 3 is a common type, or one consisting of three limbs placed at the corner of an equilateral triangle and connected at top and bottom by three armed cores.

To find the approximate net section of all the cores: total net section = kilowatt output of balancer × C, where C = 4 kw. to 7 kw., 2 kw. to 20 kw., and 1½ kw. to 100 kw. The thickness of core plates should be about ·01 to ·02 thick, and insulated with varnish or paper; 10 per cent. of the total section should be deducted to obtain the net section.

TABLE II. (dimensions in inches).

	Fig. 1.	Fig. 2.	Fig. 3.
a	·4+1·2 d	·6 d	·4+1·2 d
b	·4+2·6 d	d	·4+2·6 d
A	·4+3·2 d	3·2 d	5·4 d+·8
B	·4+4·6 d	2·2 d	·4+4·6 d
Core depth..	d	2 d	d



The flux density in the iron may be taken as B = 50,000 lines per square inch, frequency 15 to 30 ~, for enclosed ventilated or totally enclosed oil-cooled balancers, and the current density in the copper about 800 amperes per square inch. For a ring revolving on the shaft, B can be increased to 70,000 lines per square inch for the same frequencies and in the copper a density of 2,000 amperes per square inch. Having assumed the section, the total flux = B × section, and the number of turns can be calculated from the usual formula:

$$\text{Total turns} = \frac{\text{E.M.F.} \times 10^8}{\text{total flux} \times \sim \times 4{\cdot}44}.$$

For description of balancer see answer to Question 971.—H. T. A.

[Other replies to Question No. 1,033 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

QUESTIONS.

1,041. Describe a method of determining graphically the pole shape of an alternator, knowing the desired E.M.F. wave and the distribution of the winding.—LEONARD MURPHY.

ANSWERS.

Question No. 1,033.—Explain method of design of static balancers, for balancing on three-wire system.

Answer to No. 1,033 (awarded 5s.).—The method of design of static balancers is on practically the same lines as the design of power transformers. The following points must be observed and allowed for in setting out the job. The type of static balancer which is mostly in use at present is the three-phase balancer, and the other types stated in order of commercial preference are—namely, the two or four phase, the single-phase, and, lastly, the six-phase balancer. Taking the three-phase balancer into consideration, the following particulars of the direct-current system are required: direct-current voltage between outers, maximum out-of-balance current to be dealt with, resistance of direct-current armature, type of winding (two circuit or multiple circuit), speed, and pairs of poles of machine. Assume the direct-current machine has a two-circuit winding, then the number of tappings and slip-rings required on the armature will be three. For a multiple winding the number of tappings from armature to slip-rings would be three × pairs of poles.

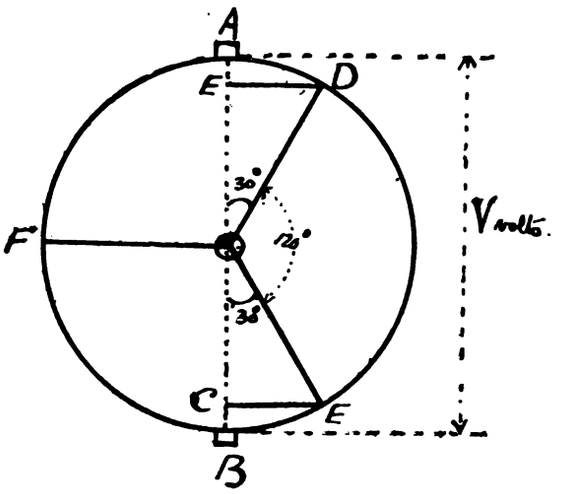

FIG. 1.

The alternating-current voltage between slip-rings can be arrived at thus (see Fig. 1). If the pressure between brushes on the direct-current armature = V volts, and D, F, and E are the tappings 120deg. apart, the relative positions of tappings to line of commutation being such that < E O D and < B O E are each 30deg. (for simplicity in sketch), then

$$\text{Radius O D} = \frac{V}{2} \text{ (radius of circle D E F)};$$

$$\therefore \text{O E} = \frac{V}{2} \cos 30\text{deg.} = \frac{V}{2} \cdot \frac{\sqrt{3}}{2}.$$

Total pressure between D and E

$$= 2\left(\frac{V}{2} \times \frac{\sqrt{3}}{2}\right) = \frac{V\sqrt{3}}{2}.$$

But this is the maximum value of the E.M.F., so the effective value will be

$$\frac{V\sqrt{3}}{2} \times \frac{1}{\sqrt{2}} = \cdot 6123\ V.$$

Therefore, the alternating-current pressure between slip-rings = 6123 times the direct-current pressure between outers of the system.

The alternate-current voltage known, also the periodicity (from the particulars of speed and number of poles), the requisite number of turns is fixed on, also the sectional area of conductor to carry half the out-of-balance current, the usual practice being to wind balancer so that the ohmic resistance is half the value of the armature resistance. The impedance of balancer must be fairly high, so that the magnetising current taken by the balancer is not excessive. There will be practically no magnetic leakage due to the alternating-current voltage in the balancer, but directly out-of-balance direct current begins to flow back through the windings the conditions are altered. In addition to the alternating-current magnetisation there will be a superimposed direct-current magnetisation. In the case of the single-phase balancer the direct-current magnetisation in each leg oppose one another, and it is possible by subdividing the coils and suitably placing them, or by using concentric coils, to quite neutralise the magnetising effect of the direct current. In the case of the three-phase balancer neutralisation is not possible, because a similar spacing of the coils as in the single-phase balancer cannot be carried out, as each phase must be kept separate. With the six-phase balancer complete neutralisation of the direct-current magnetisation can be obtained, and balancing is much better than with either three-phase or single-phase balancers. The out-of-balance current entering at a slip-ring has to overcome an average resistance of two-thirds R (where R = internal resistance of armature). This armature resistance is independent of whether there are two, three, or more slip-rings. The resistance in the path of the current by each slip-ring is the same, the various currents being in parallel. If we find the drop due to the out-of-balance current flowing from the mid wire *vid* one coil of the balancer to the nearest brush, we shall find the total drop due to the out-of-balance current.

Example.—Let the voltage between outers = 500 volts and out-of-balance current, C, be 10 per cent. of the full-load current, also internal drop of armature = 4 per cent., then 4 per cent. of 500 volts = 20 volts; then $10\ C\ R = 20$ and $C = \frac{2}{R}$. For three-phase balancer

$$\frac{C}{3}\left\{\frac{3}{2}r + \frac{2}{3}R\right\} = \frac{2}{3r}\left\{\frac{13}{6}R\right\} = \frac{26}{18} = 1\cdot44 \text{ volts} = \cdot57\ \%.$$

—STATOR.

Answer to No. 1,033 (awarded 5s.).—This problem of the design of static balancers for three-wire systems is rendered exceedingly vague and indefinite for lack of directions. In ordinary practice, three-wire systems are balanced by motor-generators connected between the neutral and the outers which run as motors when the neutral is at mean potential and the system is balanced, and either as generators or motors under unbalanced conditions. This, however, is by no means a static balance. There are various methods, more or less practical, by which a static balance can be obtained, and these are now dealt with in the case of continuous three-wire systems.

(*a*) *Resistance.*—Resistances may be connected on each side of the neutral and have means for adjusting them either automatically or by hand, so that when all the lamps or a number of them on one side of the system are cut out, a suitable resistance is inserted until no current flows through the middle wire. In design sufficient resistance must be allowed between the two, so that the maximum difference in loads may be taken up. It will readily be seen that this is an exceedingly wasteful method of regulation.

(*b*) *Induction.*—Static balance may be obtained by placing an induction coil away from the armature but connected thereto at two opposite points, the middle point of the coil also being connected to the neutral wire. This system is due to Dobrowolsky. Its operation is as follows: The E.M.F. at the coil terminals is necessarily alternating, and hence, owing to the self-induction, no short-circuiting of the armature occurs. When unbalanced conditions prevail in the system the direct current flows through the neutral wire, and to this the inductance coil offers very little resistance, and balance, therefore, results. In designing this coil it is quite obvious that the resistance must be made as low as possible and the self-induction as high as possible consistent with suitable wires for carrying the necessary current.

(*c*) *Three Brush Method.*—A method of balancing which is more or less static is to have three brushes to a machine, the extra brush being placed symmetrically between the ordinary brushes and connected to the neutral wire. In order to allow machines with this arrangement to run properly they must be somewhat modified, one manner of doing this being in the case of a four-pole machine to have

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the two north and the two south poles adjacent to each other, the action being then practically as a bipolar machine with divided poles. In designing this the yoke between the unlike poles must be made of sufficient cross-section to take the maximum flux in one pole pair, and not, as in ordinary machines, sufficient to take half that flux. Between like poles the yoke need be of negligible area magnetically, but must be made sufficiently strong mechanically. As to the armature, the radial depth of this must also be sufficient for the full flux from one field core. Owing to the armature reactions in this machine extra windings must be added to overcome the tendency of the flux to increase in one pair and to decrease in the other pair, otherwise with heavy loads unequal voltages are impressed on the different sides of the network.

In the case of alternating-current three-wire systems, the usual way to balance these is by static transformers. There is nothing especial to be noticed in the design of these except they must be of suitable size to deal with any difference of power which can possibly occur, and they must also be designed with ample iron section in order that the iron losses which are continually present should be low, but the copper may be fairly saturated, as this will probably only be loaded for a relatively small proportion of time. Until further specific data as to the actual network in use are available, it is thought that no further points in the design can be dealt with.—L. R.

Question No. 1,034.—Explain the action that takes place in a reverse-current relay, used on an alternating-current system, when set at a certain percentage of full-load current. Why do they not operate at this fixed point, whichever direction the current is flowing, for the system is alternating and constantly changing? Give clear connections of same. Is a relay in use which combines overload as well as reverse-current (any percentage) operations? If so, give connections and explain thoroughly the combined action.

Answer to No. 1,034 (awarded 7s. 6d.).—There are two main types of reverse alternating-current relays, one being the wattmeter and the other the solenoid type. The wattmeter type is made for single or polyphase circuits, the principle of working being the same, but the single-phase relay will be described for sake of simplicity. The writer takes it that the questioner, "Sub," understands how that a rotary field is produced in the gap of an induction wattmeter, and how by the action of the eddy currents set up in the disc a torque is produced on the disc, tending to cause it to rotate; the space allowed being none too large to deal solely with the points raised in the question.

Fig. 1 shows one form of wattmeter type relay, so called because the moving element consists of a wattmeter without the dial. There is an aluminium disc in an air-gap between two electromagnets—the top one being energised by a series winding, S, and the bottom one by a shunt winding, V. As in an induction wattmeter, when the current and voltage are in the same direcction in the circuit to which it is connected a torque is produced on the disc, causing it to rotate. If, now, the current in the series winding is reversed whilst that in the shunt winding is still the same as before, the direction of rotation of the rotating field is reversed, and, consequently, the disc will reverse its direction of rotation. This is the principle of the wattmeter type of relay. Fig. 1 shows the arrangement for the actual relay. To the disc spindle is attached a bent arm, C. With current in the right direction this arm rests in an insulated piece, H, attached to a brass arm, A, which is hinged at J. F is a stop to prevent H from falling backwards. With current in the right direction the disc tends to rotate in the direction of the "forward" arrow head, but cannot do owing to the arm C being on insulated piece, H, which is fixed. When a reversal of the current takes place the disc rotates in the direction of "reverse" arrow head, and the arm C travels round and knock against H on the underside, and knocks it over, making it come in contact with jaws, B, completing the tripping circuit and opening the switch; T C being the trip coil. It will be seen so long as the current is the right direction it is impossible for the relay to operate, but it operates on occurrence of reversal only. The percentage of reverse current at which it operates is got by putting a weight, D, on a cord over a drum on disc spindle. Before the relay can operate the disc must have a torque equal to that necessary to wind the weight up, and for each weight a definite reverse current will have to pass through the series winding, S, before the disc starts to revolve. This definite current can be easily expressed as a percentage of full load current. The time element is got by damping the disc, by fixing a permanent magnet so that the disc has to revolve between the poles of this magnet, and due to eddy currents set up its speed is retarded.

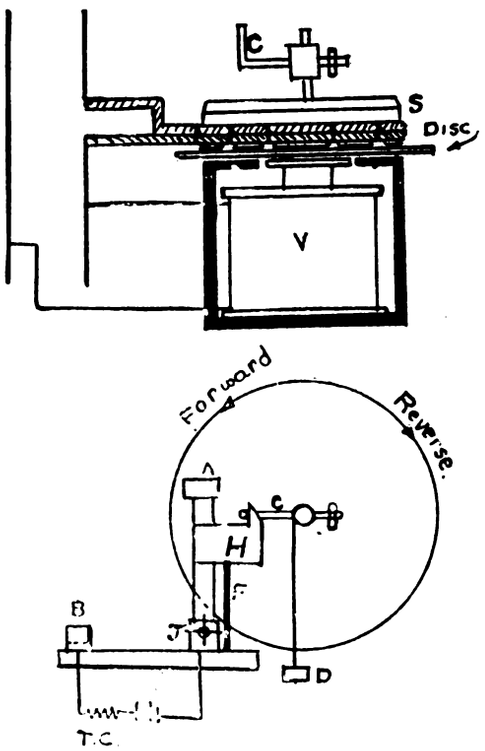

FIG. 1.

Fig. 2 shows a type of solenoid relay diagrammatically. It consists of a differential solenoid, the two halves of which are in parallel across the system (for low-voltage single-phase system). D is a small equaliser, round which is passed one turn, S, of a lead which carries the main current of system to which it is connected C is a core, which is kept in position by an adjustable stop. With no current flowing in turn S, the shunt current divides itself equally between top and bottom halves of the solenoid, with the result that the core is neither pulled up or down, but is held in position by gravity. With current flowing round turn S in the right direction—*i.e.*, in the same direction as

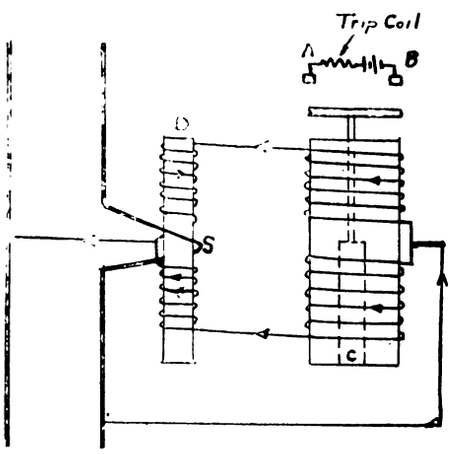

FIG. 2.

the voltage—the balancing effect of the equaliser, D, destroyed, and more current flows through the bottom half of the solenoid and less through the top half, and thus the core is held in position shown, magnetically as well as by gravity. With a reverse current in the turn S the opposite occurs, more current flowing through the top half of solenoid and less through the bottom half, and thus the plunger is drawn up, making contact A to B, and completing the tripping circuit. The percentage reverse at which it operates can be got by putting weights on core, or by raising or lowering the position of core by the adjustable stop previously mentioned. The time element can be got by closing in the top of solenoid, and allowing the

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plunger to drive out the air in the centre of solenoid through an adjustable hole in the top before it can be raised, the time occupied for lift being regulated by size of hole for driving the air through. In practice the two halves of the solenoid are wound one over the top of the other, and not as shown in diagram on one long core, diagram being so drawn for clearness.

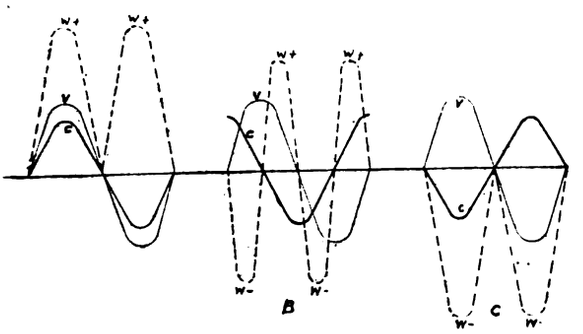

FIG. 3.

It will be seen that a reverse relay does not depend on the current alone for its operation, but on the combined effects of current and operation. Assume a non-inductive load, we should have conditions as A (Fig. 3), where C = current and V = voltage wave. Although they are constantly changing, we always get a positive value for the watts, W, which represents the torque or pull in the relay, and this never changes in direction. If, however, we get a reversal of current, we have conditions as in C (Fig. 3), and here we always get a negative value for the watts, W,

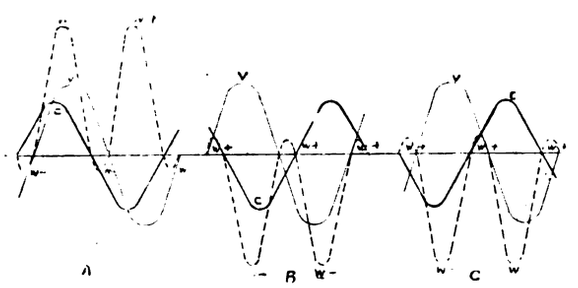

FIG. 4.

which represents the torque or pull with a reverse current. Thus so long as current flows in right direction we get an unchanging torque in one direction, but on reversal of current the direction of this torque reverses.

If we look at curves B (Fig. 3), we shall see that if we get the conditions in which a lag or lead of 90deg. is obtained, we should get no torque on relay, and thus relay would not operate under such conditions. This state of affairs is likely to be obtained where the field of a generator fails, and the prime mover still continues to drive it at its usual speed. The reverse current in this case is

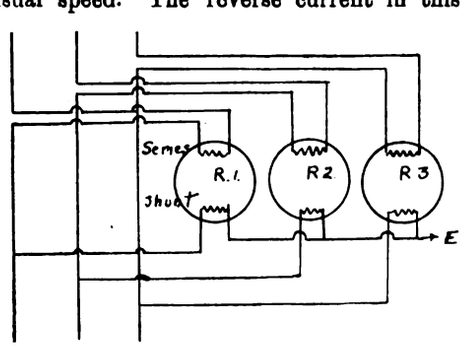

FIG. 5.

practically wattless, and is approximately 90deg. in advance of the voltage, because no energy is required to drive the faulty generator as a motor. Engineers differ in opinion as to whether a reverse relay should operate with a reversal of total current or of energy current only; if the latter, then the ordinary relays as described fulfil the particulars; if the former, the remedy is as per Fig. 4. It consists of putting resistance in series with the shunt circuit until the shunt current lags about 45deg behind the series current when the load of the circuit is non-inductive. Thus with conditions in the main circuit as in Fig. 3, the conditions in the relay will be as per Fig. 4, and hence the relays will operate when the phase difference is 90 leg., but the torque or pull will not be so large as in C (Fig. 3)

Fig 5 shows three single-phase relays connected to low-voltage three-phase circuit, the shunt windings being connected in star and earthed. Fig. 6 shows three

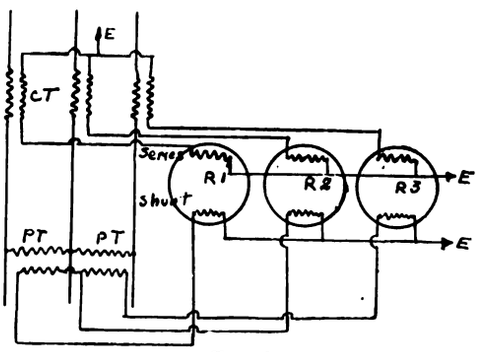

FIG. 6.

similar relays connected to three-phase high-tension system using three current and two potential transformers; as before, the shunt coils are connected in star and earthed. Fig. 7 shows three relays, the shunts of which are not connected in star, but between one terminal and the middle

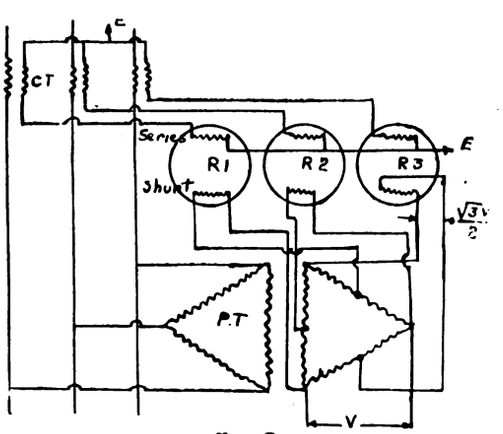

FIG. 7.

point of the opposite limb of a three-phase potential transformer. The voltage obtained for the relay is $\frac{\sqrt{3}V}{2}$, where V is the voltage between secondary terminals; C T are current transformers. Connections to single-phase circuits are as Figs. 1 and 2. The direct-current trip circuit connections are not shown in Figs. 5, 6, and 7, as they should present no difficulty.

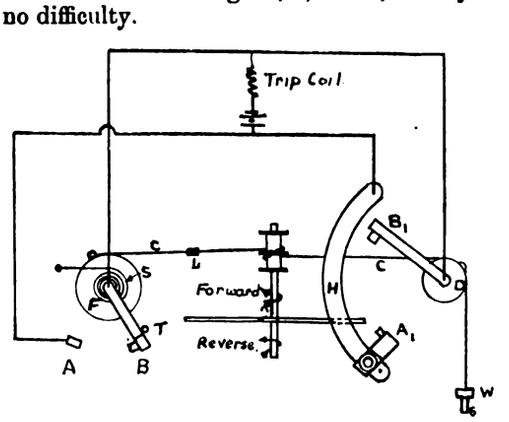

FIG. 8.

Fig. 8 represents diagrammatically a combined maximum and reverse alternating-current relay. The action in working is similar to that in Fig. 1, the disc rotating between the electromagnets excited by series and shunt windings. On the disc spindle is a double drum to which are attached two cords, C, one for maximum and one for the reverse. The operation for the maximum is as follows: The cord, C, passes over a drum, D, to which is rigidly attached a brass arm, B_1; at the end of the cord is a weight, W, which rests against a stop, S. Before the relay can operate a torque must be exerted necessary to wind up the

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weight, W; when this torque is reached the disc revolves, winds up the weight, W, and twists drum, D, and arm, B_1, this arm coming in contact with contact, A_1, and completing the tripping circuit. It will be seen that the weight, W, determines the overload at which it will commence to operate, and by having different weights, different percentage of overloads can be set. The time element is got by moving contact, A_1, along sector arm, H, and thus shortening the distance of travel for the arm B_1 before it trips the circuit. For the reverse part the cord is attached to a drum, F, and to this drum is attached a spring, S, and an arm, B, Before the disc can rotate it must exert a torque equal to that of spring; when it reaches this torque it turns drum F and arm B, thus closing tripping circuit through contacts, A B. L is a weight to take up sag in cord, C. When the maximum side is operating there is no need for one on the other side, as the sag is very little, the motion of arm B before closing trip circuit being very small. The adjustment for percentage reverse at which relay will operate is by coiling up spring, S, thus increasing the torque the disc must possess before it can operate. T is a stop to prevent the arm B coming back too far. After operation it will be seen that the relay resets itself. As soon as the trip circuit has operated the torque on the disc goes, and if it has operated by an overload the weight, W, returns it to its original position; but if it is a reverse, the spring, S, returns it to its original position. In the relay in Fig. 1 the lever, A, has to be reset after having operated.

Although several of these combined relays are installed on various systems, they are not true overload current relays. The torque depends on the watts, and the watts take into account the power factor, so that it is possible to get a large total current, but so long as its energy component does not exceed the percentage which the relay is set for it will not operate. Take, for example, a relay set at 100 per cent. overload and wound for 10 amperes. On power factor 1 this will operate with 20 amperes through it. If, however, it is on power factor ·5, 40 amperes would have to pass through the relay before it would operate.—RELAY.

Answer to No. 1,034 (awarded 5s.).—Automatic circuit breakers designed for use on alternating circuits and fitted with reverse-current or discriminating relays are of two types: (1) where the circuit breaker is tripped by the alternating-current relay; (2) where the actual tripping is carried out by means of continuous current. In Fig. 1 is shown the connections of a single-phase circuit breaker controlled by alternating current only, in which A is the alternator feeding the mains or 'bus bars, and M is a current transformer supplying the main winding, S, of the relay. The potential transformer, P, can be supplied either direct from the 'bus bars or from A; this transformer feeds the shunt winding, T, of the relay. Now, in explaining the action of the relay the question of constant polarity of the coils, S and T, cannot be considered, owing to the magnetic flux varying as the periodicity of the circuit, but the question is a comparatively simple one if the direction of the current flowing through the alternator is considered relatively to the current in the other parts of the system. It is obvious that the current in the winding T will vary synchronously with that of the alternator, A, and will be quite independent of the direction of the current in the winding S, whereas the direction of current in this latter winding, relative to that of the 'bus bars, will depend on whether A is generating or motoring. The windings, S and T, are so arranged that when A is generating the solenoid between these windings is not influenced, but should the current in the winding S be reversed due to A motoring, the relation of the two windings will be altered, and the solenoid will operate the trip gear on the main switch. Fig. 2 shows precisely the same arrangement, except that instead of the solenoid tripping the main switch it closes a local continuous-current circuit, which actuates the trip gear on the main switch. This arrangement is used where the switches cannot be tripped directly by the reverse-current relay, as in the case of "remote control."

A modified arrangement of the solenoid shown is often used, which takes the form of a small armature carrying the winding T, which rotates through an angle of about 180deg. depending upon the relation of the windings. This movement of the armature actuates direct on the trip gear of the main switch or through a local circuit, as in Fig. 2. Another type of relay which is extensively used is a metal disc revolving between the coils, S and T. When operating under normal conditions the disc revolves and winds up a small weight; further movement is prevented by means of a catch. Should, however, the relation of the windings become altered the disc revolves in the opposite

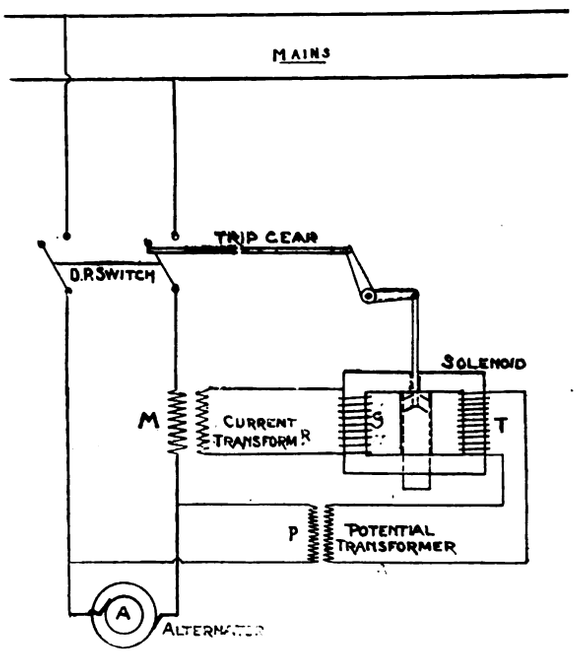

FIG. 1.

direction and releases the trip gear directly on the main switch or else closes a local circuit, which could be fed either from the exciter or a battery. With the disc type of relay, the "time element" is a great feature owing to its extreme simplicity of action. The circuit breaker can also be operated by a maximum as well as by a reverse current, but a separate relay will be necessary; the maximum release is usually arranged to operate on the opposite

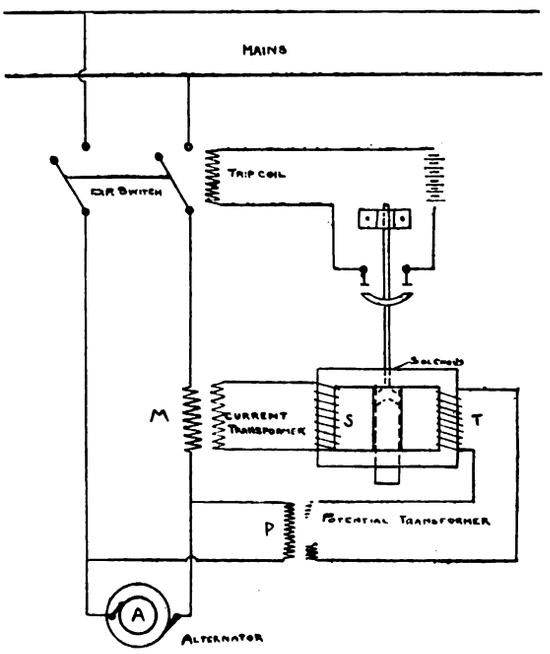

FIG. 2.

pole to the reverse relay. With a three-phase circuit breaker having a maximum and reverse release, the former would have two relays on two of the phases and the latter one relay in the remaining phase. The various relays can be operated from the transformers used in conjunction with the wattmeters, ammeters, etc., which, of course, will tend towards economy as well as saving in space and reliability.—H.

[Other replies to Question No. 1,034 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,042. In a circuit of direct-current flame lamps using carbons with the salts in the core trouble is caused by frequent white arc of low candle-power instead of yellow flame colour. Give cause and remedy. Also, in a description of a new flame lamp (*Electrical Engineer*, Jan. 3, 1908) "a minimum allowance of seven volts per lamp for steadying resistance must be made." Why so large an amount, and does this apply to flame lamps generally? The Oriflamme lamp is said to burn with about 35 volts across the arc. Why so much lower than the ordinary arc voltage, and would this require a large allowance for steadying resistance?—FLAME.

1,043. What will be the probable current and the best arrangement of motor, etc., required to drive a machine for winding copper strip (1in. wide by 0·1in. thick) into the form of helices, each one to have 15 coils and to be 6½in. internal diameter? It is proposed to turn out 200 per day, and the supply is 210 volts direct current.—ANXIOUS.

1,044. Give reasons for the shortening of the life of Nernst lamp burners. Should they be connected up to the supply mains with their polarity reversed?—G. D. A.

ANSWERS.

Question No. 1,034.—Explain the action that takes place in a reverse-current relay, used on an alternating-current system, when set at a certain percentage of full-load current. Why do they not operate at this fixed point, whichever direction the current is flowing, for the system is alternating and constantly changing? Give clear connections of same. Is a relay in use which combines overload as well as reverse-current (any percentage) operations? If so, give connections and explain thoroughly the combined action.

Answer to No. 1,034 (awarded 7s. 6d.).—Reverse-current relays for alternating-current circuits may be broadly divided into two classes: (1) wattmeter relay; (2) differential relay. These two types differ totally in their action. There is a certain vagueness about the word "reverse current" for alternating-current circuits, and one is at a loss as to what it really means. For continuous-current circuits the expression is perfectly definite. For alternating

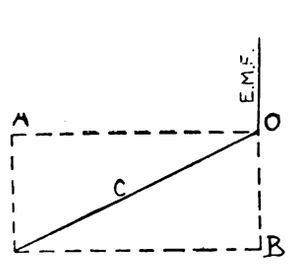

FIG. 1.

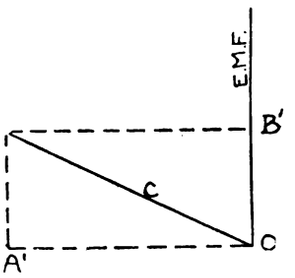

FIG. 2.

current, a current which at every instant is flowing in the direction in which the generated E.M.F. acts is undoubtedly a "forward current," while a current which at every instant flows in the opposite direction is a "reverse current." The first is in phase with the E.M.F., the second 180deg. out of phase. Now what about the current leading or lagging by 90deg. Such a current is neither a "forward current" nor a reverse current, and, therefore, it is questionable as to whether the relay will operate with such a current. Take the two cases shown in Figs. 1 and 2. In Fig. 1 current lags a little more than 90deg. behind E.M.F. Component O B is power component, and is opposed to E.M.F., and the reverse current is not C but O B. In Fig. 2 we have forward current O B', and hence no reverse current. Now, in the wattmeter type of relay the instrument consists of an ordinary alternating-current

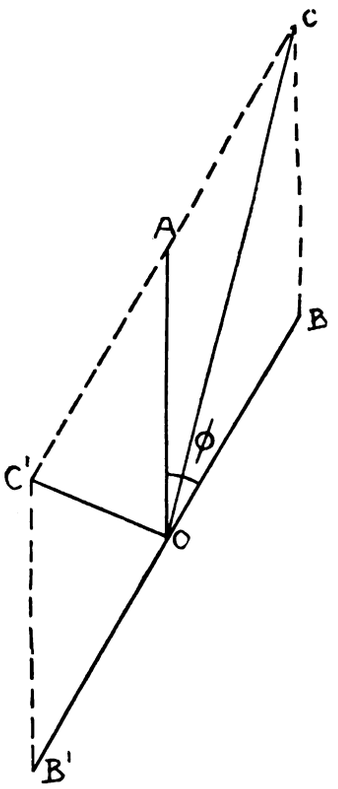

FIG. 3.—O A, Magnetomotive Force of Coil *a*; O B, Magnetomotive Force of Coil *b* for normal conditions; φ, Lag of Current behind E.M.F.

wattmeter, the moving part of which will tend to move in one direction or the other, depending on whether the current has a forward component or a reverse-current component. The moving part is, however, prevented by a stop from moving in the direction resulting from a forward-current component, but it can rotate in the reverse direction, and by means of an attachment to moving spindle closes an auxiliary direct-current circuit which

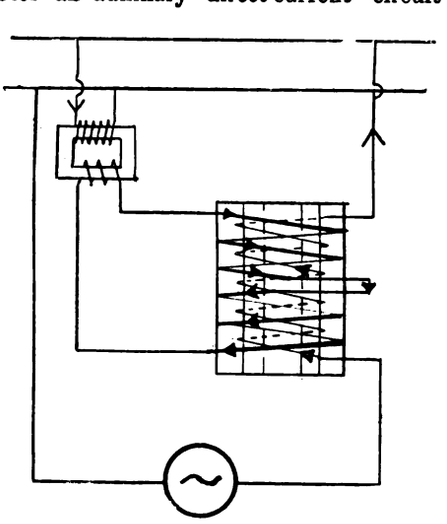

FIG. 4.

operates cut-out after having travelled a certain adjustable fraction of a revolution. We see, therefore, that the wattmeter type of relay acts only when there is a reverse-current component, and is entirely independent of the component lagging or leading 90deg. from E.M.F.

In existing forms of alternating-current relays of the differential type the energising coils consist of two windings with a common magnetic circuit. These windings, which we will call *a* and *b*, receive current from a shunt trans-

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former and a series transformer respectively connected with the alternator. Therefore, current in *a* is dependent on pressure, and that in *b* on the current. Since with constant pressure the magnetomotive force due to coil *a* is fixed in direction and magnitude, it serves to polarise the relay. Under normal conditions coils *a* and *b* act differentially, but if the direction of the magnetomotive force of *b* is reversed their action is cumulative. If coils act differentially, resultant magnetomotive force is O C^1, which is insufficient to lift the core common to both circuits, and so operate relay. On reversal of current we get magnetomotive force, O C, which may be sufficient to lift core.

Another form on practically the same principles is shown diagrammatically in Fig. 4, and has been found to be very reliable in practice. Here the bottom half of the shunt winding is wound in the reverse direction to the top half, and normal position of core is in the centre of the coil. Under normal conditions, magnetomotive force of series

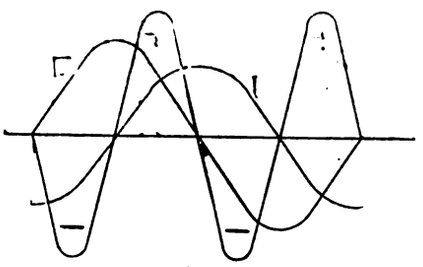

FIG. 5.

coil helps the bottom half of the shunt coil and opposes that of the top half of the shunt coil; therefore there is a tendency to pull the core into the centre of the coil, and, in consequence, the relay does not act. With reverse current, however, in the series coil the field in the top half of the core is strengthened and that in the bottom half weakened. The core will, therefore, be lifted up and switch released. In the case of two alternators running in parallel, if the field circuit of one of them be broken the current flowing in that generator will be approximately 90deg. ahead of the generated E.M.F., thus tending to maintain its field. A wattmeter relay in this case would not work unless there were sufficient "reverse current." What would happen in a differential type of relay?

As seen from Fig. 5, the pull on the core is alternately and equally positive and negative, and, consequently, the tendency to move the core is eliminated during each alternate half-period. To overcome this difficulty, it is the practice to introduce a phase difference (about 45deg. in practice) between E M.F. of generator and potential difference across shunt coil of solenoid by introducing sufficient

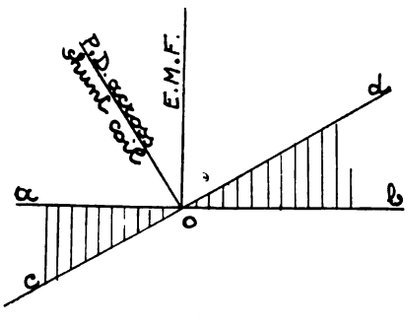

FIG. 6.

inductive resistance in series. With this arrangement it is seen from Fig. 6 that cut-out will not act when current lies between O A and O C in shaded portion, although we have reverse current in circuit, and it has a tendency to act when current lies between *o b* and *o d* in shaded portion, when alternator is doing useful work. But these conditions are rarely found in practice From Fig. 3 it is seen that if magnetomotive force of series coil is very large compared with that of shunt coil, it may be sufficient to swamp the effect of the shunt coil, and so operate the relay with overload current.

In comparing the two forms of relay there is no doubt that as a reverse-current relay the wattmeter type is the better, both as regards certainty of action and sensitiveness. The differential type is very uncertain in action, due to variable reluctance of magnetic path with various positions of the core. It is usual in practice to place reverse current relays on generator panels only and overload relays on feeder panels, so there is really no need for reverse-current relays to work an overload, as in this case there is a liability of all generator circuits being opened if a short occurs.—M. R.

Answer to No. 1,034 (awarded 5s.).—Before discussing the action of a reverse-power relay, it may be as well to define what is understood by a "reverse current." An alternating current which at every instant is flowing in the same direction in which the generated E.M.F. acts is obviously a forward current, while one which at every instant flows in the opposite direction to that in which the E.M.F.

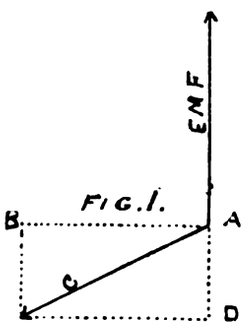

FIG. 1.

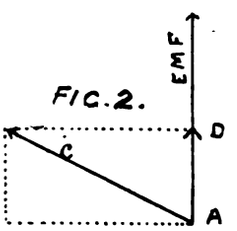

FIG. 2.

acts is equally a reverse current, the former being in phase with the E.M.F., the latter 180deg. out of phase. But suppose the current lag or lead 90deg., then during one-half of each cycle it is flowing in the same direction as the E M F., and during the other half in the opposite one. Such a current is neither a forward nor reverse current, and, whatever its magnitude, it should not cause the relay to operate. Again, suppose the current lag a little more than 90deg. behind the E.M.F. (Fig. 1), there are then two currents superimposed, A B and A D, but we have seen that A B is neither a forward nor reverse current, then A D is the only current we have to consider, and it is also the power component of the current A C. A D is at every instant flowing in the opposite direction to the E M.F., and though A C flows in the circuit, it is A D which is the reverse current and not A C. Again, suppose A C (Fig. 2) lagged behind the E.M.F. by an angle less than 90deg., then a forward current of magnitude A D flows in the same direction as that in which the E.M.F. acts.

The determining factor for the operation of a reverse-current relay is whether the power component of the current is in the same or opposite direction, at every

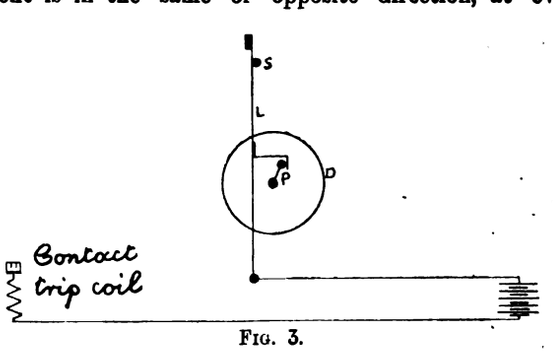

FIG. 3.

instant, to that in which the E.M.F. acts. Strictly speaking, then, the relay would be more correctly called a reverse "power" relay. The reverse relay in general use is essentially a wattmeter, and is evidently the correct device to adopt, as it has been shown that it is reverse power which should cause the relay to operate Space will not permit of dealing fully with the production of the torque in the disc of the relay, but in answer to the second part of the query it will be sufficient to say that if an absolutely non-inductive circuit be held in an alternating magnetic field it will receive a rapid alternate series of pushes and pulls. These impulses if equal and opposite would in quick succession neutralise one another, and the circuit would not be subject to any resultant force. But if the circuit be

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inductive, as the disc of the relay is, these impulses become unbalanced, due to the fact that the current lags behind the inducing E.M.F., and the repulsive impulses become far greater than the attractive ones, resulting in a force on the circuit. This, I think, will show "Sub" why an alternating current flowing in the direction for which the relay is designed cannot cause it to operate. As has been already stated, the relay is an induction wattmeter driven by a two-phase motor, whose series and shunt fluxes, being in quadrature, produce the requisite rotating field.

Fig. 3 shows the action of the Ferranti reverse relay. The weighted lever, L, is held against the stop, S, by the pin, P, in the disc, D, which tends to rotate in a clockwise direction with forward power. On a reversal of power the disc revolves in a counter clockwise direction (due to the current flowing in the reverse direction in the coils of the relay), and the pin, P, impinging against the lever causes it to fall into the horizontal position, thereby completing the trip-coil circuit. The Brown-Boveri relay works on the same principle, except that on a reversal of power the pin in the disc presses two spring contacts together.

Fig. 4 shows the connections for a reverse-power relay on a three-phase generator with the neutral earthed. A three-phase system has been used in the diagram, as the querist has not stated to the contrary, being, perhaps, most generally in use. A reverse relay on a three-phase system, having its neutral point earthed, should consist of three

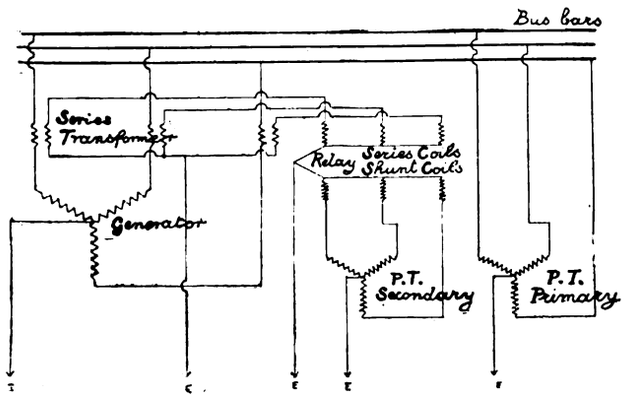


FIG. 4.

single pole relays having their series and shunt coils star connected. The potential transformer supplying the shunt coils of the relay should be star-connected on both primary and secondary sides The secondary windings of the current transformers also should be star-connected, and all star points should be earthed. The reason for these connections is that it is possible for an interchange of high-frequency energy (generally corresponding to the third hormonic of the fundamental frequency) to take place between generators having their neutral points earthed. It is necessary that the relay should be influenced by this interchange of energy, and, if it be sufficiently large, that the relay should operate. It is not often that an overload and reverse relay are required on the same circuit, as circuits feeding 'bus bars requlre a reverse relay immediately in front of the bars, whereas outgoing feeders call for an overload relay. The writer has known where it has been thought advisable to install an overload and reverse relay with rotary converters, in which case the series coils of both relays were fed from the same current transformer.—O. H. BRICKWELL.

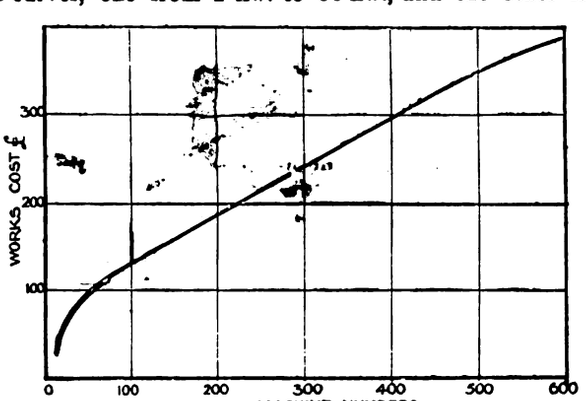
Question No. 1,035.—Show a method of estimating approximately the total works cost of a line of dynamos, from, say. 1 kw. to 300 kw., the calculations to be based simply on the kilowatt output in conjunction with the speed, and not from linear dimensions of the armature.

Best Answer to No. 1,035 (awarded 10s.).—It appears that "W. H. J." requires a method by which the works cost of any machine may be quickly determined, using as data the kilowatt output and speed of the machine. As the core size of a machine is determined from these particulars—viz., the kilowatt output and speed—it follows that it is possible to plot a curve with the works cost as a function of the output in kilowatts and the speed By the use of such a curve much time can be saved by using the curve as the designer uses curves of armature ampere-turns and field ampere-turns plotted as functions of the kilo lines per square inch. The method of obtaining the curve in question is as follows: multiply the maximum amperes for each machine by the voltage each machine would give if it were run at 1,000 r.p.m., then divide this value by the actual revolutions per minute. Take, for instance, a machine giving 800 amperes at 220 volts; speed, 500 r.p.m. We then get

$$\frac{\text{Amperes} \times \text{volts} \times 1{,}000}{500} = \frac{800 \times 220 \times 1{,}000}{500} = 352{,}000.$$

By dividing this value by 1,000 we get the watts output the machine will give at 1 r.p.m., which is very useful, since it gives an indication of the size of the machine of which we desire to find the works cost. By treating the outputs of a line of machines in this manner we get a series of numbers each referring to a particular size of machine, and may thus conveniently label each machine by the number representing the watts output at 1 r.p.m.

By plotting the works cost of the machine against the machine number, we get a curve from which the works cost of any sized machine coming within the limits of the curve can be obtained. The curve gives the approximate works costs for a line of dynamos up to about 250 kw. These costs are for direct-coupled machines supplied with outer bearing only. It is, of course, preferable to use two sets of curves, one from 1 kw. to 50 kw., and the other from



50 kw. to 300 kw.; by this means the costs can be read off much more accurately. The works costs shown on the curve are made up of two distinct charges—viz, the cost of material and labour and "trade costs," consisting of drawing office, order and estimating department expenses, etc. These two items can, of course, be plotted separately, thus giving a set of curves showing the actual works cost and the trade cost for each machine. It will be noticed that the character of the curve changes considerably at about machine No. 50; this is due to the modifications introduced in the design of the machines from this size upwards. The works cost of a line of motors may be plotted in a similar way, but in this case the brake horse-power is multiplied by 750 and divided by the revolutions per minute—that is to say, instead of taking the output that would be given at 1,000 r.p.m., as in the case of the dynamos, we take the output that would be given at 750 r.p.m.—CURVE.

Answer to No. 1,035 (awarded 5s.).—It is a pity that "W. H. J." has limited the available data to the output and speed, as it is impossible to show how to estimate the cost of a dynamo without reference to the cost of material and wages, except by practically giving him a manufacturer's catalogue, since the ratio $\frac{\text{cost of material}}{\text{cost of labour}}$ varies very much with different manufacturers and with different styles of design. A dynamo designed with a small armature, few poles, few slots, is cheap as regards machinery and winding, but this is counterbalanced by the extra material, particularly copper, required in the field magnet system. For these reasons I propose giving curves of total cost, representative of the average selling prices at the present cost of raw material.

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Fig. 1 gives the selling price of dynamos from 100 kw. to 300 kw. at different speeds. Fig. 2 gives the selling price of smaller dynamos up to 100 kw. The prices given

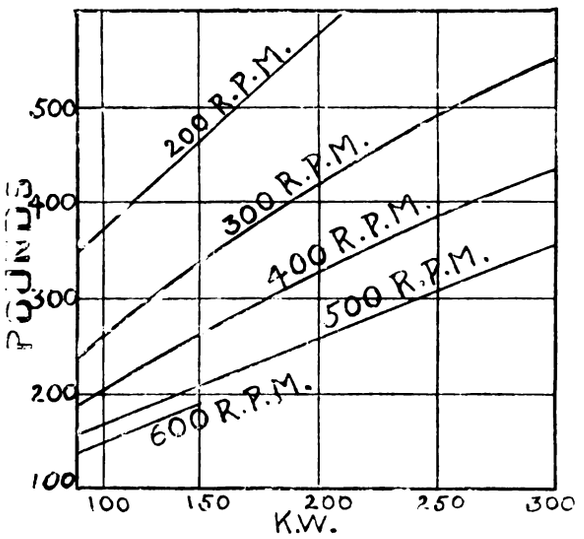


FIG. 1.

hold for machines arranged for direct coupling, and include one bearing and semi-coupling. For small machines where protected type with two bearings of the bracket type are used the prices still hold good. For 100-volt machines the prices should be increased by 7½ per cent. at high speeds down to 2½ per cent. at slow speeds. The price cannot be reckoned at so much per kilowatt per revolution on account of the reduced space factor in the slots due

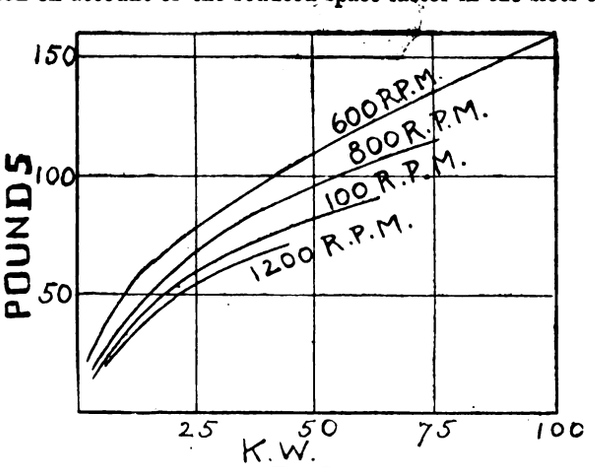


FIG. 2.

to the increased number of conductors, and also on account of the reduced ventilation at slower speeds. Considering the speed of a machine is halved, twice the number of conductors are required for the same voltage. Assuming

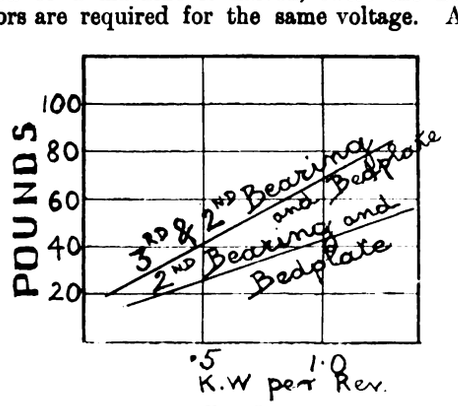


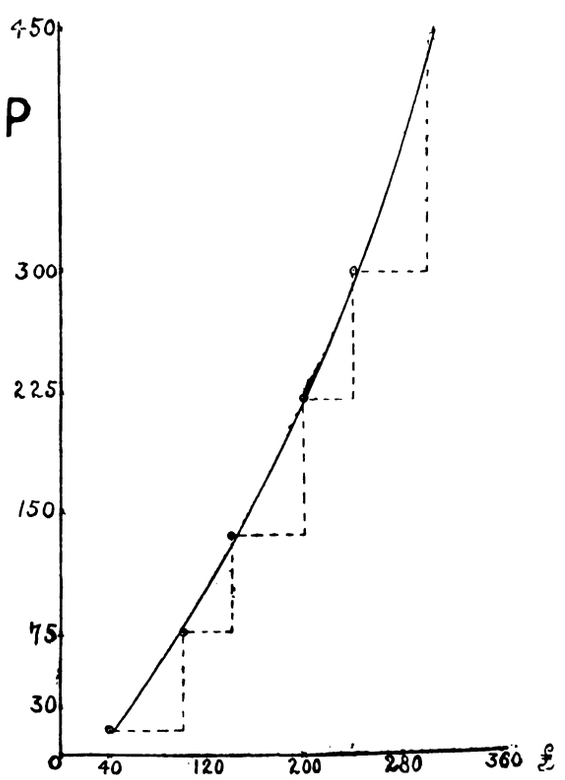
FIG. 3.

the space factor to drop from 50 to 40 per cent. and the armature to radiate 90 per cent. of the copper loss at the higher speed, the new output will be $\sqrt{\frac{40}{50}} \times \cdot 9 \times \frac{1}{2}$ = 42½ per cent. of output at the top speed instead of 50 per cent. Fig. 3 gives the extra to be added for two or three bearing machines, with bed-plates arranged for belt or rope drive.—P.

Answer to No. 1,035 (awarded 5s.).—In order to estimate the cost of manufacture of a line of dynamos approximately correct, assuming that the machines are to be of entirely new design, it will be necessary to estimate in detail three or four machines of different sizes and plot them to a curve showing the relation between cost and output. Now, it is obvious that before a comparison can be made between the machines of various outputs and speeds they must be reduced to a common basis of output. Experience has shown that it is very convenient to assume all the machines will run at 1,000 r.p.m., and give a correspondingly larger or smaller output calculated in kilowatts. The results would be represented by

$$P = \frac{KW. \times 1,000}{R.P.M.}.$$

For instance, a generator with an output of 50 amperes, 500 volts, at 500 r.p.m. would have a value P of 50. The curve mentioned above will, of course, only give an approximate indication of the average cost over the whole line of machines, as the actual cost of each machine would be shown more in the shape of a series of steps, as in the figure. The number of steps which would correspond with each size of the machine are not of the



same value; this is due to the fact that the costliest machines are usually those with the shortest core length; the other machines of the same core diameter but of longer core length will cost less per kilowatt on the basis of P, owing to the principal mechanical parts, such as bearings, shaft, bed-plate, brush gear, etc., being practically the same. If sufficient information is available regarding the actual cost of a few machines of various sizes already constructed, it would be of assistance in plotting the curve after the figures had been modified to suit the new design. The full curve in the figure is representative of the actual cost of a line of modern multipolar generators designed on the same basis and working at the usual standard voltages with a temperature rise not exceeding 75deg. F. after six hours at full load. The machines would be of the shunt-wound open type with one outer bearing and half coupling; the speeds vary from 750 r.p.m. with a 10-kw. machine to 500 r.p.m. with a 225 kw. machine. From the full curve the approximate cost of any machine between the limits given can be obtained; the shape of this curve would be slightly altered when working either way beyond these limits.—H.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

QUESTIONS.

1045. Explain the mechanical and electrical principles of the Westinghouse magnetic friction brake or clutch as applied to their series traction motors.—GEO. HUMPHREY.

1046. It has been decided to work the power at a dock by electricity. The requirement is 2,000 b.h.p. Both three-phase and continuous current can be had from a supply company. On the dock estate lighting is carried out on a large scale on the three-wire continuous-current system from the supply company. The present power on the dock estate is hydraulic, with steam-driven accumulators. Please state what system you would prefer—three-phase or continuous—whether you would drive the accumulators by electric motors, or each crane, capstan, lift, dock gate, etc., separately by motors.—MOTOR.

1047. A transformer is connected between the end of a high-tension feeding cable and a high-tension distributing overhead line with a ratio of 20,000 to 20,000 windings connected mesh to mesh. What is the object of this arrangement and its advantages, if any?—DELTA.

ANSWERS.

Question No. 1,036.—An 80-volt 50-kw. exciter commutator having a surface speed of 2,500ft. per minute gives sparking trouble, the fault being that the trailing end of one of the brushes becomes coated with copper. This causes sparking all round, with any kind of load, though when the brushes have been newly bedded the machine is sparkless on all loads. Different brushes are affected, the trouble not being traced to one or two only. State the reasons for the above, and the probable remedy.

Best Answer to No. 1,036 (awarded 10s.).—The trouble mentioned above does not appear to have received much attention in the design of commutating machines, and no definite data relating to the cause of this trouble are obtainable. It is apparently evident that the trouble is started either mechanically or electrically. When once started, the result is cumulative, and is equivalent to operating the machine with low contact resistance brushes.

The mechanical cause would be due to too soft a grade of copper in the commutator and the adoption of hard carbon brushes. In this case, we should expect that the whole of the contact face of the brush would have a coating of copper, and that the trouble would not be started on any one particular brush, unless, of course, this brush were of a different grade of carbon than the rest. It is a simple matter to determine whether the trouble is started mechanically by carrying out the following test: Run the generator at normal speed and without excitation for a period sufficiently long to give the brushes a good polished surface, the brushes being newly bedded before the start of the run. If at the end of the run any of the brushes are found to have collected copper, then the trouble is caused by the use of too hard a grade of carbon, and steps should at once be taken to fit new brushes of a softer grade of carbon or graphite. As the peripheral speed of 2,500ft. per minute is quite in agreement with modern practice, the writer is of opinion that the trouble is started electrically, and may be due to (1) the use of too thick a brush, or (2) incorrect spacing of the brushes combined with a brush thickness approaching the limit. We will now investigate these causes in detail.

1. In order to give a decision in the matter of brush thickness we should require a knowledge of number of segments in commutator, size of present brushes, number of armature slots, number of armature conductors per slot. We will, however, consider a typical case which will enable the querist to form an opinion in the above case from our deductions. The ampere output of the 50-kw. 80-volt generator would be 627 amperes at full load, and it is very probable that the armature winding is of the multiple-circuit type. If we assume a six-pole machine running at a speed of about 500 r.p.m. and having a flux of about 2·65 megalines per pole at full load, we should, by adopting a multiple-circuit winding, obtain 192 segments in the commutator. With one turn per segment and six conductors per slot we have 64 slots in the armature core, while with four conductors per slot the armature core has 96 slots. We will suppose that the 96-slot core is adopted, and assume that the designer, in order to keep down the length of the commutator, has fitted thick brushes, covering, say, six segments. The relative position of the coils undergoing commutation is represented by Fig. 1, from which it will be seen that the segments under the leading and trailing ends of the brush are connected to conductors which are in very different parts of the field, especially when the effect of armature distortion is considered. The segments under the end T of the brush are connected to conductors which are in a relatively strong field at full load, since, unless the distance between the pole-tips be large—*i.e.*, a short pole arc—the maximum forward lead of the brushes will be limited by the no-load sparking, due to conductors in slot No. 1 being under the pole-tip A. The effect of armature reaction is to weaken pole-tip A and strengthen pole-tip B, as indicated by the dotted lines in Fig. 1; consequently, slot No. 4 is in a relatively strong field when compared with slot No. 1, hence the effect is just the reverse to that required from conditions of commutation, as the current in the coil short-circuited by the edge T of the brush is actually increased, due to the coil cutting the flux from pole-tip B. Consequently, the current density under the edge T of the brush must be enormous, and as the energy (C^2R) due to this short-circuit current must be expended in heat, this heat is principally expended in melting a minute quantity of copper, which is deposited on the relatively cool brush. This lowers the contact resistance of the brush and causes a still larger short-circuit current, with a further deposition of copper, the final result being that there is not sufficient contact resistance in the brush to allow for the gradual growth of the current under the edge L, and consequently sparking occurs. The remedy is, of course, to decrease the thickness of the brush. This will, however, tend to increase the

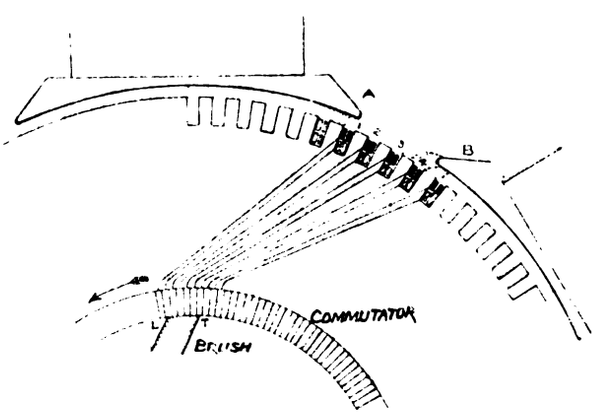

FIG. 1.—Relative Positions of Short-Circuited Coils. The dotted lines under the pole horns indicate the effect of the distortion of the armature current.

commutator temperature due to a larger brush contact C^2R loss, and if this is found to be the case, some specially low contact resistance brushes, such as "Morganite," should be tried. In this case care must be exercised in selecting the correct thickness of brush. The brush thickness should be the minimum that will give the C^2R loss at the commutator within the specified temperature limits. As an experiment with the present brushes, we would suggest that the thickness be reduced by about 25 per cent. of the present value at the contact face, by filing one edge. If this cures the trouble, but the temperature rise is too high, then some lower contact resistance brushes must be used having a thickness slightly less than in this experiment.

2. *Incorrect Spacing.*—As the querist states that *one* brush first becomes coated with copper, this would suggest that this stud is incorrectly spaced. It would also appear that the brush thickness is too great in this case. We would suggest that the spacing of the brush studs be carefully checked up before trying the experiment described above.

The sparkless operation of the machine when the brushes are newly bedded, as mentioned in the question, is due to the contact resistance of the newly bedded brushes being considerably higher than that after the brushes have obtained a good polished surface In conclusion, the evidence appears to indicate that the trouble is started electrically, and steps should be taken to conduct an experiment with brushes of reduced thickness. As a preliminary experiment the thickness of the present brushes should be

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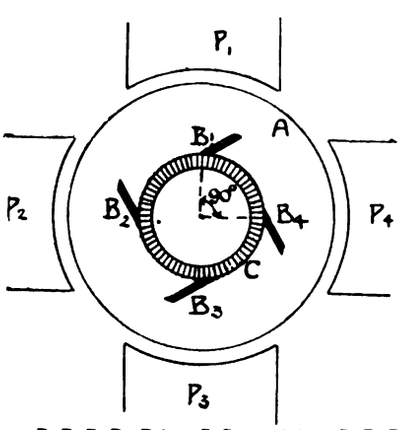
reduced by 25 per cent., as indicated above, and if the trouble still continues, this thickness should be reduced to 62 per cent. and 50 per cent. of the original thickness. We should, however, expect the first experiment with a 25 per cent. reduction in thickness to give satisfactory results.—A E. T.

Answer to No. 1,036 (awarded 5s.).—As "A. R. C." in his question first says that the fault which causes the sparking is that the trailing end of *one* of the brushes becomes coated with copper, and then, in the latter part of the question, that the trouble cannot be traced to one or two brushes only, I presume that various brushes in turn are the cause of the trouble. This seems to point to the relative positions of the brushes being incorrect, and can be explained in this way. In the diagram, which represents a four-pole machine, the correct position of the brushes in relation to one another would, of course, be 90deg. apart. But suppose the setting is not quite accurate, and that the angle between two adjacent brushes is more than a right angle, then if the one brush is in its correct position for commutation, the other will be short-circuiting a coil when it is out of its neutral line, and a heavy current will flow through the brush This will result in excessive heating, and sparking will ensue. The sparking will soften the copper of the commutator, and some copper will be picked up by the brush. The sparking will now increase, damaging the commutator and thus affect all the other brushes. Altering



A, Armature; P1 P2 P3 P4, Poles; C, Commutator; B1 B2 B3 B4, Brushes.

the position of the brush rocker will cause first one and then another of the brushes to begin the sparking, according as the various brushes are displaced from their correct positions. The remedy is obvious. Remove the whole of the brush gear and carefully space out the brush positions to give an exact right angle between adjacent brushes, replace on the machine, carefully bed down the brushes, and, I think, when the machine is next put on load the trouble will have vanished.—BALANCE.

Answer to No. 1,036 (awarded 5s.).—"A. R. C." does not, unfortunately, give sufficient data in his question to enable one to gather more than a vague idea of the machine which is causing trouble, and, therefore, only affords one an opportunity of expressing mere ideas as to the cause of the peculiar copper coating and sparking. Keeping in view the fact that the machine works correctly after having its brushes bedded, this seems to show that the winding at all events is correct, and the fault either lies in the commutator itself or in the brushes. Considering the commutator, we are only told that its peripheral speed is 2,500ft. per minute. How many segments has it? Perhaps this number is in excess of the number of slots in the armature by an amount which is not a multiple of the latter. If this is the case, it may be that the commutator has been fitted on the shaft incorrectly, and that the brush-holders are so placed on the rocker that when the others are in the right position the troublesome one is not. This, perhaps, slight inaccuracy may not cause any trouble when the brushes are well bedded, but after wearing away the contact may be changed sufficiently to cause sparking. The copper coating effect I cannot imagine to be electrolytic, and I suggest that it is due to a burnishing effect, since copper coating can be effected by burnishing. A number of causes of sparking were enumerated in the answers given to Question 1,026 in *Electrical Engineer* for Jan. 10, 1908. Possibly some of these may have been applicable to this case. However, I presume "A. R. C." has tried them. If the machine permits I should certainly try metal brushes, since the current (625 amperes) may be considered as being fairly high. The copper brushes may work at a current density of from 150 to 250 amperes per square inch and a brush tension of 1lb. to 1½lb. per square inch, also the brush should cover about 1½ segments. Again, the field windings should certainly be tested to see if these agree, and all connections to same thoroughly investigated. If none of these suggestions suffice to stop the trouble, more details of machine should be given, and especially a remark as to the kind of copper used for the commutator.—R. P.

Question No. 1,037.—Explain the principles of construction of "slow-speed" continuous-current motors, taking as an example one, say, of 2 h.p. working at a creeping speed in a 110-volt circuit, as compared with an ordinary motor. Give such particulars as will make answer fully self-explanatory, such as dimensions of respective armatures and fields, amount and gauge of wire used, the ampere-turns, ohmic resistance, current consumed at full load, etc. Also mention the starters required for each.

Answer to No. 1,037 (awarded 7s. 6d.).—A motor intended to run at a "crawling" speed is designed on similar lines to one running at a medium or high speed. There are, however, several things which must be borne in mind. The core size for the output will be very large and the copper losses high, and though the friction and iron losses are very small the efficiency will be low. There will be practically no windage caused by the armature revolving and the field coils will not get any fanning, so that we shall have to design the field coils fairly liberally. We can best see where the differences lie in a slow and high speed machine by comparing the design of a 100-r.p.m. and a 1,250-r.p.m. motor. Four-pole machines are given in each instance.

Taking first the slow-speed design. The core size can be found from Esson's formula:

$$D^2 L = \frac{KW.}{R.P.M.} . K.$$

For a machine of the size, K will be between 70,000 and 80,000. Assuming 73,000, we get a $D^2 L = 1,090$, and a suitable proportion of D : L can be taken as 12½in. : 7in. Next proceed to find the total conductors on the armature. These can be found by taking a certain number of ampere wires per inch of periphery. For this size of core 300 to 400 is found to be suitable. Taking 340, the total conductors $= \frac{340 \times 12\frac{1}{2}\pi}{10\frac{1}{2}} = 1,270$. A suitable number is 1,290, when we can use 129 commutator segments and 43 slots, the turns per segment being five. Of course, a two-circuit

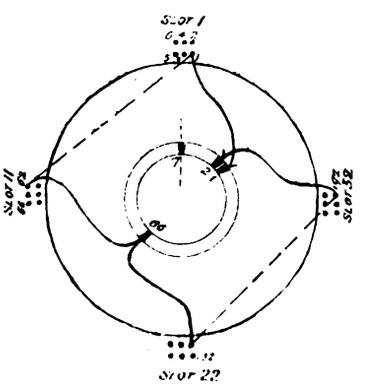


FIG. 1.

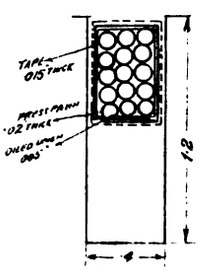


FIG. 2.

winding will be used, and, therefore, each conductor carries half the current. The probable full-load efficiency will be 65 per cent., giving an input current of 21 amperes. Fig. 1 shows a coupling-up diagram for this armature, the span of the coils being from 1 to 11. The reactance voltage is 1·2 volts, which is a low figure. The turns per segment could have been increased and the commutator parts reduced. The size of conductor is No. 14 S.W.G., which gives a current density of 2,100 amperes per square inch.

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Resistance of winding hot

$$= \frac{\cdot00000078 \times \text{conductors} \times \text{length of conductors}}{4 \times \text{section of conductor}}$$

Length of conductor $= \frac{\pi D}{\text{poles}}$ 1·24 + core length = 19·2in.

$$\therefore \text{Resistance hot} = \frac{\cdot00000078 \times 1.290 \times 19\,2}{4 \times \cdot00503} = \cdot96 \text{ ohm.}$$

The size of slot will be 1 2 × ·4. Fig. 2 shows the arrangement in the slot and the insulation.

Commutator Size.—Taking the diameter at 72 per cent. of the core diameter and the length sufficient for two 1in. wide brushes, we get 9in. × 2½in. It is usual to ventilate cores of this size, and suitable proportions of ventilating holes are shown in Fig. 3, there being one ⅜in. ventilating duct in the middle of the core. The shaft size can be found from the following formula:

$$\text{Diameter (inches)} = 9\sqrt[3]{\frac{\text{H.P.}}{\text{R P.M.}}} = 2{\cdot}47\text{in., say } 2\tfrac{1}{2}\text{in.}$$

The voltage drop in the armature = ·96 × 21 amperes = 20 volts + 2 which will be lost in the brushes. The flux $= \frac{(110 - 22)\ 10^8 \times 60}{100 \cdot 2 \cdot 1{,}290} = 2{\cdot}05$ megalines in armature, and with 12 per cent. leakage = 2·3 megalines in field.

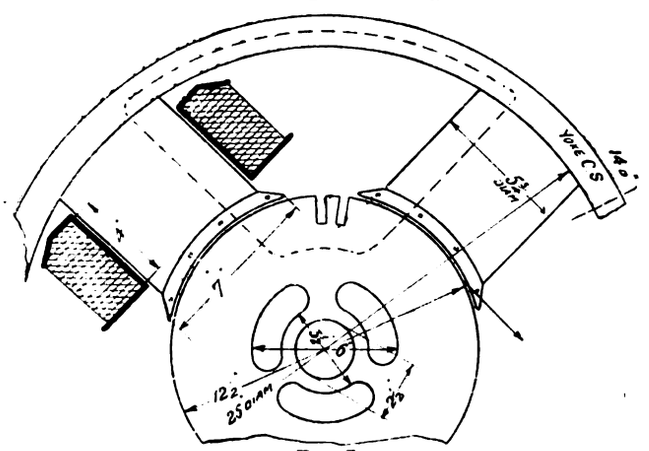

FIG. 3.

Table I. gives sections, densities, and ampere-turns required. The lengths are taken from the dotted line in Fig. 3, and the ampere-turns from a curve of average cast steel. Ampere-turns in air-gap = ·3133 B × gap, with a fringing of 7 per cent.

TABLE I.

	Sections.	B.	Length of path.	Ampere-turns.
Pole	26	88,000	5½	150
Yoke	14	82,000	8½	160
Core below teeth	12·2	84,000	2½	50
Tooth roots	17·2	119,000	1·2	250
Air-gap section	55	37,400	·125	1,450
Armature demagnetising ampere-turns = ⅓ × armature ampere-turns				570
			(Ampere-turns per pole)	2,630

If a cast-iron yoke is used instead of cast steel, 2½ times the section will be required. Assuming the motor to be shunt wound, the size of wire (area in square inches)

$$= \frac{\cdot000028 \times \text{ampere-turns} \times \text{poles} \times \text{mean length of turn}}{36 \times \text{volts}}.$$

Judging the mean length of a turn = 26in., we have

$$\frac{\cdot000028 \times 2{,}630 \times 4 \times 26}{36 \times 110} = \cdot00192 \text{ square inch.}$$

The next size of wire is No. 17½ S.W.G. By trial we find that 1,500 turns of this size of wire will give us 2,970 ampere-turns. The actual mean length is 25 2in., and the resistance of four coils in series

$$= \frac{\cdot00000078 \times 1{,}500 \times 25{\cdot}2 \times 4}{\cdot00212} = 55 \text{ ohms,}$$

and shunt current $= \frac{110}{55} = 2$ amperes,

and the $C^2 R$ = 220 watts, or ·36 watt per square inch of radiating surface. The temperature rise of the field coils should not be higher than 75deg. F. for these watts.

We must now check the radiating surface of the armature. The core loss can be calculated from the curve (Hobart) shown in Fig. 4. The core weight is 157lb, and the frequency = 3·3 ~ ; ∴ the core loss is 76 watts. The armature $C^2 R$ = 425 watts; 425 + 76 = 501 watts total. The radiating surface of the armature = π D L = 546 square inches; where $L = \frac{\pi D \cdot 7}{\text{poles}}$ + core length, ∴ 501/546 = ·92 watt per square inch. At the low peripheral speed of 328ft. per minute the temperature rise will be between 70deg. and 75deg. F. per watt per square inch, so that the rise on the armature will probably be 67deg. F. or thereabouts.

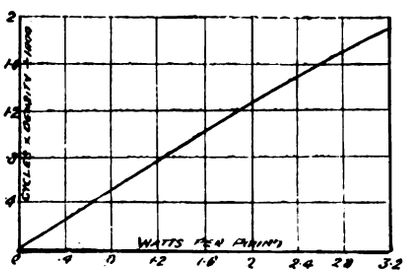

FIG. 4.

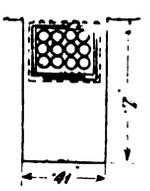

FIG. 5.

The design of the high-speed motor can be proceeded with in the same way. K in E-son's formula will be about 130,000 for the output and speed. A core size of 6½ × 4 will be found to be a good proportion. The efficiency at full load will be much higher than the slow-speed motor—viz, about 77 per cent.—giving an input current of 17½ amperes. For this size of core 250 ampere wires per inch of periphery can be taken, which will give about 550 total conductors. Using 23 slots and 69 commutator parts we get 552 conductors. The winding is a simple two-circuit one with four turns per segment. The span of coils is 1 to 6. The size of armature conductor will be No. 16 S.W.G., giving a current density of 2,700 amperes per square inch. The resistance = ·34 ohm. The slot size is ·7 × ·4, the arrangement being shown in Fig. 5. With one brush per spindle and 72 per cent. diameter of armature, we get a commutator 4½in. × 1½in. As the armature core is not ventilated and the frequency being high, we shall

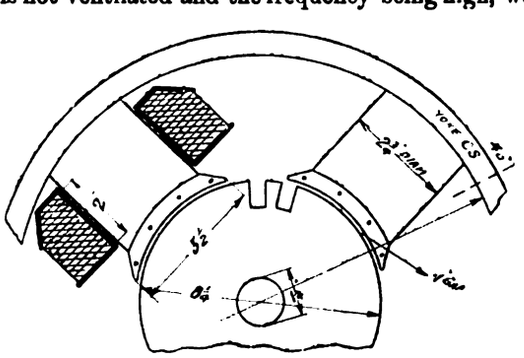

FIG. 6.

have to work at a low flux density in the core, actually 34,000 lines per square inch. The flux = ·44, and the leakage coefficient will be about 1·15. The length of polar arc can be made as before—viz., 75 per cent. of the pole-pitch. Calculating the excitation as before, we shall find that No. 22 S.W.G. will be the size of wire required, and the turns per pole 1,470. This will give a shunt current of 1·04 amperes, the hot resistance being 106 ohms. The watts per square inch of radiating surface = ·57 = 70deg. temperature rise. The watts lost on the armature will be found to be ·99 per square inch, which is equivalent to a rise of 65deg. to 70deg. F. Fig. 6 gives full particulars for calculating densities, sections, and ampere-turns The core stampings are made of charcoal iron about 024 thick, insulated with varnish or paper; 10 per cent. of the gross section of core should be allowed for insulation.

Starters.—Assuming that half full-load current only is allowed when on the first contact, the resistance required will be, in the case of the low-speed machine,

$$\frac{110}{10\frac{1}{2}} = 10\tfrac{1}{2} \text{ ohms} - 3 \text{ ohms (drop in armature and brushes)}$$

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$= 7\frac{1}{2}$ ohms resistance of starter. For the high-speed motor $\frac{110}{8\frac{3}{4}} = 12\frac{1}{2}$ ohms $- 2\frac{1}{2}$ ohms drop $= 10$ ohms resistance of starter. The over-all dimensions of the starters will be about 9in × 7in. × 2in. The number of contacts is a matter of choice; six would be sufficient.—H. T. A.

Answer to No. 1,037 (awarded 7s. 6d.).—The question is not entirely clear, as no definite speed is specified. As, however, the brake horse-power of the machine mentioned is so small, we may fairly assume that 200 r.p m. will meet "Rheostat's" requirements. The first point of difference that would strike one is the much larger armature diameter required for the slow-speed motor; also, it is probable that the high-speed machine would have two poles as compared with four poles for the slow-speed, one principal reason for this being that with the last-mentioned there is no danger of having too high a periodicity, so that the poles may readily be increased. This increase in the number of poles enables one to make a much lighter machine, which is of importance, as it entails less expense as regards material, which is sure to be great in any case due to the low speed.

In addition to the points mentioned above, the two designs would differ in the following particulars. For the sake of convenience we may assume a speed of, say, 1,400 revolutions for the high-speed motor, and call it A, calling the 200-r.p m. machine B. Then, the current density in the armature winding of B would have to be considerably less than A, due to poor ventilation obtained at the low speed (the ratio being as shown in the schedule, Table I.). On the other hand, the density of the magnetic flux in B could be increased above that in A without detriment as regards heating, as the core loss at such a slow speed would be comparatively small irrespective of the flux density. The commutator of B would require to be of larger diameter than that of A, in order to make room for the extra brush studs necessitated by the increase in the number of poles. It may here be remarked that B's armature would be series connected (otherwise the number of conductors entailed would be excessive), but, notwithstanding this, for good operation it has been found to be better in actual practice to use a set of brushes to each pole rather than using two sets only. As regards the number of commutator segments, it is probable that B would have a greater number than A, though this is not necessarily essential, as with such a low speed a very large number of turns per segment would be permissible. Considering the number of slots, there would probably be more in the core of B than A (due to the larger diameter of armature), but fewer per pole. It is desirable to keep the number down, as such a design lends itself to cheaper construction, and there is little danger of trouble due to eddy currents in the pole-faces or humming at the speed in question. The foregoing remarks apply equally well with any lower speed than the one under consideration, it being borne in mind that the slower the speed the lower the current density and the greater the number of poles. The decision as to this last item is generally purely one of cost of manufacture, as there is a certain best number at which cost of material and labour are proportioned to the greatest advantage. The fewer the poles the less the material and the greater the labour.

TABLE I.

	A.	B.
Diameter of armature—inches	6	11
Length of armature—inches	3½	6*
Number of slots	40	47
Size of slots—inches	·78 × ·23	·9 × ·35
Diameter of conductor—inches	·064	·083
Number of conductors per slot	14	24
,, ,, ,, total	560	1,128
Current density—amperes per square inch	2,650	1,850
Number of commutator segments	40	47
Resistance of armature—ohms	·51	·7
Connection	Parallel	Series
Total flux C.G.S. per pole	768,000	1,260,000
Air-gap—inches	·06	·09
Total ampere-turns per pole	1,500	2,700
Section of magnet yoke if of C.S.—square inches	·43	7
,, ,, ,, ,, C.I.—square inches	10	16
Number of poles	2	4
Section of poles—square inches	6·8	14
Diameter of shunt wire—inches	·02	·045
Number of turns per pole	3,800	1,650
Resistance total—ohms	240	63
Total weight armature copper—lbs.	10	35
,, field copper—lbs.	15	80
,, armature iron—lbs. (punchings)	15	60
,, field iron—lbs. C.S.	75	200

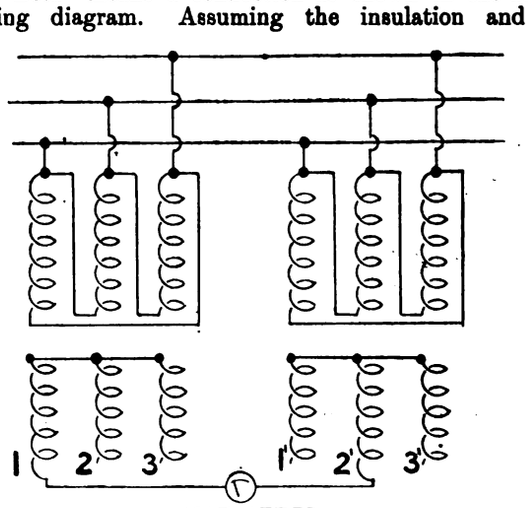
Weights include the electrical part of the machines only and are approximate. * Including ½in. ventilating duct.

The schedule in Table I. is the best medium for fully appreciating the respective proportions of the two designs. A rough approximation of the relations of various designs for various outputs *per revolution* are as follows: output per revolution increases directly as the length of the armature and also as the square of the diameter of armature.

The foregoing are irrespective of the number of poles. Any change in these will, however, affect the weight, as already shown in the foregoing. By doubling the number of poles the weight of the magnet yoke is approximately halved. As this may be taken to be rather less than the total weight of the magnets, it will be seen that (the poles keeping constant in weight) the whole frame, including the poles, will be reduced to about three-quarters of the original weight. The field copper will be decreased, say, 10 to 15 per cent. and the iron in the armature about 25 to 30 per cent. in weight, although the section will be approximately halved. As regards starting rheostats, the only difference will be in the total amount of resistance required external to the machine. Assuming that the rheostat passes a current equal to full-load current on the first step, it will be seen that this is governed by resistance of rheostat plus resistance of armature. In the case of motor B the last of the above items will be considerably in excess of that of A, though in each case it is so small a proportion of the total that it may be said that no difference in the design of starter is really necessary.—R.

Question No. 1,038.—Two or more three-phase transformers are connected in mesh on the primary to the same 'bus bars, the secondaries being star-wound and the neutral points not earthed. If a voltmeter be placed across phase 1 on one of them and phase 2 or 3 on the other, should the voltmeter give a reading? If not, explain why.

Best Answer to No. 1,038 (awarded 10s.).—I take it that "Beta" means a connection as shown in the accompanying diagram. Assuming the insulation and the



capacity of the three phases to be equal, the potentials of the terminals 1 and 1^1, 2 and 2^1, 3 and 3^1 will be the same before the same voltmeter is connected in the circuit—*i.e.*, the voltage between the terminals 1 and 2^1 is then equal to the full secondary line voltage. The insulation of the winding is as a rule so high and the capacity so small, however, that the potential distribution is completely altered, as soon as the voltmeter is connected up, due to an exceedingly small current passing through the latter; the alteration would be such that the terminals 1 and 2^1 have the same potential. An ordinary voltmeter would, therefore, not give any reading; it would, however, be possible to obtain readings on a static voltmeter of sufficient small capacity compared with that of the transformer. The same result is obtained whether the connections of any of the windings are mesh or star.—K. F. H.

[Other replies to Question No. 1,038 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

QUESTIONS.

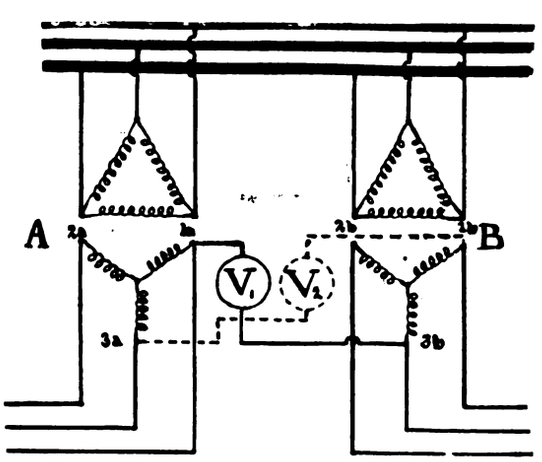
1048. It is desired to calculate the resistance and number of stops for the starting portion of a lift controller. The motors would be continuous current, 220 or 440 volts, shunt wound, with a few turns of series windings, cutting out on the last step of the starting up resistance. The motors would range from 2½ b.h.p. to 20 b.h.p. Give (1) simplest formulæ for determining resistance and number of steps; (2) state material of which resistances are best made for commercial purposes; (3) how many sizes of controllers would be necessary to meet the range of motors above stated; (4) give number of steps and resistances for each size; (5) give formulæ for calculating shunt kicking coil and operating solenoids.—KNOWLEDGE.

1049. One of the ageing processes employed by a large firm engaged in the manufacturing of permanent magnets for meters is as follows: A large copper disc (about 1ft. in diameter and ½in. thick) is rotated at a very high speed, and the meter magnet is held in the hand and slowly moved across a part of the disc so that the poles embrace the disc during the motion. The operation is again repeated, only with the poles reversed relatively to the disc. Please explain how it is, in detail, that ageing is effected.—W. NEWMAN.

ANSWERS.

Question No. 1,038.—Two or more three-phase transformers are connected in mesh on the primary to the same 'bus bars, the secondaries being star-wound and the neutral points not earthed. If a voltmeter be placed across phase 1 on one of them and phase 2 or 3 on the other, should the voltmeter give a reading? If not, explain why.

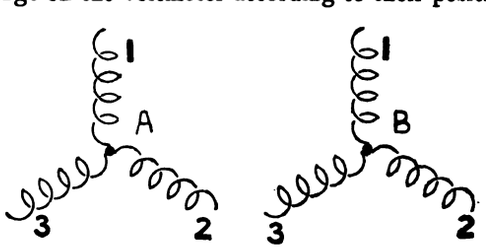
Answer to No. 1,038 (awarded 7s. 6d.).—From the wording of "Beta's" question I take it that the secondaries of the transformers are not connected in parallel, but are supplying separate circuits. In this case, if a voltmeter be connected as de-cribed, and, as shown in the figure, V_1, no reading will be obtained. The reason for this is that the secondary windings and load of transformer A form a circuit com-



plete in itself and entirely insulated from the secondary of transformer B. If, therefore, the terminals 1A and 3B be connected together, either through a voltmeter or otherwise, the result will merely be to bring these points to the same potential, and to maintain them in this condition. A sensitive voltmeter might give a momentary reading when connected up, just as a galvanometer "kicks" when an electrostatically charged body is discharged through it, but would return to zero at once, for the reason stated. Although it follows from the above that the voltmeter could not register the line potential difference, it might show a small, but definite, reading for the following reason: Suppose the maximum secondary phase potential difference to be 100 volts. Then once in each cycle the neutral point of A (and hence circuit A *considered as a whole*) will be at a potential 100 volts above the terminal 1A, and once in each cycle it will be 100 volts below terminal 1A. Similarly, but 120deg. out of phase with this, the neutral point of circuit B will vary from 100 volts above to 100 volts below terminal 3B. Since, however, 1A and 3B are, as already explained, always kept at practically equal potentials, there will be an alternating potential difference between the neutral point of A and the neutral point of B practically equal to the secondary line voltage. There will, therefore, be a small alternating current between one neutral point and the other, which must pass through the voltmeter connections, and the amount of which will be dependent on the mutual capacity between circuits A and B. This would, however, under normal conditions, be too small to affect the voltmeter appreciably. Of course, if the neutral points were earthed, the voltmeter would register the full line voltage precisely as if it were connected between two terminals of one transformer.

If the second voltmeter be connected as shown in dotted lines in the diagram, the sum of the voltmeter readings will give the sum of the voltages between 1A and 3A and between 1B and 3B—*i.e.*, if the transformers are similar, half the sum of the two readings will be the line voltage. The distribution of the potential differences between the two instruments will not, however, depend upon any actual difference in voltage between the two transformers, but will be governed by the relative impedances of the two voltmeter circuits.—A. H. B.

Answer to No. 1,038 (awarded 5s.).—Whether the voltmeter should show any reading or not depends on two things, the kind of voltmeter used and the condition of the insulation of the transformer secondaries, including all lamps, etc., connected. If the voltmeter used be of the electrostatic type, not requiring a flow of current through it for its operation, the voltmeter when placed across phase 1, transformer A, to phase 2 or 3, transformer B, will probably indicate about the same voltage as it would if placed across phase 1 and 2 on transformer A. This is because the windings of each transformer secondary, if equally well insulated, will have a mean potential equal to the earth potential, or, if the insulation is equally good all over, the neutral point will be approximately at the earth's potential, although not connected to earth. If, however, the insulation of transformer A was poor, and, perhaps, grounded at phase 1, then the potential at phase 1 would be equal to the potential of the neutral of transformer B, and the reading of the voltmeter when placed across phase 1, transformer A, to phase 2, transformer B, would only be equal to that on one leg of the star—namely, $\frac{1}{\sqrt{3}}$ times the full secondary line voltage. Grounds at intermediate points on the secondaries would cause different readings on the voltmeter according to their position.



Probably, however, a voltmeter requiring a current for its operation, such as the movable-coil type of instrument, is being used. In this case there will be no reading of the voltmeter unless bad grounds cause leakage currents. This is because this type of voltmeter is not capable of indicating the static difference of potential between two circuits, but requires the passage of a current constantly for its operation. Now, since the two secondary windings are entirely insulated from one another, there can be no continuous interchange of current between them, unless they are first connected together by two wires at different points, because there must be just as much current flow in as flows out of either circuit; and since the voltmeter only links the two separate circuits together at one point, there will be no passage of current through it unless this current can return through grounds on both secondaries.—W. S. P.

Answer to No. 1,038 (awarded 5s.).—The answer to this question is both yes and no, depending upon the type of voltmeter used. If an electrostatic voltmeter be used for the tests a reading will be obtained, but with a voltmeter which takes an appreciable amount of current there will be no reading.

(*a*) Take the latter case of the voltmeter, which requires current to make it operate. If the transformer windings are not connected in any way—*i.e.*, the primary and

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secondary windings are insulated one from the other—there will not be any reading on the voltmeter when connected between phase I. of one transformer and phase II. or III. of another, provided the secondary windings of the transformers are quite separate, with, of course, the exception of the voltmeter connections. In Fig. 1 the secondary

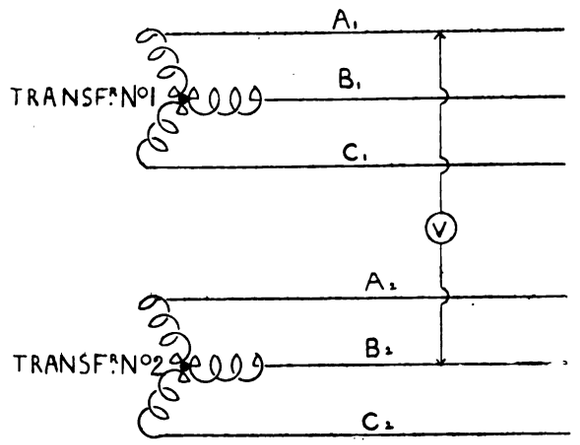


FIG. 1.

windings only are shown, as the primary windings cannot enter into the question unless the primary is connected to the secondary. Now, if the neutral points are not earthed or connected, it is impossible to obtain a current between A_1 and B_2, because there is no path by which the current could return. Should it happen that the neutral points become connected, then there would be a potential difference between A_1 and B_2, which, if the ratio of transformation of the transformers is the same, would be equal to the potential difference between A_1 and B_1. The reason for not obtaining a reading on the voltmeter is simply that the circuit is not completed.

(*b*) With a voltmeter of the electrostatic type it is quite possible to get a reading, but it is impossible to say what reading will be obtained. The primary and secondary windings of the transformers may be regarded as the two plates of a condenser and the insulation as the dielectric.

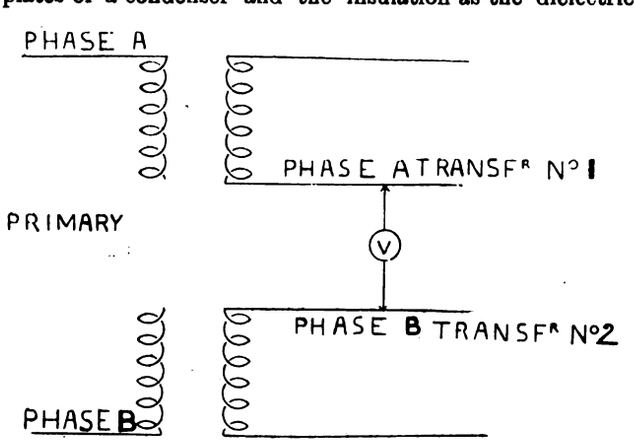
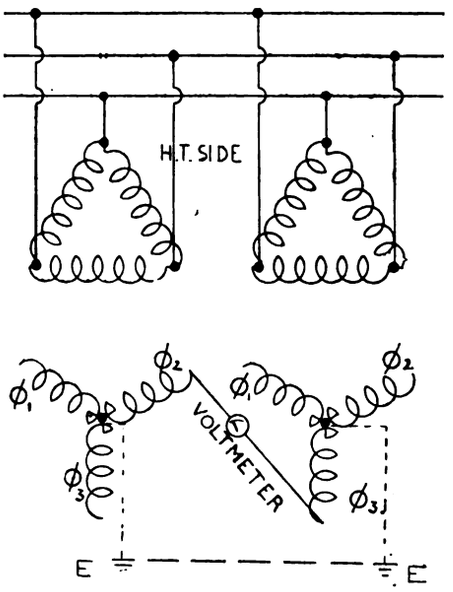


FIG. 2.

We then have the conditions as shown in Fig. 2—that is, the voltmeter in series with two condensers across the phases A and B of the primary circuit—and would consequently give a reading which would be inversely proportional to the capacities of the windings and the voltmeter; for example, if the capacity of each winding be the same as the capacity of the voltmeter, the voltmeter would read one third of the voltage between phases A and B.—A. J. MARTIN.

Answer to No. 1,038 (awarded 5s.).—If the insulation resistance of the transformers mentioned is high, and, consequently, the insulation sound, there will certainly be no reading on the voltmeter connected in the manner mentioned, and the reason for this is perfectly obvious. If we take any circuit carrying a current and break it in one place, then a voltmeter placed across the break will again complete the circuit and a current will flow, its value being inversely proportional to the resistance of the meter, and the voltage registered will be the voltage of supply. But if there are two breaks in the circuit, a meter placed across one will not complete the circuit, and, therefore, as no current is flowing there will be no reading on the meter.



Dotted lines to earth from neutral or any other point to earth show the circuit which the voltmeter would close.

From the above statement it appears that unless a current is flowing through a voltmeter it will not read. This, of course, is not strictly true in the case of a static voltmeter, but even in this case current has to flow in and out on either side of the meter before it will read, which necessitates a closed circuit up to either side of the meter in order to obtain a reading. This is exactly the state of affairs in the case under consideration, for from the sketch it will be seen that unless the neutral or some other point is earthed the placing of a voltmeter across phase 1 of one transformer and phase 2 or 3 of the other will not close any circuit between them, and, therefore, no volts will be registered. If the secondaries of both transformers were in parallel as well as the primaries, then connecting a voltmeter as before would be the same as connecting across the phases of one transformer. If a reading has been obtained on a voltmeter by the writer of the question, then the insulation of the windings of either transformer is not sound, as there is a tendency for a current to flow from the phase of one to the phase of the other and back, the insulation resistance being inversely proportional to the reading obtained, but as the earthed point of both transformers is unknown the insulation resistance cannot be calculated from the reading.—C. H. RYLEY.

Question No. 1,039.—Describe (preferably from personal knowledge) the precaution to be adopted when withdrawing lead-covered cables from earthenware ducts, the cable being ·15 C.M.A., and covered with a jute serving. What is considered a safe strain or pull (expressed in pounds) to put on such cables' end?

Best Answer to No. 1,039 (awarded 10s.).—The chief precautions to be adopted are: (1) the proper fastening of

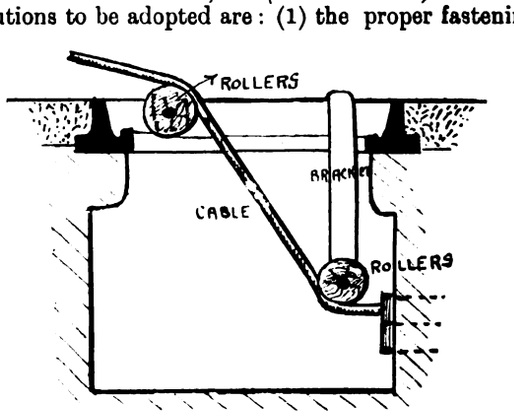


FIG. 1.

hawser to cable; (2) not to put too great a strain on the cable. Fig. 1 shows a section through the cable pit, with rollers placed in position; if the conduits are near the surface of the ground, one roller will suffice. Great care

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should be taken with the joint made between the hawser and the end of the cable The insulation should be bared back so as to expose sufficient of the conductor for the hawser to be securely lashed to same, and also to the sheathing. The great objection to this method is that the end of the cable has to be stripped, which, especially with a concentric cable, means delay and waste. A great improvement is obtained by using a flexible wire grip, which fits over the surface of the lead sheathing (Fig. 2) for about a yard, and which gives excellent results. It is also advisable that where possible the sheathing should be rubbed with soft soap, which eases the passage through the ducts. For small cables of this size it is found much better to have same pulled out by manual labour than by means of a crab, as it is much easier to tell whether the cable is binding or not before same may be damaged. There is no hard-and-fast rule for fixing the strain to be applied to a cable's end, owing to the great variety of the conditions, but it is more a matter of judgment, coupled with the necessary experience, it being found that under

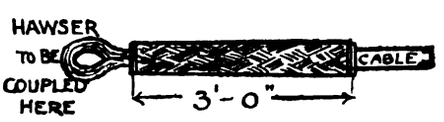

FIG. 2.

normal conditions six to eight men would be required. This includes labour for drum winding, etc.—L. H.

Answer to No. 1,039 (awarded 5s.).—In withdrawing a cable from the ducts the first thing is to decide in which direction the cable is to be withdrawn. Other things being equal, it is better to draw the cable down a slope than in the opposite direction. Due regard must be paid to the position of the bends, if any, in the run. Places where the ducts have had to be dipped to go under any of the numerous gas, water, and sewerage pipes should be noted. If it be possible, the pull should come in such a direction that, when drawing out, the minimum length of cable is pulled through such bends or dips The cable being freed or disconnected, the end which will be drawn through the ducts should be made watertight, so that should there be any water present in the ducts there will be no chance of moisture creeping up to the core. The cable is made waterproof in some cases by hermetically sealing the end of the cable by soldering a lead cap on to the lead covering after sawing the cable square. Care must be taken when this is done to see that the cable is not bent up at right angles, for if such be the case the insulation and sheathing are strained and the conductor disorted. A far cheaper and quite as good a method as regards keeping out the moisture is to cover the cable end with white tape, wrapping the tape over the lead covering and covering the tape with compound, finished off in such a manner that it will pass through the ducts without sticking. At the end of the ducts where the cable is to be withdrawn a bell-mouth must be fixed, the bell-mouth being slipped over the cable, and fitting tight in the ducts, so that it will not be withdrawn when the pull comes on the cable. Care must be taken to see that the bell-mouth does not bear on the jute or the covering will be rucked up, causing the cable to stick; this bell-mouth will prevent the cable becoming damaged as it leaves the ducts. It is always best to pull on the core of the cable; this is a safe plan and prevents injury to the sheathing. The strands of the cable being opened, they should be passed through the eye of the pulling swivel, one half in one direction, the other half in the other direction, and then bound back upon themselves. The question of pulling out the cable by winch or hand is one which the individual requirements of the case decides. For a cable of this size hand pulling is considerably quicker. Care must be taken to see that a steady pull is kept on the cable, and not to give it a jerky motion. Manila rope is preferred for hand pulling As the cable is withdrawn the pull will be on the cable itself, the slack being wound on the drum as the cable is withdrawn. When using a winch a device must be contrived whereby the sheathing is not damaged, when the pull comes on the outside of the cable. The cable should be examined as it is withdrawn for any signs of injury either from electrolysis or by withdrawing. Both ends of the cable should be examined for moisture, which will be noticed if a short length is cut off the end, the oil being dull instead of clear and bright if moisture is present. The ends of the cable should be then hermetically sealed with lead caps to keep out the moisture. Much depends upon the state of the cable as to what pull it will stand, but the questioner can rest assured that the core will be equal to stand all the pull required. The breaking strain of 0 15 C M A. cable can be taken at approximately 6,500lb., and a factor of 2 or 3 can be taken (as the questioner thinks best) for safety, giving 2,400lb. as safe pull.—F. M. M.

Answer to No. 1,039 (awarded 5s.).—Cablemaking is a science, is amenable to calculation, and can be more or less exactly defined; cablelaying is an art, and as such defies definition. A method of procedure that would be satisfactory for withdrawing cables in one case might under other conditions simply court disaster. Taking the elastic limit of soft copper as 9,000lb. per square inch, the cable should not be pulled with a force exceeding 9,000 × ·15 = 1,350lb. The strength of the lead sheathing need not be considered, as the best practice is to pull by copper only. Such a cable, as specified in the question, will weigh about 8,000lb. per mile, so that knowing distance between manholes, some idea can be formed as to the weight to be moved. Unfortunately, only the roughest estimate can be made with regard to the coefficient of friction. It may happen that considerably less force than mentioned above may move the cable; on the other hand, such a pull may have no effect. In one aggravated case, where the writer was concerned, a passing cart was requisitioned; a few turns of the hauling rope were taken round the cart axle and the horse urged forward. Just the exact pulling force in this case would be difficult to say; it was scarcely scientific engineering, but the result was O K. As the connection between hauling rope and cable does not pass through the duct, the copper conductor can be bent over and fastened to rope, or a pair of draw-tongs can be employed. A winch gives a convenient pull, and by having a fairly long distance between winch and duct considerable control is obtained in getting a direct pull on the cable. If there is a "fish-wire" in the duct, or if the duct can be rodded, a well teased out bundle of rope could be drawn through, and the cable, or cables, well smeared with a mixture of soft soap and powdered blacklead. This forms a good lubricant, and, if the soap is chemically neutral, is not at all detrimental. A rope should be fastened to far end of cable, and must be connected by a neat splice as this passes through the duct. The advantage of this rope is that should an abnormal grip be felt when withdrawing, pull can be eased off and the cable pulled back gently by the tail rope. Thus cable may be relieved and another start made at withdrawing. Generally, apply no more force than necessary at either end than is absolutely necessary, and let force be applied in as direct a line with the cable as possible. Keep the cable moving, but not too quickly; this can be assisted by carefully swinging the ropes at each end. Get as much lubricant through the duct as possible; this may be very necessary should the duct contain more than one cable As the cable comes out keep it free from twists and kinks—the worst job in the experience of the writer was with twin paper-insulated cable—any twist or sharp bend playing havoc and practically destroying the insulation. Take care that everything is ready, and hurry slowly.—M. M.

Question No. 1,040.—What are the advantages gained by using fractional pitch windings on induction motors, and how are these wound? Is it necessary to have open slots with such a winding?

Best Answer to No. 1,040 (awarded 10s.).—In a normal winding the two sides of each phase coil are 180deg. electrically apart, but in a *fractional* pitch winding they may be either more or less—in a 3/4 pitch winding they are 135deg. electrically apart, in a 4/3 pitch winding they are 240deg. electrically apart. Take, for example, a four-pole three-phase winding having 12 slots in all for simplicity. In a normal winding the coils of phase 1 would lie in slots 1 and 4, 4 and 7, 7 and 10, 10 and 1, and each slot would only contain coils of one phase. In a fractional pitch

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winding 2/3 pitch the coils of phase 1 would lie in slots 1 and 3, 4 and 6, 7 and 9, 10 and 12, but these coils would only occupy a half of each slot—there would be two coils in each slot of different phase. The diagram given illustrates the winding of the coils of one phase, the front ends of windings are shown inside the circle, and the back ends on the outside, the direction of the current in the slots being shown by • means back to front and + front to back. The advantages gained by the use of fractional pitch windings are: (1) a considerable reduction of the total leakage reactance; (2) hence a reduction of the exciting reactance, which means more exciting current for the same voltage; (3) and a much higher density in all parts of the magnetic circuit; (4) a reduction of the over-all length of motor; (5) in some cases it is much easier to wind as well as occupying less space.

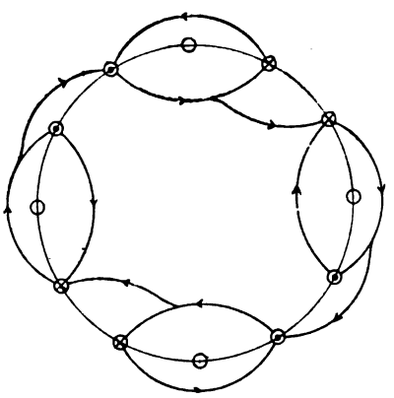

Diagram of Fractional Pitch ⅔ Winding for 4-Pole 3-Phase Motor. Only Phase 1 shown.

It is of considerable advantage for high-speed motors and also for variable-speed motors in which the number of poles are to be changed. It is not necessary to have open slots for this winding; closed or semi-closed may be used.

All interested in this subject should study Messrs. Adams, Cabot, and Irving's paper on it, which appears in vol. 26, No. 8, August, 1907, of the *Proceedings* of the American Institute of Electrical Engineers, to which the writer is much indebted.—V.

Question No. 1,041.—Describe a method of determining graphically the pole shape of an alternator, knowing the desired E.M.F. wave and the distribution of energy.

Best Answer to No. 1,041 (awarded 10s.).—In approaching this question it will, perhaps, be best to discuss first of all the possibilities. Consider the curves in Figs. 1 and 2.

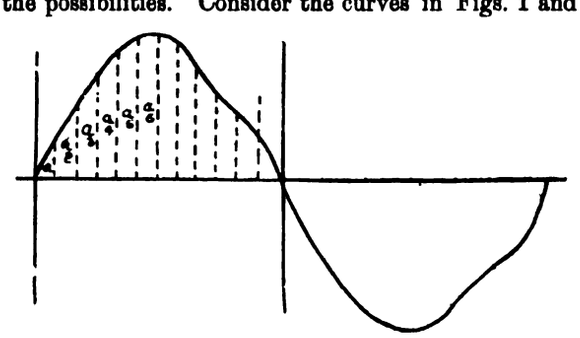

Fig. 1.

These are essentially different, in that no even harmonics appear in Fig. 1 while they are present in Fig. 2. The effect of this is that the second half of Fig. 1 is an exact replica of the first half, but reversed, and this is the type almost universally found in alternators. To generate the curve shown in Fig. 2 would need consecutive poles to be of different shapes, and we will, therefore, not deal with it. Secondly, the harmonics generated in the E.M.F. curve depend on the various groupings of the windings. For instance, a coil which embraces in the pole-pitch any number of complete periods of one of the higher harmonics will not generate that harmonic. Again, the method of obtaining a desired E.M.F. wave by shaping the pole-pieces is unsatisfactory on account of the distorting effect on the flux curve of the armature current, so that, while at no load the desired effect may be attained, when loaded to any degree the E.M.F. curve is distorted, the degree of such distortion depending upon the care taken in arranging the grouping of the coils.

But supposing we have decided on the best possible winding, and we require an E.M.F. curve as given in Fig. 1. Let us take a concrete case and assume a two-phase alternator with three slots per pole per phase, as shown diagrammatically in Fig. 3, the slots being equally spaced.

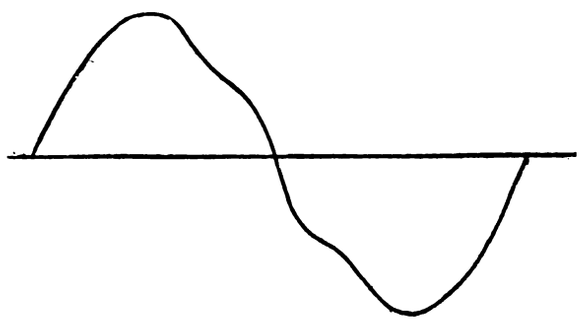

Fig. 2.

The first thing is, of course, to determine the flux curve, and as the poles are to be similar we need only consider half of a complete period. Divide the curves into 12 equal parts by ordinates a_1, a_2, a_3, a_4, etc., and divide a line representing the pole-pitch also into 12 equal parts. Then considering the set of coils in series marked 1, 2, 3, it is obvious that they are required to generate an E.M.F. equal to a_1 in the position shown. That is, calling the ordinates of the required flux curve x_1, x_2, x_3, etc.,

$$a_1 \text{ is proportional to } x_1 + x_3 + x_{11},$$

or

$$x_1 + x_3 + x_{11} = a_1 \text{ to some scale.}$$

Similarly, by shifting on through one-twelfth of a pole-pitch the set of coils we get

$$o + x_2 + x_4 = a_2.$$

Further,

$$x_1 + x_3 + x_5 = a_3.$$

By continuing thus we obtain sufficient equations to determine the ordinates x_1, x_2, x_3, etc., of the flux curve, as in Fig. 3.

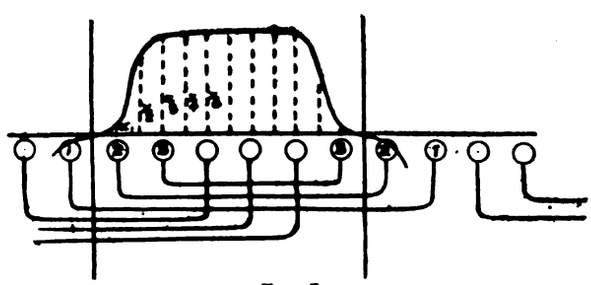

Fig. 3.

Now, to determine from this the shape of the pole-face we must make some assumptions. Possibly the best way to proceed will be to lay out a line to represent the pole-pitch, and divide it up as before. Then at points corresponding to ordinates x_1, x_2, x_3, etc., draw circular arcs of radius $\frac{1}{x_1}$, $\frac{1}{x_2}$, $\frac{1}{x_3}$, etc. The curve touching all these arcs will represent the shape required, on the assumption of straight flux lines. To get a nearer approximation, one might draw, in freehand, a more likely distribution of flux at the pole-edge, and correct the shape to bring the length of these lines to the reciprocal of the ordinates of the flux

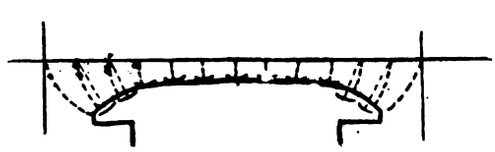

Fig. 4.

curve at these points, as shown in Fig. 4. The effect of the teeth in various positions should also be taken into account, but the investigation of this would lead us too far.—P. H.

[Other replies to Question No. 1,041 will be given in our next issue.—Ed. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,050. In designing non-inductive field discharge resistances, what rule, if any, is followed in fixing on the necessary resistance and current-carrying capacity of same? Give an example.—S. E. T.

1,051. Two 75-kw. 500-volt machines (one having interpoles and both being compound wound) when run in parallel do not take the load equally, the one having the interpoles taking 50 per cent. more load than the other. State how this can be remedied and any tests that will have to be made; also how should maximum and reverse current circuit breakers be connected to be most efficient.—J. P.

ANSWERS.

Question No. 1,041.—Describe a method of determining graphically the pole shape of an alternator, knowing the desired E.M.F. wave and the distribution of energy.

Answer to No. 1,041 (awarded 5s.).—In finding the pole shape for a given E.M.F. curve several assumptions have to be made. One of these is that knowing the shape of the pole we can, therefore, determine the shape of the flux distribution or *vice versâ*; or, again, the interference of the armature slots can be neglected. Allowing for these, the connection between pole shape and no-load E.M.F. curve can fairly easily be determined graphically. We will here deduce an E.M.F. curve from a given pole shape, as this is the simpler case, and then show how for the reverse process the pole shape may be modified to suit the given E.M.F. curve.

The first process is to determine the flux distribution. Draw the pole section and position of armature core as in Fig. 1. Divide pole-pitch into, say, 18 parts. For the

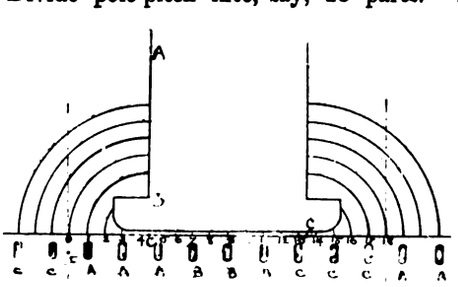

FIG. 1.

points immediately under the pole (points 4 to 9) draw straight lines perpendicular from armature periphery to edge of pole. Continue side of pole, A B, to cut armature periphery at C, and with C as centre draw arcs to meet the pole-edge from positions 3, 2, 1, 0, −1 and −2, as shown in Fig. 1. The length of these lines will then represent the reluctance of the air-gap at those different points. The arcs do not represent the actual magnetic paths of the flux, but this is a device which is found to give good results. If the pole is the same width all along, the reciprocals of the numbers representing the lengths will represent the value of the flux at the positions taken. If the width differs in places, the reciprocal must be reduced in the ratio of the width of the pole at the point considered to the maximum width. The maximum value of the flux may conveniently be called 100, and the other flux values altered in proportion. The result plotted will give a curve similar in form to curve *a b c d e* (Fig. 2). This is the flux curve for one pole, assuming no interference from the neighbouring poles. As a matter of fact, the neighbouring poles will slightly weaken the field at the edges of the pole under consideration, but this is easily allowed for by drawing on the same diagram the values of the field of the neighbouring field which are effective (*f g* and *h j* in Fig. 2), and the addition of these curves gives the resulting field shown in full line in Fig. 2.

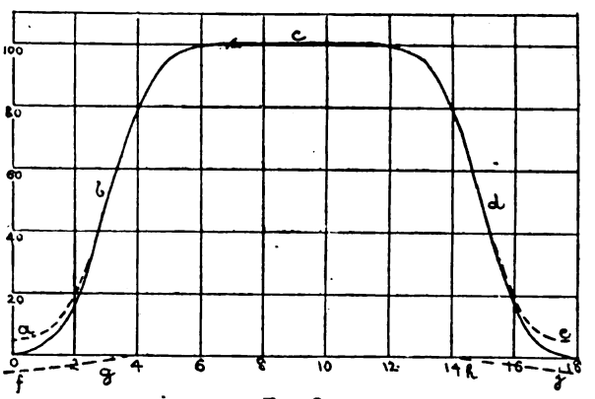

FIG. 2.

The next step is to determine the E.M.F. curve corresponding to this field distribution. To continue with the example, we will now assume that it is the terminal E.M.F. curve of a three-phase star-connected alternator that is required, and that the armature has three slots per pole per phase. The position of the phases is shown in Fig. 1. The terminal E.M.F. curve will be the difference between the E.M.F. curve for one phase and a similar curve displaced 120deg., or, what comes to the same thing, the sum of the two curves displaced by 60deg. This will be sum of E.M.F.'s induced in phases C and A. If we imagine that the armature moves through the field, a conductor at any point will have induced in it an E.M.F. proportional to the value of the field at that point, and the instantaneous value of the total E.M.F. is the sum of all the E.M.F.'s induced in the coils concerned at that particular time. The procedure, then, is to take the conductors in successive

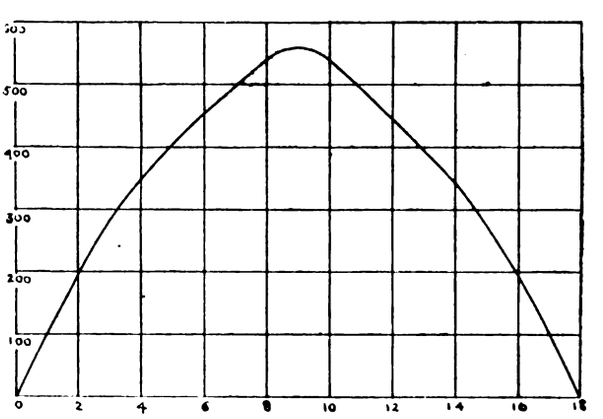

FIG. 3.

positions and add together the values of the field above those conductors in those positions. This need only be done for half a pole, as in this case the field is symmetrical about the centre line of the pole. The values of the field are taken from Fig. 2, and are in positions 0 to 9—0, 3, 17, 50, 80, 96, 99, 100, 100, 100. We will take as a starting point the position when the terminal E.M.F. is zero. The phase C is then in a field of equal strength to that in which phase A is, but of opposite polarity—*i.e.*, the centre point, X, of these two sets of conductors is at position 0. Now move conductors until X is in position 1, opposite field of value 3; the values of the field above the conductors is then −80, −17, 0, +17, +80, +99—sum = 99. This is carried out for different positions. The results are better put in Table I. Plotting the figures obtained in the last

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column we get a curve which is one-quarter period of a complete wave, the half of which is shown in Fig. 3. Now suppose the curve which is given is almost the same as this curve except that it is bulged more between positions 4 and 7. We look at the original flux distribution and find that the curve is flat because the field between points 4 and 7 is of a uniform character. Evidently the field must increase in strength from 4 to 7; therefore the width of the pole is tapered from 7 to 4 or the gap widened from 7 to 4. By making such alterations as these a pole shape is arrived at which will give the required E.M.F. shape at no load.

TABLE I.

Position of point X.	Value of field above conductors — Phase C.			Phase A.			Sum of field values.
0	-96	-50	- 3	+ 3	+ 50	+ 96	0
1	-80	-17	0	+ 17	+ 80	+ 99	99
2	-50	- 3	+ 3	+ 50	+ 96	+100	196
3	-17	0	+ 17	+ 80	+ 99	+100	279
4	- 3	+ 3	+ 50	+ 96	+100	+100	346
5	0	+17	+ 80	+ 99	+100	+100	396
6	+ 3	+50	+ 96	+100	+100	+100	449
7	+17	+80	+ 99	+100	+100	+ 99	495
8	+50	+96	+100	+100	+100	+ 96	542
9	+80	+99	+100	+100	+ 99	+ 80	558

This subject is fully treated in Chapter IV. of "Dynamo-Electric Machinery," Part II., by Prof. S. P. Thompson.—F. CLARK.

Answer to No. 1,041 (awarded 5s.).—The question of the pole form of any particular alternator, the E.M.F. and wave form or required wave form of which are known, is best considered in three steps: (1) consideration of the instantaneous E.M.F. of the wave at any point; (2) the manner in which this is made up; (3) the field necessary to produce it, from which can be deduced the shape of pole which would be required to give this field. It is thought that the best way to appreciate the matter is to take a specific example and work from this. The wave form shown in Fig. 1, therefore, may be taken, and is that of a 72-pole alternator of the Oerlikon Company, a full description of which, its calculations, etc., may be found in Dr. Silvanus Thompson's work, "Dynamo-Electric Machinery."

The first point is to set the wave form out to some convenient scale and underneath to space the conductors at their proper intervals. In this form three sets of six conductors are shown, the machine being a three-phase one with six slots per pole per phase. Should there be more than one conductor in each slot, it will not affect the desired analysis, but only the scale of the same. The base of Fig. 1 is now divided up according to the conductors

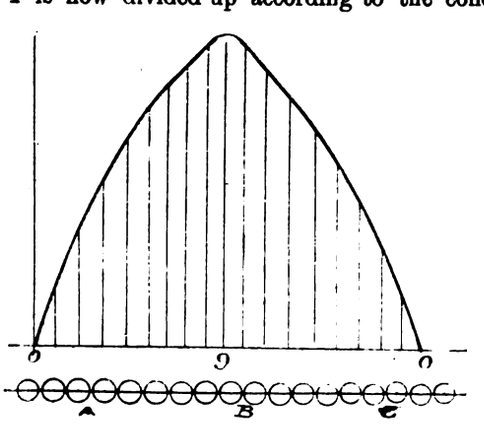

FIG. 1.

into a number of sections, and the middle point of each section taken as representing the mean instantaneous value of E.M.F. at the corresponding periods of rotation of the machine, these E.M.F. values being readable as ordinates of the curve. Now, any instantaneous value of E.M.F. is composed of the sum of the E.M.F.'s of all conductors in series at that moment, and it is, therefore, necessary to analyse the value into its proper components. The method of this is as follows—viz.: Take two values representing the middle points of two consecutive sections. The difference between these will give the algebraic effect of moving the whole series of conductors through one section—that is to say, of, for example, taking away the end conductor of one, say of A, and introducing one other conductor at the other end, say of B These differences are divided up so that when they are plotted in the form shown in Fig. 2 they will give a fair curve of the distribution of the magnetic flux required to produce the particular E.M.F.'s with the arrangement of conductors given. This can be verified by taking the curve obtained in Fig. 2, making a

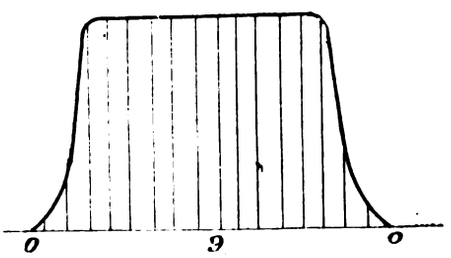

FIG. 2.

slip of paper with the distribution of the windings shown on it, moving it from point to point, taking the algebraic sum of the values at each point, and noting if they agree with the values obtained in Fig. 1.

The next step, having found this necessary distribution of flux, is to find the shape of pole required to give it. This may be done (see Fig. 3) by setting out on a base line divisions representing those corresponding to the E.M.F. divisions of Fig. 1, and drawing lines of force from them in the shape suggested by experience of design, together with a rough approximation of the pole. The length of three lines must be longer where the distribution of magnetic field is less, because, naturally, that represents most reluctance. They are, therefore, drawn to a scale

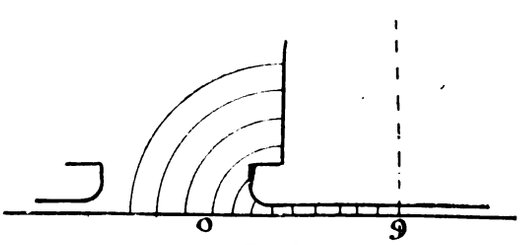

FIG. 3.

proportional to the reciprocals of the values of the ordinates of Fig 2, which will be read off from a table of reciprocals after the ordinates have been measured. If any fringe effect is found due to neighbouring poles, this must, of course, be deducted from the values found. By this means one obtains the necessary shape of pole to give the distribution of magnetic field which would result in an E.M.F. wave as given. In this account the machine is supposed to have no exceedingly large slots to disturb the flux; if it has, these must be considered in the flux diagram.

Several other methods may be used instead of that shown in Fig. 1 for transferring a flux diagram to that of a diagram showing the shape of a pole-piece to produce the flux, but it is thought that the one described is the most explanatory.—L. R.

Answer to No. 1,041 (awarded 5s.).—The E.M.F. wave form of an alternator depends upon (1) the shape of the pole-shoe and width of air-gap; (2) upon the arrangement of the armature coils in the different number of slots per pole and on the shape of the slot; (3) also upon the field distortion due to the current in the conductors, and is, therefore, affected by the lag of the armature current. When the winding is distributed among two or more slots per pole, the distortion of the field is reduced owing to the lesser inductance of the coils, and a smoother curve of E.M.F. is obtained In polyphase machines the distribution of the winding tends to reduce the peaked form of the E.M.F. curve, which is in general given by toothed armatures.

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In determining the shape of the pole for a known distribution of winding and E M.F. wave form, we must first obtain the curve of distribution of the field. In describing the following graphic method it will be more clearly understood if we assume the shape of the pole, and from it find the E.M F. wave form. Draw the pole and armature face to scale, and set off along the armature face a number of equdistant points — preferably nine — corresponding to 90deg. in one quarter period. Two or three points should be taken beyond the zero mark. Quarter circle curves are then drawn to represent the path of the flux (Fig. 1).

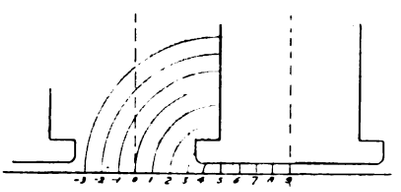

FIG. 1.

These lines are measured off, and are in our case 10, 10, 10, 10, 10, 10, 23, 75, 104, 130, 153, 182, 206 millimetres. Next find the reciprocals, percentage of mid-gap, from which the superposed fringe due to the adjacent pole is deducted. This will give the resultant percentage densities. These are given in Table I. The densities are plotted to scale in Fig. 2, the dotted line giving the percentage uncorrected for the overlap of the opposing pole. From the distribution of the magnetic field we can deduce the shape of the E M.F. wave. The number of magnetic lines cut by a conductor in moving through the field will be proportional to the ordinate of the flux curve.

TABLE I.

Point.	Length, mm.	Reciprocals	Per cent. of mid-gap.	Superposed fringe deducted.	Resultant percentage densities.
9	10	·1	100	Negligible	100
8	10	·1	100	,,	100
7	10	·1	100	,,	100
6	10	·1	100	,,	100
5	10	·1	100	,,	100
4	10	·1	100	,,	100
3	23	·0435	43·5	- 4·8	38·7
2	75	·0133	13·3	- 5·5	7·8
1	104	·0096	9 6	- 6·5	3·1
0	130	0077	7 7	- 7·7	0
-1	153	·0065	6·5	- 9 6	- 3·1
-2	182	·0055	5·5	-13·3	- 7 8
-3	206	·0048	43·5	-43 5	-38·7

A conductor moving from 0 to 1 (Fig. 2) will cut a number of lines proportional to the density of the field, and, therefore, to the area enclosed by the ordinates of the curve below these points. Assuming the slots do not perturb the distribution, the ordinates of the curve will serve as ordinates for the E.M.F. induced in one conductor. But we must remember that the E.M.F. round any loop of the winding is the sum of the E.M.F.'s in the two conductors of which it is made up, and that if the winding is distributed in more than one slot per pole, the E.M.F.'s in the turn lying in their different slots are not exactly in phase with each other.

It is possible to take these things into account by reckoning out the separate simultaneous E.M.F.'s for the conductors and superposing them. Taking a three-phase winding, star connected, with six slots per pole per phase, and, for convenience sake, one conductor per slot, these are shown at A, B, and C in Fig. 2. The width across the three phases, A, B, C, is equal to one pole-pitch. We find the no-load wave form between terminals A and B as follows: In the zero position the conductors are so placed that the total E M.F. between A and B is zero, there being as many negative as positive E.M.F.'s. In position 1, when the zero mark of the pole is opposite conductor No. 1, the ordinates to be added are: 100, 100, 100, 38·7, 7 8, 3·1, 0, - 3·1, - 7 8, - 38 7, - 100, - 100—total, 100. In position 2 we add 100, 100, 100, 100, 38 7, 7 8, 3·1, 0, - 3·1, - 7·8, - 38·7, - 100—total, 300. The whole series obtained in this way are: 0, 100, 300, 500, 638·7, 746 5, 849·6, 949·6, 1,046·5, 1,138 7, 1,138·7, 1,046·5, 949·6, 849 6, 746·5, 638·7, 500, 300, 100, 0. Fig. 3 shows the wave form plotted to scale. The form factor is calculated by dividing the quadratic mean by the arithmetic mean. The total of all the numbers = 12,539·2 and their arithmetic mean = 698.

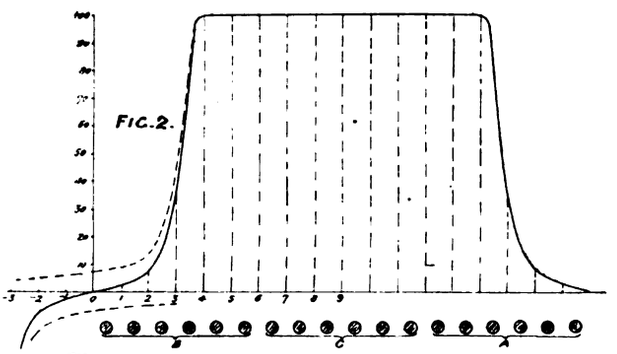

FIG. 2.

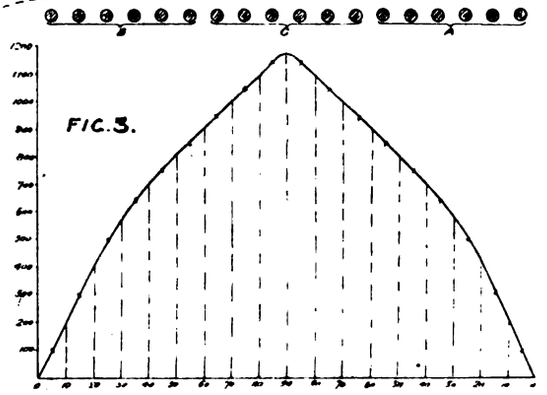

FIG. 3.

The total of all the squares = 10,645,000 and the mean square = 591,390, and R.M.S. = 770. The form factor $= \frac{770}{698} = 1{\cdot}1$, so that in this particular case the wave form is practically a sine curve; the form factor for a pure sine curve being 1·11.—H. T. A.

Question No. 1,042.—In a circuit of direct-current flame lamps using carbons with the salts in the core trouble is caused by frequent white arc of low candle-power instead of yellow flame colour. Give cause and remedy. Also, in a description of a new flame lamp (*Electrical Engineer*, Jan. 3, 1908) "a minimum allowance of seven volts per lamp for steadying resistance must be made." Why so large an amount, and does this apply to flame lamps generally? The Oriflamme lamp is said to burn with about 35 volts across the arc. Why so much lower than the ordinary arc voltage, and would this require a large allowance for steadying resistance?

Best Answer to No. 1,042 (awarded 10s.).—The troubles of variable candle-power and colour are by no means uncommon with flame arc lamps, and are due to impurities in the carbon cores or to faulty construction of the carbons. Flame carbons of both the vertical and converging types have a special core of salts, usually containing nitrate of strontium or fluoride of calcium, depending upon the colour of light required. With some makes of flame carbons silica is sometimes formed at the arc, which affects the illumination and also leads to the total extinction of the lamps, due to the insulating qualities of the silica. The presence of this silica or of any other impurity in the cores of the carbons diminishes the illumination and current and also forces the arc on to the carbon surrounding the core, which results in the lamp burning with a shorter arc and a white light similar to the ordinary arc lamp. The light, however, is very unstable, owing to the arc revolving around the outer periphery of the carbons and also to the tendency of the lamp to increase the length of the arc. The same result will be produced due to faulty construction in the pressing or baking of the carbons. In order to obtain a constant illumination both in colour and intensity, the carbons should be obtained from a reliable firm dealing in some of the well-known makes of carbons; further, the carbons should not be worked at a higher current density than that specified by the makers. The flame arc referred to in the *Electrical Engineer* of Jan. 3, p. 14—*i e*, the Crompton-Blondel lamp—burns with vertical feed carbons and requires about 38 volts across the arc, depending on the current density. The number of volts mentioned in the question to be allowed for the steadying resistance is necessary to prevent the lamps from

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taking too large a current at the moment of switching on, and also to enable them to burn steadily in spite of small fluctuations of the supply voltage. The seven volts referred to above is not excessive when compared with the steadying resistance of the ordinary arc, which usually absorbs about five volts per lamp. The extra volts necessary for the resistance of the flame lamps is due to the lower resistance of the flame arc as compared with the ordinary arc. It is, of course, not absolutely necessary to provide seven volts for the resistance; this, however, will largely depend on the voltage regulation of the circuit. If a large number of lamps are to operate in series and it is not convenient to allow seven volts per lamp for the resistance, the current should be so arranged that when switching on one or two of the end lamps should be short-circuited and a resistance inserted instead of the lamps. After they have settled down, the end lamps can be switched into circuit by means of a two or three way switch. If this arrangement is adopted, a heavy starting current and violent pumping is avoided; the lamps also settle down for steady burning very quickly. The average pressure required at the arc of vertical feed carbons is about 36 volts. This type of lamp usually burns much thicker carbons than the converging flame lamps, which have an average pressure at the arc of about 43 volts, depending on the current density.—K.

Answer to No. 1,042 (awarded 5s.).—The essential difference between an ordinary and a flame arc lamp is that in the ordinary arc the crater is the source of light, while in the flame lamp the incandescent vapour between the carbons is the light producer. The flame arc burns carbons, at a high current density, impregnated with oxides of various metals, the action of the current volatilising these oxides and producing vapour of the metal base and carbon, which, offering a path of fairly low resistance to the current, becomes the source of light. The ordinary arc burns pure carbons, and depends on the high temperature of the crater of the arc for its light-giving effects.

The cause of the trouble "Flame" is experiencing lies in the fact that the arc of his flame lamp is not long enough. Being short, the temperature of the arc will not be great enough to volatilise the metallic oxide, and the lamp will practically become an ordinary arc lamp burning the carbon of the composition carbons only. This will result in a white arc of very low candle-power, since the crater of the arc will be small. Also, as the carbons are nearly vertical, the light from the crater will be thrown in a horizontal direction towards the other carbon, and its already poor effect further reduced. The trouble can be got over by increasing the effect of the striking coil of the lamp, so that when the arc is struck the carbons are brought further apart. The seven volts for steadying are necessary, because of the high resistance of the carbons used in the flame lamp. In practically all types (except the magazine) the current is fed in to the top of the carbons by flexible leads, and has to travel the full length of the carbons to the arc. Now, it is obvious that when new carbons are put in the lamp will have a higher resistance than when the carbons are nearly burnt through. It is, therefore, necessary to have a fairly high balancing voltage to, in some measure, reduce the effect of this change of resistance.

The Oriflamme is a magazine lamp, the magazines for the carbons being nearly vertical and of metal and part of the electrical circuit. The resistance of these magazines is less than that of the carbons, with the result that the voltage across the arc will practically be the full voltage across the lamp. The lamps can, therefore, be run at a considerably less voltage than the ordinary flame lamp, as there is no need to allow a large steadying voltage, the resistance between the arc and the lamp terminals being nearly constant. Three to five volts per arc is the usual allowance, 10 lamps being run satisfactorily off 400 volts, or 12 off 460.—BALANCE.

Answer to No. 1,042 (awarded 5s.).—When white illumination is obtained from lamps using flame carbons with impregnated cores to give yellow light, it will be due to one or other of the following reasons. If, when the lamps are first switched on, the light obtained from one of the lamps is white, either the lamp is connected up wrongly for polarity, or two carbons, both of which are negative, are being used. If it is found that one lamp of a series gives white illumination irrespective whether it has just been switched on or has been running for some time, the trouble will no doubt be due to the arc being too short. This will be caused by sluggish action of the mechanism in controlling the length of the arc, and in lamps where a sliding shoe is employed the surfaces being dirty. The writer does not consider seven volts a large amount to allow for current regulation, although the amount must depend largely on the pressure of the supply; for low pressures a comparatively large amount must be allowed, but for higher pressures, with a large number of lamps in series across it, the amount may be reduced. Most makers allow approximately 10 to 20 per cent. of the line pressure for regulation. Thus, a lamp requiring a terminal potential difference of 50 volts would burn well on a 60-volt circuit—in other words, a 17 per cent. margin is allowed; or, for instance, four lamps requiring 42 volts each would be arranged in series on 200 volts—*i.e.*, a 16 per cent. margin. If the amount is reduced too low, trouble by the overfeeding of the carbons in the lamps will result.

When "Flame" ask why "the Oriflamme lamp is arranged to burn with 35 volts across the arc, this being so much lower than the ordinary arc voltage," I assume by "ordinary" other makes of flame lamps are referred to. No doubt the reason is to enable as many lamps as possible to run in series on any given pressure, so that as many points of light—and, therefore, good and even illumination—may be obtained. If reference is made to the lists of the various makers, it will be found that they are practically all agreed on the point that for 10-ampere lamps 45 volts across the lamp terminals is best. Table I. shows the factors chosen by different constructors. It will be seen that all makers, except the Gilbert Arc Lamp Company and the Oliver Arc Lamp, Limited, are agreed. Further, in the former's list the following will be found: "We can arrange the lamps to burn with either high or low voltage arcs—say 45 volts or 35 volts—and with various makes of carbons, so that we can vary the numbers in series on the same pressures. In all probability the total candle-power is nearly the same with any arrangement, but the efficiency of the arc usually goes up with the arrangement or make of carbons that takes the highest voltage across the arc."

TABLE I.

Make of lamp.	Terminal volts.	Amperes.
Union "Excello"	45	10
Davy "Sunray"	45	10
Santoni	45	10
Braulik "Eclipse"	45	10
Reason	45	11
Gilbert	45 or 35	10
Oliver "Oriflamme"	35	7-9-11-13

TABLE II.

Terminal volts.	% difference in candle-power with 45-volt arc as standard.	Watts per Hefner candle-power at various arc voltages.
32	44·5 decrease	0·2
34	33·6 ,,	0·16
36	24 ,,	0·15
38	16 ,,	0·15
40	10 ,,	0·147
42	4 ,,	0·145
44	1 ,,	0·146
46	2 increase	0·14
48	4 ,,	0·146

The foregoing remarks are well substantiated by Table II., which gives the results of tests carried out to find the percentage reduction in candle-power as the arc voltage is reduced, and, secondly, the energy taken per Hefner candle-power by a 10-ampere lamp burning with different arc voltages. From this table it will be seen that the energy expended per candle-power reaches a minimum at or about 45 volts terminal pressure, and, consequently, this is the most efficient value to adopt. A further fact to be noticed is that, say, four lamps burning in series giving approximately the same total candle-power as five lamps in series on the same pressure are cheaper to run, as only four pairs of carbons instead of five at every time of trimming are required—and the cost of flame carbons is not a point to be ignored.—H. W. C.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,052. I occasionally receive circulars *re* electric light baths. Will anyone who has had experience with them state if they are of much use: (1) to the invalid—if so, what complaints are benefited by their use; (2) to the person in good health to assist him in maintaining health, etc. Is it desirable to have a water bath afterwards to remove perspiration, etc., from the body, as in the case of a Turkish bath? If so, should it be hot, warm, or cold?—K.

1,053. A compound-wound, direct current machine is fitted with a two-phase static balancer, but this balancer is not large enough to maintain balance on the 'bus bars, so it is proposed to put a booster in series between neutral bar and machine, and this booster must necessarily be reversible to deal successfully with an out of balance on either side. How should the fields of this booster be connected, and what is the best way to get hand regulation of the boost? Would two compound machines fitted this way work well in parallel?—POWER.

ANSWERS.

Question No. 1,043.—What will be the probable current and the best arrangement of motor, etc., required to drive a machine for winding copper strip (1in. wide by 0·1in. thick) into the form of helices, each one to have 15 coils and to be 6½in. internal diameter? It is proposed to turn out 200 per day, and the supply is 210 volts direct current.

Best Answer to No. 1,043 (awarded 10s.).—A satisfactory arrangement is shown in Fig. 1, which is simply an

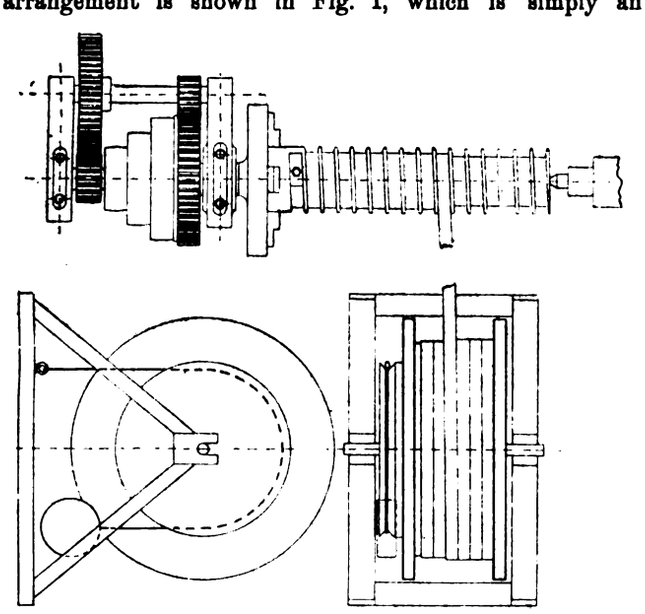

FIG. 1.

ordinary lathe. The back gear gives just what is wanted both in pull and in speed. Motor can be belted to the countershaft, pulleys being of such diameters that mandrel can be rotated in lathe at from, say, 5 r.p.m. to 100 r.p.m. It will be convenient to run lathe in the opposite direction to that required for ordinary turning, therefore, unless the chuck is bolted to running spindle, provision must be made to prevent it slacking back when winding the helices. A simple method that the writer has found serve for a similar purpose is to fit on screw, and against collar of running spindle a washer cut from a sheet of dry brown paper. The chuck is then sharply screwed home, and, although hardly a scientific procedure, it is surprising how chuck is thereby held from unscrewing. Mandrel is of cast iron, on which a screw thread has been cut to suit pitch of required helix. The thread on mandrel need not be more than about ⅜in. deep, but should be well tapered. Fig. 2 shows method of holding

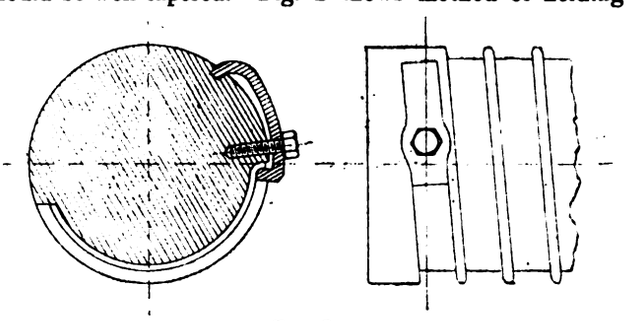

FIG. 2.

strip. Strip is slightly turned up at the end, and then slipped under the strap, which holds it firmly in its place on mandrel. After set-screw is tightened, pull round a little way by hand in order to obtain advantage of friction between strip and mandrel; there will then be little difficulty in holding the strip. The copper strip is wound on wooden drums; these drums are fitted with brakes and placed on stands about 20ft. from lathe. To ensure perfectly-formed helices, the copper strip must be straight and free from kinks. It should also be regular in hardness, preferably soft, in order that the amount of "springing" after winding may be the same in each lot of strip. With soft copper the diameter of mandrel at bottom of thread will be about 6¼in., but this can only be settled exactly by experiment. When wound, cut off with hack-saw, slack back poppet head, remove strap, and screw helix off mandrel; this can readily be done owing to "spring" having increased the diameter. There would be some advantage in guiding the strip by means of a holder in tool rest, with saddle traversing to suit pitch, but such a refinement is scarcely worth the trouble; with drums at a good distance from lathe strip can be easily led on by hand and time saved. Figure shows arrangement for a right-handed helix, but by cutting a left-handed thread on mandrel and starting from poppet-head end the helices can just as easily be wound "left-hand."

As to the number per day, much will depend on the operator and the number of hours worked. Given the strip ready wound on drums and drums placed in position, winding should be done at the rate of from 10 to 20 per hour. With a good workman on piecework, it is wonderful the rapidity with which such articles are turned out. To drive above lathe about 1 h.p. will be required. With supply at 210 volts and efficiency of motor at 70 per cent., current will be about $= \frac{7+6\times100}{210\times70} = 5$ amperes.—M. M.

Answer to No. 1,043 (awarded 5s.).—If we assume a working day of 10 hours, each coil will have to be completed in three minutes for an output of 200 per day; this, of course, would be practically impossible if the strip had to be wound on edge. The machine for winding the strip on the flat could be driven by the motor either through spur or worm gearing, belting, or a combination of gearing and belting, depending on the design of the winding machine. Whichever method of drive is adopted, some form of brake should be used in conjunction with the motor. This brake will, no doubt, be necessary in order to prevent overwinding, in view of the comparatively high winding speed required, but this depends largely on the inertia of the moving parts of the motor and machine. The brake could be operated electrically or mechanically—*i.e.*, the electric brake solenoid would be in series with the motor armature, this solenoid actuating a lever which controls the brake proper, and the mechanical brake would be operated by the same movement which controlled the

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starter. If we assume that 2 to 2½ minutes are required for making ready—that is to say, placing the strip in position preparatory to winding and also dismantling the coil—we have half to one minute left for the actual winding of each coil. The speed of the winding machine should, therefore, be about 40 r.p.m. This would allow one or two stops to enable the turns to be tapped closely together if necessary. A 2-b.h.p. motor should be large enough, provided no extra tension above the normal is required on the strip. The motor should be compound wound; this type of winding would give the best results as regards constant speed and heavy starting torque. In view of the intermittent working of the motor, a liquid starting and speed-controlling rheostat should be used as preferable to the metallic type. The rheostat should be arranged to be controlled by a pedal, so that both hands of the operator may be free for the manipulation of the strip. The rheostat would consist of a cast-iron tank of, say, two cubic feet capacity, with a switch arm carrying one or two cast-iron renewable dipper blades for the main current and an auxiliary blade to make and break the shunt circuit before and after the main circuit. This simple type of rheostat can easily be made to reverse the motor by the addition of a few switch contacts, fitted on the side of the starter and actuated by the switch arm. With a motor running at about 1,000 r.p.m. the efficiency at full load would be about 78 to 80 per cent., and the full-load current at 210 volts would be approximately nine amperes.—K.

Answer to No. 1,043 (awarded 5s.).—The first thing is to find out how much energy will be required to actually perform the operation of bending the strip. This is rather a difficult matter, as the copper is stretched beyond the elastic limit, but it will be near enough for our purpose to apply the formula

$$M = z \cdot f;$$

where M is the bending moment applied to the strip, z is the modulus of section to bending, and f is the maximum stress in the material. First to find z.

$$z = \frac{\text{moment of inertia of section}}{\text{distance of farthest layer from centre}}$$

$$= \frac{\frac{1}{12} b\, d^3}{\frac{d}{2}} = \frac{1}{6}\, b\, d^2$$

$$= \frac{1}{6} \times 1 \times 0{\cdot}1^2 = \frac{1}{600} \text{ inch units.}$$

Now the elastic strength of copper is about two tons per square inch, and the breaking strength 14 tons per square inch. To effect the bending required we should probably require about six tons per square inch. Then

$$\text{Bending moment, } M = \frac{1}{600} \times 6 = {\cdot}01 \text{ inch-tons.}$$

$$M = \frac{2{,}240}{1{,}200} = 1{\cdot}86 \text{ pound-feet.}$$

Then the bending of the strip is equivalent to the maintaining of a force of 1·86lb. at a radius of 1ft. Then work done per revolution = $1{\cdot}86 \times 2\ \pi = 11{\cdot}7$ foot-pounds—say 12 foot-pounds. Then work done in winding one helix of 15 coils equals $15 \times 12 = 180$ foot-pounds.

We must now take into account the moderate requirement of 200 helices per day. Assuming a nine hours' working day, time per helix = $\frac{9 \times 60}{200} = 2{\cdot}7$ minutes. Of course, the majority of this time will be occupied in removing the old coil and adjusting the end of the new one, and the actual time of winding should be cut down very low, say to 10 seconds. Then power required for actual bending

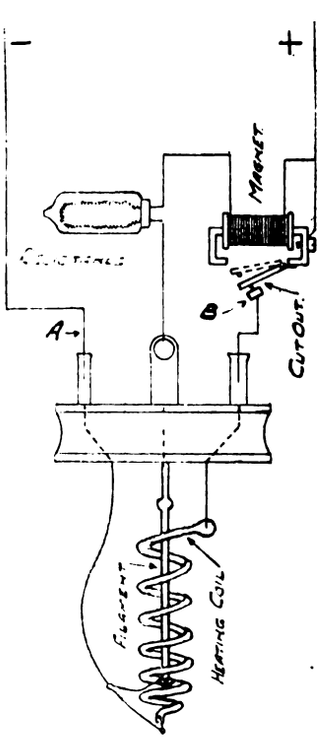
$$\text{H.P.} = \frac{\text{work done}}{\text{time} \times 33{,}000} = \frac{180}{\frac{10}{60} \times 33{,}000} = {\cdot}033.$$

From this it appears that the theoretical power required s much below what one would deem advisable. The guides which lead the strip on to the core absorb energy by friction, and this cannot be calculated. To be very liberal, allow an efficiency of winding of 10 per cent., which gives the power for winding = ·33 h.p.—that is, the power applied to turning the drum. Allow now a 50 per cent. efficiency for spur reduction gearing and we get horse-power of motor = ·66. To allow for winding larger strip, "Anxious" would be well advised to install a 1-h.p. motor. The probable current required = $\frac{{\cdot}66 \times 746}{210} = 2{\cdot}3$ amperes. With a very efficient machine this would probably be lower than two amperes, and if the motor be taxed to its full power the current taken will be $\frac{746}{210} = 3\frac{1}{2}$ amperes.

The best arrangement for coupling the motor to the machine would be to drive from the small motor pulley on to a large fast and loose pulley on the machine, starting and stopping being effected by belt shifting gear. For economy of space the motor should be placed above the machine—say fixed to the underside of the shop crane track or on one of the stanchions.—I. B. S.

Question No. 1,044.—Give reasons for the shortening of the life of Nernst lamp burners. Should they be connected up to the supply mains with their polarity reversed?

Best Answer to No. 1,044 (awarded 10s.).—The fundamental principle of the Nernst lamp is that the metal oxides of certain rare earths will conduct electricity after being heated, and will give off a brilliant white light. The Nernst lamp filament is composed of zirconia, oxide of thoria, and about 1 per cent. oxide of cerium, and requires to be heated to a temperature of 700deg. C. before it becomes a conductor. In the very earliest types of lamps this had to be done by a spirit lamp or a match, but as this prevented the lamp becoming popular an automatic heater was devised. A heating coil, consisting of a kaolin tube with a platinum wire core, is placed as near the filament as possible, and an automatic cut-out is carried in the body of the lamp to put the heater out of circuit immediately the filament lights up. As the life of the heater is only 30 hours, it will be readily seen that if through failure of the cut-out coil to act the heater is still left in circuit, the burner cannot last longer than the life of the heating coil. The majority of burners fail to give a good life through the heating coil being left in circuit longer than it should be.



The cut-out device consists of an electromagnet, which on being excited by a current flowing through the filament pulls over the little iron cut-out arm from terminal B, thus breaking the circuit to the heater whilst the filament is alight. On the current being switched off, the cut-out arm returns to the terminal B by the action of gravity or a slight spring. The cut-out coils in old lamps very often fail through the insulation of the magnet coils breaking

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down. The coils are exposed to the hot air rising off the filament, and the insulation of the old coils used often to get charred. This trouble is now avoided by covering the coils with asbestos. A common cause of failure is the cut-out arm getting beyond the influence of the magnet, and all lamp bodies should be tested for this fault before being used. A simple and effective test is to connect a carbon-filament lamp in parallel with the heater, say across the points A and B, and to note if it goes out immediately the filament lights up. Should it not do so, and adjustment of the cut-out arm prove futile, a new coil should be fixed The life of the heating coil is often needlessly wasted, in the case of the "Luna" Nernst burner, through the filament being set too far away from the heater to light up quickly. A small support is fixed to allow of adjustment in this respect, and to prevent the breaking of the filament through sagging. The filament should be set about $\frac{1}{16}$in. away from the heater, and should light up in 40 seconds.

The study of a burner that has failed will invariably give a clue to the cause of its failure. A burner that has had a good life will show a crystallised filament with a blackening of the negative end. No difficulty is experienced in tracing the polarity of the filament ends, but apart from that they can be told at a glance. The positive end of the filament is rigidly fixed, whereas the negative end has a flexible wire lead to the conductor embedded in the porcelain. The crystallisation of the filament is accounted for by electrolysis. On no account must the burners be fixed with their polarity reversed. This is a common error, and is shown on the expired burners by a glazed appearance of the filament, which has a blackening at the positive end, and in the case of "Luna" burners a slight blackening on the heating coil directly underneath the positive end of filament. An orange-coloured tint on the heating coil denotes the fact that the cut-out has failed to act, for it has been produced by the intense heat set up by the heating coil and filament together. "Luna" burners show these signs most clearly, but with practice they can be discerned on the spiral and small "Nernst" burners.

It is not generally known that the 20-volt iron-wire resistances can keep an even pressure on the filament through a 40-volt range of pressure fluctuations. The filament is most sensitive to pressure variations, and this iron-wire resistance, which is connected in series with it, is one of the most successful features of the lamp.

For a 240-volt supply the general practice is to install 220-volt burners and 20-volt resistances. If a 215-volt burner was used with a 20-volt resistance, the filament would light up quicker and the heating coil last longer. The resistance can safely stand being constantly overrun the five volts, and is still good for a possible, but let us hope improbable, rise of 15 volts. Different voltage burners should be used to suit the supply pressure at different parts of the system. If the pressure at the feeding points is 250 volts, then 225-volt burners should be used in lamps near them, and in the case of an outlying district a lower voltage burner more suitable to the pressure obtained.

With care, no difficulty should be experienced in obtaining good life results on a direct-current system. These lamps are not recommended for alternating-current systems or those of under 200 volts. The efficiency of these lamps, ·9 to 1·5 watts per candle-power, compares very favourably with the latest metallic-filament lamps, and for side-street lighting they have no rival.—C. R. PALMER.

Answer to No. 1,044 (awarded 5s.).—The answer to this query can be put in a very few words. In the process of the manufacture of the glower, which manufacture is partly electrical, the current used is passed in a definite direction through it, and the molecules of the glower given a certain "polarity" or "set." This action is similar to that which occurs when a bar of iron or steel is magnetised. Now, if the current in the glower is reversed by the lamp being wrongly connected up, this "polarity" will also be reversed and stresses set up in the glower which will tend to disintegrate it. Though this action may be very slight, it will seriously affect the life of the lamp, and it therefore becomes very essential to make sure that every Nernst lamp is connected up rightly as regards polarity.—BALANCE.

Answer to No. 1,044 (awarded 5s.).—The question as to the shortening of life of Nernst filaments is one which has never been properly settled. Various theories have been put forward, of which the most important are given below: It is well known that all oxides of the rare earths depreciate rather rapidly in the light intensity emitted, especially shortly after heating is started. Subsequently the diminution in light is not so rapid, but is still appreciable. It is also known that the second action accompanies a change from the amorphous to crystalline structure of the filaments, though whether this is due purely to electrolysis or any other action is not definite. Another theory is that the oxides of which Nernst filaments are composed do not volatilise at equal rates; therefore, after the lamp has been lighted for some time its composition is not the same as at the start, whence, owing to the fact that a definite composition is the best for giving maximum light, it follows that the light emitted is different from the light originally emitted. For this reason sometimes mixtures are made with a greater proportion of the more volatile oxide at starting, so that the maximum light is obtained after the lamp has burned a few hours. Experiments have been tried to test this theory by making a gas mantle composed of two different mixtures in two different parts and bombarding this mantle with cathode rays The tests, however, do not seem to have been absolutely conclusive, as it appears that the problem involved in both cases was not strictly identical. It has also been stated that the reason why filaments in some cases depreciate so quickly is that the platinum from the connection gradually impregnates the filaments, with the result that the energy is radiated at a lower temperature, and, therefore, less light is obtained. There is also the ordinary theory that the action is due purely to an electrolytic effect, especially in view of the fact that the filament gradually changes from the amorphous to the crystalline form in use. It is, however, by no means certain that the conduction is purely electrolytic even in view of this fact, although a filament run for a certain time *in vacuo* will destroy the vacuum owing to the liberation of oxygen.

With regard to the use of lamps whose candle-power has so depreciated as to be below the ordinary working standard, this cannot be done by putting them on the mains with reversed polarity. Experiments have been made showing that it is very harmful to a lamp to reverse its polarity during life, although it is not so harmful if it is reversed before running. As a matter of fact, it appears possible to renovate an old Nernst filament which has been used on direct current by first putting it on an alternating-current circuit, and afterwards on a direct, so that the change is gradually made. In ordinary practice, however, there appears to be no advantage in attempting to renovate old filaments, and the point at which a filament should be discarded can be calculated by plotting a curve showing the rate of increase of cost of energy with the candle-power obtained and taking a tangent to this curve from a point behind it corresponding to the cost of renewal of the lamp minus the value of the old lamp. This point is known as the smashing point, and in one instance, for example, it was found to be by this method 380 hours for a particular Nernst lamp as against 600 for a 40-c.p. incandescent lamp.

Further information on this subject can be obtained from the following papers, which are the most important and recent bearing on the matter: "The Nernst Lamp," Foell (*Electrical Review*, New York, vol. 51, p. 428)—this paper gives general information of experiments as to life, depreciation, etc., with test of new types of high-efficiency lamps; "Filament of the Nernst Lamp," Beebe (*Electrical Review*, New York, vol. 46, p. 657)—this paper has a description of the manufacture of filaments, etc., and discusses the electrolytic theory and reasons for diminution in light; "Nernst Lamps," Joseph (*Electrical Review*, vol. 56, p. 171)—this contains a letter relating to the effect of changing the polarity of Nernst lamps; "Tests on the Nernst Lamps," Hulse (Institution of Electrical Engineers, vol. 31, p. 1,180)—this is a very important paper containing life tests with curves, etc., of Nernst filaments. The question of smashing point is also fully dealt with; "The Nernst Lamp," Stottner (Institution of Electrical Engineers, vol. 30, p. 522)—the paper deals with the history and construc-

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tion of Nernst lamps and gives curves of candle-power against hours used. The discussion in this paper is also very important.—L. R.

Answer to No. 1,044 (awarded 5s.).—There is little that requires attention in the Nernst lamp, but to obtain good results a few simple precautions must be taken: (1) the lamp must be connected to the right polarity; (2) the lamp must be matched for its proper voltage, and all parts must be of the same amperage; (3) the variation in the supply pressure must be small; (4) the cut-out should be examined occasionally, and if found faulty must be repaired. The failure of the flexible which connects the filament is very common, and this is due to the flexible becoming bent and touching the heater coil. When this heater coil gets up to temperature it expands, and either burns the flexible through or the heater spiral. This can generally be avoided by examination of the burner after insertion. If the lamp does not light up, the automatic cut-out does not act properly. The heater under working conditions should cease to glow as soon as the filament is incandescent; if the cut-out is not working properly, the heater will remain in circuit and will burn out. This failure of the cut-out may be due to the spring of the cut-out sticking or the voltage of the burners being too high, when the cut-out is unable to switch the heating circuit off.

The cause of some burners failing has been traced to the resistances being at a higher amperage than the burners. When the function of the resistance is considered—that is, the iron wire in the tube acts as a safety valve for the burner—the resistance of the filament decreases as the temperature increases, but the resistance of the iron-wire resistance in series with it increases with the use in temperature, and so protects the filament from an excessive current; and when, say, a one-ampere resistance is put in series with the half-ampere burner, the mutual action of the pair is destroyed and the filament is burned out. Some failures have been due to the contacts of the lamp getting out of line with the contacts of the lampholder. Coupling up the lamps with wrong polarity is also a fruitful source of breakdown.

The poor pressure regulation on most supply mains is responsible for most of the breakdowns. One shop where I installed several lamps gave me a lot of trouble. The pressure was 200 volts, and I installed 190-volt burners and 20-volt resistances, and the average life was very low. I then tried 195-volt burners, and thus obtained a life of 600 hours. This bad regulation of pressure is the same in many towns, one where the trams are run from the same station being particularly bad. Mr. Wilkinson, at Harrogate, on a test of 90 Nernst lamps obtained a life of 520 hours as an average, and this he attributes entirely to the good pressure regulation. Trouble is sometimes experienced with the resistance burning out, and this is due to the pressure rising too high. As a general rule, though it is the burner which fails at the part where it joins the flexible connection.—F. M. M.

Question No. 1,045.—Explain the mechanical and electrical principles of the Westinghouse magnetic friction brake or clutch as applied to their series traction motors.

Answer to No. 1,045 (awarded 5s.).—Briefly stated, the mechanical construction of the Westinghouse magnetic brake is as follows: (1) A track magnet with detachable soft steel shoes (Fig. 1) fixed to each pole. These shoes run just clear of the track, the magnet being energised by the current from the motors when they are working as generators. (2) Brake blocks of the ordinary type acting on the wheel periphery. (3) A link arrangement connecting the track shoes to the brake blocks on the wheels, so that when the magnet is energised, and the track shoes are pulled downwards, the blocks act on the wheels with the desired effect. The details of the brake may be understood by referring to Fig. 1. The magnet is of the horse-shoe type, with the pole-pieces parallel to the rails, the poles taking the form of renewable track shoes. The core of the magnet is horizontal and the coil is protected by being enclosed in perfectly watertight brass case. The whole arrangement is suspended from the car frame by means of very strong springs, thus allowing the brakes to ride over any obstruction on the track. The distance between the shoes and the rails is about ¼in. The electrical connections to the magnet coil are in duplicate, and consists of armoured cables

The mechanical action which takes place when the brake is applied is as follows: (*a*) retardation of the car due to the frictional effects between the track shoes and the rails; (*b*) braking effect on the wheel periphery due to the downward pull of the shoes and the resulting effect of the link

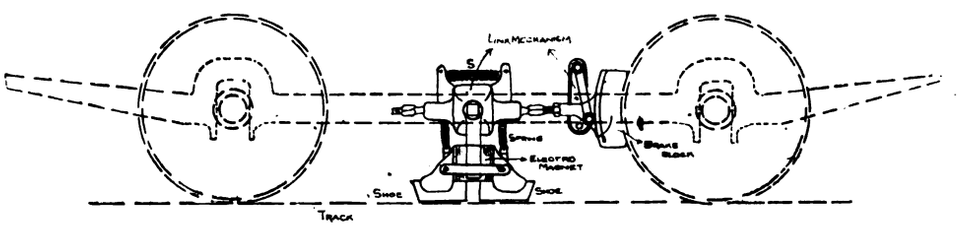

FIG. 1.

mechanism on the brake blocks; (*c*) braking on the axle due to the motors working as generators. It is also claimed by the manufacturers that the adhesion between the wheels and the rails is increased by the pull of the magnets. When the speed of the car is great and the attraction of the magnets to the rails greater in consequence, the braking effects of the blocks on the wheels is also at its maximum. As the speed of the car decreases a smaller current is generated, hence the drag of the shoes on the rails has also decreased, also the pressure of the brake blocks. This reduction in brake-block pressure is, however, compensated by the increase of the coefficient of friction at lower speeds. We can now describe the electrical principle of this brake.

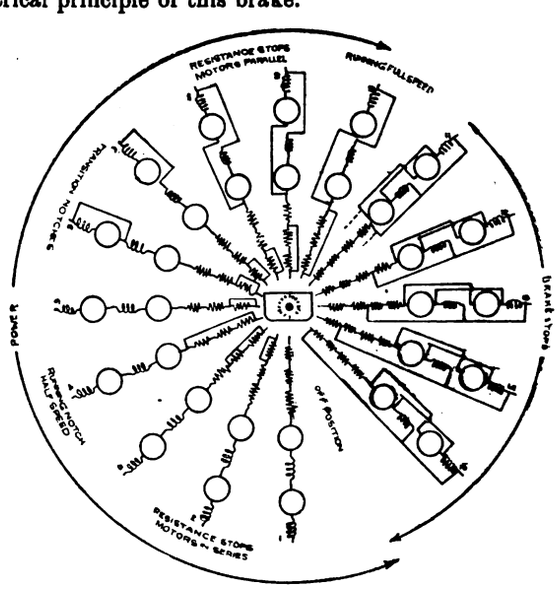

FIG. 2.

To understand the electrical part, which is very simple, a diagram of the ordinary series-parallel control system, as seen in Fig. 2, will help; the difference being that, instead of braking the car by means of using the current generated (when the motors run as dynamos) for the external resistance, it is used to energise the brake magnets. The brake is operated from the controller by moving it beyond the off position to the braking notches. Rheostatic controllers (Fig. 2) are adapted for service with this brake by taking the current generated to the track magnet from step 11 shown dotted.—OSCAR DINERMAN.

[Other replies to Question No. 1,045 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

QUESTIONS.

1,054. In our three-wire distribution system we use single lead-covered cables (with paper insulation) of ·3, ·15, and 19/14 sectional area. They are laid solid under the footpaths, but at street crossings under the wood paving they are drawn through 5in. iron pipes. We have never had any trouble with the cables in the iron pipes, but recently we tried to draw a set of three cables, of ·15 sectional area, out of a 100ft. length of 5in. iron pipe where they had lain for a period of nine years, but the attempt failed, and we had to leave the cables *in situ*. That the pipe was quite clear is proved by the fact that we then rodded it and pulled through three fresh cables. Please describe a convenient method of withdrawing such cables, stating whether it is easier to draw juted cables than plain lead cables, and whether the injection of lubricants would be of any service.—E. C. B.

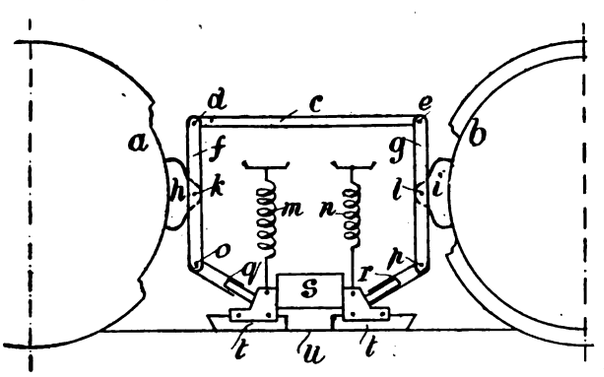
1,055. Suppose a car is travelling on a level with its own momentum, say an ordinary Dick-Kerr fitted with two 30-h.p. motors, and going at 12 miles per hour, what would be the amount of current generated and used by applying the electric brake? Form of controller, D.E.1 emergency brake.—C. S. GRAHAM.

1,056. The *Electrical Engineer*, May 31, 1907, p. 764, gives a description of a testing tank at Port Dundas, Glasgow, of dimensions 6ft. diameter 6ft. deep, to take a load of 5,000 kw. at 6,500 volts. Discuss the design of such a tank, especially with regard to the permissible current density on the surface of the electrodes, the resistance of the water path, and the conductivity of the supply water. Has the Glasgow tank proved successful for such a large output?—TANK.

ANSWERS.

Question No. 1,045.—Explain the mechanical and electrical principles of the Westinghouse magnetic friction brake or clutch as applied to their series traction motors.

Best Answer to No. 1,045 (awarded 10s.).—It is not quite clear what is meant by the Westinghouse friction and magnetic brake applied to series traction motors referred to in the question, but it is thought most probable that details of the wheel brake operated from the track are required, or what is really the Westinghouse-Newell or Westinghouse-Braun brake. This brake was very fully discussed in Problem No. 919 of 1906, and this should be referred to. A somewhat modified form is described below, the principle of which is that, when braking is to be effected, the generators—as they then become—are disconnected from the line, and their current sent around magnet coils which cause iron shoes to grip the track, the relative motion which then ensues between the shoes and the car acting to apply mechanically brakes to the wheels.



In the form shown in the diagram wheel brake shoes, *h i*, are suspended from any suitable part of the frame, and pivoted at *k* and *l* respectively to links, *f* and *g*, connected at one end to a link, *c*, and at the other through pins, *o* and *p*, to telescopic members, *q r*. The rail brake shoes, *t*, bear on the rail, *u*, and are suspended from the car by springs, *m n*. When the controller is brought to its "braking" position current flows through the coil, *s*, magnetising the shoes, *t*, which grip the rail. This causes, if the car be moving from right to left, the shoes *relatively* to the car to move from left to right, with the result that the link or lever, *g*, moves for a short distance about the point, *e*, and so applies the brake block, *i*, to the wheel, *b*. As soon as contact is made between these two the fulcrum is changed to the place of contact, with the result that the thrust is transmitted through *c*, *d*, and *f* to apply the block, *h*, to the wheel, *a*. Should the car be moving in the reverse direction, the brake is first applied to the wheel, *a*, and from this to the wheel, *b*. The advantages of this brake are many, and they need only be briefly referred to here. For example, it uses the car momentum for braking, has a large braking surface, prevents skidding, and is quick and powerful.

In conclusion, it may be pointed out that the problem may possibly refer to a different brake arrangement, consisting of a revoluble metal disc operating between two metal discs or crowns, and adapted to be drawn according to the current passing either to one side or the other into contact with the fixed disc for braking or the revoluble one for clutching.—L. R.

Question No. 1,046.—It has been decided to work the power at a dock by electricity. The requirement is 2,000 b.h.p. Both three-phase and continuous current can be had from a supply company. On the dock estate lighting is carried out on a large scale on the three-wire continuous-current system from the supply company. The present power on the dock estate is hydraulic, with steam-driven accumulators. Please state what system you would prefer—three-phase or continuous—whether you would drive the accumulators by electric motors, or each crane, capstan, lift, dock gate, etc., separately by motors.

Best Answer to No. 1,046 (awarded 10s.).—"Motor" does not give very much information in his question on which to base a recommendation. There are many points of great importance to be considered before it is possible to compare the advantages of the two systems of electric drive which he suggests. The chief difference in the two systems which would first strike one is that of initial outlay, which in the case of the individual motor drive would doubtless be great, but this heavy expenditure would be entirely warranted in the event of the present hydraulic plant being in a poor state of upkeep, entailing frequent expenditure on repairs, and the likelihood of complete renewal in the near future.

To thoroughly discuss the subject in question one might fill a whole issue of the *Electrical Engineer*. It will, therefore, be understood that the following remarks are merely a brief summary of the merits of the two arrangements proposed. To begin with, it is necessary to base all remarks on an assumption, the data given being so brief. We may take it that it is a reasonable assumption that the present method of drive is considered generally inefficient, otherwise the change would not be proposed. It is not likely that the inefficiency is confined solely to the engines and boilers operating the hydraulic accumulators, though if the engines are situated at different points about the dock and the boilers in a central position, as is often the case, this would entail a very heavy loss in the steam-piping. Assuming that the accumulators are all situated centrally (as is likely, being the most economical arrangement), we may conclude that the loss in the pipe lines, and still further in the hydraulic machinery is heavy, tending to point towards worn-out plant. If the existing machinery is in a poor state of repair, the writer would certainly recommend an individual motor drive for every dock gate, crane, etc., as the present plant would have to be renewed at an early date, entailing an almost equally heavy, if not a greater, outlay, and worse economy even then. Supposing, however, that the present plant has been well kept up and is as efficient as such an arrangement can be, and also supposing that the sum set by for depreciation, etc., was based on a probable life of, say, 25 years, and it has only been running 20 years, then it might possibly pay to put down motors for operating the accumulator pumps only, leaving the rest of the arrangement unaltered. If the present generating plant consists of large units, it is doubtful if such an arrangement would show any appreciable saving in running cost, more especially as the supply company's price per unit is not stated. In the event of the accumulators being of fairly small size, it might be possible after another 10 years (when the hydraulic plant has completed its anticipated term of years) to put down an individual motor drive, using the accumulator pump motors for some of the heavier work, though it is unlikely that they would be of small enough capacity to be used in this way. Under some such circumstances only is this scheme to be considered, otherwise the advantages are all on the side of the individual motor drive.

Below is a comparison of the various expenses entailed with the two proposed new methods, it being understood

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that all figures have been merely assumed. No mention is made as to the probable number and size of the motors, or what percentage of them will be operating under cover, thus not requiring to be totally enclosed, as they would have to be if operating in a position exposed to the weather. For the sake of argument, let us suppose that the number and size of machines is as follows, the machines being rated on an intermittent basis such as obtains in crane work, etc: for dock pumps, two of 150 h.p., six of 50 h.p., 20 of 30 h.p., 30 of 20 h.p., 40 of 10 h.p., 20 of 5 h.p. = 2,000 h.p. total; also that cost of current in bulk from the supply company is ½d. per unit; also that half the above motors are in exposed positions, and, therefore, totally enclosed, the remainder being under cover, and of the protected type. As the dock requires 2,000 b.h.p., we may assume that it is a large one, many of the motors, therefore, being situated at points far removed from the main switchboard, entailing long runs of cable. Running costs would then be somewhat as follows, assuming about 50 yards average run of cable to each motor except the two dock pump motors, to which 200 yards run each has been allowed.

Scheme I., i.e., Individual Motor Drive (Three-Phase Machines assumed).

118 motors as outlined above, capital expenditure	(say)	£6,000
Motor panels and control gear	,,	2,500
Main switchboard	,,	300
Ten distributing fuseboards	,,	150
Alterations to existing gearing, etc.	,,	780
Cables, based on assumption already outlined, including dividing boxes, poles for overhead lines, or troughing for underground mains	(say)	3,000
Complete erection and connecting up	,,	770
Contingencies	,,	200
Total expenditure	(say)	£13,700

Power consumed by motors, assuming average efficiency of 80 per cent. including line loss = 1,860 kw. × three hours per day (as service will be intermittent) × 300 days per year,

$$= \frac{1{,}680{,}000 \text{ units} \times \cdot 5\text{d. per unit}}{240}$$

Per annum.

		= £3,500	0	0
Oil	(say)	150	0	0
Waste	,,	15	0	0
Direct attendance, three electricians at 30s. per week each	(say)	235	0	0
Maintenance and Renewals.				
118 motors, say 1½ per cent. on £6,000		90	0	0
Switchgear, say 1 per cent. on £2,950		29	10	0
New gearing, etc., required to drive cranes, etc., say 5 per cent. on £780		39	0	0
Cables, say ½ per cent. on £3,000		15	0	0
Depreciation and Interest.				
118 motors, 6 per cent. on £6,000		360	0	0
Switchgear, 6 per cent. on £2,950		177	0	0
New gearing, 7 per cent. on £750		52	10	0
Cables, 4 per cent. on £3,000		120	0	0
Insurance rates neglected		—		
Total expenditure per annum		£4,783	0	0

Scheme II., i.e., Driving Accumulators Electrically.

Here we may assume an average efficiency of the hydraulic plant, which will be left *in statu quo*, as about 65 per cent. at the outside—*i.e.*, horse-power to be supplied from mains will be 3,050 h.p. (This may be an incorrect assumption, as "Motor" does not state whether the horse-power he names is that actually absorbed by the machinery after allowing all losses, or whether it is the amount required to be furnished by the supply company. This, however, is not of serious moment, as both schemes are made out on the same basis.) Say the accumulators furnish 2,450 h.p.—*i.e.*, 80 per cent. over-all efficiency, pumps and motors, which is high.

Five 500-h.p. three-phase motors		£2,800
Five motor-control panels		200
Five controllers and resistances		600
Main switchboard, say one incoming panel, five one-circuit feeder panels		240
Alterations to existing gearing		200
Cables, based on 40 yards run each from main board = 120 × 5 = 600 yards		500
Troughing, dividing boxes, etc.		100
Erection		150
Contingencies		110
Total expenditure	(say)	£4,900

Annual Expenditure.

Power consumed $= \frac{2{,}270 \times 3 \times 300 \times \cdot 5}{240}$		= £4,250	0	0
Oil, say five times the amount of Scheme I.		750	0	0
Direct attendance of electric machinery—electricians		157	0	0
Direct attendance of hydraulic plant—two fitters at 35s. (out of a number of men attending repairs of machinery in general)		180	0	0
Maintenance and Renewals.				
Five motors, 1½ per cent. on £2,800		42	0	0
Switchgear, 1 per cent. on £1,140	(say)	11	10	0
New gearing, 5 per cent. on £200	,,	10	0	0
Cables, ½ per cent. on £600	,,	3	0	0
Hydraulic plant, 6 per cent. on an assumed capital expenditure of, say, £5,000 (covering plant left unaltered)	(say)	300	0	0
Pipe lines, etc., ¼ per cent. on, say, £850	,,	2	10	0
Depreciation and Interest.				
Motors, 6 per cent. on £2,800	,,	170	0	0
Switchgear, 6 per cent. on £1,140	,,	68	0	0
New gearing, 7 per cent. on £200	,,	14	0	0
Cables, 4 per cent. on £600	,,	24	0	0
Hydraulic plant, 8 per cent. on £5,000	,,	400	0	0
Piping, 6 per cent. on £850	,,	51	0	0
Total annual expenditure	,,	£6,433	0	0

From the foregoing assumed figures it will be seen that the difference in initial outlay is in favour of driving the accumulators electrically to the extent of £8,800, but the annual running cost of the first scheme is about £1,650 less than that of the second, so that in about 5½ years the difference would be made up. Assuming a life of 25 years for the electrical plant, at the end of the 19½ years (which would elapse after the first 5½ years which are discounted) the dock owners would be about £32,000 (exclusive of interest) in pocket by adopting the individual motor drive. The figures given for the first scheme are, if anything, high as regards first outlay, whereas in the second the writer is of the opinion that they are somewhat low, so that possibly the result is even more in favour of the individual drive than is shown. It has been assumed in both cases that the current supplied is three-phase 500 volts at 40 or 50 cycles, as this is most usual.

Now to consider the respective merits of direct and three-phase current. In the first place, the fact that there is already installed a three-wire direct-current system for lighting is of little consequence, as the company would be unlikely to allow power to be taken from these mains, more especially as it would constitute a very fluctuating load, due to the nature of the machinery, etc., being driven. A cursory consideration of the matter leads one to favour the alternating-current system, and a closer investigation tends to confirm the choice, the following being the principal points in favour of this selection: transmission line, if anything, slightly cheaper, but probably little difference; motors decidedly cheaper in first cost, due to simplicity of design and manufacture; running cost lower, due to the absence of wear and tear of commutator and brushes, and less attention required; if used in warehouses or places where insurance rates are high, they may be installed open-type (with, perhaps, the slip-rings enclosed) with the same premium rates which would be required for a totally enclosed (and consequently much more expensive) direct-current machine, or lower rates than an open-type motor of the latter class if such a machine were allowed at all. Against the foregoing may be set the slightly cheaper switchgear required by the direct-current system. In all other points they may be considered equal, as the speed can be regulated equally well on either type for this class of work, and an equally heavy starting torque obtained. It may be argued that the small air-gap required by an induction motor is against it. This may be so, but it is not found to be a great difficulty in actual practice. Induction motors are now being largely installed for driving colliery haulage and winding gears and other heavy work, and appear to perform it perfectly

For dock pump work, where pumps and motors are frequently installed with vertical spindles, the induction motor is seen to particular advantage, as the absence of a commutator prevents risk of carbon and copper dust falling into the rotor windings, and a small air-gap can be no drawback, there being no tendency to lateral wear in the bearings. The three-phase machine can easily be designed to deal with the very heavy overloads which occur when

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commencing to empty the dock, due to the small head to which the water is pumped.—R.

Answer to No. 1,046 (awarded 7s. 6d.).—The three-phase supply and direct-current supply are compared under the following headings:

Cost (a) of Mains.—The voltage of the three-phase supply being doubtlessly much higher than that of the direct-current supply, there will be a great saving in copper in the distributing mains, although the quality of insulation must be better in the former case. The difference in the insulation quality need, however, not be so different, since in all probability it will be advisable and much cheaper to run overhead mains mounted on insulators.

Cost (b) of Motors.—If no transformers are used to lower the voltage for supply to the induction motors, then for high and medium speeds the cost of the induction motors will be cheaper than that of direct-current machines, but for slow speeds the cost of direct-current machines is, perhaps, the lower. The overwhelming advantages of direct-current machines will, however, nullify this difference of cost, and leave things decidedly in favour of direct-current machines.

The properties of the two types of motors are as follows:

Three-Phase Induction Motors.—The advantages are (*a*) simplicity, absence of commutator, and, in some cases of squirrel-cage type, absence of any exposed live parts. The disadvantages are: (*a*) difficulty in speed regulation over wide range and (*b*) bad starting torque and poor power factor at light loads.

Direct-Current Machines.—The advantages of these are: (*a*) possibility of variation of speed over very wide limits, especially if interpole machine be used; (*b*) possibility of obtaining a large starting torque, which is of some importance in dockyards. With respect to disadvantages, perhaps, on the whole, owing to the exposed parts (commutator), the depreciation of a direct-current machine is higher than that of a three-phase induction motor. With due attention and a semi-enclosed type of motor, however, this difference can be greatly lessened.

General Remarks.—In a dockyard the load factor, on the whole, is fairly low, and, therefore, the efficiency of generating is much lessened This, however, will not be felt by the large supply company, since the addition of new peaks may help to flatten out other peaks they have, whereas if power were generated at the dockyard itself it means putting down a very large plant for a fairly low average load. The fact that three-wire continuous current mains are already down makes very little difference, unless the mains already down can carry sufficient extra current to run a few motors and thus save copper. Another advantage of the continuous-current supply is that it is possible (with ease, if overhead mains) to tap off, and thus extensively light the place without the intermediary transformer which would be necessary if three-phase supply were used.

Electric versus Hydraulic Supply.—The installation cost for distribution is small in case of electric compared with that of a hydraulic supply, and is not so liable to failure. The efficiency of electric machinery is necessarily much higher than that of hydraulic plant for the same purpose, especially that of the older type. Electrical distribution is much more flexible and lends itself to alterations and additions as they become requisite much more readily than its competitors. Therefore, I should advocate direct-current supply overhead mains, direct-current motors, series or shunt wound, depending on initial torque required, and also the adoption of a motor for each crane, capstan, lift, etc. If, however, initial cost of an entire conversion be too great, I should convert that part of the plant which is used most often, thus increasing efficiency and lessening likelihood of shut-down, whilst gradually converting the other plant as the advantages of electric supply become apparent.—M. R.

Answer to No. 1,046 (awarded 5s.).—Any new dock which may be built would probably be fitted with electric power throughout, but it cannot be expected that the hydraulic plant in use at an old dock should be taken out and replaced by electrically-driven machinery until it is worn out. An improvement can, however, be effected by installing electrically-driven hydraulic pumps supplied by the power company, and working them automatically. This method does away with all boiler-house expenses, leaving practically only the engine-room staff to operate the pumps. Assuming the number of pumps to be four, two of these may be driven by squirrel-cage induction motors started by compensators, starting through the by-pass of the pumps. The other two pumps may be driven by induction motors with wound rotors with automatic starting switches driven by a small motor, which is brought into action by a switch attached to the accumulator. The above combination is arranged in order to reduce the capital cost of the plant. The cranes and capstans in the dock would be best driven by continuous-current motors, variable speeds being easier obtained by this method. The dock gates and lifts would be best worked by hydraulic power. Other plant at the dock will probably include centrifugal pumps, which may be driven by three-phase induction motors with wound rotors, and operated by similar starting switches to those in connection with the accumulator pump motors. It is much better to employ three-phase induction motors in preference to continuous-current motors where variable speeds are not required, thereby avoiding commutator and brush gear troubles, which in a large installation greatly add to the cost of upkeep and repairs.—S. O.

Question No. 1,047.—A transformer is connected between the end of a high-tension feeding cable and a high-tension distributing overhead line with a ratio of 20,000 to 20,000 windings connected mesh to mesh. What is the object of this arrangement and its advantages, if any?

Best Answer to No. 1,047 (awarded 10s.).—The insertion of a 20,000/20,000 transformer between the cable and the pole line first of all keeps the two circuits to a certain extent separate without the need of a switch or an attendant. With this method the rise in volts which occurs when switching on a long cable on open circuit is, in the case of the cable, almost entirely obviated, as the inductance of the transformer will swamp any capacity effect as far as stress on the cable goes. In the case of the pole line (we are assuming that the circuit is fed from the cable end) the transformer inserts a certain "time element" in the circuit, so that the voltage builds up, rapidly it is true, to its final pressure, and the strain is not thrown direct on to the line. Now, the cable will probably be the weakest part of the circuit, or, rather, the joints in the cable, as the tiniest of pinholes in the compound around the joints is almost sure to break down the cable if there is any sudden rise of volts, more especially if there is a very slight condensation of moisture on the walls of that pinhole. It is quite possible that if the pole line was struck by lightning, the choking or kicking coils would not send all the shock across the spark-gap of the arrester, and in this case the presence of the transformer ensures the safety of the cable. If, however, the spark-gaps did "go across," it is also possible that they would not clear the arc at such a high working pressure, and then, instead of the cable getting all the shock of a complete short-circuit, the transformer would automatically form a "time element" possibly long enough to trip the switches on overload without doing the cable any serious damage. Again, if for any other reason—and there are many—one side of the system broke down—and we are not told that the pole line is not in parallel with another one or another cable line—the transformer would take the first shock and give the switches time to trip. Now suppose that the pole line is not actually struck, but that there is a lightning discharge in the near vicinity, the "side flash" or inductive effects of this discharge would probably give rise to a high E.M.F. of doubtful periodicity, which might not be quite large enough to be completely taken care of by the choking coil and lightning arrester, and still might be quite large enough to break down a joint on the cable, as the spark-gaps on a 20,000-volt circuit are necessarily set very high. In fact, the transformer forms a buffer between the two circuits. The delta-to-delta connection is probably to avoid earthing and for simplicity of winding and connecting, the system, in compliance with the Board of Trade rules, being earthed at its neutral points—*i.e.*, at the far ends—where the transformer would probably be star to mesh.—POWER.

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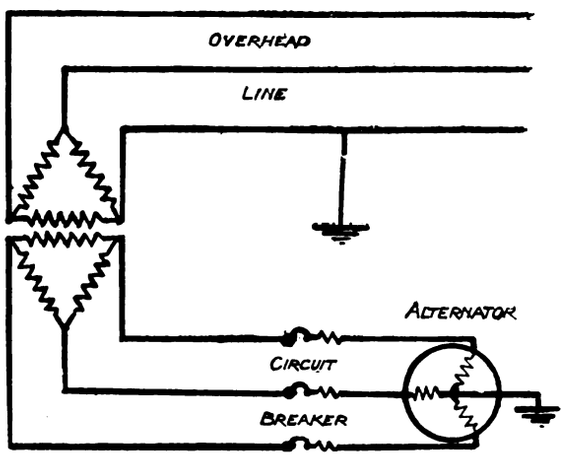
Answer to No. 1,047 (awarded 7s. 6d.).—The advantage of the arrangement described by "Delta" is that the high-tension overhead line is entirely insulated from the generator and feeder, thus greatly reducing the danger of an interruption of supply due to an earth developing on the overhead line. "Delta" does not state whether the neutral point of the generator supplying the feeder is earthed, but presumably it is. If the feeder were connected direct to the overhead distributing line in the usual manner, an earth on one phase of the overhead line would cause a short-circuit between that phase and the neutral point, thereby tripping the circuit breaker and interrupting the supply until the fault could be found and remedied.



With the arrangement described, however, an earth on one phase of the overhead line could not have this effect, since, as the figure clearly shows, there is no short-circuit, the earthed neutral point of the generator being insulated from the distributing line. The result of an accidental earthing of one phase would merely be to keep that phase always at earth potential, without in any way affecting the distribution of potential *difference* in the circuit. To cause a short-circuit it would be necessary for two phases to become earthed.—A. H. B.

Answer to No. 1,047 (awarded 5s.).—It is somewhat difficult at first sight to see the object of a transformer with an equal transforming ratio placed in the transmission line. It is, of course, well known that when connecting an underground high-tension cable with a bare overhead line, special precautions have to be taken to absorb or relieve the resonance effects that are often set up due to the two lines in series having different inductive capacities. This resonance or surging effect can, however, be provided for by suitable lightning arresters, with resistances and choke coils, etc., placed at the connection of the underground and overhead lines. It would appear that the object of the transformer is to entirely insulate one section of the line from the other. This may be necessary if the plant at the generating station is insulated from earth, the coupling of the generator to the prime mover being made through insulating couplings. It may also be required to distribute power on the four-wire three-phase system. This could be arranged by connecting the secondaries in star on the step-down transformers. There are very few instances of high-tension alternating-current systems working with the generating plant insulated. The advantage of insulating the generator from earth is that, should the insulation of the windings break down, the system is prevented from going dead to earth, with the usual resultant surgings and circuit-breaker troubles due to the short-circuit.—K.

Question No. 1048.—It is desired to calculate the resistance and number of stops for the starting portion of a lift controller. The motors would be continuous current, 220 or 440 volts, shunt wound, with a few turns of series windings, cutting out on the last step of the starting up resistance. The motors would range from 2½ b.h.p. to 20 b.h.p. Give (1) simplest formulæ for determining resistance and number of steps; (2) state material of which resistances are best made for commercial purposes; (3) how many sizes of controllers would be necessary to meet the range of motors above stated; (4) give number of steps and resistances for each size; (5) give formulæ for calculating shunt kicking coil and operating solenoids.

Answer to No. 1,048 (awarded 5s.).—In answer to "Knowledge," the following formulæ and remarks may meet his requirements.

(1). He wishes to know the simplest formulæ for determining the resistance and number of steps of a controller presumably of the tramway type. Regarding the number of steps, this is a matter simply for the designer to decide. For the range of horse-power he gives, the number of steps may be between five and eight according to the acceleration on each step before the motor attains its final speed. If the resistances are to be graduated geometrically so as to prevent large rushes of current, the following formula will give the resistance on any step:

$$R = a\left(\frac{C_1}{C_2}\right)^{n-1};$$

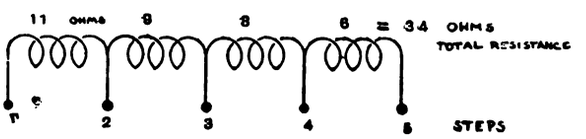
where R = the resistance of any step; n = the number of that step (first position of controller handle = No. 1); a = the armature resistance; C_1 = the initial current; and C_2 = the final current on each step.

(3). With regard to the number of sizes of controllers to meet the given range of motors, as this will vary with the current strengths and resistance of the motors, no number can be definitely stated.

(4). The number of steps is given by the formula:

$$n = 1 + \frac{\log R - \log a}{\log\left(\frac{C_1}{C_2}\right)}$$

n = here the number of steps. If the ampereage is not high, he will probably find five steps suitable for each controller.



The following is an example of the preliminary calculations of a controller. Suppose the controller to be for a 10-h.p. motor, 440 volts, 500 r.p.m., efficiency 85 per cent.

$$\frac{10 \times 746}{440 \times \cdot 85} = 19{\cdot}8 \text{ amperes.}$$

Controller to have five steps with resistances as represented. Resistance of motor, say, 2·3 ohms.

First step: $\frac{440}{34 + 2{\cdot}3} = 12{\cdot}1$ amperes. Speed 0.

Second step: $\frac{440}{23 + 2{\cdot}3} = 17{\cdot}4$ amperes. Speed 0.

Third step: $\frac{440}{14 + 2{\cdot}3} = 27$ amperes.

$(14 + 2{\cdot}3) \times 19{\cdot}8 = 322{\cdot}5$ ohmic loss.

$440 - 322{\cdot}5 = 117{\cdot}5$ back E.M.F.

$2{\cdot}3 \times 19{\cdot}8 = 45{\cdot}5$ ohmic loss.

$440 - 45{\cdot}5 = 394{\cdot}5$ back E.M.F. of motor on last step of controller.

Speed on step $3 = \frac{500 \times 117{\cdot}5}{394{\cdot}5} = 149$ r.p.m.

$(6 + 2{\cdot}3) \times 19{\cdot}8 = 164$ ohmic loss.

$440 - 164 = 276$ back E.M.F.

Speed on step $4 = \frac{500 \times 276}{394{\cdot}5} = 350$ r.p.m.

Fifth step: $\frac{164}{2{\cdot}3} = 71{\cdot}3$ amperes. Speed, 500 r.p.m.

The ratio of maximum to minimum current should conform to the formula:

$$\log\left(\frac{C_1}{C_2}\right) = \frac{\log \frac{V}{C_1} - \log a}{n - 1}$$

After the necessary calculations have been made, curves should be constructed showing the increase of speed and current on each successive step of the controller. It is convenient to plot the speed and current vertically and the steps (1, 2, 3, etc.) of controller horizontally.—V. C. P.

[Other replies to Question No. 1,048 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1057. It is required to construct some small magnetic clutches to convey 2 b.h.p. and 4 b.h.p. respectively at a speed of 100 r.p.m. Either the flat-face type or cone clutch would suit, but preferably the former, space being very limited. The over-all diameter must not exceed 9in., and over-all width, inclusive of clutch and armature (or cone), must be kept within 2½in. Give the requisite ampere-turns and method of calculating the frictional coefficient with metal-to-metal surfaces with a given portative power and varying angle of pole-face. What arrangements are necessary for de-clutching?—A. H. A.

1058. Two similar single-phase watt-hour meters are put in circuit on separate phases of a two-phase system supplying a slip-ring induction motor. On starting up motor the direction of rotation of meter B is reversed, and not until the motor is up to speed does it right itself. Also, under normal working conditions, meter A runs considerably faster than meter B. The pressures on A and B phases are respectively 204 and 200 volts. What are the causes of these phenomena?—W. P.

ANSWERS.

Question No. 1048.—It is desired to calculate the resistance and number of stops for the starting portion of a lift controller. The motors would be continuous current, 220 or 440 volts, shunt wound, with a few turns of series windings, cutting out on the last step of the starting up resistance. The motors would range from 2½ b.h.p. to 20 b.h.p. Give (1) simplest formulæ for determining resistance and number of steps; (2) state material of which resistances are best made for commercial purposes; (3) how many sizes of controllers would be necessary to meet the range of motors above stated; (4) give number of steps and resistances for each size; (5) give formulæ for calculating shunt kicking coil and operating solenoids.

Best Answer to No. 1,048 (awarded 10s.).—In order to calculate the resistances and the number of stops for lift controller starters, the best way to consider the matter is to start from first principles as to what happens when a motor is connected to a source of power. A motor on connection to the line when at rest will naturally take the current which can be driven through a resistance equal to that of its armature by the impressed voltage calculable by Ohm's law. This will be very greatly in excess of full-load current, because, being no rotation, there will be no back E.M.F. to damp back this current. It thus follows that, in order to prevent more than the full-load current flowing through the armature, a resistance must be put in series with the same across which the drop of potential when carrying a current equal to the full-load armature current would be equal to the ordinary back E.M.F. of the motor when running at full speed. In practice, however, there is no objection to running from 25 to 40 per cent. extra current through the armature for the short period of starting, and the series resistance can, therefore, be correspondingly reduced. Starters are generally proportioned so that it takes from 15 seconds to 45 to 60 seconds for full-load current to flow to the motor. If the starter is used for a longer period than this, it is liable to burn out, because the design is such as usually to allow only a slight factor as regards heating. For this reason, in lift and like controller starters as opposed to ordinary motor starters—that is to say, for starters which have to be often operated—greater cross-section of wire must be used.

In order to calculate the steps of the resistance and the value of resistance required between each step, take C_1 as the maximum current allowed to flow when the switch arm is moved from one contact to the next. This will be a current substantially equal to the difference between the impressed and back E.M.F.'s divided by the resistance. C_2 = minimum value of current reached before the switch is put one contact forward, r = total resistance in circuit at any contact, and R = total resistance in circuit at the next forward contact. Then if E be the back E.M.F. of the motor at any point and V the impressed voltage,

$$(V - E) \div r = C_2$$

and

$$(V - E) \div R = C_1,$$

whence

$$\frac{R}{r} = C_2/C_1;$$

thus C_2/C_1 being constant, it follows that the ratio of the resistance in circuit at any one contact to the resistance at the contact before it is constant. Therefore, the steps of the resistance are in geometric progression, the constant ratio being equal to C_1/C_2. Thus the resistance and number of steps are determined. As to the material for resistances, iron wire is as satisfactory as any, and the resistances of all commercial sizes of the same can be readily obtained from tables.

In determining sizes for any given range of motors, it is best to follow the ordinary practice in which for either voltages of the order of 200 or 400 the stock sizes in horse-power are ¼, ½, 1, 2, 3, 4, 5, 7½, and so on. In these, of course, the number of steps and the resistances do not entirely agree with those theoretically determined by the formula previously given, but suitable allowance is made in wiring to allow one starter to be used for intermediate powers. For example, for motors, say, from 2½ b.h.p. to 20 b.h.p. between five and ten different sizes might be usefully employed, depending on the number manufactured, the number of stops roughly being about ten for the first 50 amperes on a 200-volt circuit, and others in proportion, as found from the formula referred to above, extra stops, of course, being added for the series turns to be cut out. The series windings of the motor will, by taking the full armature current, give instantaneous impulses of heavy flux to the field, but this need not be taken into account where motor starters are to be designed for a whole range of instruments.

As an example of a motor starter designed as above, we may take the case of a 20-h.p. motor, working on 400 volts, with an allowable overload starting current of 25 per cent. Armature resistance = 0·5 ohm. Firstly, we see the maximum and minimum starting currents are 46·6 and 37·3 amperes respectively.

$$\therefore\ R_1 = \frac{400}{46{\cdot}6} = 8{\cdot}58 \text{ ohms.}$$

Multiplying this by $\frac{37{\cdot}3}{46{\cdot}6}$ we get as the second resistance 6·87 ohms, and so on until the resistance is entirely cut out at the full on position. If desired, this resistance calculation may be made graphically, but the above method is quite simple.

With regard to choking or kicking coils, the general design does not differ from ordinary choking coils, and it is, therefore, thought unnecessary to discuss the matter at greater length.—L. R.

Answer to No. 1,048 (awarded 5s.).—To treat fully, both theoretically and practically, the above question would require more space than is available in these columns, and it is, therefore, proposed to give rather practical results and figures obtained from long and varied experience in the design and operation of lift controlling gear.

(1). Since the starting current of a lift motor is at least equal to and generally in excess of full-load current, it is desirable that the ohmic value of the resistance is such as to let rather more than full load on the first step, say

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125 per cent., the necessary resistance being simply obtained from the ordinary form of Ohm's law, $R = \frac{E}{C}$, C being taken as 25 per cent. in excess of full-load current. In special cases where five-ampere and ten-ampere rules are insisted upon, the number of steps given below will require to be increased in order to give the same number of steps after the motor has started.

(3) and (4). It will be found convenient to have only two sizes of starter fronts to meet the range given, the resistances, of course, being calculated for and only used on the particular horse-power and voltage of the motor used. The first size will take from 2½ h.p. to 7½ h p on any voltage, its capacity, therefore, being that of a 7½-h.p. 110-volt motor—viz., 55 amperes. In order to obtain smooth acceleration and at the same time avoid injurious sparking at the contacts (which, however, should *always* be easily renewable), the number of sections of resistance should not be less than seven, thus requiring nine or eight contacts, according as the series field is cut out in a separate step or is connected in series with the last step of starting resistance The second size of front will range from 7½ h.p. to 20 h.p. on 220 or 500 volts, or 15 h.p on 110 volts, and should, therefore, have a continuous capacity of 110 amperes. The number of sections of resistance should not be less than nine or ten, and with even this number the resistance must be very carefully graded in order to avoid high-voltage drops. As regards the rating of the resistance, this should be at least one minute, and where the service is very frequent may require two or three minutes. The actual grading of the resistance may be similar to that used on ordinary starters, but the geometrical progression may have to be departed from somewhat in order to keep the voltage drop, as mentioned above, low—say, of the order of 40 per step where possible.

(2). For commercial purposes it will be found advisable to have two standard forms of resistance: (*a*) wire-wound tubes (which may be of porcelain, asbestos, or iron insulated by micanite, these latter being much the best) being used for fairly low currents up to about 75 amperes, and (*b*) cast-iron grid resistances for large currents and frequent use. As regards the resistance wire used, iron is cheap, but liable to rust and is generally inferior to one of the higher resistance non-rusting alloys, such as Eureka or German silver.

(5). It has been found from practical experience that the best results are obtained when the value of the resistance of the kicking coil or discharge resistance is approximately 1½ times that of the shunt field it protects, its capacity, if a wire resistance and used only momentarily, being about five times continuous rating. The use of incandescent lamps for this purpose is advantageous, since a visible indication of whether the discharge is being properly cared for is given on opening the field circuit by the lamps glowing brilliantly for a moment. The design of solenoids being rather a large subject, I would refer "Knowledge" to the recent answers on the subject, and also to a paper by Underhill published in the *Electrical World*, New York, May 20, 1905.—N. C. U.

Question No. 1,049.—One of the ageing processes employed by a large firm engaged in the manufacturing of permanent magnets for meters is as follows: A large copper disc (about 1ft. in diameter and $\frac{1}{16}$in. thick) is rotated at a very high speed, and the meter magnet is held in the hand and slowly moved across a part of the disc so that the poles embrace the disc during the motion. The operation is again repeated, only with the poles reversed relatively to the disc. Please explain how it is, in detail, that ageing is effected.

Answer to No. 1,049 (awarded 7s. 6d).—It is, of course, a first essential with permanent magnets for use in electrical instruments or meters that they should be really permanent. When freshly magnetised, it is found that they have a tendency to weaken with the lapse of time. This is mainly due to the settling down of strains and structural upsetting involved in forging and hardening. The settling of these strains and the decay of the "loosely held" magnetisation can be artificially hurried by the treatment called "ageing." One of the processes of ageing is the subjection of the magnet to a weak demagnetising field. This will reduce the strength of the fresh magnet by some 5 or 10 per cent., according to the character of the steel used, the shape of the magnet, and the method of forging and hardening employed. We may look on this 5 or 10 per cent. as the "loosely-held magnetism." The magnetism left after the ageing process is permanent in that the magnet is practically "shock proof," and also proof against ordinary exterior magnetic fields such as the meter magnets may be called upon to withstand. The method alluded to by Mr. Newman is one of the various ways of subjecting the magnet to a demagnetising field.

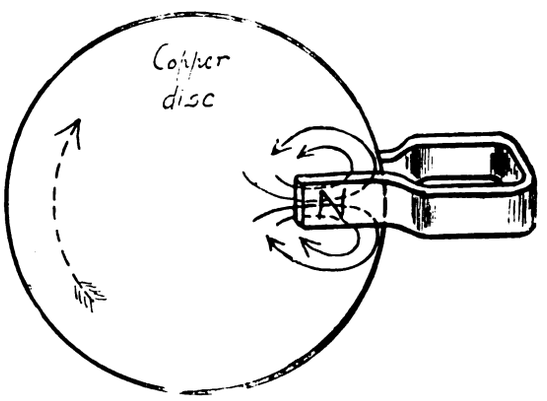

FIG. 1.

Fig. 1 shows the eddy currents produced in the copper disc when revolving relatively slowly. The directions of these eddies are settled by a simple application of Lenz's law, and it will be observed that their effect on the magnet is only a "cross-magnetising" effect. If, however, the disc revolves at a very high speed, not only are the eddy currents of a fairly large value, but, owing to the self-induction of the eddy circuits, their positions are shifted forward relatively to the magnet, as shown in Fig. 2. They

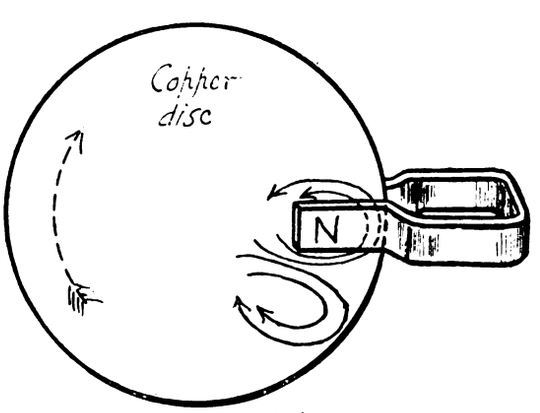

FIG. 2.

are thus no longer symmetric about the magnet poles and it is clear that a demagnetising effect is produced on the magnet. The advantage of the method is that, if the speed of the disc is always the same, each magnet is subjected to a demagnetising force proportionate to its initial strength (which is an important matter). It is easy to see that this is so, since the magnet itself provides the field to produce the eddy currents. The reversal of the poles of the magnet in the operation is probably to ensure symmetric demagnetisation.—SPANNUNG.

Answer to No. 1,049 (awarded 7s. 6d.).—This method of ageing is, I believe, due to Prof. Elihu Thomson, and forms one of the many contributions which he has made to the science of electrical engineering during the last quarter of a century. Like most devices of this kind, it was most probably discovered in an experimental way, and the theory of the operation then left for the discussion and amusement of those capable of propounding theories of this kind. In a process such as this it is really impossible to ascertain, either in an experimental or analytical way, exactly what takes place during the operation, and it is, therefore, quite possible to devise a number of theories which fit the facts, and nobody is in a position to say which is the correct one—they may all be correct in their way.

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If we first of all consider the case of an eddy-current brake, such as is used with most meters of the commutator type, we have a somewhat similar case to that set forth in the question, the only difference being that the speed of rotation is small, probably not more than one revolution per second. For this simpler case the distribution of eddy currents set up in the disc, due to its motion between the poles of a magnet, is usually given in most text-books to be like that shown in Fig. 1. We readily see from this diagram that the part of the disc immediately between the poles is carrying current which flows in a radial direction towards the periphery of the disc (assuming that the pole above the disc is a "north" and that the disc rotates in a "clockwise" direction), the part of the disc outside the pole area forming the return part of the circuit. If we examine the effect of these currents on the pole strength, we find that they exert no demagnetising influence whatever, their only influence being to produce a flux at right angles to the field of the magnet, as shown in the diagram. We are, therefore, led to the conclusion that in the case outlined in the question the demagnetising or ageing effect is a direct result of the "high speed" at which the disc is rotated, for with very low speeds we have shown that there is no such effect.

How then does the high speed of rotation so alter the distribution of eddy currents that they exert a demagnetis-

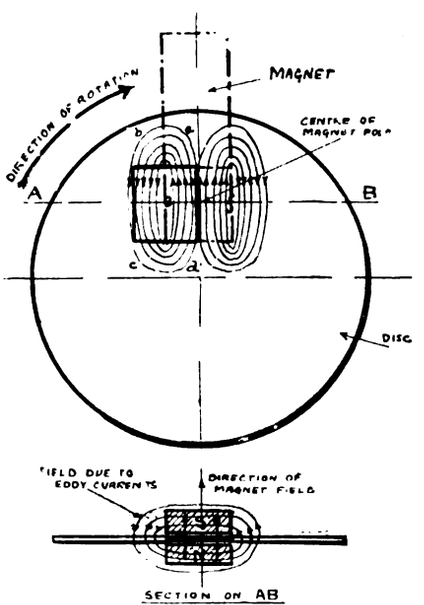

FIG. 1.

ing effect on the magnet? The answer in essence is simple enough, for it is that we now have to consider the effect of inductance as influencing the eddies set up in the disc. Again, considering the part of the disc immediately between the poles, we conclude that the current which it carries will not have dropped right away to zero by the time this section has completely passed between the poles—the motion is so rapid that the small time taken for the eddies to reach their maximum values and then to die away to zero has to be considered. In Fig. 2 a probable distribution of eddy currents, corresponding to the case given in the question, is shown. It shows that the section of the disc, *b c* (Fig. 2), is carrying current in the same direction as that carried by the section, *e f*, immediately between the poles (shown in Fig. 1), and it is the effect of this disc current which produces the demagnetising effect on the magnet. The field set up by the current in this section is shown, and we see that it opposes that due to the magnet. Of course, the current in the section, *b c*, will not be uniform, and, in fact, it is really incorrect to assume that the current flows in a definite section like this. Obviously the current density will be greatest immediately under the pole-tip, M, and will decrease in value as we move away from this tip until a point in the disc is reached where the direction of flow is reversed. From this we would expect that the demagnetising influence would be greatest under the pole-tip, M, and it is probably on account of this that the operation is repeated with the poles reversed relatively to the disc, so that the other pole-tips are the more strongly demagnetised during the second operation, the resultant effect being, therefore, of a more uniform nature. It would also seem that the tips would be the more strongly demagnetised part when the magnet first meets and then leaves the disc, and probably the reversed operation may be to take account of this effect as well.

Another way of looking at the theory of the device, which I have seen given, is to consider a complete path of the eddy currents, such as the path *a, b, c, d* shown in Fig. 1. Now, when the disc has moved a little way so that the poles are relatively in the thick line position, we see that

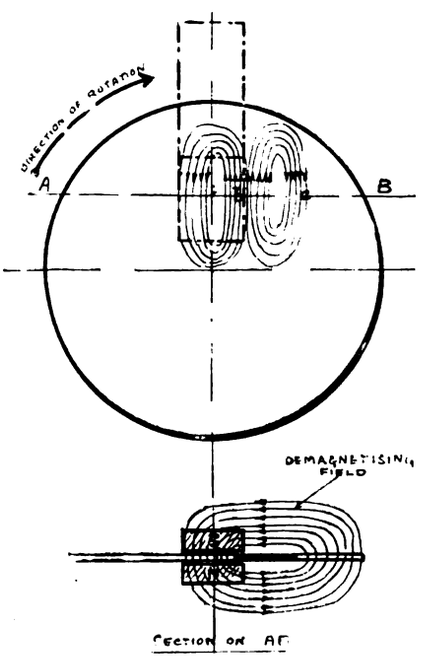

FIG. 2.

the eddies surround the pole, as they will not have died away to zero during the short interval of time which has elapsed. Their effect on the magnet is as if we had a coil wound round the pole and carrying a demagnetising current. Thus ageing is effected.

No matter how we look at it, the demagnetising action is due to the fact that the eddy currents persist after the induced voltage, which gives rise to them, has vanished; or, in other words, there is a phase displacement between the eddy currents and the induced voltage in the disc. Of course, with a high speed of rotation the eddy currents will reach a large value, but it is interesting to note that whereas for the low speeds of rotation the value of the currents will vary almost directly as the speed, when the speed is very large the inductance and frequency have to be taken into account, so that this relation will no longer hold, and beyond a certain speed the eddy currents will remain practically constant and increase but slightly with increase of speed.—A. P. YOUNG.

Answer to No. 1,049 (awarded 5s.).—The magnet is artificially aged due to the disc distorting the flux. Just

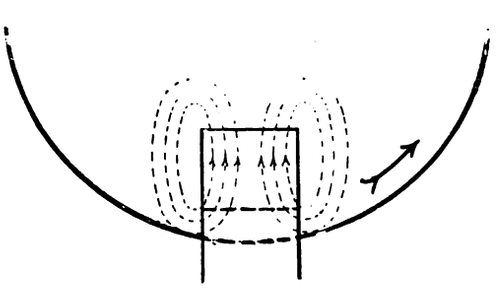

FIG. 1.

exactly how this is accomplished is very hard to state, as everyone has his own theory with regard to the eddy

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currents induced in the disc and their effect on the magnetic field. My theory is as follows: Referring to the diagram (Fig. 1) with the disc revolving clockwise with the "N" pole above the disc, the direction of the induced currents will be from the edge of the disc towards the centre. These induced currents will produce a magnetic field, as shown in Fig. 2. This induced magnetic field opposes the field due to the permanent magnet on the left-hand side, and helps the field on the right-hand side. This tends to distort the magnetic field of the permanent magnet as shown, and has exactly the same effect as increasing the gap between the pole-faces Consequently, if the steel is poor or is run at too high a flux density, some of the magnetism will be knocked out. From the above explanation it is obvious that the greater the speed of the disc the greater will be the distortion due to the eddy currents, and the more effective will be the ageing. In practice it is found expedient to reverse the poles of the magnet to obtain perfect ageing. By this means the magnetic field is distorted in the opposite direction to that described above.

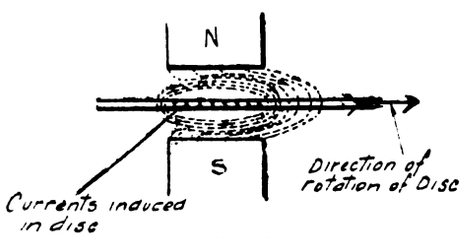

FIG. 2.

This method of ageing magnets is very efficient and very quick, the ageing being effected as quickly as the operator can place and remove the magnets.—A. J. MARTIN.

Question No. 1,050.—In designing non-inductive field discharge resistances, what rule, if any, is followed in fixing on the necessary resistance and current-carrying capacity of same? Give an example.

Best Answer to No. 1,050 (awarded 10s.).—It is the general practice to make the ohmic value of a discharge resistance equal to that of the field; the maximum effective discharge pressure then equals the excitation voltage. This may be proved as follows: Assume instantaneous and sparkless break. Obviously the conditions are less severe if the removal of the impressed pressure is rendered gradual by arcing. It need hardly be pointed out that the maximum pressure is induced at the commencement of the discharge. Now the current in an inductive circuit cannot change abruptly. At the instant after the exciting pressure is removed—*i.e.*, when only an infinitesimal period of time has elapsed after opening the switch—the current in the field winding is the same as it was before the switch was moved, but instead of being drawn from the supply it is being driven through the discharge circuit by the E.M.F. induced in the field winding by the reduction of flux which has begun to take place. The E.M.F. of self-induction automatically adjusts itself so that it sends this current through the discharge circuit, whatever resistance may be opposed to it by the latter. The voltage induced at breaking is, therefore, determined by the ohmic value of the discharge resistance. If the field could be short-circuited upon itself, only just sufficient volts would be generated to overcome the resistance of the field itself, and all points of the winding would be at the same potential. It is clear, then, that the current which passes through the field and protecting circuit when the discharge commences is the same as that which was passing under steady conditions, and that by applying Ohm's law to the non-inductive portion of the circuit we can determine the resistance which it must possess for any given voltage. Any regulating resistance which may be in use must be regarded as part of the breaking resistance. It will not, however, increase the discharge pressure, because the current to be broken is reduced in the same proportion as the resistance is increased.

Let E = excitation voltage;
E_D = maximum permissible potential difference across field winding during discharge;
C = field current;
C_D = maximum current during discharge;
F = field resistance;
D = discharge resistance;
R = regulating resistance in circuit.

$$C = \frac{E}{F+R} \qquad C_D = \frac{E_D}{D+R}.$$

We know that when E_D is a maximum $C_D = C$,

therefore $$\frac{E}{F+R} = \frac{E_D}{D+R}.$$

If E_D is to be equal to E,

$$F+R = D+R \text{ and } D = F.$$

Conversely, if we make $D = F$, $E = E_D$.

Similarly, if discharge resistance = x times field resistance, maximum discharge potential difference = x times line pressure. It should be noted in passing that, in addition to the voltage between the terminals, there must always be induced and dropped in the field winding a voltage sufficient to drive the current through the winding itself.

There is no object in reducing the discharge pressure below that of the supply, and there is the disadvantage that if for this purpose the discharge resistance is made low the current taken by it during the transition period is heavy. As this current has to be broken by the switch in addition to the field current, it should be kept low. It is probably for this reason that some German firms make the discharge resistance 50 per cent. greater than that of the field. It is of small importance whether the hot or cold value of the field resistance is taken. The writer prefers a mean value. The resistance must, of course, be as nearly as possible non-inductive, but most ordinary resistance material fulfils this condition. Special starter material is very suitable, on account of its long time constant. For small machines wire wound on porcelain is most usual, for very large ones cast-iron grids are cheapest.

The current capacity may be calculated from first principles by the formula: energy stored = $\frac{1}{2}$ L C^2 ergs, but values must then be assumed for the following quantities: frequency of operation; length of transition period; energy dissipated in hysteresis and eddies; permissible temperature rise; and time constant of resistance material. For this reason empirical formulæ are always resorted to, though they are necessarily imperfect. A method much adopted in practice, and which meets all ordinary cases, is to determine for each type of resistance material the ratio between continuous rating and field discharge rating. For bare platinoid wires 0·3mm. to 3·0mm. in diameter this ratio is 7·0—*i.e.*, to find the field current which any given platinoid wire can discharge, multiply the permissible continuous current by 7·0. For light grids the ratio is 8·0; for heavy grids, and for special starter material, it rises to 10.

Example.—Excitation voltage = 250; cold resistance of field winding = 25 ohms; maximum current = $\frac{250 \text{ volts}}{25 \text{ ohms}}$ = 10 amperes; mean field resistance = 25 ohms + 10 per cent. for heating = 27·5 ohms. Use platinoid wire, allowing maximum temperature rise of 200deg. C. Required continuous-current capacity = $\frac{10 \text{ amperes}}{7}$ = 1·43 amperes. A wire 0·5mm. in diameter is rated at 1·6 amperes, and will, therefore, do nicely. This has resistance of ·75 ohm per foot.

$$\text{Length required} = \frac{27{\cdot}5}{{\cdot}75} = 36\text{ft. } 8\text{in.}$$

—J. S. M.

[Other replies to Question No. 1,050 will be given in our next issue.—ED. *E. E.*]

Gas "Arc" Lamps.—The Cleveland Inspection Bureau in a recent report severely condemns the use of gas "arc" lamps for interior illumination, which are stated to introduce serious fire hazard. Details are given of the manner in which this type of lamp caused three recent fires in Cleveland.—*Electrical World.*

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1059. Explain fully how the power factor of a plant is improved by the use of over-excited synchronous motors. Describe the action of the above on a power load and on lighting loads. How is the machine enabled to work under both conditions?—F. M. M.

1060. Explain fully the "Merz" scale of charges for electric power users and the advantages of same to the consumers and the supply company; also disadvantages, if any.—O. D.

ANSWERS.

Question No. 1,050.—In designing non-inductive field discharge resistances, what rule, if any, is followed in fixing on the necessary resistance and current-carrying capacity of same? Give an example.

Answer to No. 1,050 (awarded 5s.).—In designing a non-inductive discharge resistance the value of the resistance is usually made equal to that of the field. The process of discharge is as follows: Ordinarily under running conditions a current, C_f, flows through field, F, from exciting mains, M M. When field switch is opened the non-inductive resistance, R, is momentarily placed in

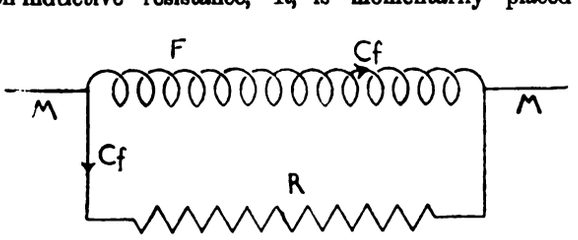

FIG. 1.

parallel with the field resistance, F, and thus a current, C_f, flows through both (Fig. 1). The exciter is finally taken off, leaving the field resistance shunted by the non-inductive resistance (Fig. 2). The mains being now off, the field continues to discharge the current, C_f, through the non-inductive resistance, the current gradually dying down towards zero although theoretically never reaching zero value, yet practically zero after a few seconds, depending on the self-induction of the field.

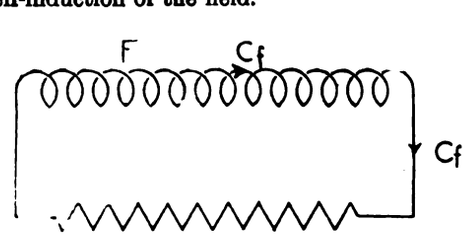

FIG. 2.

The relationship between current and time is given by the formula

$$C = C_f e^{\frac{R'}{L}}$$

where R' = resistance of field and non-inductive resistance combined;
L = coefficient of self-induction of the field;
C = current flowing at time t after switch is opened
C_f = initial current.

The curve of discharge is given in Fig. 3. The current in the non-inductive resistance immediately after opening the switch being C_f, the drop of volts across non-inductive resistance, R, is C_f R. It will thus be seen that if R is very large, there must be a high induced E.M.F. to send current C_f through resistance R, and thus a liability of piercing the insulation of the field. On the other hand, the resistance R must not be made too small, since there will be too great a demand on the exciter when switch is in position shown in Fig. 1. The usual practice is to make R equal to resistance of field, so that induced E.M.F. is not too great, and also demand on exciter is not excessive. The following three points must, therefore, be considered in designing a field discharge resistance: (*a*) it must be non-inductive, so that field discharges continuously as in

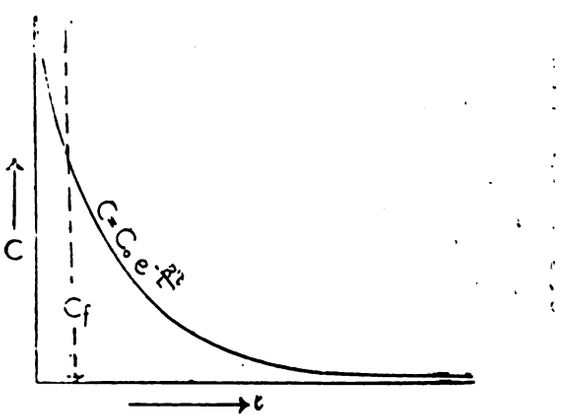

FIG. 3.

Fig. 3; (*b*) its resistance must equal that of the field; (*c*) it must carry a current of C_f amperes equal to the current which originally went through the field. However, since this value, C_f, only flows for an extremely small length of time, the current density allowable may be very high.

No hard-and-fast rule can be laid down as to the current-carrying capacity of the resistance. Manganin, for example, can stand 10,000 amperes per square inch for the space of one second, which is of the same order of time as that in field discharge resistances. The wire is usually mounted on a series of tubes of porcelain or asbestos, all joined in series electrically.—M. R.

Answer to No. 1,050 (awarded 5s.).—Field discharge resistances may be broadly divided into two classes: (*a*) those permanently connected across the terminals of the shunt field, and, therefore, always carrying current when the field is excited; and (*b*) those which are only connected across the field at the moment of breaking circuit, and thus only carry current for a few seconds at a time. Experience has shown that the best results are obtained by making the resistance of the buffer about 1½ to 2 ohms that of the shunt field it protects, although apparently there is no good theoretical reason for this. In (*a*), in order to reduce the continuous waste of energy, the higher value may be used, while for (*b*) the lower value may be taken. Now, in commercial work it does not always happen that the resistance of the shunt field is known, and, therefore, for these cases Table I. will be found useful, being based on an average shunt current varying from 5 per cent. for small motors to 3 per cent. for larger ones. The resistance used may be either incandescent lamps (which are useful in giving a visible indication of whether the field is being properly cared for) or resistance wire wound non-inductively, Eureka being a suitable material. The lamps should be selected so that normally the voltage across them is about half or rather less of their rated voltage, thus ensuring that they will not be burnt out by the momentary rise in pressure.

Table II. gives suitable sizes of Eureka wire for use in Class (*b*) for the various resistances used with shunt

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currents in Table I. If, of course, the wire resistance is always in circuit, the normal continuous capacity of the wire used should be taken, this depending on the method of winding, etc.—*i.e.*, whether open or embedded—and the permissible temperature rise.

TABLE I.—110 Volts.

H.P.	Shunt current.	Discharge resistance from A, ohms.	Discharge resistance to B, ohms.	Current in A, amps.	Current in B, amps.
1	·46	360	480	·31	·23
2	·85	195	260	·57	·42
5	1·6	103	137	1·06	·8
7½	1·7	97	129	1·14	·85
10	2·28	73	97	1·51	1·14
15	3·3	49	65	2·24	1·65
20	4·3	38	50	2·9	2·15
25	5·27	31	41	3·54	2·63
30	6·3	26	34	4·25	3·15
50	10·8	15	20	7·35	5·4
220 Volts.					
1	·23	1,430	1,900	·15	·12
2	·43	770	1,020	·28	·22
5	·80	410	545	·53	·40
7½	·85	390	520	·57	·43
10	1·14	290	386	·76	·57
15	1·65	200	266	1·12	·83
20	2·16	153	204	1·45	1·08
25	2·64	125	167	1·77	1·32
30	3·15	105	140	2·12	1·57
50	5·3	82	82	3·67	2·65
500 Volts.					
1	·1	7,250	10,000	·07	·05
2	·19	3,800	5,250	·13	·1
5	·35	2,070	2,860	·24	·17
7½	·39	1,850	2,560	·27	·20
10	·52	1,400	1,930	·36	·26
15	·75	970	1,340	·52	·38
20	1·02	710	980	·71	·51
25	1·2	610	840	·82	·6
30	1·38	530	730	·94	·69
50	2·3	315	435	1·59	1·15

TABLE II.

Current as Table I. A. and B. Amperes.	Gauge Eureka. S.W.G.
·1 to ·3	34
·3 ,, ·5	32
·5 ,, 1·5	30
1·5 ,, 2·5	28
2·5 ,, 3·5	26
3·5 ,, 5·0	22
5·0 ,, 9·0	20
9·0 ,, 18	18

N.B.—Above is for momentary service only, not continuous.

—N. C. U.

Answer to No. 1,050 (awarded 5s.).—It is not usual for field discharge resistances to be calculated specially for every given field circuit, as one particular resistance is suitable for use over a large range of motors, which the manufacturers have settled more by experience than calculation However, it is possible to indicate the method for determining the suitability of a given resistance for a known case. The conditions which limit the value of the resistance are: (*a*) the momentary rise in voltage at the moment of opening the main circuit; (*b*) the permissible loss in watts in the resistance; (*c*) the stored energy due to the self-induction.

Considering (*a*). The formula giving the fall of current in an inductive circuit left to itself is well known, and is

$$C = C_0 \epsilon^{\frac{-R T}{L}}$$

where C_0 = initial current, R = resistance of circuit, and L = self-induction of circuit. If now, the discharge resistance is n times that of the shunt coils, discharge resistance = n R. Then

$$C = C_0 \epsilon^{\frac{-(n+1) R T}{L}}$$

The voltage across the field coils will equal the voltage across the discharge resistance = therefore

$$V = n R C_0 \epsilon^{\frac{-(n+1) R T}{L}}$$

But $R C_0 = E$ = normal voltage. Therefore at time T = 0. Momentary voltage = n times normal volts.

If we do not wish the voltage to rise above normal voltage, n must be unity, from which the rule that the discharge resistance should equal the shunt resistance has been deduced. However, it is unnecessary to keep to such a low limit, and it is quite safe to allow the voltage at the moment of switching off to rise to three or four times the normal figure. With this condition, therefore, we may make a first rule: "That the discharge resistance should not exceed three or four times the shunt resistance."

Condition (*b*) is not so serious, as from the above we see that the loss in the discharge resistance will not be more than one-third of that in the shunt, except for small machines, where difficulties in constructing high resistances for very small currents prevent going to such a small loss.

As regards condition (*c*), the energy stored in an inductive circuit is given by

$$J = \frac{L C^2}{2} \text{ joules.}$$

To obtain L, the self-induction n_1 = turns per pole; p = number of poles; N = flux per pole in megalines produced by the normal current, C_0. Then

$$L = \frac{p \times N \times 10^6 \times n_1}{10^8 \times C_0}.$$

By comparing J with the total loss in shunt and discharge resistance at a current C_0, we obtain an idea of the rate of dissipation of energy.

Below is an example of a medium-sized motor, with the following particulars:

40 b.h.p., 500 volts, 800 r.p.m.
Number of poles = p = 4.
Flux per pole = N = 2·5.
Turns per spool = n_1 = 4,000.
Total shunt resistance = R = 500 ohms.
Current = 1·0 amperes.
Loss in shunt = 500 watts.

$$\text{Self-induction} = L = \frac{4 \times 4{,}000 \times 2{\cdot}5 \times 10^6}{10^8 \times 1{\cdot}0} = 400 \text{ henries.}$$

$$\text{Stored energy} = \frac{400 \times 1{\cdot}0 \times 1{\cdot}0}{2} = 200 \text{ joules.}$$

Allowing n = 3, we yet the figures for the discharge resistance: ohms required = 1,500; current capacity = ·3 amperes; watts lost = 150; momentary pressure = 1,500 volts. It is evident that since the stored energy is only 200 joules, that the greater part will be dissipated in a fraction of a second. This comparison might also be made by considering the time constant = $\frac{L}{R}$, which in above case = $\frac{400}{1{,}500 + 500}$ = ·2 seconds. It is quite evident that the discharge resistance will be suitable by this figure.—P.

Question No. 1,051.—Two 75-kw. 500-volt machines (one having interpoles and both being compound wound) when run in parallel do not take the load equally, the one having the interpoles taking 50 per cent. more load than the other. State how this can be remedied and any tests that will have to be made; also how should maximum and reverse current circuit breakers be connected to be most efficient.

Answer to No. 1,051 (awarded 7s. 6d.).—Compound-wound dynamos, to run satisfactorily in parallel, should have the same characteristic curve, or as nearly so as possible—that is to say, the proportion of shunt and series windings should be the same on each machine. If they differ, the one having the larger proportion of series field winding will tend to take the greater part of the load, as, when this increases, the increased armature reaction has less effect in the direction of weakening the field. It is this field-weakening effect which obviates the necessity of any equalising arrangement when two shunt-wound generators are run in parallel, as, if one machine takes more load than the other, its field is correspondingly weakened, reducing the voltage and relieving it of the increased output which it would otherwise give. In the case in which one machine only has commutating poles, this generator will not only have so much more series winding, but it has it so disposed that it has a greater effect on neutralising the demagnetising effect of the heavily-loaded armature than if it were all wound on the main poles.

Fig. 1 shows the approximate characteristic curves of

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two generators, one with and one without compensating poles, both being compound wound. Supposing the design of the machines is similar apart from the question of interpoles, the best way to get over the difficulty would be to fit commutating poles on the generator which is at present without them. This should not cost more than about £15. Possibly an increase of the series winding on the main poles might have the desired result, but this is very doubtful, and in any case more copper would be required, due to the greater mean length of turn, and to the fact

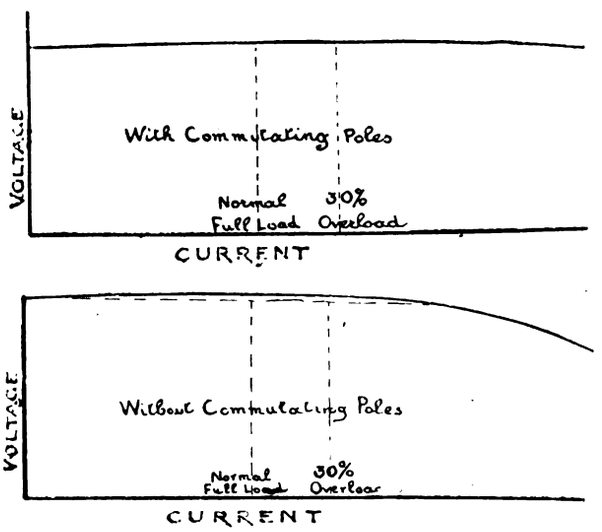

FIG. 1.

that it would not be applied to such great advantage in this position. It is possible that the series winding of interpoles on the machine thus equipped is connected up, say, on the + side and that on the main poles on the – side (or *vice versâ*), the latter only benefiting by the equaliser. When both machines are equipped with interpoles, the windings of these should be connected in series with those of the main poles on the same side of the system, so that one equaliser bar only, with its attendant connections, is required.

The arrangement of circuit breakers shown in Fig. 2 is the best, using one double-pole or two single-pole. If the latter arrangement be used, one only of the two need be

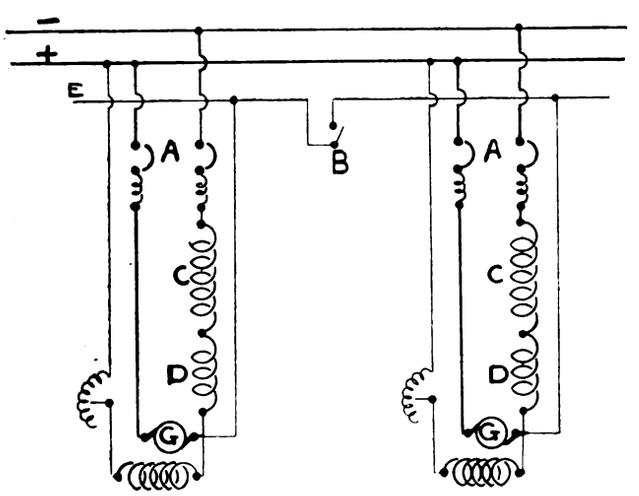

FIG. 2.—A, Circuit Breakers; B, Equaliser Switch; C, Series Winding; D, Compensating Winding.

fitted with reverse-current mechanism, and in either case no main switch is necessary. One single-pole breaker only might be used with each machine if a main double-pole switch is installed.—R.

Answer to No. 1,051 (awarded 7s. 6d.).—The trouble complained of is most probably due to a combination of several causes. Owing to the machines not being of similar design, it is quite possible that their characteristic curves are not similar. This is due to the interpoles practically neutralising the armature reaction as the load comes on, and it is possible, by putting the brushes back beyond the neutral, to cause the armature to excite the field as the load comes on. To check this, a compounding test should be taken on each machine with the brushes in their present running position. The readings should be plotted as shown in Fig. 1, the full curve being for a machine with a rising characteristic and the dotted for a machine with a falling characteristic. It will probably be found that the interpole has the former, while the other machine may have the latter, or it may be flat. If the over-compounding is not much, it should be possible to bring it down

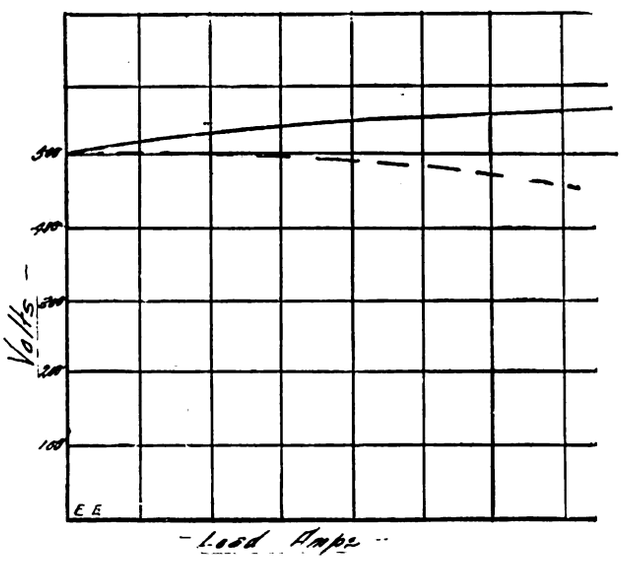

FIG. 1.

by putting the brushes forward; if, however, a flat characteristic cannot be obtained by brush shifting, it will be necessary to shunt some of the current from the series winding by means of a diverter, which can be adjusted until the compounding is flat. If the other machine is compounding down, the brushes should be put back as far as possible, and if this is not enough, it will be necessary to add more compounding turns if flat compounding is insisted on; if not, the characteristic of the interpole machine should be altered to correspond. The two machines should now be

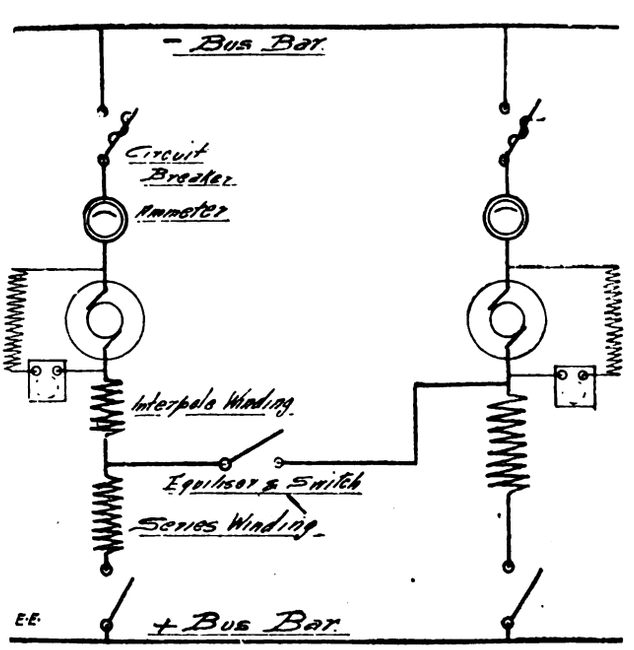

FIG. 2.

run in parallel again, and should now divide up the load equally between them. If they do not, it will most likely be due to the following reason. When the two machines are running in parallel, the equalising switch being in, the two series windings are in parallel, and supposing them to be of equal resistance, and the loads equally divided, the same current will flow through each. If, however, one winding is less than the other, the current will split itself up into the two paths inversely as their resistance, more current passing through the low resistance than through

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the higher. This will cause the machine whose winding has a lower resistance to take more than its share of the load. In the case of the interpole machine, as there is very little armature demagnetisation, it will have fewer turns, and will, therefore, be of lower resistance than the other machine, thus taking up a larger portion of the load. To remedy this, a resistance should be placed in series with its series winding, to make it of the same resistance as the series winding of the other machine.

The correct connection for the circuit breaker is shown in Fig. 2. It will be seen that it is connected in the opposite pole to the series winding. When the breaker is out the armature is disconnected from the lines. If, however, the breaker be put in the other pole, it will be seen that, even when out, the armature is still connected across the armature of the other machine, unless either the equaliser switch or other main switch is out. The ammeter should also be placed in the same pole as the circuit breaker, otherwise it will not always indicate the correct amperes. If two circuit breakers are used, both should be placed in the pole remote from the series winding, as if the overload be placed in the pole with the series winding, when this blows it will leave the armature connected across the other machines, and as the compounding will be cut out its volts will fall. This will result in the machine motoring, and will cause its reverse-current breaker to operate, thus putting an additional load on the plant, besides the overload due to the machine switching off.—E. V. C.

Answer to No. 1,051 (awarded 5s.).—The cause of the two generators not dividing the load equally is due to the machines not having the same characteristic as regards voltage drop from no load to full load. The machine carrying the heavier load would have the smaller drop, assuming, of course, constant speed and excitation. If the machines were originally designed to operate in parallel with the ordinary compound winding, the fact of fitting interpoles to one of them would have the effect of reducing the voltage drop. The interpoles would tend to compensate for the drop due to armature reaction and cross-magnetisation. By suitably proportioning the winding on the interpoles, the machine can be arranged to give an over-compounding effect. The same result can be obtained if the brushes of the interpole machine are given a backward lead, or a drop will be caused if the brushes are given a forward lead. With the interpole machine in question the brushes should be given a slight forward lead (provided the commutation permits of the brush movement); this would probably result in obtaining a drop similar to the other machine. Failing this, the series winding on the main poles should have a few turns removed or short-circuited till the correct drop is obtained. If the voltage of the machines should prove to have insufficient margin due to the drop of the interpole machine being increased, the other machine should also be fitted with interpoles; or if the commutation is satisfactory and the field not saturated, more turns could be added to the series winding in order to reduce the drop equal to the interpole machine. The necessary test to be carried out to obtain the relative drops is a very simple matter, the connections being arranged as in Fig. 1. Throughout the test the speed and excitation should be kept constant. The voltmeter reading should be taken at no load, and the drop observed as the load is increased up to full load The resistance of the connecting leads between the machines and switchboard must be equal, which is a very important point, and must not be overlooked.

Circuit breakers designed with overload and reverse-current coils can be fitted with both the automatic features on one pole if necessary. The usual practice with a double-pole circuit breaker is to fit the overload coil on one pole and the reverse-current coil on the other pole. In a three-wire system with the neutral earthed, it is sometimes considered advisable to arrange both coils on each pole. The combination is known as a compound coil. The operation of a circuit breaker fitted with overload and reverse-current release coils is briefly as follows. The overload release coil consists of a series winding carrying the whole or part of the main current. The reverse-current release coil consists of a shunt winding excited across the 'bus bars, and in series with a suitable resistance. The trip gear controlled by the overload coil is operated in the usual manner by means of a solenoid, the movement of the plunger depending upon the current flowing. The reverse-current coil is so arranged in combination with the series coil that when the machine is supplying current to the

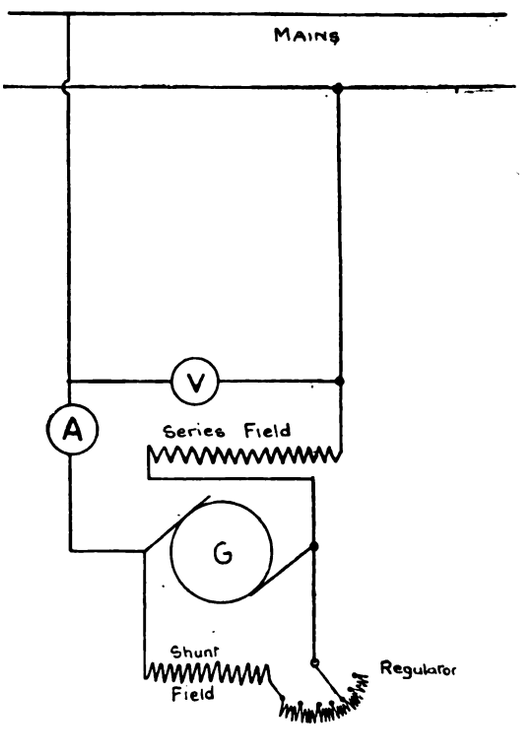

FIG. 1.

'bus bars no action of the solenoid takes place regardless of the current flowing. If, however, the current should be reversed and flow from the 'bus bars to the machine, the balance of the coils is immediately altered, the solenoid actuating the trip gear of the circuit breaker. The connections are as shown in Fig. 2. The overload release coils

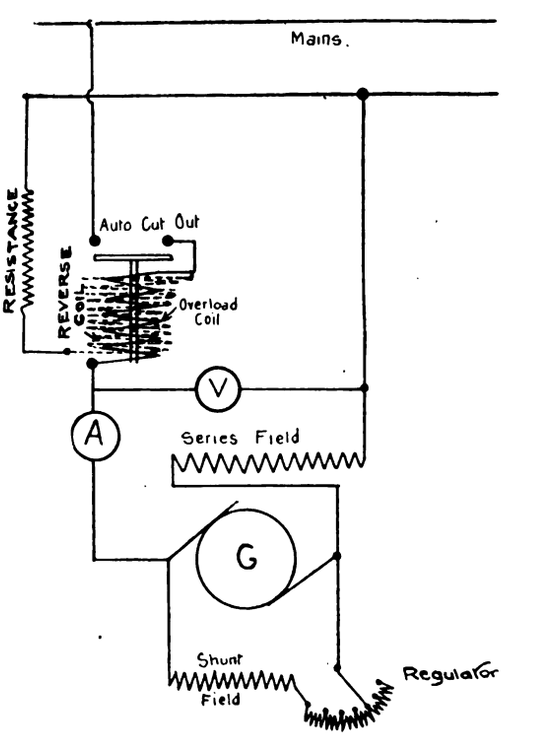

FIG. 2.

are generally designed to operate from 10 per cent. below to 50 per cent. above the normal current, and the reverse-current coil from 7½ to 10 per cent. of the normal current.—K.

[Other replies to Question No. 1,051 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

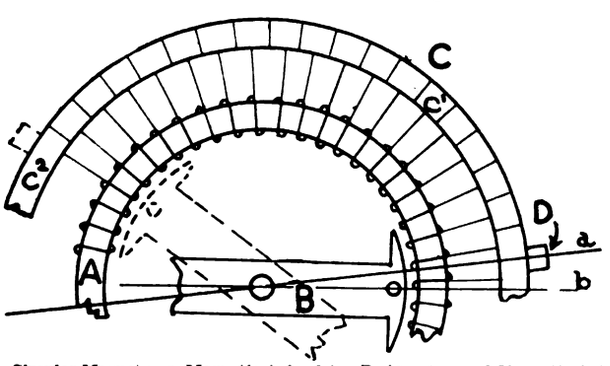
If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,061. A magnet of the rotary type for continuous use is wanted, and as it is desired to combine the *advantages* of the *long* range and the *short* range, it is proposed to construct one after the style of an electric motor, as will be seen from the diagram. Discuss the



A, Circular Magnet; *a*, Magnetic Axis of A; B, Armature; *b* Magnetic Axis of B; C, Commutator; c^1, Ordinary Segments; c^2, Segment (made rather larger) to bring A to a stop at end of its travel and hold it there; D, Brush

practicability of such a design, working out a concrete example of one capable of lifting a weight, say, of 400lb. in a 100-volt circuit, specially referring to the advantage or not of winding B as well as A (but obviously not to such an extent as would enable B to dominate A) and of connecting in series so that such winding should also contribute towards the necessary resistance required to cut down the current. A is shown as smooth cored, but in order to get the requisite number of ampere-turns upon it and make it as compact as possible, it is proposed to make it toothed, the slots being made deeper than is usual in the case of motor armatures. No sparking troubles are anticipated, although the turns per segment are roughly estimated to be about 12. But in case of any it is proposed to have the brushes of soft carbon.—MAGNET.

1,062. In Babcock boilers of both land and marine types it is noticed that a slight bending of the bottom two rows of tubes (over the centre of the fire chiefly) takes place, always in a vertical plane and with the *concave* side of the bend towards the fire. The bending only takes place in the first chamber, just over the fire, and is always *upwards*. Why?—FROISSART.

ANSWERS.

Question No. 1,051.—Two 75-kw. 500-volt machines (one having interpoles and both being compound wound) when run in parallel do not take the load equally, the one having the interpoles taking 50 per cent. more load than the other. State how this can be remedied and any tests that will have to be made; also how should maximum and reverse current circuit breakers be connected to be most efficient.

Answer to No. 1,051 (awarded 5s.).—The machines take unequal shares of the load because they have dissimilar characteristics. In Fig. 1 A, B, and C are voltage curves under different loads for three generators; A is compounded for constant voltage, B is over and C is under compounded. Two, or more, machines such as C would be best for parallel running; with over-compounded machines it is impossible to keep the load equally divided. Remedy will be to fit a diverter across terminals of series winding of the interpolar machine; by this means its characteristic will be brought more nearly the shape of that of the other dynamo. Load will then be equally divided between the two machines. By connecting up a rough resistance across the series winding a few trials at different loads will soon give the necessary amount of resistance required for the diverter. Although 50 per cent. appears at first sight a great difference, such inequality in load will often occur with machines that under normal conditions run perfectly in parallel; bad switch contacts or indifferent brushes easily cause any amount of trouble.

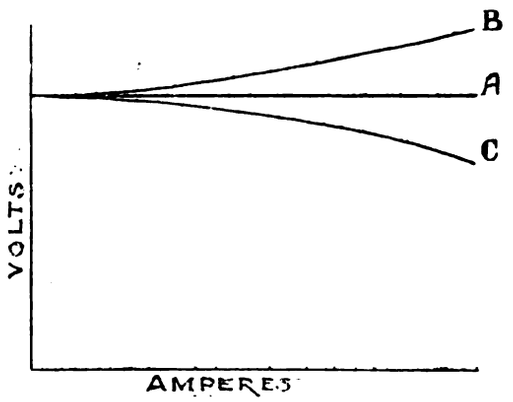


FIG. 1.

Make sure before commencing alterations on the dynamo that fault is not with the engines; it does not take much difference in speed on the part of the prime mover to make the satisfactory running of generators in parallel almost impossible. A simpler alternative would be to cut out, or reduce winding on, the interpoles. By doing this any advantage due to fixed position of brushes will be lost, but this will be more than compensated for by the governing effect obtainable from brush adjustment. In any case the machine not provided with interpoles will require to have

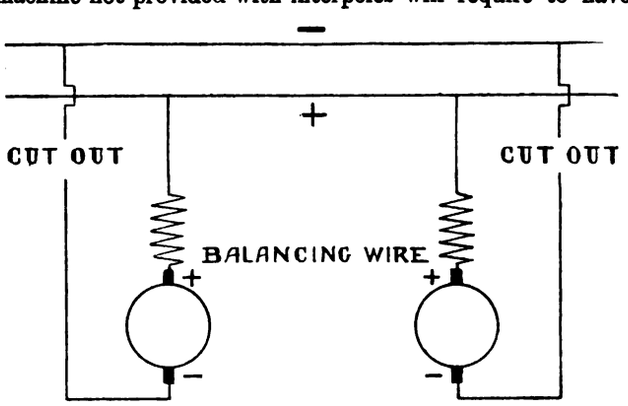


FIG. 2.

its brushes adjusted as load varies, so that this need not be a serious consideration.—M. M.

Answer to No. 1,051 (awarded 5s.).—The trouble is that the relative effect of the series and shunt windings is not the same in both machines. Let us call the machine with interpoles A and the other B. The remedy is either (1) to increase the ampere-turns of the series winding of B or (2) to decrease the ampere-turns of the series winding of A. The choice of methods may be guided by the requirements of the case. If the voltage of the 'bus bars at full load is required to be high compared with the no-load voltage, then the first course is desirable. If a moderate increase of voltage with load will suffice, then the second method is preferable. (It is assumed that the machines are over-compounded.) If the point is of no moment, then the second method should be chosen as being the easier. It is here described. If the designer's data are available, it will be possible to calculate the voltage of the machines due to the shunt fields alone, and the added voltage at full load due to the series field. The shunt resistance of B should be set so that the no-load voltages of A and B are equal. A stop should be fixed in this resistance to limit its range to this point. From the data mentioned it will be possible to calculate the difference between the full-load voltage of A—firstly, as a shunt, and, secondly, as a compound machine. This difference should be divided by the number

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of series turns per pole-piece, thus giving the added voltage per series turn. It is then a simple calculation to find the number of turns required to bring the voltage of A at full load as compound machine to the similar voltage of B. The difference between the number of turns required and the actual number should be short-circuited, or preferably cut out. The windings will probably be ⅛in. copper strip, and in cutting out a thin sheet of steel should be slipped behind the series turns to protect the shunt winding. If no designer's data are available, the foregoing method may still be followed, but instead of having the figure for the full-load voltage of A as shunt machine, it must be estimated by allowing for the drop in volts from no load to full load. All other voltages may be read on the voltmeter. The machines will then take up their load equally throughout their whole range The incident of interpoles does not necessarily affect the question.

There is only one correct way of connecting up maximum and minimum circuit breakers. Between the main switches and the 'bus bars one circuit breaker should be fixed on each pole. The equalising connection should not be broken except by the equalising switches. The most generally useful setting for a minimum circuit breaker is so that the breaker shall open with a reverse current of 5 to 10 per cent. of full load, and for a maximum breaker twice full load.—J. ARTHUR SYKES.

Question No. 1,052.—I occasionally receive circulars *re* electric light baths. Will anyone who has had experience with them state if they are of much use: (1) to the invalid—if so, what complaints are benefited by their use; (2) to the person in good health to assist him in maintaining health, etc. Is it desirable to have a water bath afterwards to remove perspiration, etc., from the body, as in the case of a Turkish bath? If so, should it be hot, warm, or cold?

Best Answer to No. 1,052 (awarded 10s.).—For many years electricity has been used as a means of electrical treatment, principally in its direct application to the human body; but it is only recently that the electric current has been applied to the production of light and heat in such a form that it can be readily used for medical purposes. Its total absence of fumes, flame, and danger, its ready control, its almost instantaneous action, all tend to make electric light and heat baths the ideal system, especially where sickness is concerned. The application of this system was made at the suggestion of a well-known medical authority, and is called the radiant heat and sight treatment.

Direct luminous heat, according to its intensity, has a germicidal action, and cultures exposed to a strong light are more readily killed than by heat alone. Light is also a counter irritant, and, like the mustard plaster, draws the blood from the internal parts to the surface. This action takes place almost immediately the rays are applied, and is one of the first effects noticed, giving almost immediate relief to the congested parts, the temperature of the blood is raised to a small extent, the circulation is increased, and a process of "washing out" commences, which is continued during the treatment. Thus the ureates which have been deposited in different parts of the body are discovered and removed, and removed from the system by the pores and general circulation.

During treatment, a porous cloth covered with an inflammable material is thrown over the whole bed. (The reflectors of lamps are placed at suitable places around the bed.) The patient is thus reclining in an enclosure, but being subjected to the direct rays of light and heat from the lamps surrounding him. The reflectors are of a special form, and are made to reflect and disperse the heat rays, so that the interior of the bed is heated and flooded with rays of light and heat. A large proportion of luminous rays penetrate the patient under treatment, and tend to increase the metabolism of the body, unloading the congested parts of morbid matter and increasing the blood stream, and hereby increasing their power of oxygenation.

The light baths are most effective for all uric acid troubles, such as gout, lumbago, etc., also for rheumatism, rheumatoid, sciatica, arthritic sprain, and all nervous troubles. To the person in good health, an occasional light bath would assist him greatly in maintaining good health, as the luminous heat radiations have been proved to be a very good substitute for the sun bath, giving very abundant perspiration, greater activity of the functions of general nutrition, and increasing the stamina of the whole constitution.

"K." would do well, I think, by treating the whole body by warm massage, as in the case of a Turkish bath, with a variable temperature shower bath. I might cite a case which I know of a child 2½ years, who some six months ago contracted paralysis of right leg, and until recently was spoken of as incurable, having had to be wheeled about in an invalid's chair. Radiant heat of light was applied locally, and I say authentically she is now able to walk about without the aid of any supports.—HUMPHRY.

Answer to No. 1,052 (awarded 5s.).—It is, I think, fairly well recognised by the medical profession that electric light baths are not only of use in curing various complaints, but also serve to promote the health of the normal individual troubled with no particular ailment. Electric light baths act on the system in two ways: the heat which they give off induces perspiration, and in this respect they are capable of producing the same beneficial effects as given by the well-known reviver and curer of certain ills, the Turkish bath. Then, again, with electric light baths we have light rays, and these rays may be of various kinds. That sunlight is a promoter of health there is not the least doubt, and it is reasonable to suppose that these baths act in a similar manner. Electric light baths are of several kinds. One form consists of a cabinet in which the patient sits. Round the sides of this cabinet there is a large number of incandescent lamps which give off a large amount of heat and light in a much more convenient and safe manner than could be obtained in any other way. The sides of the cabinet are completely closed, with the result the temperature soon rises. Usually the person remains in the bath for about half an hour, at the end of which time considerable perspiration has taken place. By the aid of a thermometer the temperature may be seen, and it is possible to adjust the temperature by turning out some of the lamps. As a rule, the maximum temperature is about 130deg. to 140deg. F. In some cases after the electric bath an ordinary bath at a temperature of about 40deg. C. is taken, while in other cases a cold wet rubbing is administered. In all cases the perspiration should be removed. There is no doubt these baths have a stimulating and refreshing effect upon the system, and they are good for rheumatism, gout, and complaints of a kindred nature.

One of the most useful forms of electric light baths for curing complaints contains both incandescent and arc lamps. The arcs are covered by sheets of blue glass, which exclude the red rays which give rise to heat. Among other things, these baths are used for the treatment of skin diseases, neuralgia, ischias, etc. The blue light has a smoothing effect upon the nervous system; the blue rays kill the bacteria, and some forms of skin diseases have been cured in this way.

The great advantage about these baths is they may be used at home, provided, of course, electric current is available; they are compact and easily operated.—CALCULUS.

Answer to No. 1,052 (awarded 5s.).—Although I have undergone no course of light treatment, I think possibly some assistance to the querist may be gained from the following remarks. Light has been found to be very beneficial in certain cases for certain complaints and diseases, but what sort of diseases depends on the kind of light employed. From the nature of the query one is led to imagine that light of the kind used in cabinet baths is referred to, and these will first be dealt with. Such baths are usually constructed as a casing adapted to receive the body of the patient, who is seated, and a top having an aperture closable, so as to encircle the neck and leave the patient free to breath air normally. The interior of the bath is enamelled or the like to reflect towards the patient the light of 30 to 50 incandescent lamps. Baths of the same kind but arranged so that the patient may recline instead of sitting are also in use. The effect of these baths depends on the strength of current and the time of "immersion," but the usual practical effect is to draw from the pores of the skin a large amount of foreign matter as in a Turkish bath, which, in fact, they practically replace.

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As to their benefit to the invalid, this depends on such conditions as those referred to above, and also on the particular complaint from which he suffers, the most usual complaints which these baths are disposed to treat being rheumatism, gout, and some nervous troubles. Here, I think, should be inserted a word of caution, and that is, in my view, that an invalid should consult a medical man before undergoing a light treatment, placing before him the exact state of his case, and taking his advice on the time of immersion, frequency of baths, etc. Unless this be done, in my opinion it is quite easy to overdo any good effect. To a person in good health, such a light bath as that referred to above would act somewhat as a Turkish bath, the main differences being that in the light bath ordinary breathing is maintained, and thus the lungs and heart are not adversely affected. Further, perspiration sets in practically immediately, and a higher temperature may be used because of the dryness of the air. With regard to the point of a subsequent water bath, this I do not think can be answered—especially with invalids—generally. My view on the matter is that the opinion of a medical man be taken in each case. Unless a person is in very good health, and can stand a Turkish bath easily, I feel a cold bath should not be taken.

In addition to the above remarks, it must be noted that there are other light treatments for different complaints, but as these are not thought to be required in the present instance, they will not be considered at length. The most important of these is the Finsen treatment for lupus, which consists in exposing the parts of the skin affected to the action of rays from an arc lamp or a condenser spark, after rendering the places anæmic by the pressure of rock crystal, quartz, or ice. The next case is that of Röntgen rays obtained by means of a coil or Wimshurst, which are applied in many skin disease cases, the chief of which are phthisis, rodent ulcer, lupus, and eczema.—L. R.

Question No. 1,053.—A compound-wound, direct-current machine is fitted with a two-phase static balancer, but this balancer is not large enough to maintain balance on the 'bus bars, so it is proposed to put a booster in series between neutral bar and machine, and this booster must necessarily be reversible to deal successfully with an out of balance on either side. How should the fields of this booster be connected, and what is the best way to get hand regulation of the boost? Would two compound machines fitted this way work well in parallel?

Best Answer to No. 1,053 (awarded 10s.).—As the question specifically states that a booster is to be employed between the neutral point of the balancing coils and the middle wire, this solution of the problem will be first treated. The difficulty would, however, be met much more satisfactorily with a lower capital outlay, and also without the use of running machinery, by another method indicated later.

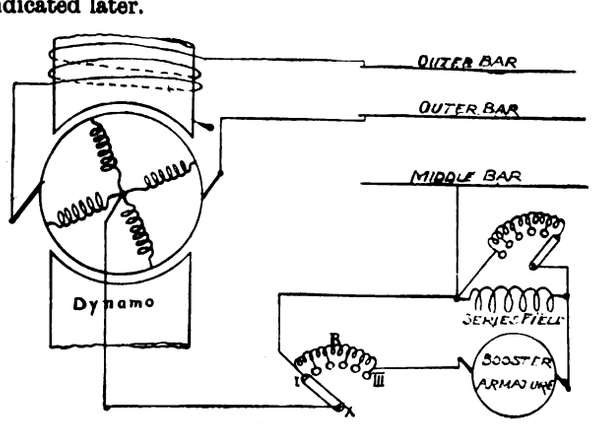

FIG. 1.

The simplest form of booster will consist of a series-wound dynamo connected directly in circuit between the neutral point and the middle wire, and driven at approximately constant speed by a shunt motor. The dynamo must, of course, be capable of carrying the largest out-of-balance current likely to occur, and must be so wound as to develop with this current a voltage equal to the deficiency experienced with the existing balancing gear. Such an arrangement will, if properly designed, be self-regulating, but manual regulation may be obtained either by variation in the speed of the shunt motor or by shunting part of the exciting current of the dynamo. The connections of the machine are shown in Fig. 1. For small out-of-balance loads the booster will not be used, and the switch, X, will remain on contact I. When the booster is to be used it will be started while the switch is in this position, the resistance, R, being sufficient to keep the current arising from the residual magnetism of the field from reaching a dangerous value. When the booster is running at full speed, switch, X, is moved over to contact III. and the machine is then in full operation. Care must be taken to observe this procedure, and if for any reason the booster should be cut out of circuit with a large out-of-balance current flowing, the switch must be turned to position I. before switching out the shunt motor. Failure in this respect may cause the booster to run as a series motor in the opposite direction, when an excessive speed will probably be reached, and damage to the machine will result. If hand regulation be adopted, it will be advisable to weaken the series field as far as possible before performing either operation. By providing for shunting practically all the dynamo field current, the resistance, R, may be dispensed with, care being taken to cut in the shunt before starting or stopping the booster. The former arrangement is, however, safer, as in the second case a dirty contact in the series diverting switch would probably be the cause of a burnt-out armature. As regards the parallel running of compound machines so connected, no difficulty need be anticipated, the booster being entirely external to the case. It may be pointed out that static balancers can never be so satisfactory with compound-wound as with shunt machines, every change in the balance altering the voltage across the outers of the system. It is obvious that if the out-of-balance current is on the opposite side of the system to the series winding, the latter is entirely unaffected by change in its value, while, if on the same side, the reverse is the case. The regulating properties of the machine will, therefore, be variable, depending on the character of the balance.

A simpler way to improve the performance of the static balancer is, as indicated above, available without the use of a separate contrivance of any description. This would consist in moving the neutral point of the balancing winding, by means of a switch and a few contacts, in either direction from the central position. Near the middle of

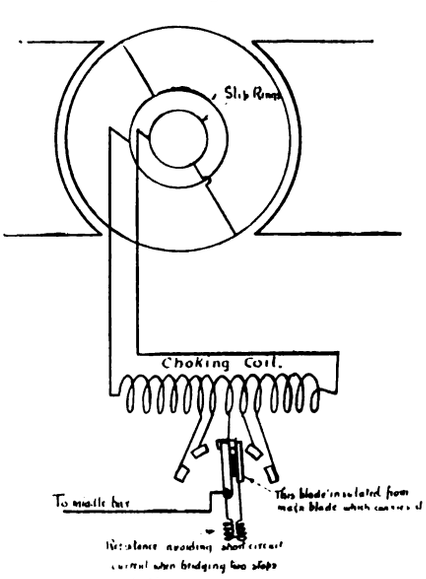

FIG. 2.

the choking coil a few tappings would be brought out from adjacent windings to terminate in contacts. The middle-wire connection would be made through a switch sliding over these contacts, and the voltage of the neutral point thus varied to suit the particular ohmic drop due to the out-of-balance load. This adjustment would be made manually, and would, unless the load were very variable in character, provide a solution at once much less complicated and much freer from risk of accident and possibility of misuse than is the booster arrangement. Fig. 2 shows diagrammatically this method, employing for greater

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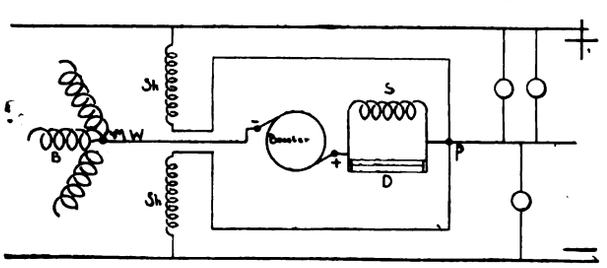
simplicity a single-phase balancer. The two-phase balancer requires merely the provision of a double row of contacts on the switch, and, of course, tappings from them to each winding respectively.—CN.

Answer to No. 1,053 (awarded 5s.).—A static balancer, for working a three-wire system from a compound-wound generator, must have a resistance as low as possible, and the self-induction must be as high as possible, consistent with suitable conductors for carrying the necessary current. If the resistance of the balancer is high in comparison to the self-induction, there will be a tendency of the current to alternate, and it is to prevent this that "Power" proposes to use a booster. The static balancer being overloaded, its resistance will be higher, and the unbalancing will be more pronounced, as the out-of-balance current increases; the current through the balancer being equal to $\frac{E}{R}$, as the current increases there will be a fall in the voltage, E. If, now, we boosted up the out-of-balance current to allow for this drop, the tendency will be to balance at whatever current passes through the balancer. The positive lead is coupled to the + terminal of the generator, the negative lead to the – terminal, and the middle wire, M W, through the static balancer, B. The booster is driven by a motor, and is in series with the middle wire. The magnet limbs are laminated to allow a quick reversal of field, and are wound with a shunt winding, Sh, across the positive and middle wire, and Sh', across the negative and middle wire, the point where the shunts are joined to the middle wire, P, must be beyond the booster altogether. These two windings are in opposition to each other, and under normal balanced load exactly cancel; the booster under these conditions revolves, generating no E.M.F. Suppose, as shown in the diagram, the



positive side becomes heavily loaded, there will be a drop in pressure in this line and a reduction in current through Sh, the pressure between P and the negative line being the same, the shunt winding Sh' predominates, and a flux is sent through the booster field. The booster now generates an E.M.F. in the same direction as the current in the middle wire; the series coil, S, strengthens the field in proportion to the current flowing through the middle wire. In parallel with this field is a diverter, D; by adjusting this the boost can be regulated. The E.M.F. at M W is now boosted up, and helps to maintain the balance. When the heavy load occurs between P and the negative, the current through the booster will be reversed, the reversal of field being due to Sh predominating. Such a combination as the above with each compound machine would hardly work well in parallel, as the loading of each machine would depend to a great extent upon the booster-balancer arrangement to ensure good results in the division of the load.—F. M. M.

Answer to No. 1,053 (awarded 5s.).—In the sketch the connections are shown for two compound machines working in parallel on a three-wire system with a two-phase static balancer to each machine; in addition, a booster is shown in the neutral wire as suggested by the proposer of the question. Before explaining the diagram, it might be as well to point out, although rather obvious, that if the present balancers are too small from a heating point of view, the inclusion of a booster will not overcome the difficulty. With regard to the design of the booster, it should be worked at such a flux density that the saturation curve of the machine will be practically a straight line. It will then give a definite number of volts boost for every 100 amperes flowing through the armature. The arrangements of the field are shown alternatively in Figs. 1 and 2.

Fig. 1 shows a normal series field fitted with a diverter, of which the resistance can be varied by hand, thus obtaining hand regulation of the boost. In the arrangement shown

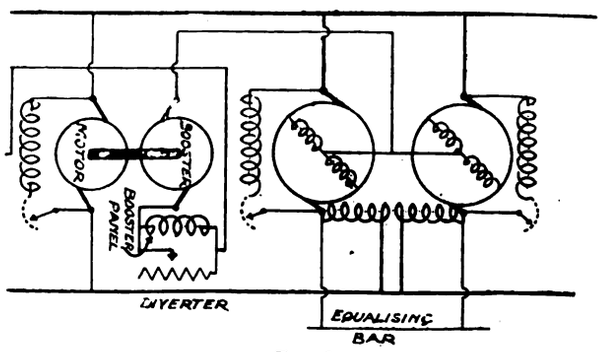


FIG. 1.

in Fig. 2 two fields in opposition are provided by the current in the outers. Each is fitted with a diverter, and probably this arrangement would be found to be more flexible than the former. The booster motor may be connected in the usual way, and in other respects the drawing is self-explanatory. As regards parallel running,

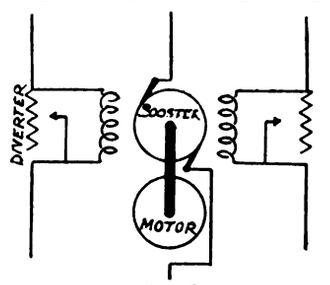


FIG. 2.

it does not appear that this alteration should make any difference to the performance of the machines in this respect.—P. H.

Question No. 1054.—In our three-wire distribution system we use single lead-covered cables (with paper insulation) of ·3, ·15, and 19/14 sectional area. They are laid solid under the footpaths, but at street crossings under the wood paving they are drawn through 5in. iron pipes. We have never had any trouble with the cables in the iron pipes, but recently we tried to draw a set of three cables, of ·15 sectional area, out of a 100ft. length of 5in. iron pipe where they had lain for a period of nine years, but the attempt failed, and we had to leave the cables *in situ*. That the pipe was quite clear is proved by the fact that we then rodded it and pulled through three fresh cables. Please describe a convenient method of withdrawing such cables, stating whether it is easier to draw juted cables than plain lead cables, and whether the injection of lubricants would be of any service.

Answer to No. 1,054 (awarded 5s.).—When lead-covered paper cables have lain underground for a number of years they become very rigid. If there has been undermining of the ducts or pipes they will sink through time, and the lead cable, becoming set in the dip thus caused, will be very difficult to draw out. The only way then to pull out the cable is by sheer force. Fix a hawser to the three cables and attach to a tramcar or any power convenient. The reason why the three cables should be pulled out together is that in pulling them in they may have worked round each other in a twist, and one could not be pulled out without the other two coming with it. First of all, "E. C. B." should examine the ends of the pipe where they join the troughing for traces of bitumen that may have run in when the other lengths were being laid solid. A very little would take a firm hold of the pipe and prevent the cables from being drawn out easily.

As to the drawing in of jute-covered cables and plain lead cables, the one draws in as easily as the other. The writer has seen a length of jute-covered ·1 square inch three-core cable drawn through 200 yards of duct without the covering becoming loose. The duct was 4½in. in diameter. Always use a lubricant when drawing in cables. Apply the lubricant where the cable enters the pipe. The lubricant should be an oil or grease free from acids.—T. I. C.

[Other replies to Question No. 1,054 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,063. What do you consider the necessary instruments, etc., required on the switchboard panels of a three-phase power plant for the necessary control and safety, etc. (parallel running): (1) generator panels and (2) power panels, 550 volts, 25 cycles? They must comply with the Coal Mines Regulation Acts (Special Rules). Give sketches.—THREE-PHASE.

1,064. I should be obliged if some of your readers would supply me with full particulars of an electro-galvanising plant for boiler tubes, etc. The sizes of the tubes vary from 1in. bore to 8in. bore, and the maximum length about 20ft. Also state if more than one tube can be treated at one time.—J. C. DOWNIE.

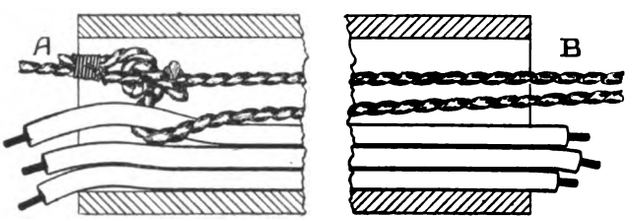
ANSWERS.

Question No. 1054.—In our three-wire distribution system we use single lead-covered cables (with paper insulation) of ·3, ·15, and 19/14 sectional area. They are laid solid under the footpaths, but at street crossings under the wood paving they are drawn through 5in. iron pipes. We have never had any trouble with the cables in the iron pipes, but recently we tried to draw a set of three cables, of ·15 sectional area, out of a 100ft. length of 5in. iron pipe where they had lain for a period of nine years, but the attempt failed, and we had to leave the cables *in situ*. That the pipe was quite clear is proved by the fact that we then rodded it and pulled through three fresh cables. Please describe a convenient method of withdrawing such cables, stating whether it is easier to draw juted cables than plain lead cables, and whether the injection of lubricants would be of any service.

Best Answer to No. 1,054 (awarded 10s.).—The practice of using cast-iron pipes for street crossings is not an uncommon one, and I have had similar trouble on several occasions—namely, the cables becoming fast in the pipe. The length of time the cables have been underground does not affect the question much, as in one case I had, the cable, of 1in. sectional area, 60 yards run, had been in six years, and in another case a length of twin $^{7}/_{16}$, 20ft. run, had only been about a month. In the case of the 1in. cable, after drawing a well-oiled rag dolly through twice, the cable moved and came out without any further trouble. In the latter case the trouble was found to be due to the fact that when the pipes are received from the makers they are covered thickly with tar. If the weather happens to be warm, and the pipes are placed in position and the cables drawn through within a day or so, the tar not having had time to dry, as it settles and hardens the cable becomes firmly stuck in the pipe, and it is a difficult matter to shift it. In this case it was only a matter of drawing a foot or two back for jointing, but, although two drawing ropes were broken, it proved immovable, and it was decided not to leave it, as it was not a matter of urgency. Later on, when we broke up the road and took out the pipe, we found out the cause which I previously stated. If it is the same thing that is holding the cables in question, the injection of paraffin or benzoline might loosen them sufficiently to enable them to be withdrawn. I presume that there is no chance of the cables overlaying, because, if such was the case, the three cables would come with greater ease bunched than trying to draw them singly.

As to whether a plain lead-sheathed cable draws easier than one with jute serving, I certainly think that the former would draw the easiest, although I have never noticed any radical difference.—E. A. P.

Answer to No. 1,054 (awarded 5s.).—Cables that have lain for a long time in troughs or pipes become covered with dust, etc., to a surprising extent; this dust, with the addition of moisture, acts like a cement and considerably increases the difficulty of withdrawal. One method which is sometimes successful is to pass a rope through in a bight and slip under one of the cables as shown in figure. At manhole A the bight is placed under a cable and a tail rope attached some little distance away from the bight.



The two ends of rope are now pulled at manhole B, and thus it may be possible to separate the cables; in that case withdrawal should be comparatively an easy matter. The great advantage of this arrangement is that after a pull forward at B the bight can be backed a little by means of the tail rope at A; thus a sort of governing motion is obtainable. If found impossible to separate one cable from the others, a trial should be made by slipping the bight under the three; it is quite likely, particularly if the cables have a covering outside the lead sheathing, that the trouble is at one or more joints in the piping. This outer protective covering may be rucked up and caught in a faulty joint or even a broken pipe, therefore, by judiciously coaxing the bight through the cable may be freed. Pipes often drop out of line owing to subsidence of soil. This gives more or less of a kink to the cables, which greatly increases the difficulty in getting them to move. If the bight of the rope can be drawn through, matters will be much improved; by pulling at the cables as a whole the total resistance to movement has to be overcome, the bight tackles it in detail. In any case tension should be on both drawing ropes and the tail rope at same time, a sort of to-and-fro motion being given with the idea of separating or easing the cables, and gradually working the bight through from manhole A to manhole B. An occasional pull on the cables will tell the operators when withdrawal may be attempted. Plain cables are usually easier to draw than those which have been served with an outside protective covering, as such covering not only sets up more frictional resistance when intact, but becomes troublesome if it gets rucked. With cables, particularly those which are paper insulated, such an outer covering is extremely useful in protecting the lead sheathing from injury. Lubricating the cables would certainly be an advantage, the lubricant being either soft soap or French chalk. These lubricants could be applied by means of a "swab" attached to a rope and drawn through the pipe.—M. M.

Answer to No. 1,054 (awarded 5s.).—The reason why the cables cannot be withdrawn is probably due to the deterioration or corrosion of the lead sheathing and the iron pipe, the salt from such action probably forming a solid mass between the cables and the pipes on the underside, leaving the upper half of the pipe practically clear. Corrosion of the sheathing and iron pipe is due to local electrolytic action between the lead and iron in any part of the pipe where water or any slight moisture is present. Such action, though slow, will in time cause the lead sheathing to deteriorate, and even if the action is not sufficiently pronounced to affect the insulation of the cable, the length of time these cables have been undisturbed would account for the salt of such corrosion, however slight, forming practically a solid mass from cable to pipe, making it impossible to withdraw the cable. In a three-wire system, where the neutral is earthed, minute currents tend to pass from the neutral to the negative conductor, resulting in electrolysis. From the wording of the question I take it that the cable

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drawn through the pipe ends at either end in a joint-box. In such joint-boxes it is, or was, the rule to seal the insulation at such points by means of lappings of so-called insulating tapes, such tapes being wrapped over the conductor socket and back on to the lead sheathing of the cable. A point often overlooked in such cases is that the creeping electrolysis will set up across the tape between the socket and sheathing of the conductor. If such action is taking place, the salts due to the electrolysis will be noticed on the tape. This electrolysis will not necessarily result in the deterioration to any great extent of the cable at the end of the pipes, due to the rust or oxide of iron formed on the interior of the pipes tending to insulate the cables, preventing rather than helping the action; the deterioration will be most marked in the damp places found in the pipes. If such actions as either of the above have taken place, it will be impossible to withdraw the cable; any attempt to pull out the cables will result in the cables parting where such deterioration has taken place. The use of lubricants in such a case would have little or no effect, the only way to clear the pipes being to take them up.

The use of juted cable would prevent such actions as noted above to a great extent, and such cables would be certainly easier to withdraw, care being taken that the jute does not ruck up. The chance of the cable developing a high resistance fault in some other part of the system, between the core and sheathing, and jumping to earth in the metal pipes, fusing the sheathing to the pipe at such points, is discounted by the assertion that no such faults have been observed. It should be noted that the deterioration of the cables, to allow of such actions as above, will not necessarily cause the insulation to fail for some time.—F. M. M.

Answer to No. 1,054 (awarded 5s.).—In this problem details of certain leads laid partly in iron pipes are given, and it is stated that they could not be removed after a certain number of years. Although the details at first sight seem fairly full and sufficient, yet on carefully going into the matter one sees that this is not so; for example, it would be advantageous to know the run of the pipes and the actual arrangements made for the withdrawal of the cables. In the absence of these data one must deal with the matter more or less generally. Firstly, one should endeavour to ascertain for what reason the cables could not be withdrawn. This may be due either to some action taking place on the lead, on the iron pipe, or on both, due, for example, to an internal electrolytic action, causing the coefficient of friction of the bodies to be greatly increased, and so hinder or prevent the cables being hauled out. In this connection it might have been mentioned whether any light on the internal condition of the pipe—besides the fact that it was clear — could not have been obtained from the rodding test. As to the best method of withdrawing cables set as these, this depends on the particular details of the case, and in this connection attention is called to the answers to Query No. 1,039, which appeared in the *Electrical Engineer* of Feb. 28 last, which have considerable bearing hereon. As a start for operations the cable should be lubricated wherever possible. A lubricant often recommended is soft soap, but personally I recommend something with less affinity for water, such as mineral grease. The next point is to see that the cable is brought out clear of the pipes, manhole, etc. A sketch of an arrangement of guide pulleys for allowing this was given in the answers referred to above, and need not be repeated here. In addition to these pulleys, it is also advisable to have a bellmouth to the tube to increasingly safeguard against chafing. The cable sheath should be gripped by means of a sleeve of woven flexible strands, the grip on the cable then increasing with the pull. Instead of a sheath attachment, however, a core connection may be made, but the former is usually preferable. Gentle increasing strain should now be applied to the cable, preferably in such a direction as to tend to pull it down hill. If this will not move it, the pull should be started from the reverse end of the cable, and if this will not move it, the treatment should be repeated at each end alternately, lubricant being applied as freely as it may, when the cable should come out.

With regard to the other point as to whether it is easier to withdraw juted or plain lead cables, it is very difficult to answer this in a general manner, but, in my opinion, the juted cables will have less tendency to be acted on against the iron pipe pipe, and thus tend to set; but, on the other hand, the friction of a juted cable against an iron pipe is normally greater than that of lead, although the presence of lubricants reduces the difference.—L. R.

Question No. 1,055.—Suppose a car is travelling on a level with its own momentum, say an ordinary Dick-Kerr fitted with two 30-h.p. motors, and going at 12 miles per hour, what would be the amount of current generated and used by applying the electric brake? Form of controller, D.E.1 emergency brake.

Best Answer to No. 1,055 (awarded 10s.).—As "C. S. G." has not supplied all the necessary data certain assumptions will have to be made. It is taken that the electric brake referred to is the plain rheostatic, in which the motors are cut off from supply—paralleled and run as generators by the momentum of the car—being loaded on a resistance, which is cut out in steps to secure uniform retardation. It is obvious at first sight that the amount of current generated will depend on the weight of car and the rate of retardation. The former has been assumed at eight tons, and several values for retardation rate have been taken. Further, a value of 25lb. per ton tractive resistance has been taken as assisting the retardation—and the momentum of the car increased by 10 per cent. of its weight to allow for the rotary inertia of the armatures—tending to oppose the retardation.

From the fundamental law, force = mass × acceleration (either + or −) we get

$$\text{Retardative effect} = \frac{1{\cdot}1\ W}{32{\cdot}2} \times 1{\cdot}47\ r,$$

W being in pounds and r the retardation in miles per hour per second. For a retardation of three miles per hour per second

$$\frac{1{\cdot}1 \times 8 \times 2{,}240 \times 3 \times 1{\cdot}47}{32\ 2} = 2{,}700\text{lb.}$$

The tractive resistance, however, will supply 8 × 25 = 200lb. of this, so that the net tractive effort required is 2,500lb. The mean speed during retardation is, of course, six miles per hour, or 8·8ft. per second. Hence the average power required at the car wheels in watts

$$= \frac{2{,}500 \times 88 \times 746}{550} = 30{,}000.$$

Assuming uniform retardation, this quantity will be about double this at the instant of commencing to brake, and, of course, zero when the car has come to a dead stop.

The above settles the dynamical part of the question. It is now only necessary to determine in what way this power is given out by the motors. At the instant just before braking the motors were running on line potential of 500 volts. Allowing 10 per cent. for C R drop, the back E.M.F. of each motor will be 450 volts. When supply is cut off each motor becomes a generator, supplying current at a pressure of 450 volts. Now, to secure uniform retardation, a uniform load should be applied. Inasmuch as the speed decreases from 12 miles per hour to zero, the voltage will decrease from 450 to 0. Thus it is necessary to cut out resistance at the same rate, so as to maintain a constant current output, and consequently a constant torque on the shaft.

The mean voltage will be 225 during retardation. The watts per motor $= \frac{\text{watts at wheel tread}}{\text{motor and gear efficiency}}$. Taking 85 per cent. as the efficiency, we have that the current per motor

$$= \frac{30{,}000}{225 \times 85 \times 2} = 79 \text{ amperes.}$$

TABLE I.—Equivalent Current for Various Retardation Rates.

Rate of retardation. Miles per hour per second.	Retardative effort at wheel treads. lbs.	Tractive resistance. lbs.	Power required. Watts.	Current per motor, allowing 85 per cent. efficiency.
5	4,500	200	51,600	136
4	3,600	200	40,800	107
3	2,700	200	30,000	79
2	1,800	200	19,200	50·5
1	900	200	8,400	22·2

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Table I. gives values for several rates of braking, and assumes correct braking—*i.e.*, resistance cut out at such a rate as to maintain uniform retardation, and the rheostats should be so graded as to secure this. The higher rates in the above table are, of course, far in excess of the requirements of a service stop.

Considering the question of emergency stops. In a tight place the motorman will, perhaps, throw on to the last braking notch, thus dead-shorting the motors. The instantaneous current rush will be extremely high, but in this case the current will fall with the speed and motor voltage. Thus the retarding torque diminishes, and the retardation consequently is a maximum on commencing to brake and gradually falls off. This shows the necessity for an auxiliary friction brake in such emergencies.—E. V. P.

Answer to No. 1,055 (awarded 5s.).—It is absolutely impossible to foretell the exact current generated in the given case unless more particulars than are included in the question be supplied. The following, however, will indicate the general outline of a suitable investigation, and will give Mr. Graham some idea how to apply it in any case of which he has the full particulars. In the first place, assume the weight of the car, including passengers, to be 12½ tons. For the coefficient of friction between wheel and rail take the average value of 30lb. per ton. Now, when an electric brake operates the wheels do not skid indefinitely, as is possible with an ordinary mechanical brake, but the condition may and does approach very near to skidding. We can, therefore, take it that the maximum power generated will be the equivalent of the pull on the rails multiplied by the velocity of the car. Naturally, the maximum current will be taken on first application of the brake.

Total force of friction = $30 \times 12\frac{1}{2}$lb.

Rate of doing work

$$= \frac{30 \times 12\frac{1}{2} \times 12 \times 1.760 \times 3}{60} \text{ foot-pounds per minute.}$$

Equivalent horse-power exerted

$$= \frac{30 \times 12\frac{1}{2} \times 12 \times 1,760 \times 3}{60 \times 33,000} = 12 \text{ h.p.}$$

Watts generated = 12×746.

Then on a supposed 500-volt circuit, current required and generated

$$= \frac{12 \times 746}{500} = 17{\cdot}9 \text{ amperes.}$$

This would probably be more than doubled on a sanded rail.—I. B. S.

Answer to No. 1,055 (awarded 5s.).—In reply to Mr. Graham's query, the current generated varies throughout the braking operation, falling off as the speed, and therefore the voltage, gets lower, and finally dying away when the car stops. It is, therefore, impossible to give any one value of current as the answer, but an estimate of the duty on the motors may be gauged from a knowledge of the ampere-seconds and the maximum current flowing in the circuit. These may be measured by placing in the brake circuit a recording ammeter working in conjunction with a time-marking device by means of which marks are made upon the chart at suitable intervals.

The following figures obtained by this means relating to the performance of Dick-Kerr and Westinghouse motors may be sufficiently close to be of use: (1) Car weighing 10 tons 15cwt., fitted with two 35-h.p. Dick-Kerr motors; rail very greasy; speed, 12 miles per hour; ampere-seconds, 780; maximum current, 152 amperes. (2) Car weighing 10 tons 11cwt., fitted with two 30-h.p. Westinghouse motors; rail fair; speed, 12 miles per hour; ampere-seconds, 530; maximum current, 174 amperes.—TRACTION.

Question No. 1,056.—The *Electrical Engineer*, May 31, 1907, p. 764, gives a description of a testing tank at Port Dundas, Glasgow, of dimensions 6ft. diameter 6ft. deep, to take a load of 5,000 kw. at 6,500 volts. Discuss the design of such a tank, especially with regard to the permissible current density on the surface of the electrodes, the resistance of the water path, and the conductivity of the supply water. Has the Glasgow tank proved successful for such a large output?

Best Answer to No. 1,056 (awarded 10s.).—It will, perhaps, be well to discuss each part of the testing tank separately.

1. *Tank.*—The tank may be made of three materials: (*a*) metal (iron); (*b*) wood; (*c*) porcelain. Porcelain is expensive, but otherwise is very good material to use both on account of its insulating properties and also because it is unaffected by heat. It is also not subject to corrosion like iron. Mechanically it is, perhaps, not as strong as iron or wood. Wooden tanks are liable to become charred due to the heat produced, and so in time rot, and water is liable to leak; also, there is the danger of receiving shocks from it, since the water soaks through and makes it partly conducting. Iron tanks of sufficient size are well adapted for such use, although more expensive than wood; the tank itself may be earthed (together with neutral electrodes if there are any), and thus possibility of shock is obviated. The tank may corrode due to leakage currents, but it will remain a good time in service before becoming useless.

2. *Water.*—The following are particulars of resistances:

	Ohms per cm³.
Pure water	66,000
Pure water with 4 per cent. dilution of canal water	10,000
Pure water with 10 per cent. dilution of canal water	5,000
Mixed with equal quantity of canal water	1,000

Variations with temperature:

510 ohms (canal water) per cm³ at	50° F.
300 ,, ,, ,,	90° F.
200 ,, ,, ,,	140° F.

Specific resistance:

	Ohms at 60° F.
Distilled water	60,000
Birmingham tap water	13,200
,, canal water	435
Glasgow tap water	17,500
West London tap water	2,800

According to J. P. Kempe, of Manchester, for use of 70deg. F. 50 gallons of cooling water per kilowatt-hour are required; therefore, about 250,000 gallons of water will be required at Glasgow per hour working at full load. It will be seen that it is impossible to use canal water in an iron tank for absorbing 5,000 kw. at 6,500 volts on account of low resistivity of that kind of water. As a precaution against failure of supply water and consequent increase of load due to higher temperature of the water, a drain pipe at the bottom of the tank is advisable.

3. *Electrodes.*—For economical reasons it is advisable to use iron electrodes worked at a current density of about two amperes per square inch of surface. This will mean an area of about two square feet in case of Glasgow installation. These should be placed symmetrically at 120deg. apart and about 7in. from the inlet pipe in the centre. If current density be too high, corrosion sets in rapidly.

4. *Water-Pipes.*—The inlet pipe should be perforated along its length so as to allow perfect mixing of water, and thus greatest cooling effect. The water supply should be regular and uniform, so as to keep temperature as uniform as possible, and thus prevent fluctuations in the load. This pipe should be earthed and preferably surrounded by three earthed neutral electrodes placed 120deg. apart and facing the other electrodes so as to direct current flow. Three outlet pipes should be placed at the top of the tank so as to take away the hot water, and there should also be a drain pipe at bottom in case of emergency. The electrodes should be supported on a triangular wooden frame and insulated from same with porcelain insulators, which should not be brought too near the tank lest their surfaces become damp. The whole should be as rigid as possible, and not subjected to much side motion. They can be either mechanically lowered or electrically by means of a motor from the switchboard.

A tank of this description, but only 4ft. high, has been successfully used at Manchester for absorbing 4,000 kw. at 6,500 volts for six hours; so there is no reason why this should not extend to the case of Glasgow.—M. R.

Answer to No. 1,056 (awarded 5s.).—On consulting the *Electrical Engineer* of May 21, 1907, it will be seen that the Glasgow tank referred to has as electrodes three copper rods suspended from a frame and dipping into water in a

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tank, the dimensions of which are given in the query. The water is taken from the Glasgow town (Loch Katrine) supply, which, however, was of no use for starting the resistance, and canal water had to be used. The water is supplied through a central pipe and discharged through three radial pipes. The above information, and that contained in the problem, is practically all that is available from the reference, and it is thought, therefore, that the discussion of design should be rather broad. This principle has, therefore, been adopted here, and refers to the latest practice in water resistance design, for further details of which the paper read by Messrs. Morcom and Morris before the Birmingham Section of the Institution of Electrical Engineers on 11th ult., and now being reprinted in the *Electrical Engineer*, should be consulted.

First, as to current density at electrodes. Experience teaches that if a steady resistance or load is to be obtained, the maximum current density at an iron electrode must not be greater than one ampere per square inch. If this rule be neglected, the corrosion of the iron becomes too great for practical working, and the liberation of gas becomes too rapid, causing unsteadiness and variation. As regards the Glasgow tank, 5,000 kw. of power at 6,500 volts have to be absorbed, corresponding to a current of about 770 amperes, which, according to the above rule, requires about 770 square inches of electrode surface, or about 250 square inches per electrode if three be used. With a tank 6ft. deep, therefore, and the electrodes fully immersed, electrodes of about 3½in. periphery are required—that is, of diameter rather more than 1in. It is not clear from the drawing exactly what diameter the electrodes actually were, but they appear to be of considerably less diameter than this, and, therefore, one would expect a steadier resistance would be obtained by using larger electrodes.

Second, as to the resistance of the water, and, third, as to the conductivity of the supply water. These two points had better be taken together. Distilled water has a specific resistance (cubic centimetre) of 600,000 ohms at 60deg. F.; a normal tap water of 13,200 ohms and a normal canal water of 435 ohms. It will thus be seen how greatly affected the results are by the kind of water used. Glasgow tap water—which would not start the action—has a specific resistance which is somewhat high—namely, 17,500 ohms. The reason of this apparent failure would appear to be due to this high resistivity, the reason of the success by starting with canal water and continuing with tap water either being due to a partial solution of the electrodes raising the conductivity of the water, or the heating due to the current, which has a like effect. With regard to design, the dimensions should be such that, with the particular kind of water one desires to employ, the voltage drop per foot should not exceed 600 volts. This limit appears to be exceeded in the Glasgow design, and it is an important point, especially in high-tension work.

Whether the Glasgow tank is practically successful or not I cannot at present say, having no information before me; but, in addition to the points referred to above, it may be compared with other tanks as follows, which are stated to work satisfactorily—namely: (1) a 6,000-volt tank, the size of which is 7ft. by 1ft. 6in. by 1ft., and electrodes not less than 2in. apart; (2) a 6,500 volt tank at Manchester, 6ft. in diameter and 4ft. deep, with electrodes at 120deg. and 7in. from the neutral; and (3) three tanks, each 6ft. by 1ft. by 6in., for 950 kw. at 7,500 volts.—L. R.

Answer to No. 1,056 (awarded 5s.).—The dimensions of a water-load tank of small size to deal satisfactorily with large generator outputs depend greatly on the purity of the cooling water available. Town's water is generally the best and cleanest to use, and after being used in the test tank can be passed on to the feed tank as heated feed for the boilers, effecting an appreciable saving in the amount of coal required for the purpose of the test. Canal and river water in large towns varies so greatly in composition and conductivity due to trade effluents that its use cannot be recommended; under this heading also comes the use of salt and soda in the water, as it is extremely difficult to keep the proportion constant, thereby causing large variations in the load.

Samples of water from the town's mains should be tested for resistance at various temperatures, the most convenient method being to take the resistance in ohms between the surface of electrodes 1ft. square in area and 1ft. apart. This does not give the specific resistance per cubic foot of sample, but the results are more convenient for calculating the spacing of the electrodes in the tank. The resistance of water at various temperatures is shown in Fig. 1. The data for plotting the curve having been obtained in the way described above, it will be seen from the curve that the resistance of the water falls as the temperature increases. If vapour is to be avoided, the final temperature of the water should not exceed 120deg. F. at the outlet from test tank. The presence of dense vapour must be avoided, as it would cause a flash over between the electrodes. The current density at surface of electrode may be taken as 1·5 to 2 amperes per square inch of surface with an ample supply of cooling water.

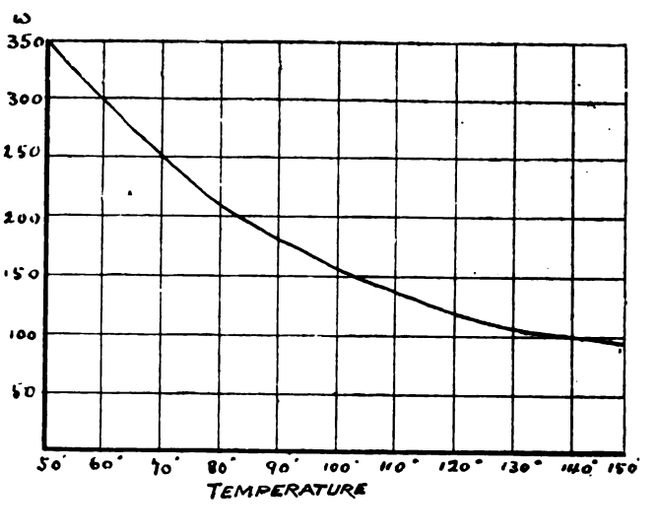

FIG. 1.

The quantity of water required for the tank may be calculated from the following formula:

·0009 E C T = heat in B·Th.U. generated by load,

where E = volts, C = amperes, and T = time in seconds; 1 B.Th.U. being the amount of heat required to raise the temperature of 1lb. of water 1deg. F. Taking the outlet temperature at 120deg. F. and inlet temperature 50deg., the rise in temperature = 70deg. F. ∴ pounds of water required per kilowatt-hour

$$= \frac{\cdot 0009\ E\ C\ T}{\text{temperature rise}} = \frac{\cdot 0009 \times 1{,}000 \times 60 \times 60}{70}$$

= 48lb. per kilowatt-hour. ∴ Number of pounds required per hour for 5,000 kw. = 48 × 5,000 = 240,000lb., or 24,000 gallons.

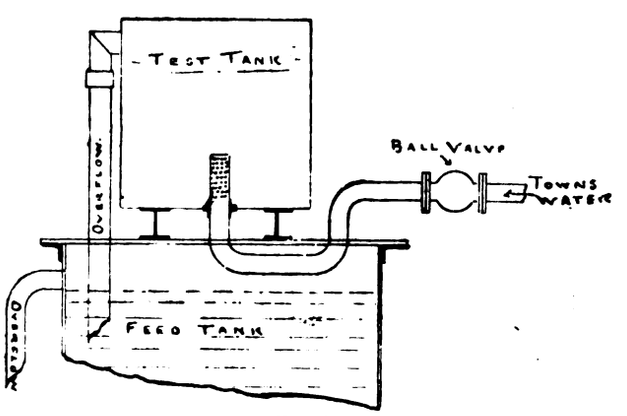

FIG. 2.

The test tank could be arranged as shown in Fig. 2, good-sized pipes being provided for both inlet and overflow. The ball valve only comes into action when the feed tank gets too full, thus preventing water overflowing the sides of the test tank.—A. V. A.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

1,065. I should be pleased to learn through your columns the most practical method of testing the temperature rise of coil and other resistances, and shall also be glad to know what formula to use in calculating the rise of temperature of resistance wires.—H. H. C.

1,066. In converting a steam power-driven engineering shop to electric power-driven, what are the chief items to take in consideration, and what are the best formulæ to adopt for lathes, slotting and planing machines, say, up to ¼in. cut; also formula for blower for smiths' fires?—WORKSHOP.

ANSWERS.

Question No. 1,057.—It is required to construct some small magnetic clutches to convey 2 b.h.p. and 4 b.h.p. respectively at a speed of 100 r.p.m. Either the flat-face type or cone clutch would suit, but preferably the former, space being very limited. The over-all diameter must not exceed 9in., and over-all width, inclusive of clutch and armature (or cone), must be kept within 2½in. Give the requisite ampere-turns and method of calculating the frictional coefficient with metal-to-metal surfaces with a given portative power and varying angle of pole-face. What arrangements are necessary for de-clutching?

Best Answer to No. 1,057 (awarded 10s.).—The practical method of designing a clutch of this kind is to assume a general section as in Fig. 1, and then run through the calculation to see if the number of ampere-turns is normal. If not, then the shape must be modified.

Let P = frictional pull in pounds at 4in. radius. Then

$$P \times 2\pi \times \frac{4}{12} \times \frac{100}{33{,}000} = \text{H.P. transmitted}$$

$$= 4 \text{ (for larger size).}$$

$$\therefore P = \frac{4 \times 12 \times 33{,}000}{2\pi \times 4 \times 100} = 630\text{lb.}$$

Taking coefficient of friction between faces = 0·2, we get

$$\text{End-wise thrust} = \frac{630}{0{\cdot}2} = 3{,}150\text{lb.}$$

Thus we want the magnet to have a total pull on its armature of 3,150lb.

Now $$P = \frac{A\,B^2}{K},$$

where A = area of pole-face in square inches, B = induction across joint in lines per square inch, and K = 72,134,000—a constant.

Area of annular pole-face = $1 \times 2\pi \times 4 = 25$ square inches.

Area of central pole-face = $\frac{2\frac{1}{2}^2\,\pi}{4} = 5$ square inches.

Let induction across annular part be B lines per square inch. Then induction in central core

$$= \frac{25\,B}{5} = 5\,B.$$

Attraction due to annular part

$$= \frac{25\,B^2}{72{,}134{,}000}\text{lb.}$$

Attraction due to central core

$$= \frac{5\,(5\,B)^2}{72{,}134{,}000} = \frac{75\,B^2}{72{,}134{,}000},$$

$$\text{Total pull} = \frac{100\,B^2}{72{,}134{,}000}$$

and this must equal 3,150 as obtained above.

$$\frac{100\,B^2}{72{,}134{,}000} = 3{,}150.$$

$$B^2 = 3{,}150 \times 721{,}340.$$

$$B = 48{,}000 \text{ lines per square inch.}$$

$$\text{Total flux} = 48{,}000 \times 25 = 1{,}200{,}000 \text{ lines.}$$

Mean length of magnetic circuit from figure (dotted line), about 10in.

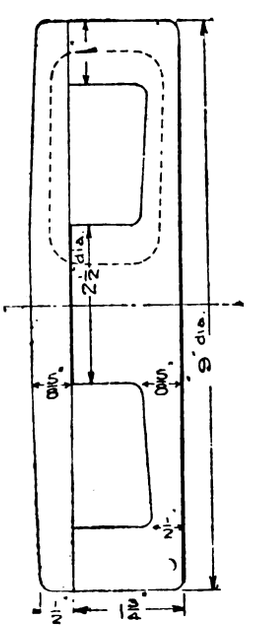

FIG. 1.

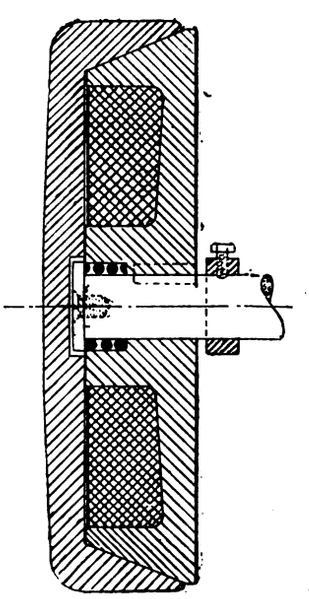

FIG. 2.

By running out the cross-sectional area at various points in path of the lines of force the mean area comes about nine square inches. Then taking a permeability of 2,000, we have

$$1{,}200{,}000 = \frac{1{\cdot}257\,CS}{\frac{10}{9 \times 2{,}000}},$$

which gives $CS = 530$ ampere-turns.

To allow for reluctance of joint this would be increased, say, to 600 ampere-turns.

The remainder of the desigu will depend upon the voltage of supply, and it is quite possible that the space provided for the wire will be more than required, in which case it will be advantageous to thicken up the iron part a little more. An arrangement which would be more efficient and which would take up no more room than the above is shown in Fig. 2. In this type advantage is taken of the wedging action of a conical clutch.

For the method of calculating the frictional coefficient with metal to metal surfaces with a given portative power, W, and varying angle α of pole-face, the following formula holds:

$$\text{Moment due to friction} = \frac{2\,\mu\,W\,(R_1^3 - R_2^3)}{3 \sin\alpha\,(R_1^2 - R_2^2)};$$

where μ = ordinary coefficient of friction for flat surfaces, and the other dimensions are shown in Fig. 3. A proof of this formula will be found in Goodman's "Applied Mechanics."

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An arrangement for de-clutching is shown in Fig. 2. The magnet part of the clutch is loose on the shaft, but is driven by a sunk key (shown dotted). Normally, when no current is flowing round the coils the magnet part is pushed out of contact with the armature by a spiral spring. The

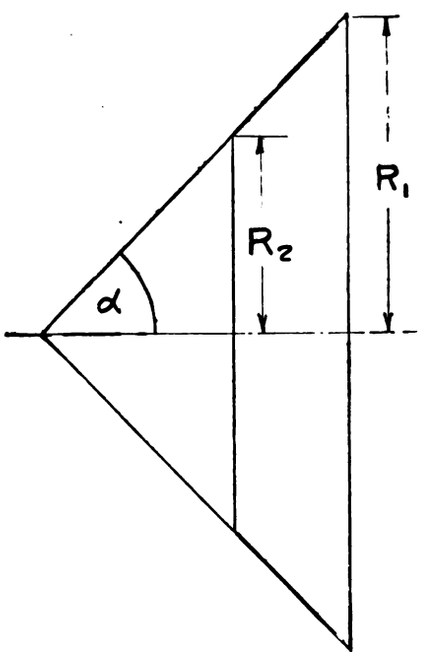

FIG. 3.

collar on the shaft is simply to prevent the two parts separating too far.

In the above description the 2-b.h.p. size has been ignored, but from what has been said "A. H. A." will be able to fix on the sizes for the smaller clutch.—I. B. S.

Answer to No. 1,057 (awarded 5s.).—Owing to the very limited space available, it is impossible to construct a clutch on the ordinary lines capable of transmitting the power required at 100 r.p.m. The author thinks the following design, if carefully carried out in all the mechanical details, will overcome the difficulty in the case of the 2-h.p. clutch, but the 4-h.p. is out of question at the speed required. Fig. 1 shows the general arrangement of the

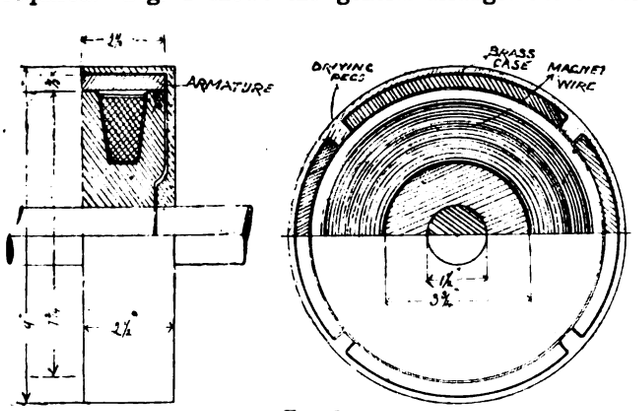

FIG. 1.

clutch. It will be seen that the electromagnet, or clutch proper, consists of a deep grooved pulley, made of either annealed wrought iron or magnet steel, the exciting ampere-turns being embedded in the groove. The armature is formed of four loose pieces of wrought iron, each forming a portion of a perfect circle, the inside diameter of which is equal to the outside diameter of the electromagnet. These portions fit easily into the outside case, which is made of brass, and is provided with four driving pegs, extending the full width. Other details, such as slip-rings, etc., I presume the querist is familiar with, and need not be discussed.

The calculations for pull, ampere-turns, etc, are based on the following data: Assuming the horse-power = 2; revolutions per minute = 100; diameter of the electromagnet = 7¾in.; allowing 1¼in. for the case and armature, and width of electromagnet 2⅛in.; allowing ⅜in. for the case and clearance.

$$\text{I.} \qquad \text{H.P.} = \frac{2\,\pi\,R\,P\,\mu\,N}{33{,}000},$$

where R = radius of electromagnet in feet; P = magnetic attraction in pounds; μ = coefficient of friction, for iron on iron = 0·17; and N = revolutions per minute.

$$\therefore\ 2 = \frac{6{\cdot}3 \times 322 \times P \times 0{\cdot}17 \times 100}{33{,}000}$$

$$P = 1{,}900\text{lb.}$$

$$\text{II.} \qquad v\,P \text{ pounds} = \frac{B^2\,A}{72{,}134{,}000},$$

where B = induction density in lines per square inch; A = area of both pole-faces in square inches; allowing v the coefficient for slip 5/4, v P = 2,400. B in this case should be at least 90,000 lines per square inch.

$$2{,}400 = \frac{81 \times 10^8 \times A}{72{\cdot}134 \times 10^6}$$

$$A = 21 \text{ square inches.}$$

The area of each pole-face being 10·5 square inches. The cross-section of the magnet can now be settled; the shaft will form a portion, and should be made a good fit, so as to avoid loss of lines. Diameter at the bottom of groove = 3¾in. and width of the pole-face = $\frac{7}{16}$in.

III.—The law of the magnetic circuit is

$$\text{Magnetic flux} = \frac{\text{magnetomotive force}}{\text{magnetic reluctance}}.$$

Using this law it is possible to calculate the number of ampere-turns required to produce any prescribed number of magnetic lines as follows when dimensions are given in inches:

$$A\,T_s = v\,M_F \times \frac{l''_m}{A''_s\,\mu} \times {\cdot}3132,$$

where A T_s = ampere-turns of magnet wire; M_F = total magnetic lines = $A_s \times B = 10{\cdot}5 \times 90{,}000$; l_m = mean length of magnetic circuit in inches = 9 5; A_s = area of cross-section in square inches; μ = permeability of iron, which according to Hopkinson's table = 823 for annealed wrought iron; v = coefficient of allowance for leakage, which in this case will be large, say 3/2.

$$A\,T_s = 1{\cdot}5 \times 945{,}000 \times {\cdot}3132\ \frac{9\,5}{10{\cdot}5 \times 823}$$

$$A\,T_s = 490.$$

The querist will find that he has ample of room for the wire required, but to build a 4-h.p. clutch means double the iron, and the dimensions given will amply prove that this is impossible. The de-clutching is due to the centrifugal force of the armature, the outside case being the rotary part when the clutch is not doing work. There is no definite method of calculating the coefficient of friction, as this depends on the state of the surfaces in contact. The following table gives some mean coefficients for a horizontal or flat surface:

Surfaces in contact.	State of surfaces.	Coefficient of friction.
Metal on metal.	Wet.	·3
,, ...	Dry.	·2
,, ...	Greasy.	·15
,, ...	Lubricated.	·08

—H. COLLINSON.

Question No. 1,058.—Two similar single-phase watt-hour meters are put in circuit on separate phases of a two-phase system supplying a slip-ring induction motor. On starting up motor the direction of rotation of meter B is reversed, and not until the motor is up to speed does it right itself. Also, under normal working conditions, meter A runs considerably faster than meter B. The pressures on A and B phases are respectively 204 and 200 volts. What are the causes of these phenomena?

Best Answer to No. 1,058 (awarded 10s.).—Consider any given load on the motor. If the voltage on one phase drops, the current in the other phase must increase by an amount great enough to bring up the resultant rotating flux (which produces the rotor currents) to its normal value.

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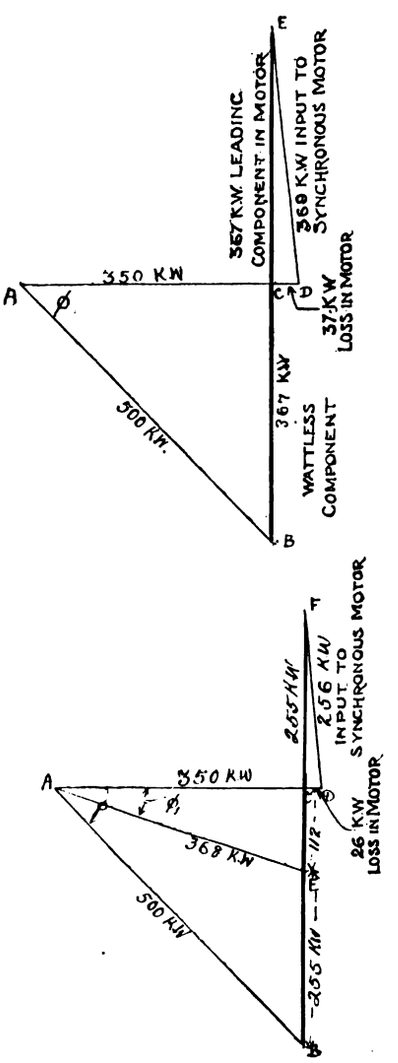
If the voltage falls still further till eventually it is of less value than the back volts due to the rotating flux, it is obvious that the current in its phase will be reversed—that is to say, one phase will be taking power and the other will be delivering power back. The reversal of meter B is most probably due to an unbalancing effect, such as described above, but as it only occurs at starting it almost appears as though the trouble was in the rotor winding, phase B having different magnetic qualities to phase A, and possibly a bad power factor, this accounting for meter B running faster than A on normal loads. Again, if the meters are connected with their series coils in series in a common return wire, the current in one meter when the motor starts will lag more than 90deg. with respect to the voltage impressed on this meter, thus producing a reversal. In this case, however, there is, of course, no current being returned to the line as in the case explained previously.—BALANCE.

Answer to No. 1,058 (awarded 7s. 6d.).—The reason that the meter in phase B is reversed is due to a motor-generator effect; owing to want of symmetry phase A motors while phase B generates, and is able to overcome the supply voltage. Phase B is then giving current to the line, and its meter runs in the reverse direction. The algebraical sum of readings on the two meters represents power taken from mains, but such readings will give an amount exceeding that which would be required were the motor working properly. We have, from data given in the question, that phase B is four volts below that of phase A, therefore the rotating field due to phase A, aided by the effect of the currents in the rotor, appear to generate an E.M.F. greater than the supply voltage of phase B. Thus the meter in phase B is reversed. It would be worth while to change the meters—that is, put the meter that is now in phase A in phase B and B meter in phase A. This would give an easy method of finding out whether the meters were at fault. The question says "separate phases," therefore any reversal due to the current coils of the meters being connected in the common return need not be considered. With unequal voltages on the phases it is to be expected that the meters will give unequal readings or undergo reversal, even with symmetrical machines. When the motor is at full load and running at normal speed, the tendency of the meter to reverse will be a minimum, but still the effect will be felt. The motor should, however, be carefully examined for any inequality in the windings. Such inequality may have been caused by faulty workmanship or by the endeavour to utilise a frame having an unsuitable number of slots. An out-of-balance winding would explain the matter at once, and in such a case remedy is obvious.—M. M.

Answer to No. 1,058 (awarded 5s.).—From the particulars stated regarding the phenomena of the two wattmeters, which are taken as being single-phase instruments connected one in each phase of the system, the following suggestion would lend itself as a solution to the cause of the trouble. It is well known that if a single-phase wattmeter is reading power (E × C), where E and C have a phase displacement of much more than 60deg., the instrument will in all probability commence to read in the opposite direction, this being due to the flux relation of the current and potential elements. In view of this it would appear that the induction motor in question when starting would do so at a low power factor (cos θ), differing in value in the two phases A and B, its value in phase B being below 60deg. Since meter A runs faster than B, it is evident that the power factor of phase B must also be lower than phase A when the machine is running, though, of course, "W. P." states there is a potential difference of four volts between the two phases, this, of course, tending, in addition, to cause a difference in the meter speeds. A further suggestion that could be put forward is that the currents in the two phases of the machine vary in value due to the impedance of each of the windings being different, this difference in impedance being often due to the stator construction and type of winding used. This, again, would cause a difference in the power factor of the two phases A and B, and consequently account for the speed difference of the wattmeters.—X.

Question No. 1,059.—Explain fully how the power factor of a plant is improved by the use of over-excited synchronous motors. Describe the action of the above on a power load and on lighting loads. How is the machine enabled to work under both conditions?

Answer to No. 1,059 (awarded 5s.).—The wattless current in a circuit due to a load of induction apparatus or machines having a power factor less than unity causes additional heating losses in generator and transmission line, increases the drop in the line, and, owing to the demagnetising effect of the lagging current on the generator field, a drop in terminal pressure results. If this idle current could be got rid of or localised in some way, then an increase in efficiency and better regulation would at once follow, and the available generator output would be increased. By connecting a condenser or an over-excited synchronous motor in parallel with the load, the generator and part of the line will be relieved of part of the idle current, and by suitably proportioning the size of the condenser or increasing the excitation of the synchronous motor the power factor of the generator may be raised to unity.



FIGS. 1 AND 2.—ϕ is the angle of lag and cos ϕ is the power factor.

The following example will illustrate the theory. Suppose a 500-kw. generator supplies 500 k.v.a. to a mill driven by induction motors with an average power factor of ·7. Then the true power supplied will be 350 kw., but the generator heating and losses are practically equal to their full-load value. Let it be required to raise the power factor to unity, thus enabling the generator to deliver its full output. Fig. 1 shows graphically the conditions existing. The E.M.F. vector lies along A C, and the current vector lies along A B. The loss in the motor is taken to be about 10 per cent. of its rating. The size of motor required would be 369 kw. The output of the generator could be increased by 500 − (37 + 350) = 113 kw., and the regulation would be much improved. Fig. 2 shows the conditions when a power factor of ·95 is required. Cos ϕ = ·7, cos ϕ_1 = ·95. The leading component of the motor must

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be equal to E B. The size of motor required is 256 kw., and the gain in output is 500 – (368 + 26) = 106 kw. The corresponding sizes of motor for power factors of ·9 and ·85 are 182 kw. and 152 kw., while the power gained is about 92 kw. and 73 kw. respectively. It will be noticed that the size of motor required increases very rapidly as the power factor approaches unity. Taking into account the cost of the motor, it would not be economical to raise the power factor above ·9 – ·95. If required, the extra power available by using a synchronous motor can be taken from the motor itself.

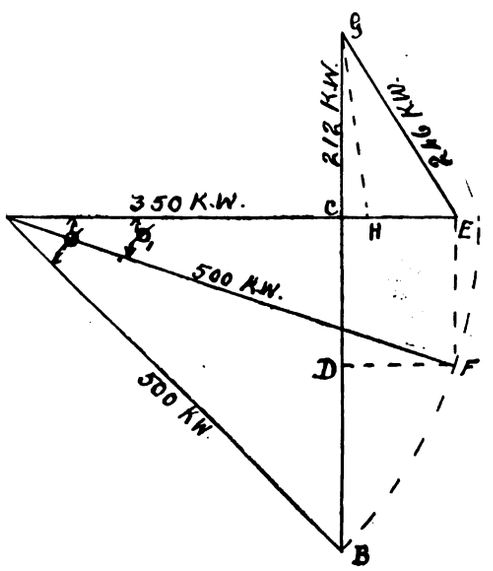

FIG. 3.—Cos ϕ_1 = ·95; D B = C G = wattless component of synchronous motor = 212 kw.; C E = power component of synchronous motor = 125 kw.; G E = input to synchronous motor = 246 kw.; C H = losses in motor—say 25 kw.; H E = output of motor = 100 kw.

Let it be required to determine the maximum output which can be obtained from the motor when the generator is giving 500 k.v.a. with a power factor of ·95, the load power factor being ·7. Fig. 3 shows graphically the conditions. For reasons of economy the synchronous motor should be placed as near to the inductive load as possible. The idle current will then only circulate in the local circuit formed by the motor and load. If any lamps, which are practically non-inductive, are connected to the circuit, then the variation in voltage at their terminals will be reduced, and, therefore, the steadiness of the lights will be improved. In fact, the synchronous motor and inductive load may be replaced, as far as the lamps are concerned, by a resistance which is non-inductive, or nearly so, depending on the power factor required in the circuit.—D. H. B.

Answer to No. 1,059 (awarded 5s.).—If the power factor in an electric circuit be less than unity, it is obvious that all the current in the circuit is not in phase with the E.M.F. producing it. That is to say, if we represent voltage and current by vectors, there will be an angle of phase difference between the two vectors. The current vector may either lag behind or lead the voltage vector. Generally the current will be lagging.

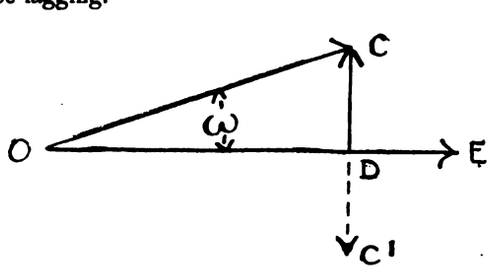

FIG. 1.

Consider Fig. 1. Here the current vector, O C, lags behind the voltage vector, O E, by an angle ω. Resolve O C into the component O D parallel to O E, and the component C D perpendicular to O E. Then, evidently, O D will be the component of the total current in phase with the E.M.F., and D C a component lagging 90deg. behind the E.M.F. The actual power in the circuit will be represented by the product of O E and O D. If, now, we neutralise the wattless component, D C, of the total current by introducing a new current, D C', equal and opposite to it, it is evident that the total current in the circuit will become equal to O D, and will be exactly in phase with the voltage, thus giving us a power factor of unity. The power in the circuit will not be affected. To neutralise the component D C in this way, we need a current equal to D C, but *leading* the voltage by 90deg. To get this leading current the circuit must, as is well known, have some capacity. This capacity may be provided by connecting condensers or over-excited synchronous motors to the circuit. When used for this purpose synchronous motors are sometimes known as "rotary condensers."

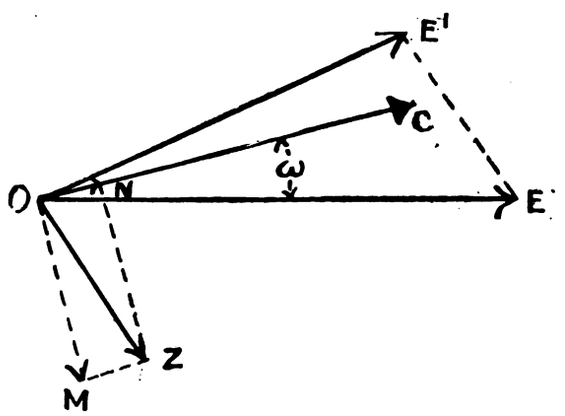

FIG. 2.

The condenser action of an over-excited synchronous motor may be simply shown as follows: In an alternating-current generator the excitation required to produce a given terminal voltage will, as is well known, depend upon the phase relation of voltage and current in the armature. Conversely, in the synchronous motor this phase relation will depend on the excitation for given terminal voltage. In Fig. 2, let O E = constant terminal voltage of motor; let O C represent the current taken by the motor, lagging behind the terminal voltage by an angle ω; let O N (in phase with O C) be the resistance drop of the motor, and O M its reactance drop (perpendicular to O C). Then O Z will be the motor impedance drop. Now, the terminal voltage, O E, is the resultant of the back induced voltage of the motor and the motor impedance drop. In the diagram (Fig. 2) we already know the magnitude and phase of the motor terminal voltage, O E, and the motor impedance drop, O Z. Hence find the motor back induced voltage. In this case it is represented by O E'. The value of O E' will obviously depend on the motor excitation. If, now, this diagram be constructed for a case in which the current leads the voltage O E, it will be at once seen that the back induced voltage, O E', will have to increase in order to get the resultant (constant) terminal voltage. Conversely, if we increase the back induced voltage (by increasing the excitation), we shall cause the armature current to lead the terminal voltage. Similarly, by decreasing the excitation, the current may be made to lag still further behind the terminal voltage. Thus by over-exciting a synchronous motor the current which it takes may be made to lead the voltage. By varying the amount of over-excitation we can vary the amount of this lead at will. Thus the over-excited synchronous motor behaves like a condenser of variable capacity. Finally, whether the current in the circuit lags behind, is in phase with or leads the voltage—*i.e.*, whether power or lighting load—the power factor may be brought up to unity if required by suitable adjustment of excitation. To get the power factor under complete control, it is evident that the synchronous motor must be of sufficient capacity to deal with all the current. It is, therefore, very desirable that the motors should be usefully loaded in order to defray as far as possible their initial cost and upkeep.—DAN AP SAM.

[Other replies to Question No. 1,059 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

QUESTIONS.

1,067. What is the best method of laying cables in a power-house between machines and switchboard? Give sketches showing method of fixing both high-tension and low-tension cables, both when run in subways and in a trench in engine-room floors.—H. C.

1,068. A four-pole, 440-volt, compound, cumulative, direct-current motor, 35 h.p., with wave-wound armature (one set of brushes), 710 r.p.m., has four coils on the armature burnt out. On attempting to start the motor after repair the motor makes one-quarter of a revolution, then pulls up dead. Also it is found considerable force is required to move the armature round when no current is passing through the armature (brushes being lifted), but with the shunt field fully excited. The connections are gone through, and apparently the only thing wrong was that two adjacent commutator bars were short-circuited. Give explanation of behaviour. Diameter of armature 15½in., length 9¼in., 69 slots ⅜in. wide, 348 conductors, 137 commutator bars.—J. WALKER.

1,069. Explain the process of calculating the magnetising current of a two-phase induction motor; also the rotor current in a star-connected three-phase rotor in a two-phase stator.—ROTOR.

ANSWERS.

Question No. 1,059.—Explain fully how the power factor of a plant is improved by the use of over-excited synchronous motors. Describe the action of the above on a power load and on lighting loads. How is the machine enabled to work under both conditions?

Answer to No. 1,059 (awarded 5s.).—Before commencing to describe the operation of a synchronous motor for use as a machine to improve the power factor of a transmission line, it might be well to enumerate a few of the effects of lagging wattless current in a system. The following are a few of the more important: (1) increased generator output for a given amount of real power; (2) this increased current exists at a time when the armature coils of the generator have such a position with respect to the field that the magnetising action set up by the armature ampere-turns is opposed to those of the field ampere-turns, and is, therefore, demagnetising; (3) increased field current required, therefore more field losses.

A cheap solution of the problem of improving the efficiency of a power transmission line running at a comparatively low power factor, which can be due to a number of induction motors taking power and running at light loads, is to install one or more synchronous motors at the receiving end of the line, the excitation of the motor being adjusted so that the leading current which is taken by it exactly balances the lagging current taken by the load. The wattless current is thereby entirely confined to the local circuit formed by the synchronous motor and the load, while the line current is in phase with the potential difference at the receiving end of the line. The synchronous motor here plays the part of a compensator for the wattless current of the load, and at the same time can be used to give mechanical power if required. The working vector diagram of such a machine which shows approximately the theory and marked stability, is given in Fig. 2. Thus, suppose the potential difference across the armature of the machine and the exciting current are maintained constant. Let V = potential difference, E = open-circuit E.M.F. corresponding to given exciting current, and I = armature current per phase. In what follows we shall consider the action of one phase only, so that the reasoning will apply to both single and polyphase motors.

Let O V = V denote the potential difference and O E = E the E.M.F. induced in the armature winding. The vector resultant of these two, O R, gives the E.M.F. available for overcoming the armature impedance. The current is represented by O I = I, and lags behind O R by an angle whose tangent $= \frac{\text{armature reactance}}{\text{armature resistance}}$. If O I′ = projection of O I on O V, and O I″ = projection of O I on O E produced backwards, then V × O I′ (= V I cos ∠IOV) represents the total electrical power supplied to the motor

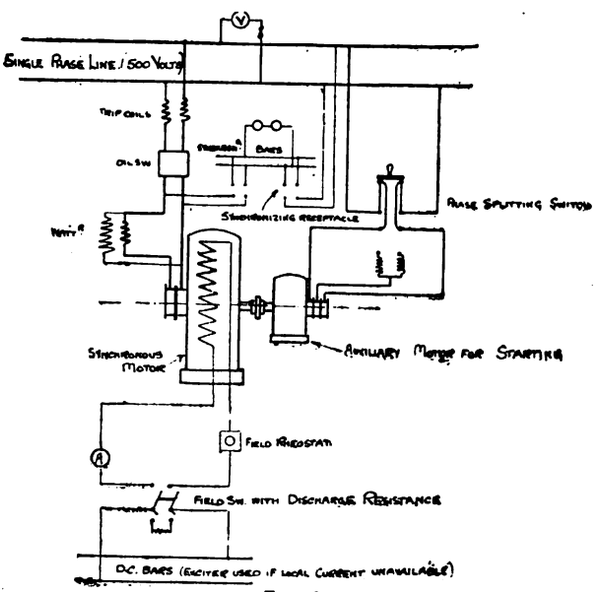

FIG. 1.

(excitation not included), while E × O I″ (= E I cos θ) represents that portion of the total power which undergoes conversion into mechanical power. If the load is suddenly decreased acceleration begins to take place, and the vector O E swings forward—*i.e.*, in a counter clockwise direction)—gradually gaining in phase on O V. The effect of this is

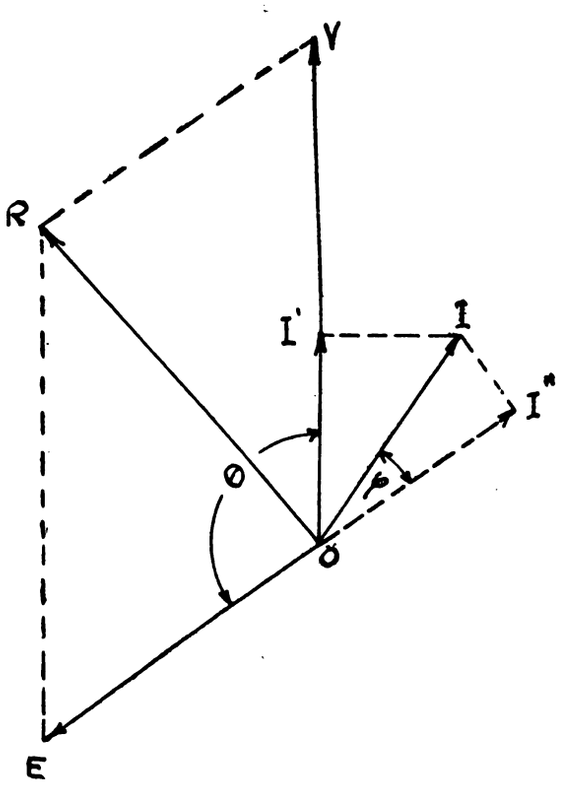

FIG. 2.

to reduce O R and so reduce the current O I in the same ratio. The driving power, E × O I″ (by driving power is meant power which actually undergoes conversion into mechanical power; it therefore includes power lost in overcoming frictional resistances), is thereby decreased, and this decrease will go on until the driving power becomes equal to that required to deal with the decreased load. The opposite effect takes place with a sudden

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increase of load. Thus the current automatically adjusts itself as regards magnitude and phase to the exact value required; hence the motor is running under stable conditions.

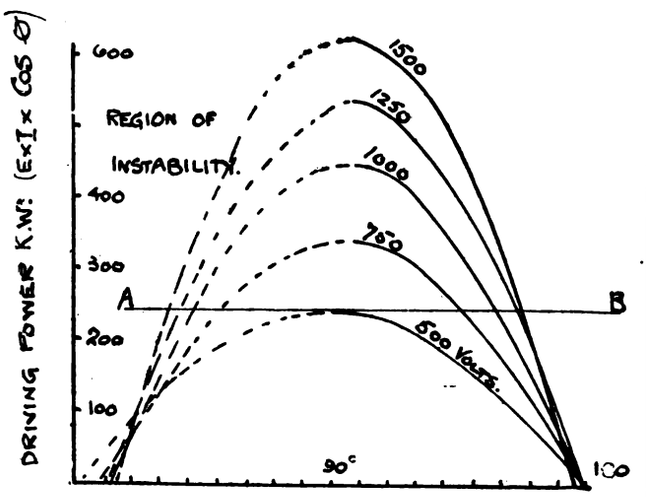

FIG. 3.

Fig. 1 shows the connections for such a machine to the line (single phase taken as an example), with the necessary controlling and synchronising gear; an ammeter or wattmeter is generally included in the circuit, though the power

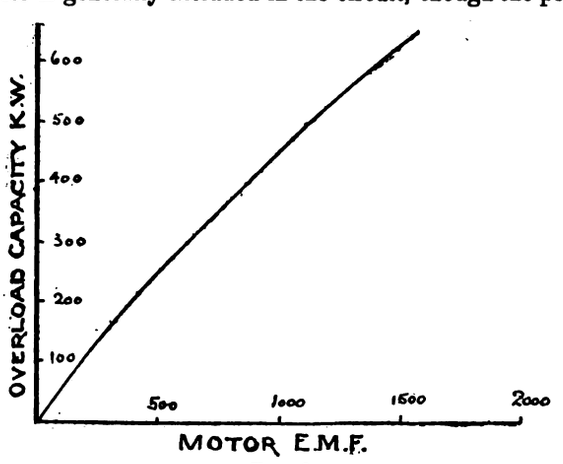

FIG. 4.

factor of this portion would be low. For starting purposes a small auxiliary motor is usually installed, the same being de-clutched, if necessary, afterwards. Fig. 3 shows the relation connecting the driving power of the machine with

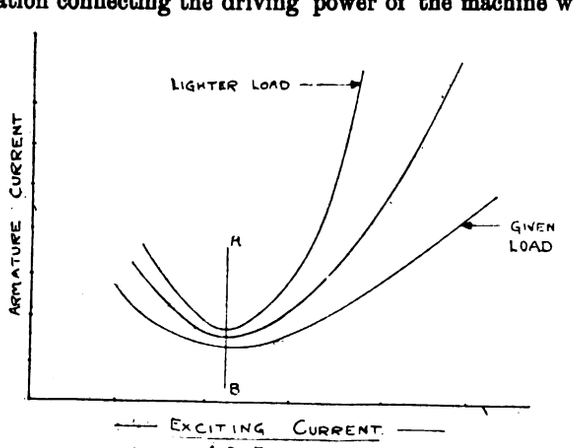

FIG. 5.

the angle of advance of motor E.M.F., indicating very clearly that corresponding to each excitation (or each value of the motor E.M.F.) there is a certain maximum load, represented by the top of the curve—viz., at A B—where it becomes horizontal, and where the stable descending branch passes into the unstable ascending one, beyond which the motor will refuse to run. This maximum load is seen to increase with the excitation, and the relation connecting the maximum load with the motor E.M.F. is represented graphically in Fig. 4. From this it will be seen that if a large overload capacity is desired, the motor E.M.F. should have a relatively large value. One of the most useful curves relating to a synchronous motor is that shown in Fig. 5, and known as the V curves on account of their shape; these curves show the relation connecting excitation and armature current. It is evident that as the exciting current increases, the armature current decreases to a minimum value, and for still higher excitations again increases. This variation of the armature current with varying excitation is an important characteristic of the synchronous motor, first pointed out by Mr. Mordey. The variations in the armature current for a given range of variation in the excitation are greater at lighter loads, and the curve obtained when the motor is running light is more V shaped than that for heavier load.—X.

Answer to No. 1,059 (awarded 5s.).—Synchronous motors may be used to compensate the low power factor of a system in two ways: (1) by running the motor light, the motor doing no external work, and being used only for improving the power factor; (2) by allowing the motor to do external work, besides improving the power factor. To fully consider the action it will be advisable to first consider case 1.

In dealing with synchronous motors, as with direct-current motors, we have three E.M.F.'s to consider: (1) the impressed or line E.M.F.; (2) the back or induced E.M.F.; and (3) the resultant E.M.F., which is the E.M.F. available for overcoming the resistance and reactance of the motor armature. Now, in the case of a direct-current motor the relation between these quantities may be algebraically represented by the equation:

$$E_r = E_i - E_b,$$

where E_r = resultant E.M.F.; E_b = back E.M.F; and E_i = impressed or line E.M.F. In the case of a synchronous motor these E.M.F.'s cannot be so simply expressed, as they are not in phase with each other. Now, with a direct-current motor running light, if we alter the excitation the motor will alter its speed to correspond, and the back E.M.F. will remain constant. With a synchronous motor, however, the speed must be constant independent of the field strength, and as the line E.M.F. is also constant the back E.M.F. will alter, and this will result in an alteration of the phase relations between the various E.M.F.'s. To make this clearer, consider the vector diagrams (Figs. 1 and 2) Fig. 1 represents the approximate conditions of the various E.M.F.'s in a synchronous motor with a given excitation. Let the vector E_i represent the impressed E.M.F. and E_b the back E.M.F. Owing to the induction of the motor armature, E_b will not be in exact opposition to E_i, but will take up some such position as shown, and by construction, shown, we now get the resultant E.M.F., E_r, this being the E.M.F. available for overcoming the armature impedance. E_r is also the resultant of two other E.M.F.'s—viz, the C R drop due to the resistance and the p L C drop due to the reactance of the armature, these two being in quadrature with each other. By construction we can obtain these components—viz., O D, representing the C R drop, and D E_r the reactance drop—the angle E_r O D being such that

$$\tan E_r O D = \frac{P L}{R} = \frac{\text{reactance}}{\text{resistance}}.$$

Since the current will be in phase with the C R volts, the current vector will lay along O D, and will have a value O C which will be given by

$$C = \frac{E_r}{\sqrt{R^2 + p^2 L^2}},$$

and the angle θ_1 will be angle of lag between the current and impressed E.M.F. Now let the excitation be increased such that the back E.M.F. becomes equal to O E_b' (see Fig. 2) by the same construction as in Fig. 1. We now get the resultant voltage given by O E_r', and the phase direction

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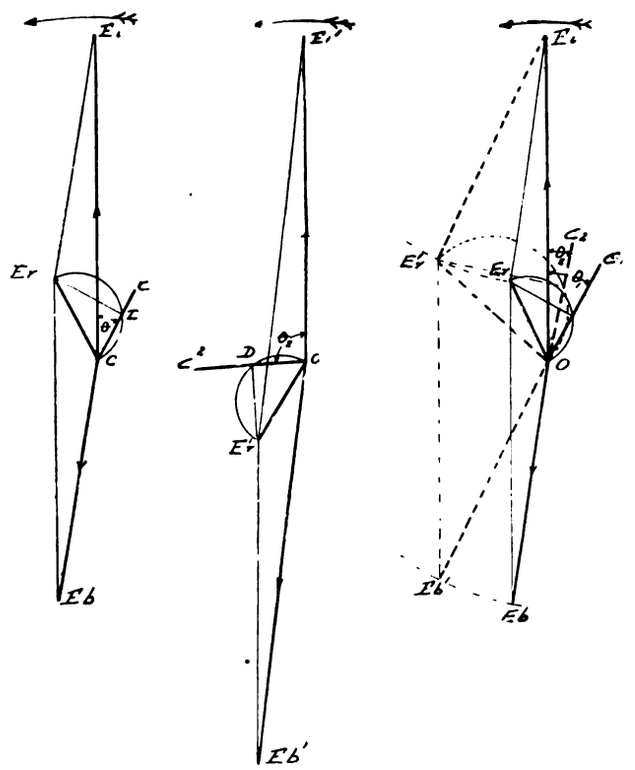
of the current is given by O D', the value of the current now being given by

$$C^2 = \frac{E_r'}{\sqrt{R^2 + p^2 L^2}},$$

and we now see that the current vector leads the impressed E.M.F. by the angle θ_2, the power factor now being a *leading* one. From this we see that increasing the excitation on a synchronous motor increases the power factor.

We will now consider the case of a synchronous motor running under load, the induced E.M.F. and excitation remaining constant. Since the speed also remains constant, with an increase of load, in order to allow the necessary current to flow, to overcome the increased torque the resultant E.M.F. must increase, and this can only be done by an alteration in the phase difference of the back E.M.F. This is shown in Fig. 3, as the various vectors have the same significance as in Fig. 1. The full lines represent the machine running light when a load comes on. Since the back E M.F. is constant, its vector will move along the semi-circle of radius O E_b', and will take up some such position as shown, until the resultant E.M.F. has increased to a value sufficient to allow enough current to flow to overcome the torque, the resultant E.M.F. being now shown by the dotted vector O E_r'. The current



FIGS. 1, 2, AND 3.

vector will now be represented by O C_2, it values being given by

$$C_2 = \frac{E_r'}{\sqrt{R^2 + p^2 L^2}},$$

and the angle of phase difference being now θ_2 by a further increase of load, O C_2 will come more and more into phase with O E_i and may slightly lead it. It will thus be seen that with a synchronous motor under load the power factor is to a certain extent increased with the load, and by suitably adjusting the excitation on light loads may be made to lead with an increase of load.

The principle of working is the same for either a lighting or power load. With a power load, however, the power factor would average between ·7 and ·8, and would be approximately the same all day. In the case of an alternating-current lighting load the power factor during full load would be fairly high, as the transformers would be well loaded. With the load coming off this would rapidly fall, until when there were few lights being used the power factor would be low, owing to the number of lightly loaded transformers on the mains. With a power load it should be possible to arrange to have several synchronous motors installed, and by arranging the excitation the power factor could be kept up. With purely a lighting load it would be necessary to run the motor light to compensate for the power factor unless it could be used to drive the auxiliary machinery, such as exciters in the power station. It should be remembered in considering the installation of synchronous motors that with a high power factor the regulation of the generators is greatly improved, and on a rapidly varying power load this consideration would be of importance, whereas in the case of a lighting load the load comes on steady and the regulation can be easily attended to. Where both lighting and power are supplied from the same mains, the better regulation with synchronous motors would be of great advantage.—E. V. C.

Answer to No. 1,059 (awarded 5s.).—For a thorough investigation of this problem we had better consider: (1) the cause of a low power factor; (2) the effects of "lagging wattless currents" on power station equipment; and (3) the effects of "lagging wattless currents" on the supply circuits.

The Cause of Low Power Factor.—One of the most prolific sources of relatively low power factor conditions is found in the supply of power to induction motors. The current taken by an induction motor may be considered as being made up of two components—namely: (1) a power component in time phase with the impressed E M.F., and (2) a wattless magnetising current, which gives rise to power factors below unity.

The Effects of Lagging Currents on Power Station Equipment.—Lagging wattless currents give rise not only to an increased generator armature current for a given amount of real power, but this increased current exists at a time when the armature coils are in such a position as to produce a demagnetising action on the field. To keep the generator E.M.F. constant under such conditions requires an increased field excitation by an amount, which in some cases may be so great that should a heavy inductive load be suddenly taken off the voltage may run up to the danger point before the field current can be reduced. As stated above, low power factors mean increased current, and as a safe temperature rise, and, therefore, the rating of the generating equipment, is largely limited by the value of the armature current irrespective of its phase relation, it is evident that the idle currents limit the possible amount of useful currents which may be derived from an alternating-current generator. Further, the increased field currents necessary with loads having low power factors give rise to increased field copper and core losses, which also add to the temperature elevation.

Effects of Lagging Currents on the Supply Circuits.—Low power factors result in increased line drop, due to increased current necessary for a given amount of real power, also to an increased power loss in the line, which depends upon the square of the total current flowing, so that a small decrease in power factor results in a much more rapidly increasing line loss. To neutralise the above detrimental effects in the generating and transforming equipment and supply networks, it is desirable to supply these lagging currents from another source if possible. This may be accomplished by means of synchronous apparatus, from which, by proper manipulation, leading currents may be obtained to supply the lagging currents. Hence an over-excited synchronous motor can improve the general regulation and efficiency of the system as a whole.—CHAS. D. WHARLDALL.

Answer to No. 1,059 (awarded 5s.).—If the excitation of a synchronous motor is increased, the armature current will flow with smaller angle of phase difference between applied and back voltage, and the motor will, therefore, lag by a smaller angle, and C cos ϕ will approach nearly to C. When the excitation is such that the armature current is in phase with the back E.M.F., cos ϕ will be nearly equal to unity, and the current required to drive the motor will be a minimum. On increasing the excitation, the angle ϕ will change its sign—*i.e.*, the current supplied will get greater for the same load, and will lead the voltage instead of lagging behind it. An abnormal increase of excitation will increase the armature current on account of the great phase difference between the current in the armature and the voltage. For every load there will be a certain value of the excitation which will give the lowest

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value of armature current—*i.e.*, the highest power factor and smallest idle component of the current.

Before describing the effect of over-excitation on the plant, it is necessary to show what occurs in the motor. It may be seen in Fig. 1 (vee curves) that with 1·5 amperes excitation the armature current is very nearly in phase with the back voltage, and the current required by the motor is a minimum. On decreasing the excitation the current lags behind the back E M.F., and a greater armature

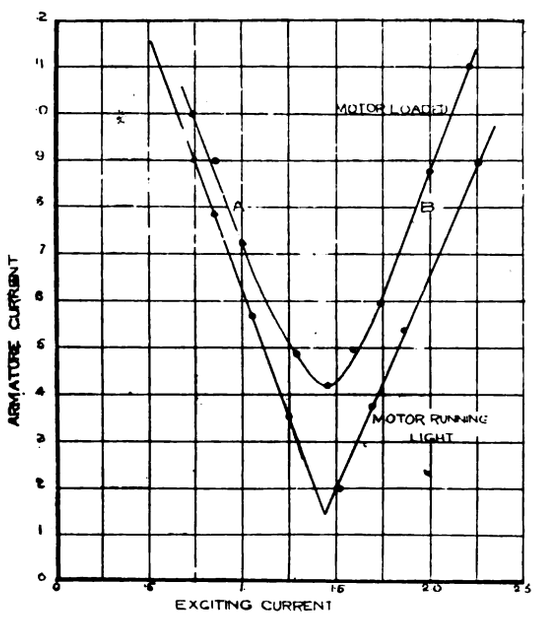

FIG. 1.

current is required, due to the decreased field, and because the total current supplied must increase in a greater ratio than the weakening of the field, because only the portion C cos ϕ is active and ϕ increases as the current lags behind the back E M.F. Hence the curve rises for excitations higher than 1·5 amperes, due to the fact also that the armature current will lead the back E.M.F. in phase, so that a smaller and smaller component of the current

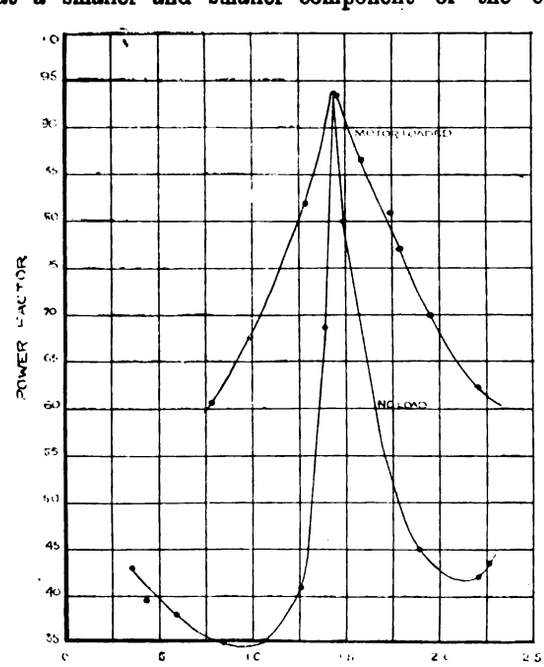

FIG. 2.

supplied to the armature reacts on the fields so as to produce rotation. It is evident from the difference in inclination of the two limbs, A B of the vee curves, that the alteration in the strength of the field produces but a small change in the armature current, and that almost the whole change is caused indirectly because of the alteration in the *lag* of the motor armature which follows the change of field; this point should be kept in view when considering the action of an increased power factor on a motor. Fig 2 shows the relation between exciting current and power factor. The no-load curve shows how quickly the power factor changes with the exciting current in the case of a motor running light.

Having described the effects of a variable power factor on the motor, we can now proceed to show the effect on the plant or circuit. Assuming we have a synchronous motor driven by an alternator, if the motor is so excited that it gives a voltage equal to that of the alternator the motor will lag slightly behind exact opposition in phase to the alternator, but since it runs in synchronism its back E.M.F. will be equal to that of the alternator. The phase and amount of current will vary with the load on the motor, and will also lag behind the generator.

Let O E_1 = voltage of alternator; O E_2 = voltage of motor; E_R = resultant voltage; O L = energy component of the resultant E.M.F. in the circuit and is in phase with current; ϕ = angle enclosed between O L and voltage of machine; C_{e1} = current of alternator; and C_{e2} = current of motor. Assuming the motor voltage, O E_2 (Fig. 3), is smaller than O E_1 the current vector, O C, will rotate backwards towards O E_1, so that the current is almost in phase with O E_1. The current given by the alternator has increased because the component O C_{e1} is greater; also, is the power given to the motor greater, since O E_2 and O C_{e2} is increased. It is thus seen that decreasing the

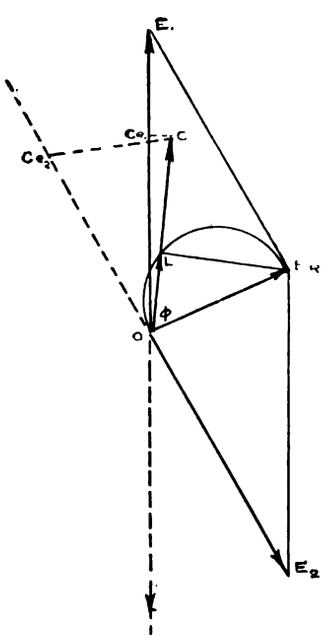

FIG. 3.

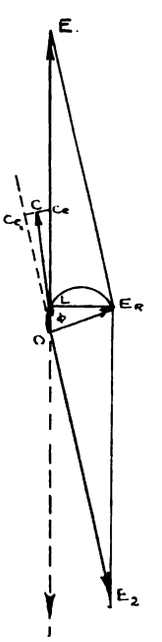

FIG. 4.

excitation of the lagging machine has the effect of increasing the power supplied by the other to drive it. Again, if the excitation of the motor is reduced to D E_2, the motor will receive an increased amount of power and will, therefore, accelerate. The phase angle of the circuit will consequently increase, hence a *decreased power factor*. On increasing the excitation (Fig. 4) of the motor O E_2 the two voltages become more in opposition, and resultant voltage and current have decreased. The power factor is seen to be *higher*. The angle of lag of the current in the plant is C O E_R, and the cosine of this angle will be the power factor of the whole circuit. The action of an increased power factor on a power load is to increase the efficiency of the motors, as C cos ϕ will be nearer C; also, the current and voltage being nearer in phase, there will be less negative power, and the power developed in the circuit will have its greatest value. In a lighting load, there being no self-induction, there will be no difference in phase between voltage and current, and cos ϕ should be constant and equal to unity. Any well-designed machine should be able to stand the variations mentioned, margin being always allowed when designing.

For further information on this subject I beg to refer "F. M. M." to Prof. C. F. Smith's book on "Alternating Currents."—OSCAR DINERMAN.

[The best answer to Question No. 1,059 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

QUESTIONS.

1,070. Compare in regard to inital cost, attendance, running costs, ease of speed regulation, and life, the relative advantages of direct-current and induction motors (including the squirrel-cage motor) for (*a*) heavy starting torque; (*b*) light starting torque and heavy overloads; (*c*) medium starting torque and equable running loads. Include also the cost of suitable starting gears in each case.—A. G. LONDON.

1,071. Explain the theory and construction of auto-transformers as employed to reduce the supply voltage for use with metallic-filament lamps.—E. C. O.

1,072. Given a three-phase overhead transmission line, 1,000 yards long, each conductor being $^{37}/_{12}$ bare copper, and the conductors occuping the three corners of an equilateral triangle with 20in. sides, generator voltage 650, frequency 50, give a method of predetermining the voltage drop (as measured between any two phases) between the generating and receiving ends of the line, working out the above as an example. Take two cases—viz, one with a load having a power factor of ·75 and the other with a power factor of unity—line current in each case 200 amperes. Show what is the actual power lost in the line in each case.—K. O.

ANSWERS.

Question No. 1,059.—Explain fully how the power factor of a plant is improved by the use of over-excited synchronous motors. Describe the action of the above on a power load and on lighting loads. How is the machine enabled to work under both conditions?

Best Answer to No. 1,059 (awarded 10s.).—The method of improving the power factor of a circuit stated in this question is based on the fact that by varying the excitation of a synchronous motor it may be made to take either a leading or a lagging current. A lighting load has, as a rule, a high power factor, but in a circuit containing induction motors there is usually a large phase displacement, as an induction motor takes a large wattless magnetising current, especially when starting or when running at light load. In a synchronous motor the resultant E.M.F., *e*, is the difference between the impressed E M.F. and the component of the counter E M.F. which is in phase with the applied volts. The armature current is given by the formula

$$\text{Current} = \frac{e}{\text{impedance}}.$$

The impedance of the armature may be resolved into its two components—*i.e.*, ohmic resistance and magnetic reactance. The drop in volts due to the former will be in phase with the armature current, but the reactance volts will lead it by 90deg., since they will have their maximum value when the current is zero.

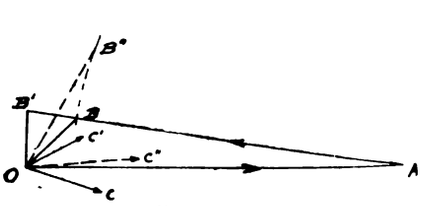

FIG. 1.

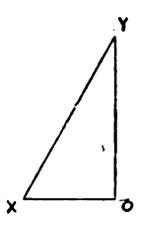

FIG. 2.

The relation between these different quantities is best shown by means of a vector diagram. Draw O X equal to the resistance drop, and O Y at right angles to O X equal to the reactance volts; then X Y will represent the impedance drop (see Fig. 2). Let O A (see Fig. 1) represent the impressed volts, and A B the counter E M.F. At no load the angle O A B will be small. O B will represent the resultant E.M F.—*i.e.*, the volts which drive the current through the armature impedance—and is, therefore, the same as X Y in Fig. 2. Lay off from O B the line O C so that the angle B O C equals the angle Y X O. Then the vector O C represents the armature current, since O X, the ohmic drop, is in phase with the impressed E.M.F. Using counter clockwise rotation of vectors, the angle C O A will represent the angle of lag. Let the excitation be increased, thereby increasing the counter E.M.F. from B to B'. Set off the angle B' O C' equal to Y X O as before (since the ratio between reactance and resistance is practically constant), and the current vector O C' will now lead the impressed volts by the angle C' O A.

The same effect can be produced, but to only a limited extent, by loading the synchronous motor (keeping the excitation constant), as the increased current necessary to provide the additional torque will be supplied by a decrease in the component of the counter E.M.F. in phase with the impressed voltage, since the speed of the motor is constant. The vector O B will now swing into the position O B'' as shown by the dotted line, and the current vector to the position O C''. It is thus seen that a synchronous motor can be made to take a leading current, and so may be used to raise the power factor of the circuit to which it is connected. Since a rotary converter is a type of synchronous

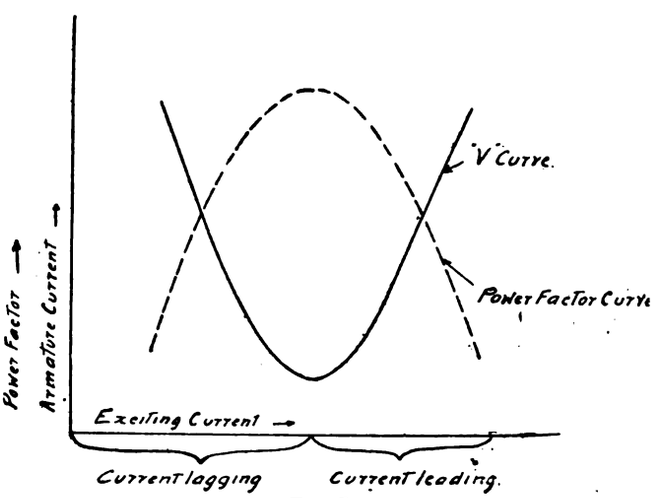

FIG. 3.

motor, it may be used for the same purpose. The results obtained by this method are clearly shown by the curves in Fig. 3. The curve shown by a full line is known as the "V" curve, and is obtained by plotting armature current against excitation. The curve shown by the dotted line gives the value of the power factor for the same excitation.—E. J.

Question No. 1,060.—Explain fully the "Merz" scale of charges for electric power users and the advantages of same to the consumers and the supply company; also disadvantages, if any.

Best Answer to No. 1,060 (awarded 10s.).—Since the cost of production and capital outlay depend on the load factor and diversity factor of a given load, the price charged for energy should take into account both these factors. It also sometimes happens that the power company goes to a great expense in order to connect up a consumer, the consumer afterwards taking very little energy. In this case, again, it is necessary that the consumer should pay annually a sum which partly or wholly overcomes the interest on the capital expended to connect up such a consumer. The "Merz" scale of charges to a certain extent takes into account all these factors. In this case a fixed charge of so much per annum, say, for instance, £9 per kilowatt of maximum demand plus a uniform charge per unit, say, for instance, ·25d. per unit. The maximum demand here referred to, however, is not the maximum demand as ordinarily spoken of, but is a figure arrived at by taking note of the maximum number of units used in any one hour of the month, quarter, or year, as the case may be, over which the maximum demand is intended to apply. This figure is arrived at by an attachment to the ordinary meter, involving, among other things, the addition of a clock, which, once every hour, sets back a certain part of the mechanism to the starting point, allowing an indicating needle to be turned round by the ordinary rotation of the meter and to indicate directly the number of units used during this time. The indicating needle does not return to zero, but remains in the position in which it has been left, unless the number of units used in any succeeding hour should be greater, in which case the needle advances accordingly. There is, of course, an arrangement for resetting the needle to zero at the beginning of any fresh period, such as the first of the month or the first of the quarter. The price per unit paid is fixed according to how

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it affects the cost of production, and will, therefore, depend on (*a*) the load factor, (*b*) the number of units sold annually to each consumer, and also (*c*) the manner in which the additional load will affect the present load at the station. The fixed annual sum will depend on the capital expended to connect up the new consumer, and also the diversity factor of the new load, so that this method of charging is very flexible, and can be varied to suit each particular load.

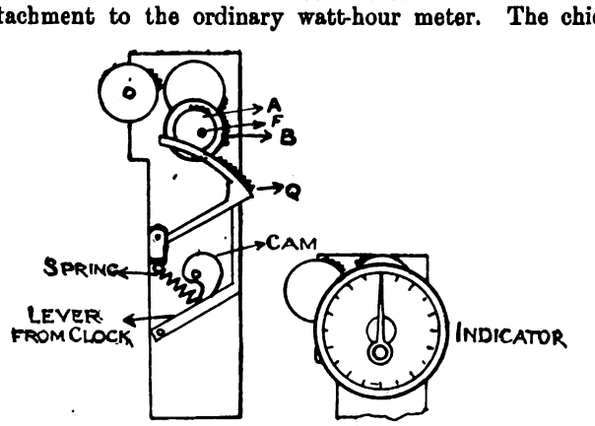
The advantages to the supply company are: (1) The consumer in order to cheapen his bill tends to make his load factor as high as possible, with the consequent advantages at the station; also the more the consumer takes the cheaper does his rate become, and thus he tends to make full use of the copper in the mains, which is a source of great expenditure with power companies. (2) Even if the number of units sold is few, the company is partially repaid by the fixed sum per annum. The advantages to the consumer are: (1) It allows an intermittent load to be recorded at a much lower figure than where the actual maximum demand used at any one time is recorded—that is, the consumer may have momentary peaks of high value, but, provided his mean over the hour is fairly small, these peaks will not affect his bill as much as the old maximum demand system.

With regard to the disadvantages, they cannot be serious in any case, since the system is so flexible as to be applied advantageously to any consumer. The addition to the meter may be looked upon as a disadvantage, but it is no worse than the other maximum demand indicators which are in use, except, perhaps, a little more complicated.—M. R.

Answer to No. 1,060 (awarded 5s.).—The "Merz" indicator was specially designed for the benefit of large users of electric power to enable the scale of charges to be proportioned in accordance with the maximum demand during any particular period of working. The indicator is designed to register the integrated maximum values of the power used during one hour, and at the end of each hour the indicator automatically resets itself to zero. The same result could, of course, be obtained by observing the maximum values of the power consumption taken many times during the hour and integrating them. The result gives us an integrated value of the average maximum load during one hour. Assuming P is the variable amount of power consumed, and T is the interval of time between each resetting to zero, the indicator registers the maximum value of

$$\frac{1}{T}\int_0^T P\,dt.$$

The indicator should be considered as an auxiliary attachment to the ordinary watt-hour meter. The chief



points of construction are the dial pointer which is driven by the meter gearing, an indicating dial, and a clock, the latter for periodically resetting the instrument at the end of each hour. In the figure the toothed wheel, A, is driven by a suitable train of wheels from the meter gearing; the wheel A also carries a driving pin, F. The ratio of the driving wheels is arranged so that the pointer moves through somewhat less than one revolution. The driving pin, F, actuates another pin on a toothed wheel fitted to the same spindle to that which carries the pointer. The pointer is held in its maximum position by means of a ratchet and pawl, which prevents it being reset to zero by the automatic action. Another toothed wheel, B, also on the same shaft gears in a quadrant, Q, which is moved through the maximum angle by the meter gearing. The quadrant is pushed back to its original position at the end of each hour by a lever movement actuated by the clock. The meter reader at the end of, say, each month releases the ratchet and pawl mentioned above, and pushes the pointer back to the zero stop. If, after any automatic resetting of the pointer by the clock, the load increases, the toothed wheel and pin will move further round before the resetting arm again works, which will allow the pointer to give a higher reading. The resetting automatic movement is practically instantaneous, and does not introduce any error during the hour's integration.

The advantages of the indicator would appear to be rather in favour of the consumer, insomuch that the sudden fluctuations of load caused by starting of heavy motors are not registered against him. It is clear from the above description that the meter will only register the maximum load averaged over one hour, which is a very useful period in fixing a suitable charging rate. It is frequently necessary for the supply company to guarantee that the price should not exceed a certain value, and also to offer a rebate on the total consumption. This can be easily calculated with the "Merz" indicator. The meters and attachments require careful manufacture and adjustment, and it would not pay to install them except in fairly large consumers' premises, where they would receive careful attention. This class of meter is also of advantage with an unbalanced three-phase load, as only one indicator is required. The scale of the indicator may be designed to indicate the power in units to be charged at a higher rate (as in the original "Brighton" system), but for general power scheme purposes it is convenient that the indicator should read in units which are charged at a low rate and a rental charge per kilowatt of maximum demand.—K.

Question No. 1,062.—In Babcock boilers of both land and marine types it is noticed that a slight bending of the bottom two rows of tubes (over the centre of the fire chiefly) takes place, always in a vertical plane and with the *concave* side of the bend towards the fire. The bending only takes place in the first chamber, just over the fire, and is always *upwards*. Why?

Best Answer to No. 1,062 (awarded 10s.).—Owing to their position, the tubes in the bottom row of Babcock boilers are subjected to a higher temperature than the tubes in the other rows. The result of this is that the bottom row of tubes expand more than the others, and will be under compression when the boiler is steaming. When the capacity of the material to withstand this strain is not the same at all points, the tube will bend and curve inwards where the material is weakest. Now it is found that after a tube has been in use for some time, in the bottom row, that the material where exposed to the fire has deteriorated to a very marked degree when compared with the rest of the tube. Especially is this the case when the tubes contain scale. The underside of the tubes, over the fires, being, therefore, less able than the top to withstand the strain, the tube bends and curves upwards.—H J. W.

Answer to No. 1,062 (awarded 7s. 6d.).—The cause of the tubes of Babcock and Wilcox boilers having a tendency to bend in the opposite direction to that in which the fire is situated appears to be somewhat as follows. Suppose the tubes to be in a condition without stress when the fire is first lighted, then when the boiler warms up and the fire attains its maximum temperature, owing to there being a deposit of mud on the lower side of the tube, and also through its being nearer the fire, this portion is raised to a temperature very much higher than the upper portion, the result of this being to impose a tensile stress in the top half and a compressive stress in the lower half of the tube due to the bottom expanding to a greater degree than the top half. The lower portion of the tube, in fact, gets raised at times to nearly a red heat, with the result that it is stressed slightly beyond its elastic limit, the latter being comparatively low at this temperature. Now, when the boiler cools down there will be, as a consequence of the bottom portion of the tube contracting to a larger extent than the upper portion, a tensile stress set up in the lower half of the tube and a

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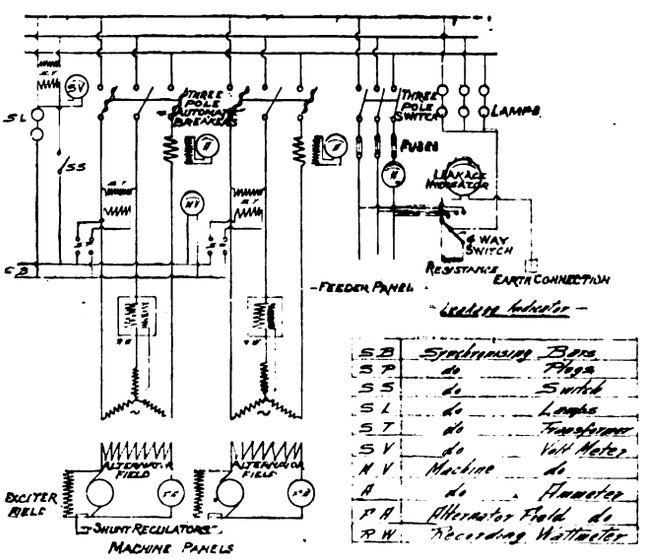
compressive stress in the upper part of the tube, and owing to both portions being nearly about the same temperature at this time they will be both stretched to the same extent, and so it is seen that as the boiler is repeatedly heated and cooled the tubes exposed to the greatest heat gradually acquire a permanent set.—S. F. SMITH.

Answer to No. 1,062 (awarded 5s.).—The bending of the tubes complained of is probably due to the position of the brickwork in the furnace. The design of the Babcock and Wilcox boiler is such that the tubes should be perfectly free to expand, the weight of the tubes and headers being taken up by the drum, which is hung from the girders, which pass under it, at the front and back ends. If, however, the brickwork be built up so as to interfere with the free expansion of the tubes in a longitudinal direction, bending must take place. When we consider the brickwork we can see that the tubes are more or less supported by the bridge at the back of the grate. At a distance back about the same as the bridge from the front is another baffle wad, which would tend to keep the tubes from bending up here. It will thus be seen that the easiest way for the tubes to bend is *upwards*, and the maximum bend will take place somewhere about the tubes over the grate.—E. V. C.

Answer to No. 1,062 (awarded 5s.).—The slight bending of the tubes on the bottom rows of the Babcock boiler is due to the following reasons: In a water-tube boiler it is a well-known fact that the likeliest place for failure is at the bottom row just over the centre of the fire, this being the portion of the boiler where the tubes catch the hottest flame, and there is the probability of a heavy internal coating of scale in these tubes. The carbonic acid in the feed water, which holds the carbonates in solution, is lost as the water rises in temperature, and the sediment is thrown on to the inside of the tubes. According to the thickness of this scale the tube will heat, in extreme cases bulging and splitting of the tube resulting. In the case in question this heating of the tube is probably not very marked, but still local heating due to the scale does occur. The heat due to the combustion of the gases naturally decreases as the gases (due to the combustion of the fuel) rises through the tubes, and the top rows will not become so hot as those nearest the fire. If such heating is taking place, the force of the draught, which is upwards, will tend to strain the tubes in the direction noted by "Froissart." Of course, such bending will only be slight. The forcing of this class of boiler, especially on the peak loads, is pretty general, and under this excessive forcing the boiler is subject to undue straining. In this case the weakest part of the boiler must suffer, and when the pressure of the gases on the tubes is considered when forced draught is used, the slight bending of the tubes in the upward direction is easily accounted for.—F. M. M.

Question No. 1,063.—What do you consider the necessary instruments, etc., required on the switchboard panels of a three-phase power plant for the necessary control and safety, etc. (parallel running): (1) generator panels and (2) power panels, 550 volts, 25 cycles? They must comply with the Coal Mines Regulation Acts (Special Rules). Give sketches.

Best Answer to No. 1,063 (awarded 10s.).—The sketch shows the necessary instruments and connections for the parallel running and control of two generators and one feeder, the gear for any other circuits being a repetition of that shown. As the load is mostly for power, it may be assumed to be balanced, and only one watt hour meter and one ammeter are provided for each machine. If, however, it is not found possible to properly arrange the lighting circuits so as to get a good balance, it will be necessary to have two recording watt-hour meters and, at least, two ammeters in each machine. The ammeters in the machines are of the series transformer type, but may be replaced by moving-iron type if it is required to reduce the expense. The connections for the exciting circuits are shown for a direct-driven exciter for each machine, and no field switch is then needed. The leakage indicator, which is called for in the Coal Mines Regulation Act, is shown on the extreme right, and consists of a milli-ammeter, a multi-way switch, and suitable lamps and resistances; in practice the meter and switch are usually combined in one case. The three-pole automatic switches in the generators should be of the oil-break type, and the fuses on the feeder of the enclosed ventilated switch type. Transformers are shown for the synchronising gear, but this is not absolutely necessary for 550 volts, although it is to be preferred, as it does away with the large number of lamps otherwise required. In addition to the instruments shown, those being the only necessary ones, it would be advantageous to have an indicating wattmeter in each machine, and also some form



of rotary synchronoscope, the latter making the paralleling a much easier and more certain matter. No 'bus-bar voltmeter is shown, as the synchronising voltmeter may be used for this by leaving the switch, S S, open when not actually paralleling.—E. V. C.

Answer to No. 1,063 (awarded 5s.).—The instruments, etc., may be coupled up with or without the intervention of instrument transformers. The addition of instrument transformers makes the system, perhaps, more complicated and more costly, but since 550 volts alternating current is rather dangerous to life, it will, perhaps, be safer and better to use instrument transformers so that it will be quite safe to handle any of the instruments while alive. It is the usual practice to transform down to 100 volts for the voltmeters and shunt coils, so that the ratio of transformation for the shunt transformers will be 550 to 100 or 110. If there is no one in constant attendance at the board, then I think it is advisable to have automatic circuit breakers in the generator circuits fitted with reverse-current relays. This, however, is, perhaps, unnecessary if the board has constant supervision. For paralleling purposes it is possible to use either a voltmeter (with, perhaps, lamps as a stand-by) or a rotary synchroscope, the latter being the better if the load fluctuates greatly during paralleling. There may be in the generator circuit either only one ammeter in one of the phases or three ammeters for the three phases. If expense is an item, then one may be used, but it is advisable to install three, since then it is possible to discover any fault more readily, and so rectify it quickly, so that the following will be the arrangement:

Generator Circuit.—Leads from generator come to quick-break circuit breaker (or automatic circuit break with reverse-current relay), then to an isolating switch (which can be used for paralleling) and on to 'bus bars, through the medium of current transformers, to the secondaries of which are connected the ammeters, the current transformers being placed between the two switches. Between the circuit breaker and other switch will be placed the shunt transformers, to the secondary of which is connected the paralleling voltmeter. On this panel will also be a direct-current ammeter placed in the field circuit, and also a regulating resistance in the field circuit.

Feeder Panel.—The leads from the 'bus bars will go through an isolating switch, then on to series transformer (for ammeter or wattmeter in this circuit), and then on to an automatic circuit breaker fitted with overload release, and then out. The trip coil fitted to overload release will be connected either directly in the circuit or through

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an intermediary current transformer. In this circuit it will be necessary to have only one ammeter or a wattmeter giving instantaneous watts.

An energy meter can be placed either on each generator or one only can be placed between the generators and the feeders, and thus giving the total number of units used. In this case there will be series transformers in the 'bus-bar circuit (between the generators and the feeders) for the energy meter and also two shunt transformers, to the secondaries of which will be coupled the synchronising voltmeter, 'bus-bar voltmeter, and shunt coils of the three-phase energy meter. Only one 'bus-bar voltmeter is necessary, as by means of a plug this voltmeter may be coupled to any phase. A voltmeter may also be connected (in a similar manner to the 'bus-bar voltmeter) so as to give voltage of each generator, and may be connected to

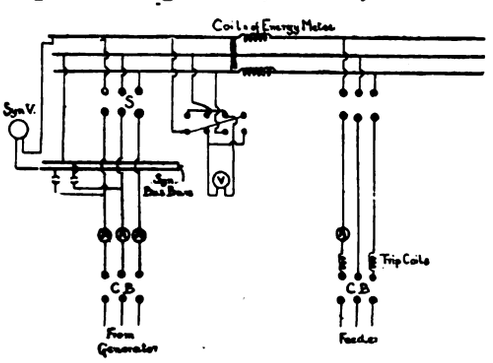


FIG. 1.

any machine by means of plugs. Fig. 1 gives a rough sketch of the arrangement, the instrument transformers being left out for simplicity.

In accordance with Rules No. 6 and 7 of the "Special Rules for the Installation and Use of Electricity" issued by the Home Office, as required by the Coal Mines Regulation Act of 1887, an instrument is required which will show immediately any defect of the insulation of the system. The readings of this instrument are to be recorded daily. Fig. 2 illustrates the three-phase leakage indicator for circuits in which the neutral points are not earthed by Messrs. Ferranti Limited, which fulfils the requirements of the special rules mentioned previously. In consists of a long-scale alternating-current milliammeter reading up to 250 milliamperes, a spring four-way switch, a special resistance, and three tell-tale lamps; the whole is attached to a polished slate base, and, therefore, self-contained. The

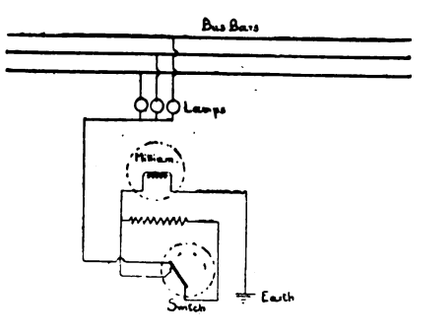
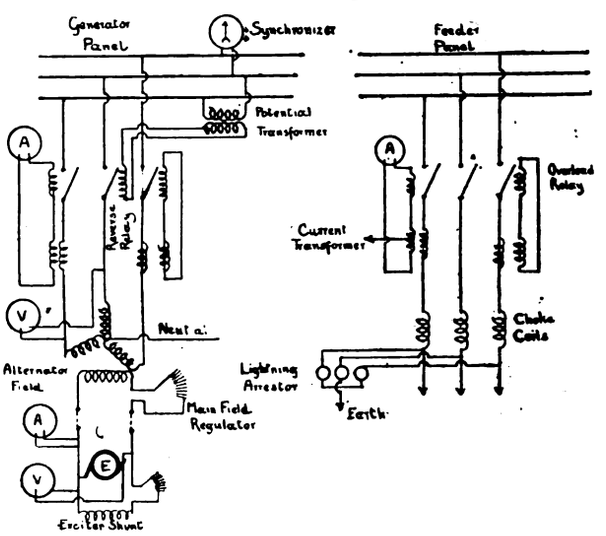


FIG. 2.

three lamps are connected in star. To the artificial neutral point so formed one terminal of the milliammeter is connected, and thence through a switch to earth. The voltage of the lamps must correspond with the voltage between phases. Thus for 550 volts, two 220-volt 16 c.p. lamps must be used in series on each phase. Under normal conditions the tell-tale lamps would glow with equal dullness, providing the insulation on each line is good. A slight leakage on any line, though not sufficient to be seen by the eye on the lamps, will be indicated on the ammeter. With perfect insulation, therefore, no reading will be observed on the instrument. Directly, however, the insulation begins to fail this will show up the milliammeter. Should one of the mains become of bad insulation, the lamp belonging to it goes out and the other two burn brighter. The object of having the lamps is to indicate directly a bad fault comes on the system without the attendant having to make observations on the instrument. In order to get more accurate criterion of the insulation, readings must be taken periodically with the switch in positions 1, 2, and 3. By moving the switch off the normal position, the earth on the artificial neutral point of the lamp is removed and each line is connected up in its turn to earth, through resistance as well as milliammeter. This resistance is of such a value that with a dead earth on one phase the instrument will indicate a full scale deflection when connected to either of the other two and zero when connected with that one phase. The switch is provided with a spring which automatically brings it back to its normal position.—M. R.

Answer to No. 1,063 (awarded 5s.).—The alternating-current instruments required for the efficient control of each alternator are a voltmeter, ammeter, three-pole circuit breaker fitted with automatic reverse-current and overload release coils and suitable synchronising apparatus. It is a matter of opinion whether one ammeter is provided in each phase; the usual practice, however, is to provide an ammeter in only one of the phases, especially as the average power load is practically balanced. The circuit breaker should be provided with overload relays on two of the phase leads and a reverse-current relay in the remaining phase. These overload relays would be operated by current transformers, which could also be utilised for working the ammeter, as shown in the figure. It is optional whether the generator panel is equipped with a circuit breaker or a switch fuse on each pole, or three-pole switch



and ordinary fuses. Fuses are now very seldom employed on the generating panels of up-to-date alternating-current power boards, especially in view of the modern requirements of circuit breakers fitted with no-volt, reverse-current, and overload release coils. Further, the use of a circuit breaker, which can be easily reset, is of great advantage compared with the ordinary fuse with the attendant troubles on blowing, especially with alternators in parallel. The exciter panels would contain a voltmeter, ammeter, double-pole switch, double-pole fuse, main field regulator, and possibly a shunt field regulator, depending on the size of the sets. The volt and ampere meters are not an absolute necessity, but it is preferable to employ both, or at least one of them. The main feeder panels should each contain an ammeter and a three-pole circuit breaker fitted with overload release coils on two of the phases, or, in place of the circuit breaker, a switch fuse on each pole or a three-pole switch and fuse is sometimes used. The previous remarks on the employment of three ammeters for each machine apply here also for each feeder. If the neutral is "earthed," it may be necessary to equip each generator with an "earth" switch and a suitable resistance. An earth detector will also be required, but this apparatus need not be fitted on the main board. The provision of wattmeters is not a necessity, and is chiefly influenced by the question of first cost.—K.

[Other replies to Question No. 1,063 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

1,073. By what methods can a short-circuit in an armature be accurately located without the use of testing instruments?—A. L. R.

1,074. In many designs of turbo-generators fans are fixed to the rotor to produce the necessary draught for cooling. What governs the design of these fans for such high tip speed? How is the pressure, efficiency, and output affected by number of blades, depth of same, and shape?—ERNEST LINDOW.

ANSWERS.

Question No. 1,063.—What do you consider the necessary instruments, etc., required on the switchboard panels of a three-phase power plant for the necessary control and safety, etc. (parallel running): (1) generator panels and (2) power panels, 550 volts, 25 cycles? They must comply with the Coal Mines Regulation Acts (Special Rules). Give sketches.

Answer to No. 1,063 (awarded 7s. 6d.).—The design that has been taken for an example is that for a power switchboard to control two three-phase 550-volt 25-cycle generators of about 1,000 kw. each, supplying four feeder circuits, this constituting a fair example of modern switchboard design. The design of the board has been laid out based on the proposed new Home Office rules, the equipments of the panels being as follows: generator panels, each containing one triple-pole main oil-immersed switch having automatic overload trips, one main ammeter, one generator voltmeter, two current transformers (mounted at back of board), one exciter ammeter, one exciter voltmeter, two field regulating rheostats (exciter and generator), one double-pole field switch, two four-point receptacles with two plugs (the receptacle being capable of taking its respective plug only); feeder panels, each containing

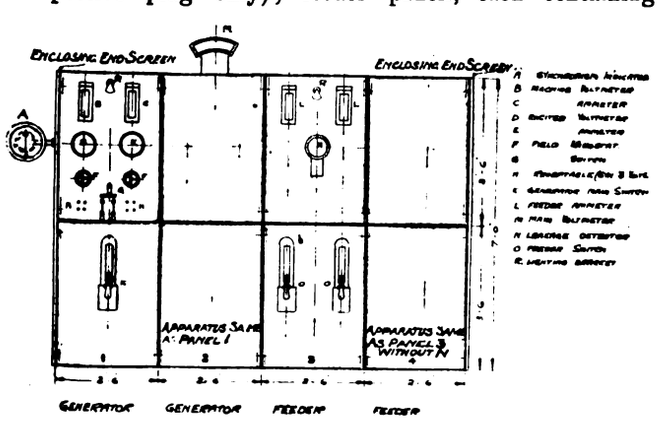

FIG. 1.

two triple-pole main oil-immersed switches with auto trips, two main ammeters, four current transformers (at back). One main station voltmeter has been shown mounted on a pivoted bracket at the top of the board, a synchronism indicator being necessary for paralleling, this being mounted at the side of the switchboard on a swinging bracket. End screens with doors are necessary for enclosing the two ends of the board in accordance with Home Office rules. These rules also states that there shall be a clear height at the back of the board from live conductors of not less than 7ft. (for 550 volts) and a width from any bare conductor of not less than 3ft., so that the height of 'bus bars and width of passageway should be arranged to comply with these requirements. The front view of the switchboard is shown in Fig. 1, and a reference to Fig. 2 will show clearly the connections of the apparatus and machines, complete connections for one generator panel and one feeder panel being shown. Reverse-current or power relays have not been included, as they do not form an *essential* feature for generators running in parallel, and are an additional expense to the initial cost of the switchboard. Indicating lamps or bells are usually used in connection with the main oil switches to indicate a switch automatically opening. These have not been shown. Isolating swing links are shown between all the oil switches and the 'bus bars to enable the former to be isolated from the bars for inspection or repairs.

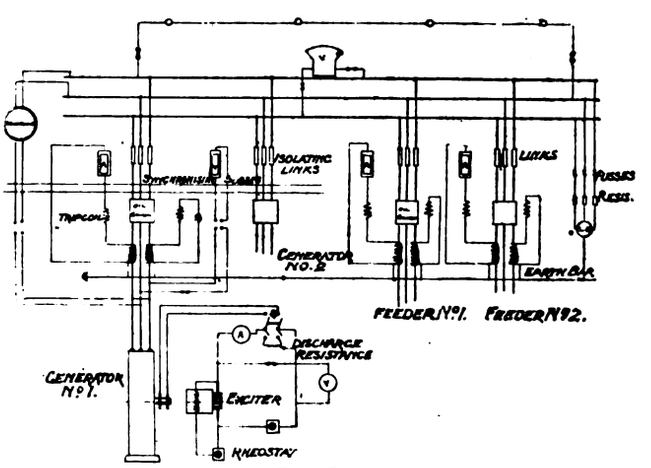

FIG. 2.

These links also constitute a means of completely isolating the 'bus bars from the generators, which, I think, is one of the Home Office rules. It might be mentioned that oil switches operated by means of current transformers effect a considerable saving in the cost of heavy connections at the back of the switchboard. Quick-break lever switches and circuit breakers could be installed as an alternative to previous arrangement.—X.

Answer to No. 1,063 (awarded 5s.).—Fig. 1 shows the general arrangement for a three-phase plant, and consists of two generator panels, two power panels, and a synchronising panel. The generator panels have a three-pole knife switch, S, and reverse-current cut-out, which trips the switch on a reverse current passing through the cut-out, a wattmeter, voltmeter, and ammeter of the direct-reading type. The field regulator of each generator, S R, on the

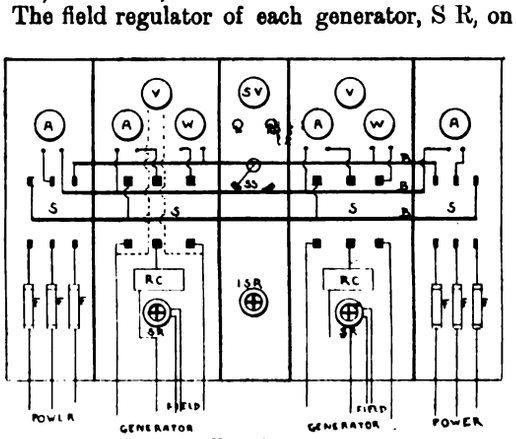

FIG. 1.

panel are so arranged that when running in parallel these regulators are interlocked and both worked from the common handle, I S R. The three 'bus bars, B, B, B, run the length of the board, the voltmeters being coupled across the two outer generator leads. The writer does not consider it necessary to put fuses in the circuit to protect the generator, as modern alternators will stand a short

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for a few minutes. The reverse current cut-out will be found to possess advantages. The two extreme panels are for power distribution, and only one ammeter is shown. If, however, the middle point of the generators is earthed, it will be necessary to have an ammeter on each phase, because, should one of the cables break down, one amperemeter alone would not show the overload necessarily, which is caused by the earth. These panels also contain the necessary three-phase switches and fuses of the cartridge type in each phase. The middle panel contains the

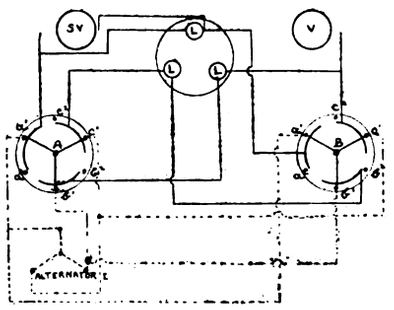

FIG. 2.

synchronising switches, lamps, and voltmeter. Details of this synchronising arrangement are shown in Fig. 2. As shown, the No. 2 generator is connected on to the studs, a_2, b_2, c_2. If it is desired to synchronise No. 2 generator with the generator already on the 'bus bars, the first thing is to see that both the voltages are alike by means of the voltmeter on three respective panels; switch B is left on studs a_2, b_2, c_2, and switch A on studs a_1, b_1, c_2 of the running machine or the 'bus bars. The extinction of the lamps is then noted, and the speed of extinction is made identical by regulating the speed of the generator. The main switch is closed when the lamp, L_1, is dark and the voltmeter, S V, registers zero voltage. The above arrangement should meet all the requirements. The voltage not being high the switchboard should be so arranged as to allow ample room at the back for any alterations, and in Fig. 1 it will be noted that all fuses, etc., become dead on breaking at the switches.—F. M M.

Question No. 1,064.—I should be obliged if some of your readers would supply me with full particulars of an electro-galvanising plant for boiler tubes, etc. The sizes of the tubes vary from 1in. bore to 8in. bore, and the maximum length about 20ft. Also state if more than one tube can be treated at one time.

Answer to No. 1,064 (awarded 10s.).—The electrical method of galvanising has so many advantages over the hot process that the arrangement of plant and details of working deserve careful consideration. A complete equipment includes not only the actual "zincing" process, but also the preparation of the objects ready for the bath. In the first place, it should be noted that the chemicals used in this process are destructive to machinery, etc., so that the work should be carried on in a well-ventilated building with a good water supply. To ensure the tubes having a clean surface, they are subjected to a previous process known as "pickling," which removes all rust and scale. This is accomplished by immersing them in a solution of one part of hydrochloric acid in 20 parts of water contained in a long bath, the time required depending entirely on the condition of the surfaces. After being pickled the tubes are washed in clear water, and are then

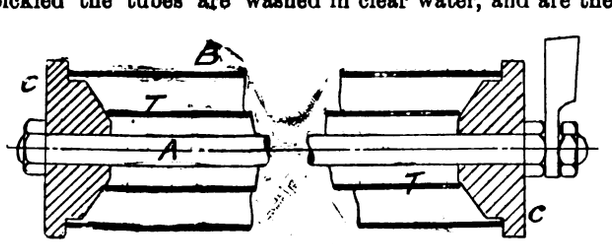

FIG. 1.

ready for the plating vat. This consists of a solution of zinc sulphate in the following proportion: 350oz. zinc sulphate, 1oz. sulphuric acid, and 10 gallons of water, which should be kept free from impurities to obtain good bright deposits. The anodes used are of lead, as zinc electrodes are found to crumble away and cause a rough, lumpy deposit. Fire-tubes for boilers do not need galvanising inside, but tubes for use in condensers and economisers have to be coated inside. This is a more difficult matter than at first sight appears. In order

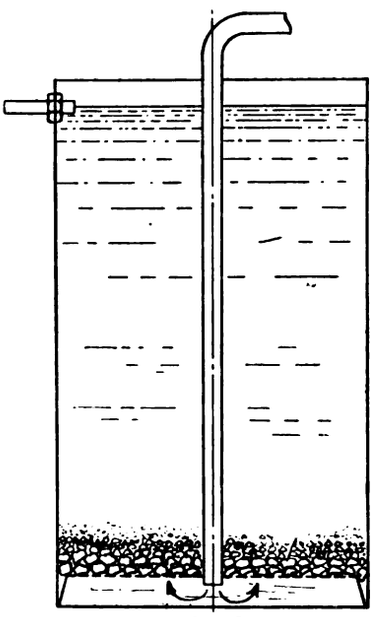

FIG. 2.

that the deposit may be uniform all over, an anode must be taken down the centre of the tube as shown in Fig. 1. T, the tube being treated, is fitted at the ends with insulating caps, C, which hold the anodes, A and B, in

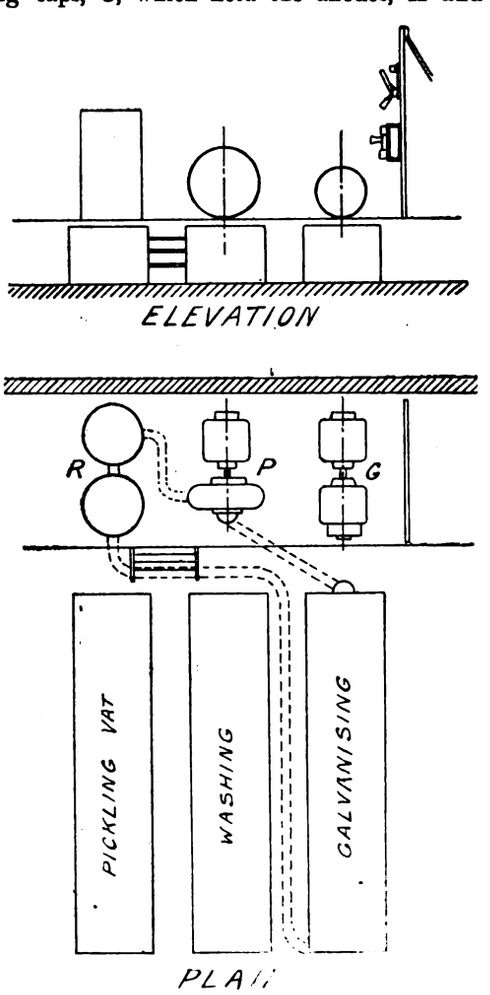

FIG. 3.

position, and are drilled to allow of circulation of the electrolyte. One anode, A, takes the form of a rod clamping the whole together, and the other, B, is a cylinder enclosing the tube.

To keep the solution up to normal strength, a regenerating process is effected by having a filter-bed of zinc dust

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or tultz and coke in separate tanks through which the solution is pumped. A regenerator is shown in Fig. 2, where the electrolyte passes down the centre tube and up through the mass supported on the grid at the bottom of the tank. The impoverished electrolyte is drawn by a centrifugal pump from the bath over a sill at the end, through the regenerators, and back again into the bottom of the bath. When the articles are first placed in the tank it is found well to use as high a current density as possible, and after a few minutes to reduce it to about 15 amperes per square foot. A dynamo having a capacity of 1,000 amperes at 6 volts will be a convenient size for galvanising a pipe 8in. bore by 20ft. long, and with a thickness of 1oz. to 1½oz. per square foot about 60 such tubes will be turned out per week of 54 working hours. As many tubes can be treated at once as the bath will accommodate, but it will be no advantage to increase the bath beyond a certain size, as the limit to the rate of production will be found in the dynamo; but up to a certain point it is better to do a moderate number of tubes quickly than a great number slowly, as less electrolyte is required in the former case.

The general arrangement of a plant is shown in Fig. 3. The tanks are placed on the floor level, and the motor-driven pump and dynamo, along with a small control board, are fixed on a raised portion to keep them out of the dirt and wet. The pipe connections between the "zincing" vat, pump, P, and regenerators, R, are shown by dotted lines. G is the motor-generator for supplying the galvanising current, and is placed near the tank to save lengths of stout copper conductors.—I. B. S.

Question No. 1,065.—I should be pleased to learn through your columns the most practical method of testing the temperature rise of coil and other resistances, and shall also be glad to know what formula to use in calculating the rise of temperature of resistance wires.

Answer to No. 1,065 (awarded 7s. 6d.).—There are several methods of determining the temperature rise of resistances, and the most suitable one to adopt will depend upon the circumstances of each individual case. The simplest is by direct measurement with a thermometer placed upon the coil. In many cases, however, this method cannot be adopted, as parts of the coil are inaccessible. If the resistance is wound in such a manner that air is free to circulate through the winding, as is the case with arc lamp resistances, resistance frames consisting of stretched spirals, etc, the best method in the writer's opinion is by measuring the increase of resistance of the coil after it has attained its normal working temperature. The resistance of the coil may be easily determined by passing a direct current through it and measuring the voltage drop across its terminals. Then

$$\text{Resistance} = \frac{\text{voltage drop}}{\text{amperes}}.$$

If R_1 = resistance when cold, R_2 = resistance when hot, t = temperature rise, and a = temperature coefficient, we have

$$R_2 = R_1 \{1 + a\,t\} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Transposing,

$$t = \frac{\left(\frac{R_2}{R_1} - 1\right)}{a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The temperature coefficient a varies for different metals, and a list of values is given in most pocket-books. If a is given for degrees C., then t will be in the same units. The coefficient a varies slightly at different temperatures, but for all practical purposes may be assumed a constant. It is obvious that this method will give the mean temperature rise of a coil, and will only give actual figures if the whole of the coil is at an even temperature. In the case of resistance coils wound in several layers, the inside layers may attain a much higher temperature than the exposed portions, and the best method of measuring the temperature would be to bury thermo-junctions at suitable positions in the coil when it is being wound. The terminals of each thermo-junction may then be connected to a micro-voltmeter, calibrated to read directly in degrees C.

Temperature rise may be calculated from the formula:

$$t \text{ degrees C.} = \frac{\text{K} \times \text{watts wasted in resistance}}{\text{radiating surface in square centimetres}};$$

where t = temperature rise and K = a constant. The value for K will depend upon the shape of the coil. It will probably be between 340 and 380, but can best be determined by experience.—MARCUS.

Answer to No. 1,065 (awarded 7s. 6d.).—A common laboratory method of obtaining the temperature of a wound bobbin or resistance consists of fixing a thermometer to the outside of the coil and wrapping the bulb of the thermometer with a small piece of felt or flannel to prevent the heat from radiating from the surface of the bulb, and, provided the resistance or bobbin is shielded from air draughts, very fair results can be obtained by this method. In the case of a bare resistance the thermometer should not touch the resistance itself, but should be fixed as near as possible. In any case a number of readings should be taken and the mean value obtained as the final result. An alternative method to the above would be to calculate the temperature rise from the following particulars: The rise of temperature in a coil due to the passage of current through the wire, is approximately proportional to the watts lost in the coil per unit of effective radiating surface. Thus:

$$t \propto \frac{I^2 R}{S} \text{ or } t = \frac{I^2 R}{K\,5}.$$

I = current, t being the temperature rise in degrees F., S the effecting radiating surface, and K a coefficient which varies widely according to conditions. In electromagnet coils of small size and power K may be as large as 0·015. Ordinarily it ranges from 0·012 down to 0·005; a fair average value is 0·007. The more exposed the coil is to air circulation the larger is the value of K. The larger the proportion of iron to copper, by weight, in the core and winding, the thinner the winding with relation to its dimension parallel with the magnet core, and the larger the "space factor" of the winding, the larger will be the value of K. The space factor is the ratio of the actual copper cross-section of the whole coil to the gross cross-section of copper, insulation, and interstices. The average temperature throughout a bobbin wound 2in. or 3in. deep may be 20 to 30 per cent. higher than the surface temperature.

Regarding the calculation of the temperature rise in any resistance, the following particulars may be taken for the calculation. When a current, C, passes through a resistance, R, the rate of dissipation of energy as heat = $C^2 R$ watts, where C is in amperes and R = ohms. One watt = ·24 calorie per second. This heat will be partly absorbed, causing a rise of temperature, and partly dissipated by radiation. The relation between temperature rise and watts is given by the following formula:

$$\text{Watts} = \text{W S} \frac{\theta}{t} \times 0{\cdot}524;$$

where W = lbs. = weight of resistance, S = specific heat (see Table I.), θ = temperature rise in degrees C., and t = time in hours. Thus for copper at 1,000 amperes per square inch the rise of temperature without radiation will be 0·77deg. C. per minute.

The heat dissipated by radiation depends upon the following: (1) nature of radiating surface represented by a constant, K; (2) area of surface represented by A; (3) the temperature difference between the radiating surface and the surrounding space, represented by θ.

$$\text{Watts dissipated (in radiation)} = \text{K A } \theta.$$

K, taken as before, = 0·007 for a fair average value. Thus, bearing in mind that, as previously stated, the total heat will be dissipated partly by radiation, the remainder absorbed causing a rise of temperature, it will be easily possible to find this temperature rise from the above.

TABLE I.

Metal.	Values of S.
Copper	·09332
German silver	·09710
Nickelin	·00795
Kruppin	·01228
Aluminium	·21800
Platinum	·03230
Brass	·09390
Iron wire	·11300

—X.

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Answer to No. 1,065 (awarded 5s.).—There are two methods of obtaining the temperature rise of coil or other resistances.

First Method. — The bulb of a sensitive mercury thermometer is placed against the resistance the temperature of which it is desired to obtain, the bulb and as much of the stem as possible being well covered with cotton wool. This method only gives the surface temperature, *not* the internal temperature; this in a deeply-wound coil may be several times greater than the temperature on the surface.

Second Method.—Measure the resistance of coil when cold with a Wheatstone bridge. Pass full load current through the resistance until surface temperature remains steady. Switch off current from the resistance and quickly measure the resistance of coil when hot. Now copper increases its resistance ·42 per cent. per degree C. rise in temperature; from this the average temperature can be obtained.

Let resistance when cold = 60 ohms and resistance when hot = 65 ohms. Then percentage increase of temperature

$$= \frac{5 \times 100}{60} = 8{\cdot}3 \text{ per cent.}$$

$$\frac{8{\cdot}3}{{\cdot}42} = 20\text{deg. C. rise in temperature.}$$

Or the temperature may be calculated from the formula employed for finding the increase in resistance of a conductor when the temperature rises.

Let R_1 = initial resistance, R_2 = final resistance, a = a coefficient = ·004 for all metals except iron and tin; for iron equals ·005. Let T = temperature in degrees C. Then

$$R_2 = R_1 (1 + a\,t).$$

$$\therefore \quad T = \frac{\frac{R_2}{R_1} - 1}{a}$$

The rise in temperature of resistance coils cannot be exactly determined by means of a formula; approximate results may only be expected. The rise in temperature depends on so many conditions; it depends on the resistivity, the specific heat, and the surface, the radiating power of which varies greatly, being greater for dull or black bodies than for bright or polished ones. Roughly, ·00025 of a heat unit will be radiated per square centimetre of external surface per degree C rise of temperature above the surrounding medium. The temperature will rise until the rate of radiation is equal to the rate of development of heat, when the temperature will remain constant.

Let an example be taken such as the following: Let current = 50 amperes, resistance = ·5 ohm, and surface of resistance strip = 10,000 square centimetres. Then heat generated by current in calories per second

$$= C^2 R \times {\cdot}24$$

$$= 50^2 \times {\cdot}5 \times {\cdot}24 = 300 \text{ calories.}$$

$$\text{Now, temperature rise} = \frac{\text{rate of development of heat}}{\text{rate of radiation of heat}};$$

$$\therefore \quad \frac{300}{{\cdot}00025 \times 10{,}000} = \frac{300}{2{\cdot}5} = 120\text{deg. C.}$$

The above calculation only applies to bare wire or strip resistances with free ventilation.—A. V. A.

Answer to No. 1,065 (awarded 5s.).—"H. H. C." does not state whether the resistance coils are of large or small capacity. Let us assume first that they are of high resistance and comparatively small current capacity. The obvious method would be to measure the temperature rise by means of a thermometer, but this is not always practicable on account of, say, delicate construction or inaccessibility. If this is so, it is possible to arrive at a very fair approximation of the temperature in the case of spirals in an enclosed situation as follows: Wind a spiral which can be placed in amongst the coils of resistance without making electrical contact with them. It should have a resistance of at least 200 ohms, and should be situated at about three-quarters of the height of the spirals from the bottom. Measure its resistance accurately when cold, and then pass current through the rheostat for any stipulated time, and at the end of this time measure the resistance of spiral again. Leads for this purpose should be permanently attached to the spiral and a "bridge," so that, if necessary, a curve of temperature rise may be plotted. Now, calling R_2 = final resistance of spiral, R_1 = initial resistance of spiral, T_2 = final temperature, T_1 = initial temperature = temperature of atmosphere (assumed), a = temperature coefficient = ·0038 for copper = 00044 for German silver. Then

$$T_2 = \frac{(R_2 - R_1)}{R_1 \times a} \times (1 + a\,T_1).$$

Great care should be taken in measuring R_2 and R_1, and in order to make $R_2 - R_1$ as large as possible, it is advisable to use copper wire for the spiral. In measuring the temperature of a large capacity resistance of cell or woven type, it is usually possible to get a thermometer into good contact with the current-carrying metal, and by screening the bulb with cotton waste avoid errors due to draughts, etc. With regard to formula for calculating temperature rise, so many things affect this that it is impossible to arrive at an expression to cover all cases from open spirals to resistances enclosed in boxes. We may calculate temperature rise for given cases, but unless the conditions are fairly straightforward a large error is likely to result. An expression for the temperature rise of a straight wire carrying current may be found in many text-books.—BALANCE.

Question No. 1,066.—In converting a steam power-driven engineering shop to electric power-driven, what are the chief items to take in consideration, and what are the best formulæ to adopt for lathes, slotting and planing machines, say, up to ¼in. cut; also formula for blower for smiths' fires?

Answer to No. 1,066 (awarded 5s.).—This is a question which is and has been receiving a great deal of attention. The first thing to consider, after it has been decided to change to electric driving, is the size and arrangement of the machines and the nature of the work they have to do. The next item to settle is which machines shall be separately driven, and how to group others together. It is preferable for many reasons to give a separate motor to all large machines such as lathes, planers, and slotters, etc., which require more than 10 h.p., but when there are a number of small machines a motor for a length of shafting is good practice. It is hardly possible to give formulæ to adopt for calculating the power of motor required, or to give curves of capacity of machine and power of motor. At present it is one of those things which can best be decided by experience and experiment.

The following particulars are from actual practice in a large works in this country:

Machine.	Rated horse-power of motor driving it.
Large four-head locomotive frame slotter	25
Cylinder port slotter (special machine)	4
Chuck lathe for tyres	2
Axle lathe (large)	25
Wheel-turning lathe (small)	5
Planer, 10ft. 6in.	4

The power required to drive a given machine varies so much with the design of it, the method of driving material worked on and nature of tool used, that no definite law can be laid down.

With regard to the request for a formula for power taken for blowers for smiths' fires, it is not possible to give a satisfactory one. However, Mr. Williamson in his paper on "Applications of Electricity in Engineering and Shipbuilding Works" read before the Institution of Electrical Engineers in May, 1903, gives the following particulars: (*a*) fan for nine fires, 5 h.p. to 5·5 h.p. actually required 5-h.p. motor installed; (*b*) fan for 23 fires and a laboratory air blast, 8·5 h.p. required, 10 h.p. installed; (*c*) Roots' blowers for eight fires and heavy lead melting pot required, 6·4 h.p., 10-h.p. motor installed, which works out for (*a*) ·55 h.p. installed per blast, ·61 h.p. required; (*b*) ·42 h.p. installed per blast, ·35 h.p. required; (*c*) 1·1 h.p. installed per blast, ·71 h.p. required, which gives an average of 7 h.p. installed per blast and ·55 h.p. required per blast. "Workshop" should also read Mr. Chatwood's paper on "Electric Driving in Machine Shops" read at the same time as Mr. Williamson's.—M. G. TWEEDIE.

[Other replies to Question No. 1,066 will be given in our next issue.—ED. *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

1075. Which is the most efficient system of electric welding for jobbing work about a large engine works—*i.e.*, repairs to shafts, etc.? It is to be worked during the day from a private lighting installation of about 110 volts, 400 amperes, continuous current (compound-wound dynamo).—E. J. McDONALD.

1076. What are the chief difficulties met with with single-phase commutator motors for railway work?—POWER.

ANSWERS.

Question No. 1,066.—In converting a steam power-driven engineering shop to electric power-driven, what are the chief items to take in consideration, and what are the best formulæ to adopt for lathes, slotting and planing machines, say, up to ¼in. cut; also formula for blower for smiths' fires?

Best Answer to No. 1,066 (awarded 10s.).—In adopting electric driving to an engineering shop the evident motive is economy. This economy may be obtained in various ways, and may not in all cases be dependent on the power costs. Ease of working and the speed at which the work goes through the shop are important items, which may far outweigh any considerations as regards power costs. It should be borne in mind that in a works of this description the cost of power rarely exceeds 10 per cent. of the cost of the finished production. A saving of 50 per cent. in this respect will mean a saving on the total costs of 5 per cent., an item sufficiently large in these days of fierce competition not to be underestimated. However, the ease of doing the work and the increased production due to electrically-driven tools, amounting from 20 to 40 per cent, would certainly favour electric driving even at the same power costs as steam, so this increased production and ease of working must be considered before anything as regards power costs. Lathes, and that class of tool direct driven by shunt motors, the speed being varied by the insertion of resistance in the shunt field, thus enabling a much nearer approximation to the best cutting speed of the tool than can be obtained with speed cones, are tools which show a great increase of output by so driving.

The cost of power is the next consideration, such cost to include the upkeep, interest, and depreciation on the motors, plus the cost of the current. If it is decided to generate the current at the works, the saving effected by reducing the current consumption to a minimum, such as can be accomplished by providing motors to each tool, and doing away with all idle shafting, is not so important in regard to the power costs, as if current is obtained from an outside source the saving accomplished is not proportionate to the current saved, for the simple reason that the generating costs are made up of some items which do not decrease with the lower current consumption; this, then, is an item which must be considered—*i.e.*, the source of the current supply.

Upkeep of motors is the next consideration. Generally speaking, this cost is higher with the smaller motors, and a factor to take into consideration is that a motor possesses very little flywheel power, all the shocks and strains experienced in the working of the tool being thrown direct on the armature if the tool is direct coupled. The use of short belts for driving many of these tools is a point worth consideration; the belt being a very elastic coupling, the strain on the motor will not be so severe and the liability of a burn-out is lessened. The belt acts as a guide to the machine man; if he puts on too large a cut the belt slips and he knows at once that he has too large a cut on, whereas the blowing of fuses and the action of circuit breakers involves longer periods for the tool to remain idle. This point is worthy of study both in connection with the output and upkeep factors. The valuable speed properties of the motors can still be used, the belt simply acting as a flexible coupling. The nature of the work, as regards overtime running of the tools, must be considered, and, if possible, the tools must be arranged so that the minimum power in consideration of the work to be done is used at such times.

Considering the methods of driving: (1) Motor replacing existing driver is a most uneconomical method, anything up to 80 per cent. of the total load on the motor being taken by shafting and belts; it is very inelastic; the use of overhead cranes is most inconvenient troubles, due to light and vibration. (2) Motors direct coupled to line shafting require no cross belts or speeding arrangements, the cones being mounted on the shafting and actuated by clutches. A saving of 25 per cent. is accomplished by this method, owing to the absence of the speeding arrangements. This method is better than the former, but the current consumption is very high in comparison to the current actually required to do the work. (3) Direct-driven tools secure low current consumption, but high capital charges. The cost of power in this case may equal that in No. 2. When the total cost of the power is calculated, the ease of working, increased production, and the ability to place the tool in the best position as regards light and accessibility must be considered. Considering the factor of increased production in the first case, and then the cost of driving, the writer is of the opinion that a combination of systems 2 and 3, whereby the power costs are reduced to a minimum—that is, the total power costs, current, interest, depreciation, and upkeep—the grouping of suitable machines in small groups, and driving from short lengths of shafting, with separate motors to the larger tools, will be found the best, but the speed of production must always be the first consideration. The use of direct current is taken for granted in the above, this system being far superior to the alternating system, owing to the ease of speed control. For constant-speed work the induction motor is probably the better motor, owing to the absence of commutators. It gives very little trouble, and as a consequence the upkeep costs, as at a minimum it will take 100 per cent. overload for short periods, and can be even pulled up dead without injury. If the speed control of the motor is sacrificed, then the induction motor is the best motor to install. The power required to drive the individual tools varies greatly with various makes, the power required at the tool being only a small proportion of the power required.

The following gives a fair indication of power required: lathes up to 24in., 2 h.p.; milling and slotting machines, 6 h.p.; planing machine, 6 h.p.; drilling machine, ¾ h.p. to 1½ h.p.; metal saw, 3 h.p.; Root's G_2 blower (six fires), 6 h.p.; fan for smiths' (nine fires), 6 h.p.

The following formulæ are for lathes running light: light lathe H.P. = ·05 + (·0012 × spindle revolutions per minute); heavy lathe H.P. = ·25 + (·18 × spindle revolutions per minute); working H.P. = C × weight removed per hour in pounds; C = ·0314 cast iron, ·0327 wrought iron, ·047 steel.

For slotting and shaping machines,

$$\text{H.P.} = \cdot045 + \frac{\text{number of strokes per minute} + \text{stroke in inches}}{4{,}000}$$

Full load = 80 per cent. more.

For planing machines, H.P. = C × weight removed per hour in pounds; C = 112 mild steel, ·052 wrought iron.—F. M. M.

Answer to No. 1,066 (awarded 5s.).—The power required to drive the various machine tools doing actual work depends on the density of the material, the depth and breadth of the cut, and also on the shape of the tool. It is a difficult matter to definitely state the total power required to drive any particular machine unless obtained by dynamometric measurement, and although a great deal of information is available on the actual power consumption of the various machine tools, it is not necessarily representative of the power required for the individual machines as a class. The character of the work may also affect the power absorbed; thus a machine that is to be used exclusively for brasswork may have its speed increased from 10 to 15 per cent. above the speed that should be used with ironwork of similar size, and the power required would be proportionately greater. From actual test it has been shown that less power is required to turn off a given weight of metal in a given time than to plane off the same amount.

The power required to remove a certain amount of metal in a machine, according to Dr. Hartig's researches, is H.P. = C W, where C is a constant and W is the weight of

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metal in pounds removed per hour. The value, C, for various metals is as follows: cast iron, ·030; wrought iron, ·032; mild steel, ·047. The average of three actual tests, however, that have recently been carried out give a constant for cast iron ·026, wrought iron ·032, and mild steel ·044. To the power obtained from these constants for the actual work done must be added the power to drive the machine tool running light. This power varies so largely with the respective makes (although they are compared with the actual work done), that it is not possible to give any reliable rule to determine the power consumption. It is clear that, apart from the question of design of the machine, the free running of all the working parts, the tightness of the belt, etc., largely increases the power absorbed. An approximate rule to determine the power when running light for small lathes is:

$$H.P. = \cdot 095 + \cdot 0012\ N,$$

where N = the number of revolutions per minute. An average equation for the power necessary for small lathes under 20in. swing, with back gears in mesh, is:

$$H.P. = \cdot 10 + \cdot 006\ N.$$

These powers, of course, assume that the machines are in perfect running order, and that the belt losses are a minimum.

The power absorbed in driving a blower supplying air to smiths' fires will depend on the type of blower and size of same. The brake horse-power in the air delivered by the blower is:

$$B.H.P. = \frac{V \times W\ G \times 5 \cdot 2}{33{,}000};$$

where V = volume in cubic feet per minute, W G = water gauge in inches, and 5·2 = the pressure in pounds per square inch due to 1in. water-gauge. The over-all efficiency of small blowers should be taken at 50 per cent., and with large blowers of the Root's type up to, say, 50 h p, 65 per cent. These figures represent an average obtained from many makes of blower, and are reliable.

In converting the shop from steam to electrical driving, careful consideration will have to be given to the grouping of the machines to ensure the maximum economy consistent with a minimum capital expenditure. The tools which only work intermittently should each be driven, if possible, by a separate motor, or it is possible a row of machines are driven by a single line of shafting, in which case a single motor would drive the shafting. The advantage of this arrangement more be more apparent if the tools on this shafting were all constantly loaded. The question of the tools chiefly used for overtime work should also be considered, and if these tools cannot be adapted for a separate motor drive they should be driven by a line of shafting and a single motor. A compromise between the above suggestions might prove the most satisfactory. The driving of planers can be either arranged with motors geared direct or by belting; the former necessitates a reversible motor and special switchgear for the braking and reversing switches. A non-reversible motor can be efficiently employed by arranging the motor with a compound winding and flywheel. The field of the motor at normal load is not saturated, and as the extra load comes on at the reversal of the planer the speed of the motor is reduced, thereby permitting the flywheel to give up some of its stored energy. This has the effect of reducing the peaks of the energy consumed by the motor.—K.

Answer to No. 1,066 (awarded 5s.).—The object to be kept in view in considering the adoption of electric driving in any works is without doubt the saving of money, either by driving more cheaply or by turning out more or better work. The various machines in a works may be driven each by its own motor, or may be grouped in larger or smaller groups, and considerable experience and careful study of the particular works are essential in the determination of the particular arrangement which will best suit any particular case. It is essential not to form any hard-and-fast opinions as to the best arrangement, as there is room for the display of careful thought and the exhibition of much skill. The various items needing consideration may be summarised as follows: (1) will any, and, if so, which, machines turn out appreciably more or better work if provided with a variable-speed motor; (2) will the average power actually taken to run certain machines in a group under ordinary working conditions be a large or small proportion of the total power absorbed when the necessary shafting is included; (3) will any machine require to be placed in an inconvenient position, or in bad light, to avoid an awkward mechanical drive.

1. If a variable-speed motor will allow more or better work to be done by a machine, the adoption of such a motor will invariably be a wise investment of capital; among such cases in the machine shop are lathes which are not used regularly on repetition work, planing, boring machines, etc. Consider the time required to bore cylinders on a boring mill dealing with those, say, from about 16in. to 50in. in diameter, and suppose a complete range of sizes to be bored, the diameters rising by 1in. between sizes, the number of cylinders will be 35, the machine will have, say, 12 speeds. Taking maximum cutting speed at 50ft. per minute, and assuming the fastest and slowest speeds of the machine to give this cutting speed on the smallest and largest cylinders respectively, and the intermediate speeds to give equal differences, the time taken to bore a complete set, each of the same length, will be near enough 7 per cent. less with variable-speed motors than with the 12 speed used to the best advantage. This would mean after allowing for setting of work about 2·75 hours per week, or, taking the value of the output of the machine and man at 2s. per hour, 5s. 6d. per week, or £13. 15s. per year of 50 weeks, which is sufficient to more than pay the interest and depreciation on the extra cost and maintenance of the extra motor. In actual practice the saving on a machine such as that described would in all probability be considerably more.

2. Consider a line of 10 lathes of 18in. centres, driven by: (*a*) one 40-b.h.p. motor and a line of shaft 110ft. long; (*b*) 10 5-b.h.p. constant-speed motors, belt driven; (*c*) 10 5-b.h.p. variable-speed motors mounted on head stock. Capital outlay and full-load losses are given in the following table by Williamson:

—	Cost of driving arrangement.	Loss in shafts and belts, B.H.P.	Loss in motors, B.H.P.	Total loss, B.H.P.
(*a*) 40-h.p. motor, machines in two rows of five per row	£410	4	4	8
(*b*) 10 5-h.p. motors (C.S.).....	575	2	7·5	9·5
(*c*) 10 5-h.p. motors (300 r.p.m. to 900 r.p.m.)	685	—	7·5	7·5

With five out of ten working the losses are:

40-h.p. motor	3	3·00	6·00
Five 5-h.p. motors (C.S.)	1	3·75	4·75
Five 5-h.p. motors (variable speed)	—	3·75	3·75

The choice resting between (*a*) and (*b*). The average condition of affairs is that eight out of ten lathes are running. The total losses are: (*a*) 7 5 b.h.p.; (*b*) 6 b.h.p.

3. To reduce the whole question to a very simple basis, I would advise as follows: Plan out the shop so that the progress of work from machine to machine is constantly in one direction. Pick out the tools that will benefit from individual drives, and then group the rest to the best possible advantage. For further information respecting power for operating tools and machinery, "Workshop" is referred to the papers read by Mr. D. Selby Bigge before the Iron and Steel Institute in 1902, and Mr. A. D. Williamson, *Proceedings* of the Institution of Electrical Engineers, May 7, 1903.

A better account of the blower would be of much service, as "Workshop" has omitted the amount of work it has to do.

For centrifugal fans: P = pressure of blast in pounds per square inch; A = area of the sum of the tuyeres in square inches; V = velocity of tigns of fan in feet per second; H.P. = horse-power. Then

$$V = \sqrt{P \times 97{,}300}$$

$$P = \frac{V^2}{97{,}300}$$

$$H.P. = \cdot 000016\ V^2\ A\ P.$$

—W. HINGLEY.

Question No. 1,068.—A four-pole, 440-volt, compound, cumulative, direct-current motor, 35 h.p., with wave-wound armature (one

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set of brushes), 710 r.p.m., has four coils on the armature burnt out. On attempting to start the motor after repair the motor makes one-quarter of a revolution, then pulls up dead. Also it is found considerable force is required to move the armature round when no current is passing through the armature (brushes being lifted), but with the shunt field fully excited. The connections are gone through, and apparently the only thing wrong was that two adjacent commutator bars were short-circuited. Give explanation of behaviour. Diameter of armature 15½in., length 9¼in., 69 slots ⅜in. wide, 348 conductors, 137 commutator bars.

Best Answer to No. 1,068 (awarded 10s.).—From the question it can safely be assumed that the field is in order. The fault is confined to the armature, and is quite a common one, the symptoms developed clearly pointing to part of armature being short-circuited. The breakdown, cause, and phenomena noticed when attempting to start can be explained simply as follows:

Breakdown.—Four coils completely burnt out on armature.

Cause.—Two adjacent commutator bars short-circuited. This means that four coils are connected across these bars as a closed circuit. (Trace connections or consult any chart showing diagram of a two-circuit winding.) Consequently current is generated in these coils when armature rotates, and as the resistance in these coils is very low the current increases until coils are completely burnt out. There are many causes for sections getting shorted: (1) blob of solder at back of bars; (2) defective mica between sections; (3) copper turning not picked out from between bars when commutator was turned out; (4) dirt or other foreign matter embedded in mica. These defects would have been easily discovered before running by taking volt drop test between bars. Shorted bars would show no drop.

Phenomena at Starting.—This is simply accounted for as follows: The short-circuited coils are in series with the rest of the armature turns, but, due to the short-circuit, are also in parallel when the shorted sections come under either brush, as happens every quarter of a revolution. The actual shorted sections only come under the brush every half of a revolution, but the diametrically opposite sections have the same effect, so it comes down to quarter of a revolution. As the shorted coils have comparatively no resistance the rest of the armature turns are practically cut out, consequently the motor has no torque, and will not start or come to rest at this point if started. If you move the shorted sections from under the brush, all coils are in series, and the arm will rotate until one end of the closed circuit again gets under the brush.

In reply to last query, force is necessary to rotate any conductor in a magnetic field, and this is very much accentuated if the conductor is a closed coil embedded in iron, due to the very much increased induction, and consequent increased induced currents in conductor.—J. M.

Answer to No. 1,068 (awarded 5s.).—Mr. Walker's case appears to be somewhat similar to one that I came across some time ago, which I will describe in the hope that it may help towards a solution of the difficulty. The motor was 30 h.p., series, four-pole, wave-wound armature, with two sets of brushes. On attempting to start, the motor made about a quarter of a revolution and then stopped dead, blowing the fuse. When the armature was opened up it was found that there was a short-circuit between the top and bottom coils in one of the slots. Now, as the machine is four-pole, the two coils in the same slot will be connected to commutator bars 90deg. apart. Therefore, when the machine is started the armature will rotate until the brushes are bearing on the commutator bars which are connected to the defective coils, the rush of current which then ensued owing to the short-circuit blowing the fuse. I do not think that the short-circuit between the commutator bars is the cause of the peculiar behaviour. I have seen a good number of cases of short-circuit between adjacent commutator bars, and in all cases the motor started satisfactorily, but, of course, the coils connected between the defective bars were soon burned out. A short-circuit would also account for the difficulty found in turning the armature by hand with the field excited. The short-circuit between the commutator bars should be removed, and then test for short-circuit between the coils. The best way to do this is to disconnect and remove the commutator. Now connect all the top ends together with fine fuse wire, also connecting one end of a workshop galvanometer to the fuse wire. Now remove the fuse wire from one of the connections, and touch this with the other galvanometer wire. If a deflection is obtained, it shows that this coil is "shorted" to some other. The whole armature should be gone round in this way. In the diagram, coil A is shown being tested. This method is very quick and certain, but requires to be done systematically, the fuse wire being removed in rotation from the connections, and that connection then tested. This looks to be the most satisfactory solution, as only four coils were renewed in the armature, and only one fourth of the commutator connections would require to be lifted to get these coils repaired, therefore there would not be much chance of connecting up wrong, as the remaining connections would serve as a guide Also in armatures which have a high temperature rise the insulation on the coils gets very brittle, and it requires very great care in replacing those coils which had to be lifted to reach the defective ones to not damage the insulation. This considerably increases the chances of a "short" between the coils —G. A. LUNDY.

Answer to No. 1,068 (awarded 5s.).—I read with interest the difficulty the querist has with a 35-b.h.p. motor, wave-wound armature, since same has been repaired by renewing four of the armature coils. Now with 69 slots and four poles, by formula

$$C = ny \pm 2m,$$

where C = number of face conductors; n = number of poles; y = average pitch; m = number of windings. For a two-circuit single winding, as the one in question, the pitch is always forward, the coils being embedded between teeth in slots Nos. 1 and 18, whilst the connections to the commutator will be in segments Nos. 1 to 69. From this it follows the armature has 138 coils, two per slot—*i.e.*, two tops and two bottoms—one coil being cut out, which is generally known as a dummy coil, to make single re-entrancy. The fault would appear to be a dead short between the top and bottom windings, and should the armature rotate a quarter revolution or 90deg. exactly, the short will be found in the slot; if less than 90deg., the short is between coils in the end winding. However, the latter is of little consequence. It will be necessary to disconnect the commutator, to start with the top connections only, so that each coil may be tested independently, through a lamp circuit for preference (say, 200 volts to be more reliable). Attach one wire to a certain coil and with the other wire proceed to test each top connection; should this be O.K, fix wire on next connection and try round again and so on until short is found and indicated by the lamp glowing.

Another way to test is to proceed as above and short-circuit all the top connections, with the exception of one, by lapping together with 24 S.W.G. wire; connect the two ends to lamp circuit as before, and lamp will glow, circuit being formed through short; disconnect singly until the coil of short-circuit is found by lamp failing to glow. When fixing your test wire to this and trying the top connections about a quarter of the way round armature will soon locate exact position of short-circuit, when the necessary coils will have to be lifted, after totally disconnecting the commutator, and the coils replaced.

It may only be necessary to test coils in one half of the armature, if the other half has not been disturbed, which will considerably lessen the time necessary for testing, but this I will leave to the querist. Care should be taken in replacing the uplifted coils or the same trouble may occur again. The fact that the armature requires considerable power to turn round when shunt is excited and brushes lifted is true with a correct armature, and therefore, does not, to any extent, enter into this query.

The number of conductors—348—would appear incorrect, possibly a printer's error; this should read 548, obtained by 137 active coils of two turns each.—EDW. L. CASTLE.

Answer to No. 1,068 (awarded 5s.).—The phenomenon described is often met with by test-room engineers when first starting up direct-current motors on their preliminary run, and is a certain indication of a short-circuit either between adjacent commutator bars, between top and bottom coils in a slot, or in the end connections of the armature winding. Immediately the armature current is switched on, the armature will make about a quarter of a

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revolution and then stop dead, with the brushes covering the segments connected to the faulty coil. The effect of the short-circuit is now to cause practically the whole of the starting current to pass through the faulty coil, round which a powerful magnetic field is induced, and the coil itself maintains its position mentioned above. Considerable force will be required to turn the armature even when the brushes are raised—*i.e.*, with no armature current—with the field fully excited, as the slightest movement of the armature would produce an E.M.F. in the short-circuited coil and cause a current therein.—TURBINE.

Question No. 1,069.—Explain the process of calculating the magnetising current of a two-phase induction motor; also the rotor current in a star-connected three-phase rotor in a two-phase stator.

Answer to No. 1,069 (awarded 10s.).— The following method of calculating the magnetising current of a two-phase motor is one of the simplest, and the results obtained are found to be very accurate. At the outset I will define the notation used: V = volts per phase maintained at the motor terminals; R = resistance per phase of stator winding; A = current per phase flowing in stator winding when motor is developing normal full load; E = counter E.M.F. induced in stator winding per phase; M_P = average flux per pole per phase; M_S = flux per pole per phase which enters the rotor core; N = frequency of supply in complete cycles per second; P = number of poles per phase; r = rotor resistance per phase; T = turns per pole per phase on stator winding; t = turns in series per phase on the rotor; e = rotor volts per phase; a = rotor current per phase; B = maximum flux density at pole face in lines per square centimetre; F = magnetomotive force; L = radial depth of air-gap in centimetres.

Consider a two-phase induction motor developing normal full-load torque and taking A amperes per phase, then drop of voltage due to the resistance of the stator coils is given by R × A. Therefore the counter E.M.F. that must be induced in the stator winding will be

$$V - R \times A = E.$$

The flux per pole per phase that will be required to generate E is

$$\frac{E \times 10^8}{N \times 4{\cdot}2 \times T \times P} = M_P.$$

The flux that is induced in the stator core by the current flowing in the stator winding alternates with a frequency equal to that of the supply circuit. The magnetising current is estimated from the maximum flux density, B, which depends for a given total flux upon the shape of the curve of distribution of that total flux. As the distribution of the magnetic flux in the stator core does not follow a true sine wave, it becomes necessary when calculating the maximum value of the flux to allow 8 per cent. by which the maximum value of the flux will be increased due to the distortion of the distribution curve. Therefore the maximum flux per pole is equal to

$$M_P \times 1{\cdot}57 \times 1{\cdot}08.$$

Unlike most dynamo-electric machinery, practically the entire magnetomotive force is required to overcome the reluctance of the air-gap. The iron part of the magnetic circuit requires from 12 to 15 per cent. of the total magnetomotive force, therefore, instead of attempting to calculate the magnetomotive force required for the teeth, the total magnetomotive force can be calculated sufficiently accurate for all practical purposes by ascertaining the magnetomotive force required for the air-gap, and adding 12 per cent. for the iron part of the magnetic circuit.

$$F = B \times 0{\cdot}8 \times 1{\cdot}12.$$

The magnetising current per phase required to produce F is given by $\frac{\frac{F}{T}}{\sqrt{2}}$ = R.M.S. amperes per phase.

In order to calculate the current in a three-phase star-connected rotor in a two-phase stator, I will take the case of a two-phase motor developing full-load torque and the rotor revolving at a speed 5 per cent. below synchronous speed. Of the total flux per pole M_P, only M_S actually enters the rotor core. M_S is approximately 10 per cent. less than M_P. Voltage generated per phase in rotor $= t \times 4{\cdot}2 \times M_S \times 0{\cdot}05 \times N \times 10^{-8} = e$. The rotor current per phase is given by $\frac{e}{r}$ for a star-connected three-phase rotor.—F. PARKINSON.

Question No. 1,070.—Compare in regard to inital cost, attendance, running costs, ease of speed regulation, and life, the relative advantages of direct-current and induction motors (including the squirrel-cage motor) for (*a*) heavy starting torque; (*b*) light starting torque and heavy overloads; (*c*) medium starting torque and equable running loads. Include also the cost of suitable starting gears in each case.

Answer to No. 1,070 (awarded 5s.).— The relative advantages of direct-current and induction motors are as follows:

Initial Cost.—For the same speed and output there is very little difference; if anything, the induction motor has the advantage, especially in the smaller sizes, as the starter may be dispensed with, only a simple switch being required. Taking a 10-h.p. motor at 1,000 r.p.m. the cost of the direct-current machine and accessories is £40, against £35 or £40 with auto-starter for the induction motor.

Attendance.—The induction motor certainly has the advantage, especially if without slip-rings, as the commutators of direct-current machines usually require a good deal of attention to prevent sparking, and even then they require occasional grinding up.

Running Costs.—Where variable speed is not required and motors run at full load there is not much to choose between the two types, as induction motors are now made almost equal as regards efficiency to the direct-current motors, but where variable speed is required and motor frequently running at light loads the direct-current motor has a decided advantage. The efficiency of a 10-h.p. direct-current motor is about 88 per cent. at full load as compared with 86 per cent. for the alternating-current machine, but to obtain variable speed with the latter, which is usually achieved by inserting resistance in the rotor, the efficiency falls very rapidly, and it is then advisable to have direct-current supply.

Speed Regulation.—In the ordinary way there is very little difference between the two types. The shunt-wound direct-current motor is practically self-regulating, but will have a rise in speed of about 8 per cent. from time it is started up to time final temperature reached, which should be in about six hours, but apart from this, and assuming supply voltage is constant and machine has powerful field magnets, the speed will remain practically constant. On the other hand, the induction motor will follow any variations of prime movers, and it has a fall in speed of about 3 per cent. from no load to full load, but the heating up of the machine has very little effect on its speed.

Life.—With proper care the induction motor should outlive the direct-current machine, as commutator would require renewing in about 10 years, and brush gear usually gives trouble before that time.

(*a*) *Heavy Starting Torque.*—The direct-current motor, especially if series-wound, has the advantage, the squirrel-cage motor only being used for starting light, unless it is provided with a high-resistance rotor, which, of course, will bring down the efficiency, but if the machine has a wound rotor and slip-rings for inserting starting resistance, the torque can be made to almost equal the direct-current machine.

(*b*) *Light Starting Torque and Heavy Overloads.*—The squirrel-cage induction motor has the advantage, as it is capable of withstanding an overload of 100 per cent., but with such an overload the direct-current motor would spark badly, and, therefore, overload of latter is limited to about 50 per cent.

(*c*) *Medium Starting Torque and Equable Running Load.*—It would be most advantageous to use the induction motor with wound rotor and slip-rings, especially if the motor arranged to run at full load, as the absence of the commutator, with its attendant troubles, would certainly be appreciated.—A. THOMPSON.

[Other replies to Question No. 1,070 will be given in our next issue. The answers to No. 1,067 are unavoidably held over.—ED., *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

QUESTIONS.

1077. Describe Frahm's frequency indicator. One of these indicators is in use on a 50 ~ supply, single-phase. If the frequency be increased, say, from 49, the vibrations of the reeds die away on reaching 50, increasing again at about 51. On the frequency being reduced, all the reeds respond over the above range. Give cause of this.—HAROLD BARNES.

1078. Explain what effect on the permeability the increase or decrease of the various impurities in steel castings or rolled sheets will have. How is it that there is a difference in the permeability of steel casting samples which show the same analysis? What points in the manufacture should be specially attended to to obtain castings both of steel and iron showing relatively high permeability, and sheet steel showing low losses when used as armature or transformer punchings?—J. N. C. H.

ANSWERS.

Question No. 1067.—What is the best method of laying cables in a power-house between machines and switchboard? Give sketches sowing method of fixing both high-tension and low-tension cables, both when run in subways and in a trench in engine-room floors.

Best Answer to No. 1,067 (awarded 10s.).—To lay down on paper the best method of installing the cable work of a power-house is rather a difficult task, unless the lay-out of the station is given, makers and sizes of cables, etc. Even

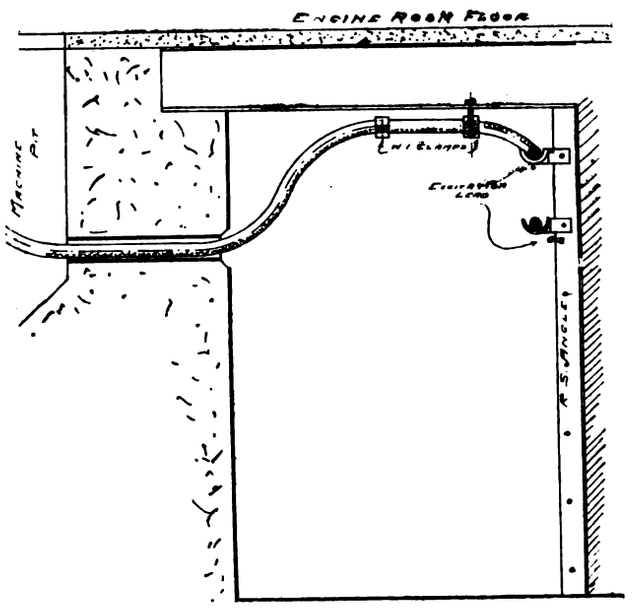

FIG. 1.

if the station is very small, laying cables in trenches will never be satisfactory, and it is essential that the run of engine-room leads has as much consideration as the steam-pipes, etc. In the good old days, when architects designed a pretty building, and the consulting engineer's draughtsman was left to get the plant in as well as possible, or to the best of his ability, the cable trenches were generally about 12in. square, and the man on the spot arranged the cables.

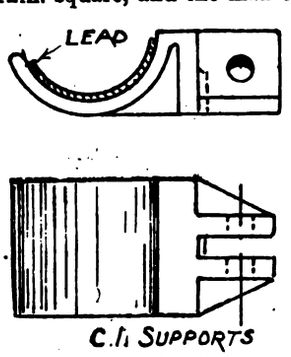

FIG. 2.

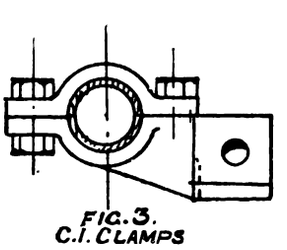

FIG. 3.

Needless to say, the result was in most cases far from satisfactory, and it is now general practice to arrange for a fair space between the end of the machine foundations and the wall entirely for a cable run. If this is the case, Fig. 1 makes a very good arrangement for lead-covered cables. Fibre conduit or earthenware ducts are concreted in with the machine bed to form a smooth run between the machine pit and the passageway; the cables are led through these ducts and clamped to the underside of the engine-room floor. Care must be taken in the design to allow large radii; at least twelve times the cable diameter for lead-covered leads, but considerably less for braided. From these clamps the cable bends down and runs along the wall on supports, similar to Fig. 2, or clamps shown in Fig. 3. It will be found convenient if the angles or tees to which the supports are bolted are drilled their whole length, as shown, when first erected. The supports or clamps can be added at a later date when required. As a cable bends away from the racks to a machine all the lower cables should step up one. By doing this the cable going to the next machine is always on top, thus keeping a good headroom in the passageway.

At the switchboard end a very similar method can be arranged, as shown in Fig. 4, copper rod or braided cable being led up to the switch terminals. This arrangement is equally applicable to a high-tension plant if using lead-covered cable, with the exception that a better finish is obtained if the lead is taken just inside the switch cell and bare rod taken to the switch, or the lead and insulation cut away and the core of the cable taken up to the switch.

If rubber-insulated and braided cables are used, an excellent arrangement is obtained by using a clamp type of insulator as made by Doulton and Co. These insulators are made in two series, large and small, the larger being 4in square and the smaller 3in. The large size takes cables from 1in. to 3in. diameter, and the smaller from $\frac{5}{16}$in.

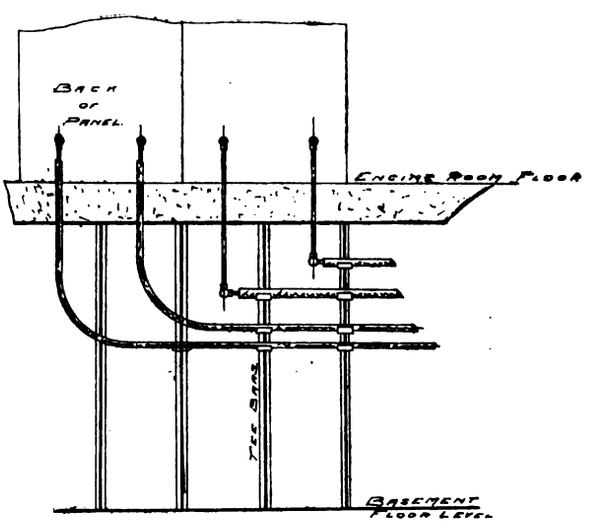

FIG. 4

to 1½in. diameter. Fig. 5 shows the general appearance of a rack complete, the insulators being made of cream glazed stoneware.

For trenches in the engine-room floor it is to be hoped that they are of liberal dimensions; if not, and the cables are simply to be laid one on another, it is only a matter of time for the trenches to be full of filth and dirt. Also, it is almost a certainty that if one cable fails and causes anything of a flare up, its companions will all be injured.

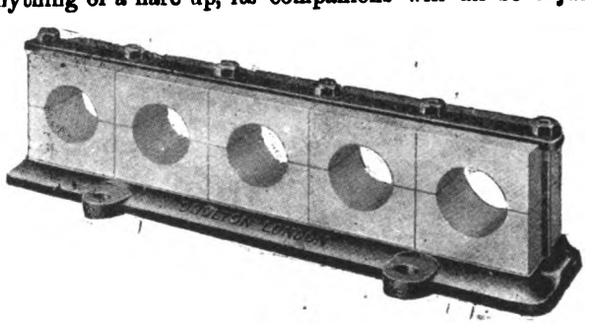

FIG. 5.

The schemes Figs. 1 to 5 are equally adaptable for trenches, and, if fairly large, a reliable design is not a difficult matter. Figs. 6 and 7 show trenches fitted for lead-covered cable, Fig. 6 being the best arrangement if the height is not restricted, but if this is the case Fig. 7 is a workable

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arrangement. An objection to Fig. 7 is the difficulty of cleaning the trench bottom. In each case the cables are well separated and accessible; a further refinement is possible by keeping all cables of one polarity on one side.

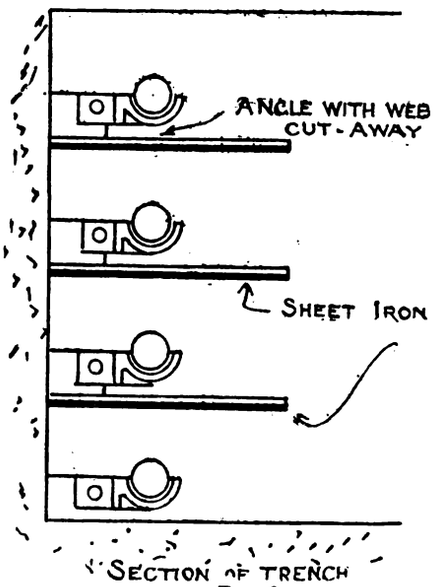

Fig. 6.

In a station where the space is not limited, Fig. 8 is an excellent scheme. The passageway is lined on each side, as shown, with stone shelves (natural or artificial stone), and the lead-covered cables laid direct on these shelves. If

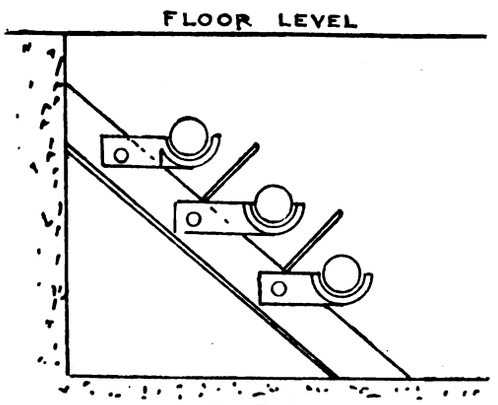

Fig. 7.

the machines are of a large size, and two or more leads are used per pole, it is advisable to keep each machine's cables of the same polarity on one shelf, thus entirely doing away with the possibility of one machine's cables damaging those

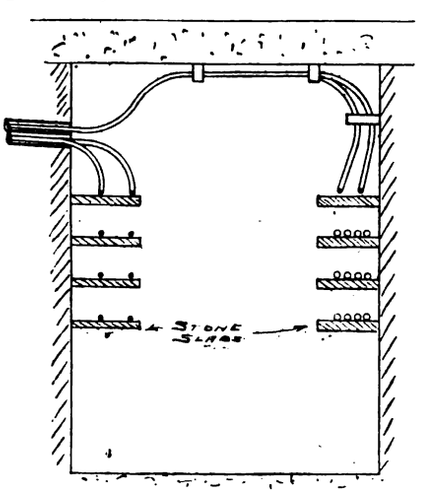

Fig. 8.

of another machine. The exciter leads, which if of a small size should be made up as a twin for mechanical strength, can be clipped to the main cables, shown in Fig. 1, or supported as in Fig. 1.—J. H. S.

Answer to No. 1,067 (awarded 5s.).—It is somewhat difficult to describe the best way of fixing cables from generator to switchboard, as the best way in one case might not be applicable to another, local conditions practically deciding this point. On the Continent it is almost entirely the custom to run the connections from the generator terminals to the switchboard on insulators, the conductors being entirely free from insulating covering, whether high tension or low tension, with the exception that high-tension cables are usually cased in, either by means of a standard metal shield or wire netting. This method has also been adopted in a modified form in this country (see Fig. 1),

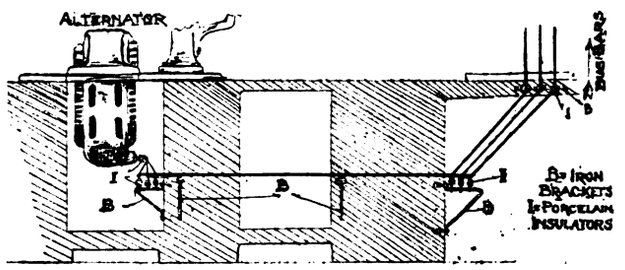

Fig. 1.

where three high-tension mains are taken in edgewise copper bars on insulators, running below the engine-room floor and up behind the switchboard, thus permitting of easy inspection, and avoiding trouble due to overheating of the cables or damp from the steam-pipes. The fixing of the brackets for supporting the insulators is very simple. Having decided on the shortest route to the switchboard, the brackets are spaced about 10ft. apart, and mounted on rag bolts cemented into the wall. The insulators are then fixed on to the bracket, the conductors, whether bar or bare cable, taken and bent to the required curves, being then fixed in position and painted. Aluminium bars and cables have lately come into great requisition owing to the lightness of the metal, and comparatively high conductivity (63). No job looks nearly so neat and clean as a switchboard with connections of bare metal whether rod or bar, discrimination of phases and poles being facilitated 90 per cent, as even if cable connections are painted they look clumsy and untidy.

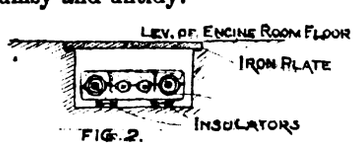

FIG. 2.

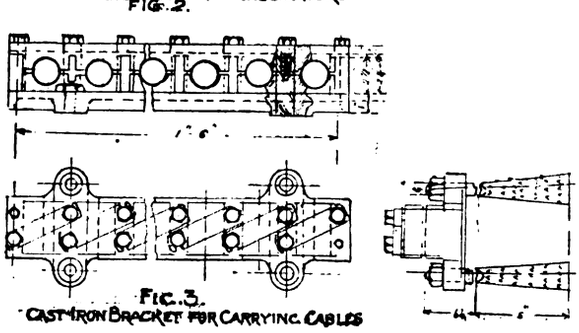

FIG. 3.
CAST-IRON BRACKET FOR CARRYING CABLES

If no cellar of basement is available beneath the engine-room floor, the conduit system is very simple and reliable, more, perhaps, for low tension than high tension. A trench is cut in the engine-room floor, about 10in. to 12in. deep (according to the size of insulated cable to be used), and the interior smoothed over with cement. In the trough thus obtained are then fixed wooden bridge pieces made in halves, and slotted to receive the cables The most convenient spacing for these is about 18in., as when the top half of the bridge is put over and screwed down it grips them and prevents any sagging or contact with the floor (see Figs. 2 and 3). Iron plates are then fitted over the trough, the sides of which are recessed to receive them. These plates have holes punched in them to permit easy inspection of the cables by simply lifting the plates. This method is most satisfactory in a small generating station where neatness combined with accessibility is required.

Fig. 4 shows various methods of suspending cables in subways; A being especially applicable to extra high-tension where the conductors are bare, and carried on

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insulators fixed in ∀-shaped brackets, and externally enclosed by an expanded metal guard, rag bolts being employed to support the brackets, which are spaced about 15ft. from one another. The expanded metal is fixed either with rivets or wire straps. B shows a most efficient and simple arrangement for hanging cables in a subway, iron hangers being bolted to the wall by two rag bolts, the cables merely lifted into position and pulled taut, a little sag being unavoidable. The cables can be removed with the greatest of ease and without disturbing one another. C shows Messrs. Callender's conduit, which consists of cast-iron trough containing wooden bridge piece in which the

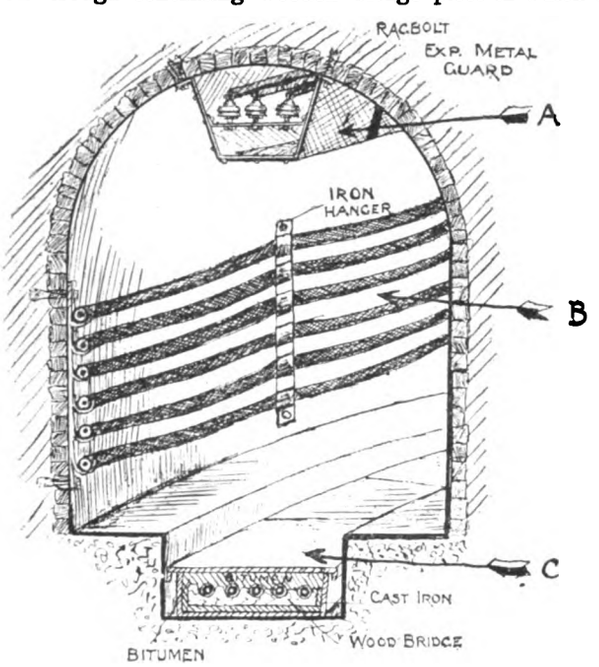

FIG. 4.

cables rest, the whole being filled in with bitumen. This, however, is scarcely applicable to the case in question, as it is designed more for long-distance transmission, and, being filled with bitumen, does not easily allow any alteration in route or number of cable, which is an important factor in a generating station.—M. B. H.

Answer to No. 1,067 (awarded 5s.).—Now that auxiliary plant in central stations is usually stowed away in a basement, one often finds the cables connecting the machines to the switchboard slung about in a most careless manner, as the designer probably gave his attention mostly to the question of his pipe arrangements and prepared for slinging the cables where they would fit. Happily, that is not always the case, and when one realises that the question of the cable lay-out is most important they should certainly receive due consideration. The following are the chief points to consider when deciding the method of laying to adopt: (*a*) protection from mechanical damage; (*b*) protection from excessive heat from hot steam-pipes, etc.; (*c*) protection from fire or fusing of adjacent cables; (*d*) accessibility for inspection, repair, and identification; (*e*) easily removed if required without disturbing the remainder.

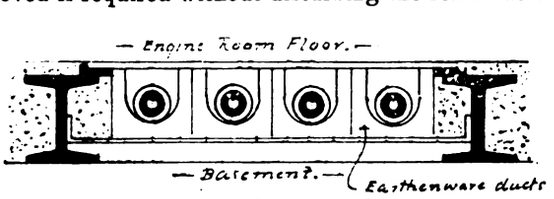

FIG. 1.

To mechanically protect the cables they should, of course, be entirely encased, and the writer recently inspected some cables laid, as shown in Fig. 1, in earthenware troughs set in the flooring and covered with removable iron plates. This arrangement practically provided all necessary protection from mechanical damage, possibility of fire, or the arc set up by cable breaking down doing damage to its neighbours. The question of accessibility and easy removable was all that could be desired and the cables were supported throughout their entire length, which is essential with heavy cables, as, due to sagging, they often get damaged at the supports if only supported at intervals, and, if the latter course is unavoidable, they should rest on soft material at the supports. When bringing cables up the face of a wall to the switchboard, the same system as shown in Fig. 1 can be adopted, but the cables need only

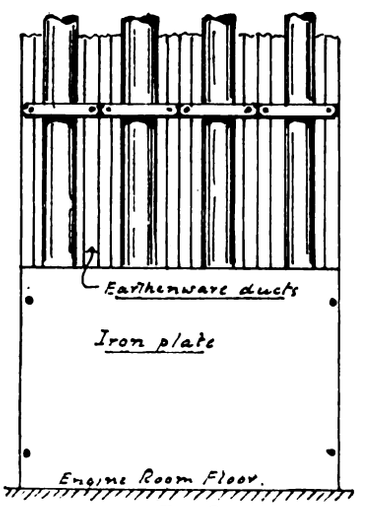

FIG. 2.

be protected by iron plates where they are within reach, as shown in Fig. 2.

In the case of low-tension cables and where finances and existing arrangements will not allow of the system as shown in Fig. 1 being adopted, a simple bracket system could be used, a very convenient form of which is shown in Fig. 3.

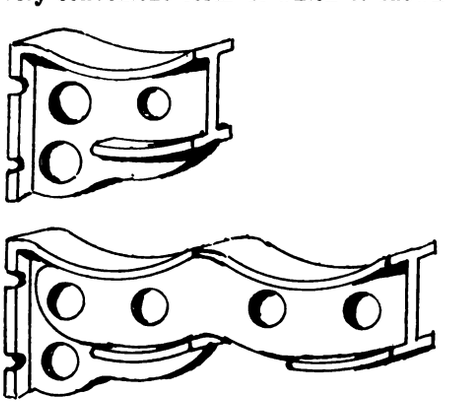

FIG. 3.

It will be seen that it is possible to arrange for supporting any number of cables without stocking different brackets, and unnecessary ways can be removed or additional ones provided as required. This type of bracket is most convenient, as one often wishes to change the number of ways on brackets according to whether the number of cables is increased or diminished at various points about the station.

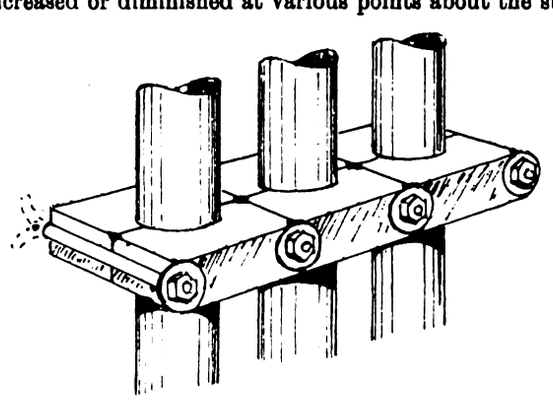

FIG. 4.

A very suitable form of support for cables on the face of wall leading up to the switchboard is shown in Fig. 4, and this can also be made to take any number of cables.

I think "H. C." will find that one of the above systems will be applicable to his case, and if carefully installed

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TABLE I.

Type.	Price.	Starting torque.	Speed regulation.	Governing overload capacity.		Starter.
Single-phase commutation	Very expensive.	Very good.	Good ; efficient.	Bad.	Fair sparking.	Expensive and complicated.
Compound continuous	Expensive.	Good.	Excellent ; efficient.	Good.	Fair.	Value for money.
Single-phase induction.....	Expensive.	None.	None.	Very good.	Not very good.	Expensive and troublesome.
Shunt continuous	Value for money.	Fairly good.	Excellent ; efficient.	Very good.	Fair.	Value for money.
Series continuous	Good value for money.	Excellent.	Excellent ; efficient.	Bad.	Very good.	Value for money.
Single-phase induction.....	—	Fairly good.	Small ; efficient.	Very good.	Good.	Value for money.
Short-circuit rotor induction	Cheap.	Only fair.	Small ; efficient.	Very good.	Excellent.	Cheap, small sizes ; expensive, large sizes.

on either system his cables should not give him any trouble, at any rate not from the method of installing.—A. THOMPSON.

Answer to No. 1,067 (awarded 5s.).—The best method to adopt for any particular case is largely determined by local conditions and the class of cable employed, whether lead covered or braided rubber. Of the two methods illustrated one or other will probably be found suitable under the conditions most generally met with. Fig. 1 shows a hanger suitable for use in a subway with any class of lead-covered cable. A felt pad should be inserted to prevent the weight of the cable thinning the lead where

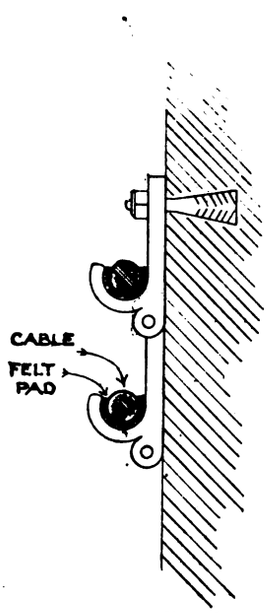


FIG. 1.

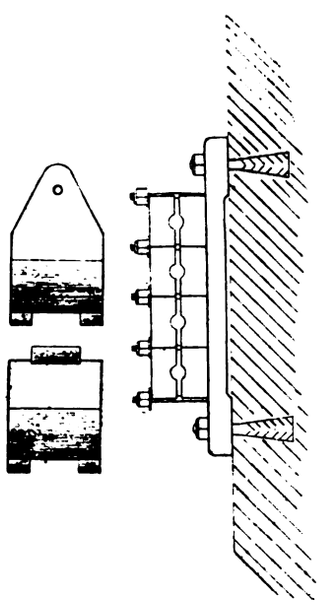


FIG. 2.

resting on the hanger. A point in favour of this method is, as can be seen from the sketch, the easy and cheap way in which extensions can be provided for. The depth of a trench in an engine-room is not generally sufficient to permit of many cables being fixed in this manner. Fig. 2 shows a rack which can be used in any position, and is suitable for high or low tension braided cables. By fitting longer studs another row of the porcelain split insulators can be added, thereby doubling the capacity of the rack without increasing its length. Another method which has been used in large power stations is that in which stone shelves are run along the walls of the subway, the cables lying on the shelves.—O. H. BRICKWELL.

Question No 1,070.—Compare in regard to inital cost, attendance, running costs, ease of speed regulation, and life, the relative advantages of direct-current and induction motors (including the squirrel-cage motor) for (*a*) heavy starting torque; (*b*) light starting torque and heavy overloads; (*c*) medium starting torque and equable running loads. Include also the cost of suitable starting gears in each case.

Answer to No. 1,070 (awarded 5s.).—I am assuming that by induction motors the questioner refers to all kinds—that is, one, two, and three phase. The initial cost of the motors is as follows: the most expensive are single-phase, series and repulsion; continuous, compound; continuous shunt and single-phase induction, continuous series and slip-ring induction (two and three phase). The cheapest being short-circuit rotor induction (two and three phase).

Attendance.—The attendance on machines having commutators is always greatest, so that, arranging them in order of attendance, those requiring the most are continuous shunt series and compound and single-phase commutator motors, slip-ring induction, and short-circuit rotor induction. The only attention required by short circuit rotor motors is in frequent oiling and occasional blowing out of dust.

Ease of Speed Regulation.—The compound and shunt continuous motor can be had with an efficient speed regulation of 5 to 1. Induction motors may be had with two or three efficient speeds, but are complicated and very costly. Series continuous and alternating motors are capable of good speed regulation by series resistance, but this is inefficient. Induction motors are capable of limited speed regulation by resistance in the rotor circuit, but this is inefficient.

Life.—Life is proportional to the number of wearing parts, and here the short circuit rotor induction motor is easily first. The others are about equal. The life of a modern continuous-current motor, without renewal of bearing bushes or commutator, is about 12 to 14 years, but depends on treatment.

(*a*) *Heavy Starting Torque.*—The series motor is the best motor for dealing with heavy starting torque, except when it may also have to run absolutely light, when the compound motor may take its place. The slip-ring induction motor is also good on torques up to 100 per cent. full-load torque. Continuous shunt motors are not so good, and short-circuit rotor machines possess comparatively small starting torque.

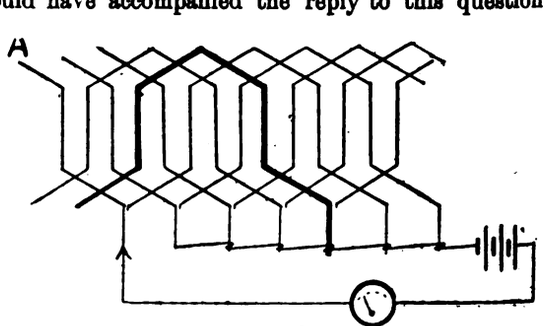
(*b*) *Light Starting Torque and Heavy Overloads.*—The short-circuit rotor induction motor is the best for this type of work, as it can be built to withstand very severe overloads without damage. Shunt continuous motors will also stand up to an overload.

(*c*) *Medium Starting Torque and Equable Running Loads.*—The shunt continuous and slip-ring induction motors are equal for this duty, as both give good speed governing on varying load.

Starting Gear.—No starting gear is required for small short-circuit rotor motors except a three-pole switch. For large ones auto-transformers are required, and these are probably the most expensive form of starting gear there is.

Slip-ring resistances and continuous starting resistances are about the same price. Table I. shows all the properties of the various kinds of motors on the market at present, given under comparative terms.—M. JENNISON.

[*Question No. 1068.*—The diagram given herewith should have accompanied the reply to this question sent



by Mr. G. A. Lundy, but was unfortunately omitted from our last issue.—ED. *E. E.*]

[Other replies to Question No. 1,070 will be given in our next issue.—ED., *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

1079. In a sub-station supplying direct current by means of dynamos direct-coupled to induction motors, the latter working on a three-phase network, the load is very small over the greater part of the 24 hours. It has been suggested to run the motor single-phase during the hours of light load by disconnecting one phase after the machine is up to speed. What saving, if any, would be made by this? And what detrimental effects, if any, would it have on the machine and the three-phase network?—ECONOMIST.

1,080. A small village in Ireland is to be lighted from a dynamo 1½ miles from the centre. The current required is 18 amperes; pressure at dynamo, 115 volts. State most economical size of mains and method of distribution; also what sanction is required for running overhead mains.—LIGHTING.

1,081. What is the most frequent cause of failure in the induction coils of motorcars, either accumulator or high-tension magneto ignition? How can it be discovered and remedied?—C. K. S., LIVERPOOL.

ANSWERS.

Question No. 1,070.—Compare in regard to inital cost, attendance, running costs, ease of speed regulation, and life, the relative advantages of direct-current and induction motors (including the squirrel-cage motor) for (*a*) heavy starting torque; (*b*) light starting torque and heavy overloads; (*c*) medium starting torque and equable running loads. Include also the cost of suitable starting gears in each case.

Best Answer to No. 1,070 (awarded 10s.).—For the purpose of comparison between the various motors, we will assume the size and speed to be the same with each type of machine. The motors are of standard protected design, to work at a pressure of 440 volts 50 cycles in the case of the two or three phase alternating-current motors and 440 volts with the continuous-current motors. The torque (*a*) is assumed to be 2½ to 3 times normal full-load torque, (*b*) starting with about 30 per cent. of the full-load torque and developing an overload of 100 per cent., (*c*) starting with about 75 per cent. of the full-load torque. The no-load speed in each case will be about 1,000 r.p.m.

COST OF MOTOR AND STARTER.

(*a*)				
B.H.P.	5	10	20	30
Continuous-current compound motor, £	29	40	66	87
Full-load efficiency, per cent.	81	83	86	87
Alternating-current motor, wound rotor, £	32	43	61/10	76
Full-load efficiency, per cent.	82	84	87	87
Alternating-current motor, squirrel-cage rotor, £	39	51	70	86
Full-load efficiency, per cent.	78	80	83	84
(*b*)				
Continuous-current shunt motor, £	24	35	57	78
Full-load efficiency, per cent.	82	84	87	88
Alternating-current motor, wound rotor, £	27	39	54	63
Full-load efficiency, per cent.	82	84	86	87
Alternating-current motor, squirrel-cage rotor, £	29	42/10	56	64
Full-load efficiency, per cent.	82	84	86	87

The cost of the motors as required under working conditions (*c*) will be practically the same as for (*b*). The continuous-current starters will be fitted with automatic no-voltage release coils. The alternating-current motors with wound rotors will have ordinary rotor resistances of the liquid or metallic type, and with the short-circuited rotors under (*b*) the starters will be of the auto-transformer type with change-over switches. If these latter motors were to be designed for a 220-volt circuit, they could be arranged to be started by means of the star-mesh connection, thereby reducing the cost of the motor and starter by about 7 to 10 per cent. The alternating-current motors with squirrel-cage rotors under (*a*) are provided with simple three-pole switch for starting purposes.

Attendance.—The only cost for attendance that can be anticipated is due to lubrication and brush gear. The former, however, is a very small item, as is also the latter, but the cost of the continuous-current motors in this respect is higher than the alternating-current slip-ring motors owing to the extra amount of care necessary for cleaning the commutator and adjustment of the brushes.

Running Costs.—From the efficiencies given above it will be seen that the continuous-current motors have the advantage as regards power consumption, especially in the case of the squirrel-cage motors with a high starting torque.

Speed Regulation.—The modern continuous-current motor, designed for speed regulation by shunt resistance and fitted with interpoles, is a much more satisfactory machine than the alternating-current motor, especially when required for a large regulation of, say, 3 or 6 to 1. For small speed regulation—up to, say, 25 per cent.—there is very little to choose between the alternating-current slip-ring motor, but, of course, a finer regulation can be obtained with the former motor with a shunt resistance. The alternating-current squirrel-cage motors can be used for speed regulation up to about 15 per cent. by varying the impressed pressure by means of an auto-transformer. This method is not satisfactory, and can only be used for fans, blowers, and other similar work.

Life.—The alternating-current squirrel-cage motor has the advantage as regards life and length of time before renewal of any working electrical parts, owing to the absence of any commutator or brush gear. The life of either type of motor may be taken at about 25 to 30 years.

Torque.—The continuous-current motors under (*a*) are provided with a compound winding to obtain the large flux necessary when starting against the heavy load. This class of motor must, therefore, be designed to work at normal load with an unsaturated field. There is no great difficulty in designing three-phase motors with slip-rings to start with three times full load. If alternating-current squirrel-cage motors are used, it will be necessary to design a special high-resistance rotor with resistances permanently in circuit. The efficiency is lower than the other motors, owing to the permanent rotor resistance losses. Full voltage will be necessary at the motor terminals to obtain the maximum torque, and the motor will have to be thrown direct on the line without the intervention of an auto transformer. This method of starting is objectionable owing to the high starting current required, which would possibly cause an excessive voltage on the supply system.—K.

Question No. 1,071.—Explain the theory and construction of auto-transformers as employed to reduce the supply voltage for use with metallic-filament lamps.

Best Answer to No. 1,071 (awarded 10s.).—The auto-transformer (or "one-coil" transformer) consists essentially of a coil of wire wound on an iron core and connected across the supply mains. At some point in the coil, at a greater or less distance from one end, according to the voltage required, a lead is tapped off and current is drawn off between this branch line and one end. In this way current can be supplied at voltages smaller than the supply voltage, whilst the power taken from the main circuit will be but very little in excess of that consumed in the auxiliary circuit—in fact, the excess of power will correspond to the iron and copper losses occurring in the transformer, which under full-load conditions will not exceed 2 to 3 per cent. of the total output. The auto-transformer has, therefore, a considerable field of use, and it is used extensively for supplying current for starting induction motors, in which case a large current at a small voltage is required for a short time. It is also used in connection with the distribution of alternating current for arc lighting, and certain types of alternating-current arc

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lamps are fitted with auto-transformers, so that they can be run direct off a high-voltage (200 to 500 volts) circuit, just in the same way that they are used for reducing the voltage when operating metallic-filament lamps.

Fig. 1 gives a diagrammatic view of an auto-transformer, and the theory of the apparatus can be readily understood by the aid of this diagram. Assume, for the sake of simplicity, that the transformer is supplied from a 200-volt circuit, and that the point A is exactly midway between the ends of the coil, so that the voltage supplied to the lamp is 100 volts; suppose, further, that the resistance of the lamp is 100 ohms, so that normally it takes one ampere. Now, if we imagine that the lamp circuit is broken, the current taken from the line will be practically a wattless magnetising current. This current will flow under all conditions, for, if the supply voltage remain constant, we can assume that the iron core is magnetised up to the same flux density regardless of the value of the current passing in the auxiliary circuit. Now, suppose that the lamp circuit is made, then one ampere will pass through the lamp, and this current will distribute itself through the two halves of the coil in such a way that the magnetic equilibrium — if we may use the term — of the core is undisturbed—that is, the current in each half of the coil must be the same, and they must flow in relatively opposite directions. The arrows represent the directions of the

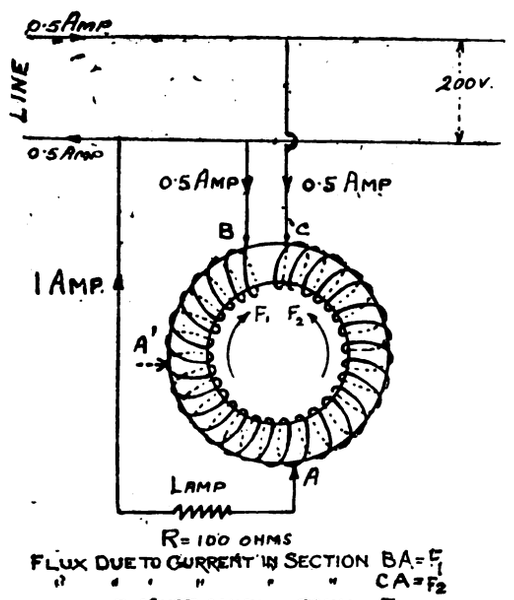

Fig. 1.

currents, and, obviously, the current taken from the mains will be 0·5 ampere, neglecting the current necessary to overcome the losses in the transformer. If the point A is moved round so that only one quarter of the coil is included in the lamp circuit, the voltage supplied to the lamp will be reduced to 50 volts, and, assuming this gives half an ampere through the lamp, the current through the part of the coil C A′ will then be one-eighth of an ampere, whilst that through the part B A′ will be three-eighths of an ampere. If necessary, the part of the coil connected to the auxillary circuit can be wound with thicker wire than the rest of the coil, so that it can deal with the larger current.

The auto-transformer can be used with advantage in connection with lamps coupled in series. Suppose that another similar lamp is connected across the other half of the coil, C A, then, if everything goes all right, the lamps will burn equally as well whether the transformer be connected in circuit or not; but if one of the filaments should break, the usefulness of the transformer is apparent, for it enables the other lamp to continue burning with but slight decrease in efficiency.

The shape of the core used in constructing an auto-transformer can be either rectangular or circular. If the former, it will be built up from laminated punchings, as in an ordinary core type transformer—that is, the ⊐ shape punchings will be first assembled together and a coil then slipped on each leg, the end punchings being finally placed in position. The two coils are joined in series, and a lead tapped off at a predetermined point Certain types of auto-transformers having a circular core are built up from ring punchings having a radial gap. By making the coil up in thin sections it is quite an easy matter to get the sections on the core after the punchings are assembled together by slipping them through the gap. The sections are then connected in series, and the voltage can be readily varied by varying the number of sections included in the auxiliary circuit.—A. P. Young.

Answer to No. 1,071 (awarded 5s.).—For low voltages and small powers the most suitable method of changing the voltage of an alternating current is by means of a single-coil transformer or an auto-transformer, as it is usually called.

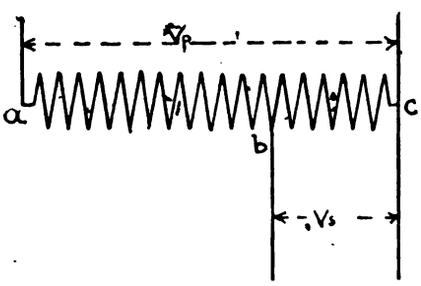

Fig. 1.

These transformers have long been used instead of a resistance to reduce the voltage where a single arc lamp is installed. The small loss in the transformer was negligible in comparison with the relatively heavy loss in the resistance, and on this account the transformer was often called an economy coil. These auto-transformers have lately come into prominence in connection with the lighting of low-voltage metallic-filament lamps. The only difference between an auto-transformer and a single-phase transformer is that the former has only one winding with three leads connected to it, two at the ends and the third in an intermediate position.

Let Fig. 1 represent diagrammatically an auto-transformer winding. Instead of using a separate secondary, a portion of the one winding serves both as primary and secondary.

Let V_P = primary voltage; V_s = secondary voltage; t_1 = number of turns between a and c; t_2 = number of turns between b and c. Then

$$V_s = \frac{t_2}{t_1} V_P.$$

Correspondingly the current is also changed, but inversely, so that a larger current than the primary current, C_1, is delivered to the secondary at a lower voltage than the primary voltage, V_P.

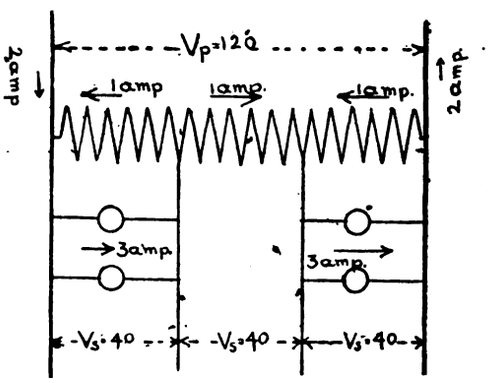

Fig. 2.

The capacity of an auto-transformer is

$$= C_1 (V_P - V_s)$$
$$= C_1 V_P \left(1 - \frac{t_2}{t_1}\right)$$
$$= C_1 V_P \left(1 - \frac{V_s}{V_P}\right).$$

From this it follows that the amount of power transformed varies with the position of b, decreasing with increasing value of V_s, so that the greater V_s is the more power is taken directly from the mains. Since only a part of the power undergoes transformation, the losses are much

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less than in an ordinary transformer delivering the same amount of power, and it is obvious that the advantage is greater the greater the ratio $\frac{V_s}{V_p}$.

For use with metallic-filament lamps the size of auto-transformer could be reduced by taking two, three, or more tappings. Fig. 2 shows the arrangement with two intermediate tappings. Let the maximum current in each circuit be, say, three amperes. If all the lamps are on at once, then practically the only current in the transformer is the magnetising current. Fig. 2 shows the conditions existing at the instant when the maximum current is flowing, and there is full load in the two outer circuits. It will be noticed that the maximum current that can flow in the transformer is two amperes, which happens when one circuit fully loaded is used alone.

The capacity required would be

$$= C_1 V_p \left(1 - \frac{V_s}{V_p}\right)$$

$$= 1 \times 120 \left(1 - \frac{40}{120}\right)$$

$$= 80 \text{ watts.}$$

Fig. 3 shows the conditions if the whole load is put on one circuit. The maximum current in the auto-transformer is now six amperes. The capacity is

$$= 3 \times 120 \left(1 - \frac{40}{120}\right)$$

$$= 240 \text{ watts.}$$

With the connections shown in Fig. 2, when 360 watts are being used in the secondary, there is no power transformed. In Fig. 3 there are 240 watts transformed when

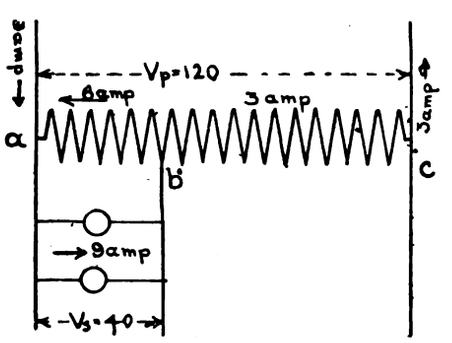

FIG. 3.

360 watts are being used in the secondary. Obviously, an arrangement like Fig. 2 would be much more economical. In Fig. 3 it will be noticed that the maximum current between *a* and *b* is twice the maximum current between *b* and *c*, so that copper could be saved by reducing the area between *b* and *c*, but there is no advantage in this unless the ratio of transformation is very large.

The chief value in using an auto-transformer is that it does away with the practice of using two lamps in series, and by using several secondary circuits the lamps used can be of very low voltage, thus reducing risk of breakage and increasing the efficiency of working. These advantages quite outweigh the slight loss in the auto-transformer.—D. H. B.

Answer to No. 1,071 (awarded 5s.).—An auto-transformer is wound with only one winding, which forms the high-tension winding, the low-tension winding being part of the same winding. For instance, an auto-transformer to transform down from 100 to 25 volts, if there were 200 turns in the whole winding, then a tapping would be taken out at the fiftieth turn, and the whole winding being connected to the 100-volt circuit, 25 volts would be obtained between the start and the tap. The part of the winding between the start and the tap would be of larger wire than the remainder, as it would have to carry a larger current. The advantage of this arrangement is that a considerably larger output can be obtained with the same weight of copper and iron, the same losses, temperature rise, and price than can be obtained with a transformer having separate primary and secondary coils. This method can only be adopted when there is no necessity to insulate the high-tension and low-tension circuits from one another, and there is no great advantage to be gained when the difference between high-tension and low-tension voltages is very large. The advantage that can be obtained depends upon the difference between the primary and secondary voltages, and the less the difference the greater the advantage.

The output as an auto-transformer is:

$$\text{Output as ordinary transformer} \times \frac{\text{H.T. voltage}}{\text{H.T. volts} - \text{L.T. volts}}.$$

Thus if a given transformer has an output of 1 kw., when wound as an auto with a ratio of 200 to 100 volts the output is increased to 2 kw., with the same losses as before, same weight, cost, etc. These transformers are most economical when used as balancers: two-circuit balancers when the low-tension voltage is half the high-tension voltage, and four-circuit balancers when the low-tension voltage is one-quarter the high-tension voltage. In the latter case a tapping would be taken out at each quarter of the winding. The load is then divided between the different circuits, and one transformer will supply any number of lamps if the *difference* between the load on the separate circuits does not exceed the normal output of the transformer. Thus if a house has 1 kw. in lamps requiring 50 volts, and the supply is 100 volts, if half the lamps are

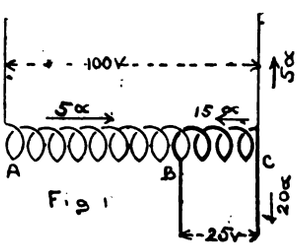

Fig 1

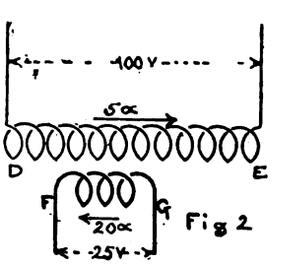

Fig 2

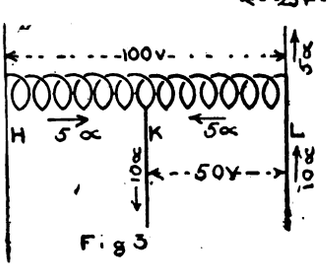

Fig 3

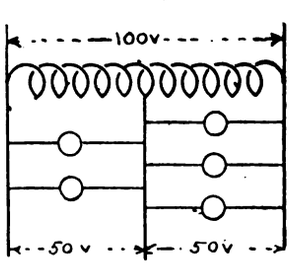

Fig 4

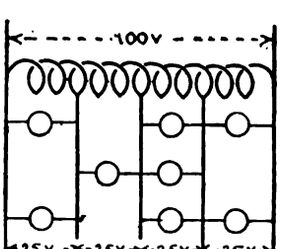

Fig 5

put on one side and half on the other, a ½-kw. auto-transformer is all that is required, since it will only be full load for it under the worst conditions—namely, when no lamps are lighted on one side, and all are lighted on the other, any other lamps coming in on the other side will simply reduce the load on the transformer, until when all lamps are in on both sides there will be no load on the transformer. Since the transformer is a 2 to 1 ratio auto it will only require to be the same size, losses, and price as an ordinary ¼ kw. So that for the price of ¼-kw. transformer current is supplied to a load of 1 kw. when using an auto-balancer. It is essential to keep the iron loss as low as possible, as this loss is always going on as long as the transformer is in circuit, and special care is taken by supply companies to ensure that their meters are sensitive enough to read these small loads. It is best wherever possible to arrange that the transformer can be disconnected when the lamps are not required—at least, from the consumer's point of view it is. The transformers are made in sizes varying from 25 watts for single lamps up to 2 kw. or 3 kw. for large installations. They are useful for arc lamps as well as for metal-filament lamps.

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Several of these transformers were shown in an article on the subject which appeared in the *Electrical Engineer* a few weeks ago, and the Westinghouse Company have a very complete catalogue of them giving illustrations of various types and methods of connection, etc., which can be obtained, I believe, from any of their offices.

Fig. 1 shows the distribution of current in a 500-watt auto-transformer 100 to 25 volts, Fig. 3 shows the same for one of 100 to 50 volts, and Fig. 2 an ordinary two-winding transformer of 100 to 25 volts and same output. Assuming 100 turns required for 100 volts, then in Fig. 2 D to E will be 100 turns 5 amperes capacity, and F to G 25 turns 20 amperes, whereas in Fig. 3 we only require 100 turns 5 amperes capacity, thus saving all the room required for the secondary in Fig. 2, and the copper. For the winding in Fig. 1 the 25 turns between B and C must be large enough for 15 amperes, so that we cannot save so much space and copper when there is a larger difference between the primary and secondary voltages. Fig. 4 shows the connections for a two-circuit balancer, with three lamps on one side and two on the other, the load on the transformer being one lamp—*i.e.*, the difference between the loads on the two circuits. Fig. 5 shows a four-circuit balancer in the same way. Fig. 6 is a section

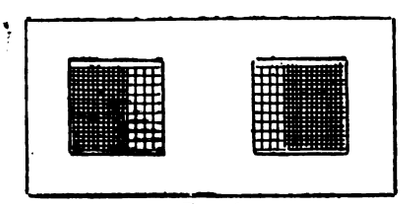


FIG. 6.

through the winding and core of an auto-transformer, showing how the thicker wire is wound up on the mould and the thinner wire on the top of it; a tap would be taken out where the two sections join. The complete coil is then wrapped with insulating material and the core built up round the coil. The shell type is more economical than the core type for these transformers.—J. HOLROYDE.

Question No. 1,072.—Given a three-phase overhead transmission line, 1,000 yards long, each conductor being $^{37}/_{12}$ bare copper, and the conductors occupying the three corners of an equilateral triangle with 20in. sides, generator voltage 650, frequency 50, give a method of predetermining the voltage drop (as measured between any two phases) between the generating and receiving ends of the line, working out the above as an example. Take two cases—viz., one with a load having a power factor of ·75 and the other with a power factor of unity—line current in each case 200 amperes. Show what is the actual power lost in the line in each case.

Answer to No. 1,072 (awarded 5s.).—The usual method adopted when calculating the pressure drop on a three-phase transmission line is to assume a fixed voltage at the receiving end of the line, and not at the generator end, as the generating volts have to vary with the load. We will, therefore, work on this basis, assuming a fixed voltage of 550 at receiving end of the line and a generator voltage of about 650. We now have the following data: current = 200 amperes; volts at receiving end = 550; frequency = 50; length of transmission = 1,000 yards; wires fixed 20in. centres apart; size of cable = $^{37}/_{12}$'s; diameter of cable = ·728in.; resistance of 1,000 yards of $^{37}/_{12}$'s cable = ·000078 × 1,000 = ·078 ohm.

(*a*) *Load Non-inductive—i.e., Power Factor = Unity.*—Power received = $\sqrt{3} \times 550 \times 200 = 191$ kw.; loss in line = $3 \times 200^2 \times ·078 = 9{,}360$ watts; volts drop in each line due to ohmic resistance = $200 \times ·078 = 15·6$ volts; reactance drop = $2\pi \sim$ L C (L = henries; $\sim$ = frequency; and C = current).

We can find L by the following formula:

$$L = 2\,l\left(15·24 + 140·366 \log \frac{d}{r}\right) 10^{-9}$$

where l = length in feet, d = distance between centres of wires, and r = radius of wire.

$$L = 2 \times 3 \times 1{,}000 \left(15·24 + 140·366 \log \frac{20}{·364}\right) 10^{-9}$$

$$= 6\,(15·24 + 140·366 \log 55)\, 10^{-9}$$

$$= 6 \times 260·24 \times 10^{-6} = ·00157 \text{ henry.}$$

$\therefore$ Reactance drop = $2\pi \times ·50 \times ·00157 \times 200 = 98·7$ volts.

Now, the back E.M.F. due to self-induction of the line lags behind the current by a quarter of a period, so the component of the total pressure at generating end to balance this E.M.F. must be 90deg. in advance of the current. As the current and impressed E.M.F. are in phase, the component of total pressure at generating end required to balance the ohmic drop in the line will be 180deg. in advance of the current, and, therefore, the vectors representing these two E.M.F.'s will be at right angles.

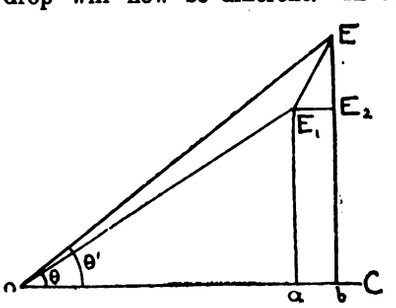
Total volts drop in line = $\sqrt{15·6^2 + 98·7^2} = 110$ volts approximately.

$\therefore$ Total voltage at generating end must be $550 + 110 = 660$.

$$\text{Efficiency} = \frac{\text{power delivered}}{\text{power delivered} + \text{watts lost}} = \frac{191}{191 + 9\,36} = 95\ \% \text{ approx.}$$

(*b*) *Inductive Load (Power Factor = ·75).*—Power received = $\sqrt{3} \times 550 \times 200 \times ·75 = 143·3$ kw.; loss in line = $3 \times 200^2 \times ·078 = 9{,}360$ watts; volts drop in each line due to ohmic resistance = $200 \times ·078 = 15·6$ volts; reactance drop = $2\pi \times 50 \times ·00157 \times 200 = 98·7$ volts.

Now on an inductive load of ·75 power factor the current lags behind the impressed E.M.F. by an angle of about 41° 25', and while the components of the total pressure at generating required to balance the E.M.F. of self-induction and ohmic drop are in the same positions relative to the current as in A—*i.e.*, 90deg. and 180deg. in advance respectively—they have moved through an angle of 41° 25' relative to the impressed E.M.F. at generating end, and so the volts drop will now be different. In the diagram,



O C = phase of current; O E = generating end voltage; and O E_1 = receiving end voltage. The actual line drop is given by the arithmetical difference between O E and O E_1.

$$\text{Total line voltage} = \text{O E} = \sqrt{(\text{O } b)^2 + (b\ \text{E})^2}$$

$$= \sqrt{(\text{O } a + a\ b)^2 + (b\ \text{E}_2 + \text{E}_2\ \text{E})^2}.$$

Now O a = O E × cos θ = 550 × ·75 = 412·5 volts; b E_2 = a E_1 = $\sqrt{(550)^2 - (412·5)^2} = 363$ volts; $a\ b$ = ohmic drop = 15·6 volts; E_2 E = inductive drop = 98·7 volts.

$$\therefore \text{Total line voltage} = \sqrt{(412·5 + 15·6)^2 + (363 + 98\,7)^2}$$

$$= \sqrt{(428·1)^2 + (461·7)^2}$$

$$= 630 \text{ volts.}$$

And, therefore, volts drop = 630 − 550 = 80.

$$\text{Efficiency} = \frac{\text{Power delivered}}{\text{Power delivered + watts lost}}.$$

$$= \frac{143·3}{143·3 + 9·36} = \frac{143·3}{152·66}.$$

$$= 94 \text{ per cent. approximately.}$$

It will be noted that with an inductive load the power transmitted is much less than with a non inductive load, the efficiency is less, but the volts drop is not so great. It is, therefore, of the utmost importance in all transmission schemes to keep the power factor as high as possible, as by doing so the power a given line will transmit is increased. Capacity and conductor impedance have been ignored in the above calculations, as they are negligible.

Part of the above has been obtained from articles written by Mr. Still and others appearing in the *Electrical Engineer* from time to time during the last few years. The slide rule has been used in making the calculations.—H. C.

[Other replies to Question No. 1,072 will be given in our next issue.—ED., *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

1,082. Can you kindly give me "connections" of "wiring" of switchboards, etc., that is supplied by energy by (1) shunt generator and shunt booster direct coupled; (2) shunt generator and *motor*-driven booster, supplying two batteries (parallel). I should like to charge one and discharge the other (lights) and keep motors separate.—EDWD. WIBLETT.

1,083. Give a definition of the term "diversity factor," and explain its effect on the load factor and on the capital cost per kilowatt installed.—E. P. A.

ANSWERS.

Question No. 1,072.—Given a three-phase overhead transmission line, 1,000 yards long, each conductor being $^{37}/_{12}$ bare copper, and the conductors occupying the three corners of an equilateral triangle with 20in. sides, generator voltage 650, frequency 50, give a method of predetermining the voltage drop (as measured between any two phases) between the generating and receiving ends of the line, working out the above as an example. Take two cases—viz., one with a load having a power factor of ·75 and the other with a power factor of unity—line current in each case 200 amperes. Show what is the actual power lost in the line in each case.

Answer to No. 1,072 (awarded 7s. 6d.).—To begin with the last part of the question first, it must be noted that the actual power loss in the line is only dependent upon the resistance of the line, and, therefore, for the same line current this loss will be the same at any power factor. It is only the voltage drop which suffers by altering the power factor of the load.

The resistance, R, of each line made up of $^{37}/_{12}$ 1,000 yards long is ·07744 ohm at 60deg. F. With 200 amperes per phase the total line loss at any power factor is $3 \times 200^2 \times \cdot07744 = 9{,}292.8$ watts. To calculate the voltage drop, the resistance drop and the inductive drop have to be calculated for each phase. The C R drop is 200 amperes × ·07744 = 15·5 volts. The inductive drop is given by the formula

$$E_L = 2\pi f L C,$$

where f is the supply frequency, L the inductance of the line in henrys, and C the load current. To find L, Maxwell's formula for the inductance of two parallel conductors must be used. This in English units is

$$L = \frac{2l}{10^9}\left\{15{\cdot}24 + 140{\cdot}366 \log \frac{d}{r}\right\}$$

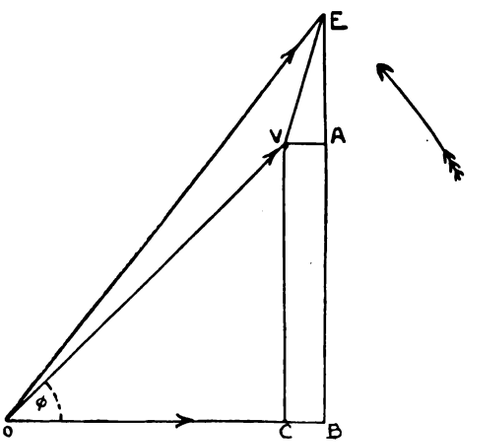
where l is the length of the line in feet, d the distance between the centres of the conductors, and r the radius of the conductor. In the case under consideration $l = 1{,}000 \times 3$, $d = 20$in., and $r = \cdot364$in. for a $^{37}/_{12}$ conductor.

$$\therefore L = \frac{2 \times 1{,}000 \times 3}{10^9}\left\{15{\cdot}24 + 140\,366 \log \frac{20}{\cdot364}\right\}$$
$$= 6{,}000 \times 259{\cdot}6 \times 10^{-9}$$
$$= \cdot00156 \text{ henrys.}$$

Inductive drop is, therefore,

$$E_L = 2 \times \pi \times 50 \times \cdot00156 \times 200.$$
$$= 98 \text{ volts.}$$

Having found the values of the two drops (C R and inductive), they must now be considered in their proper phase relation with the rest of the circuit. The vector diagram is given here; the vectors are assumed to be rotating clockwise. O E is the generator voltage, O V is the voltage at the end of the line, V A being the C R drop and E A the inductive drop; O C represents the phase position of the current, the power factor of the load being cos V O C. This is the diagram for one phase; the other two could be represented by similar diagrams.



With a power factor of unity O V is in phase with O C, and, therefore, O V A is a straight line, and $O A = \sqrt{O E^2 - A E^2}$.

$$\therefore O A = \sqrt{\{650^2 - 98^2\}} = 643.$$
$$\therefore O V + V A = 643.$$
$$\therefore O V = 643 - 15{\cdot}5 = 627{\cdot}5$$

i.e., voltage at end of line for power factor 1·0 = 627·5 volts.

For a circuit of power factor ·75,

$$O E^2 = E B^2 + O B^2$$
$$= (E A + V C)^2 + (O C + V A)^2$$
$$\therefore 650^2 = (98 + V C)^2 + (O C + 15{\cdot}5)^2.$$

Now $\cos \phi = \cdot75$ and $\sin \phi = \cdot662$

$$\therefore 650^2 = (98 + \cdot662 \,.\, O V)^2 + (15{\cdot}5 + \cdot75 \,.\, O V)^2$$
$$\therefore 422{,}500 = 9{,}604 + 129{\cdot}7 \,.\, O V + \cdot4{,}375 \,.\, O V^2$$
$$+ 240 + 23{\cdot}2 \,.\, O V + \cdot5{,}625 \,.\, O V^2$$
$$\therefore O V^2 + 153\, O V - 412{,}660 = 0$$
$$\therefore O V = \frac{-153 \pm \sqrt{153^2 - (4 \times -412{,}660)}}{2}$$
$$= 571$$

i.e., voltage at end of line for power factor ·75 = 571 volts.—F. H. CLARK.

Answer to No. 1,072 (awarded 7s. 6d.).—The voltage drop in each line is made up of two components—namely: (*a*) the E.M.F. consumed by the line resistance, which is in phase with the line current; and (*b*) the E.M.F. consumed by the line reactance, which is 90deg. out of phase with the line current.

We can readily compute the resistance drop in the line, and also the power lost in consequence of this drop as follows. From the London Electric Wire Company's catalogue we find that resistance per 1,000 yards of $^{37}/_{12}$ cable = ·073 ohm. Therefore, resistance of each line = R = ·073 ohm; current flowing in each line = C = 200 amperes; resistance drop per line = C R = 14·6 volts; power lost in each line = C^2 R = 2·92 kw. That is, total power lost in transmission lines with 200 amperes flowing = 2·92 × 3 = 8·76 kw. This loss is independent of the power factor so long as the current remains constant, so that the value given above will be the actual loss in the lines for the two cases given in the question.

We will next consider the reactance drop in the lines, and before we can calculate this it is necessary that we should know the reactance of each line. Referring to Fig. 1, which gives a sectional view of the three transmission lines showing their relative positions, we can readily derive, from first principles, an expression for the reactance per line. Consider a point between any two

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lines at a distance x from one of them, A. Then the field strength at this point due to a current, C (in absolute units), flowing in the line, A, is given by

$$H = \frac{2\,C}{x},$$

x being measured in centimetres. If length of lines $= l$ centimetres,

$$\text{Total flux between lines} = \int_{\frac{d}{2}}^{m} \frac{2 \cdot C\, l \cdot dx}{x}$$

$$= 2\,C\, l \cdot \log_\epsilon \frac{2\,m}{d}$$

neglecting the flux inside the transmission wire.

$$\therefore L = 2\, l \cdot \log_\epsilon \frac{2\,m}{d} \text{ absolute units.}$$

$$L = 2\, l \cdot \log_\epsilon \frac{2\,m}{d} \cdot 10^{-9} \text{ henrys.}$$

That is, reactance per line $= 2\,\pi\, f\, L$

$$\text{,, ,,} = 4\,\pi\, f \cdot l \cdot \log_\epsilon \frac{2\,m}{d}\, 10^{-9} \text{ ohms}$$

$$\text{,, ,,} = 2{\cdot}88\, f\, l \log \frac{2\,m}{d}\, 10^{-8} \text{ ohms}$$

where f = frequency. In the present case, $f = 50$; $l = 36{,}000$

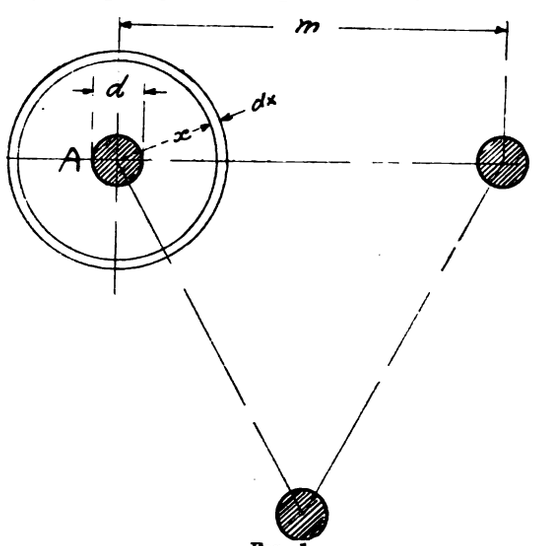

FIG. 1.

× 2·54cm.; m = 20in.; d = ·73in. (from London Electric Wire Company's catalogue).

$\therefore$ Reactance per line

$$= 2{\cdot}88 \times 50 \times 36{,}000 \times 2{\cdot}54 \times \log \frac{40}{{\cdot}73} \times 10^{-8}$$

$$= {\cdot}228 \text{ ohm} = R_a.$$

$\therefore$ E.M.F. consumed by reactance $= C\,R_a = 200 \times 228$

$= 45{\cdot}6$ volts.

This component is at right angles to the resistance drop component, so that

$$\text{E.M.F. consumed by impedance} = C\sqrt{R^2 + R_a^2}$$

$= 47{\cdot}8$ volts.

The angle θ between this component and the resistance drop component is such that

$$\tan\theta = \frac{45{\cdot}6}{14{\cdot}6} = 3{\cdot}13.$$

$$\therefore \theta = 72{\cdot}2\text{deg.}$$

We will now proceed to calculate the voltage drop (as measured between any two phases) between the generating and receiving ends of the lines for the two cases given in the question.

Case I.—Power factor assumed to be unity—that is, we will assume that the current is in phase with the voltage (measured between line and neutral) at the *receiving end* of lines Fig. 2 gives a vector diagram showing the phase relations of the various voltage components. A B = resistance drop = C R; A D = reactance drop = C R_a; D B = impedance drop = $C\sqrt{R^2 + R_a^2} = E_2$; D C = voltage between line and neutral at generating end = E_1; B C = voltage between line and neutral at receiving end = E. Then in general

$$E_1^2 = E_2^2 + E^2 + 2\,E\,E_2 \cos\theta,$$

and for this simpler case where the angle D A B = 90deg.,

$$E = \sqrt{E_1^2 - R_a^2\,C^2} - R\,C.$$

In this case

$$E_1 = \frac{650}{\sqrt{3}} = 375 \text{ volts.} \quad \therefore E_1^2 = 141{,}000.$$

$$R_a\,C = 45{\cdot}6 \text{ volts.} \quad \therefore R_a^2\,C^2 = 2{,}070.$$

$$\therefore E = \sqrt{141{,}000 - 2{,}070} - 14{\cdot}6$$

$$E = 372{\cdot}6 - 14\,6 = 358 \text{ volts.}$$

That is, voltage between lines at receiving end $= 358\sqrt{3}$

$= 620$ volts.

Therefore, *apparent* drop in lines = 30 volts.

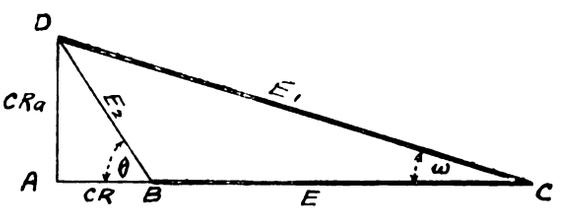

FIG. 2.

A reference to Fig. 3 shows that there is a phase displacement between E_1 and E This phase displacement, w, is such that

$$\tan w = \frac{C\,R_a}{C\,R + E}$$

$$\tan w = \frac{45{\cdot}6}{372\,6} = {\cdot}123.$$

$$\therefore w = 7\text{deg.}$$

The meaning of this is that whereas at the receiving end of the lines the current is in phase with the voltage (between line and neutral), at the generating end the current lags by 7deg. behind the voltage due to the inductance in the transmission lines.

Case II.—Power factor assumed to be ·75. Therefore, $\cos\phi = {\cdot}75$, or $\phi = 41{\cdot}5$deg., which means that at the *receiving end* of the lines the current lags by 41·5deg. behind the voltage (measured between line and neutral).

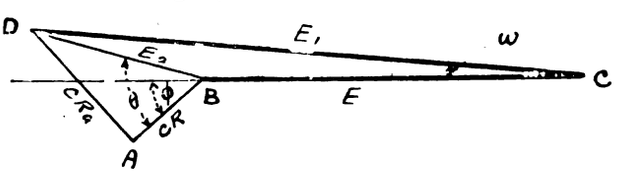

FIG. 3.

Fig. 3 shows the vector diagram for this case. From the geometry of the construction we can write

$$E_1^2 = E_2^2 + E^2 + 2\,E\,E_2 \cos(\theta - \phi),$$

from which E can be calculated. In this case we have

$E_1 = 375$ volts. $E_1^2 = 141{,}000$.

$E_2 = 47{\cdot}8$ volts. $E_2^2 = 2{,}280$.

$\theta = 72{\cdot}2$deg.

$\phi = 41{\cdot}5$deg. $(\theta - \phi) = 30{\cdot}7$deg, $\cos 30{\cdot}7\text{deg.} = {\cdot}86$.

$$\therefore E^2 + (95{\cdot}6 \times {\cdot}86)\,E - (141{,}000 - 2{,}280) = 0.$$

$$\therefore E^2 + 82\,E - 138{,}720 = 0.$$

$$\therefore E = -41 + \sqrt{\frac{(82)^2 + 554{,}880}{2}}.$$

$$E = -41 + 375{\cdot}3 = 334{\cdot}3 \text{ volts.}$$

Therefore, volts between lines at receiving end

$$= 33{,}413 \times \sqrt{3} = 579 \text{ volts.}$$

Apparent drop in lines between generating and receiving ends = 71 volts.

As in the previous case, there is a phase displacement, w, between E_1 and E, which means that whereas the dis-

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placement between current and voltage (between line and neutral) at the receiving end is 41·5deg., at the generating end it will be less than this by the angle w; or, in other words, the power factor at the generating end is greater than that at the receiving end, and in this case it will be somewhat more than ·75, as we have assumed this to be the power factor at the receiving end.

If "K. O." wishes to pursue this subject further, I would refer him to "Elements of Electrical Engineering" by C. P. Steinmetz, where this type of problem is dealt with at length, and from which the method of reducing the reactance of a transmission substantially as given above is taken.—A. P. YOUNG.

Question No. 1,073.—By what methods can a short circuit in an armature be accurately located without the use of testing instruments?

Best Answer to No. 1,073 (awarded 10s.).—The mode of procedure depends under what conditions you are situated. We will briefly discuss the matter under the following heads: (1) When the armature is in the machine ready for running; (2) when the armature is in the repair shop, where a source of supply is available, either alternating or direct; (3) when there is no source of supply available.

Firstly, a word as to the causes. The nature of a short-circuit may be as follows: (*a*) two grounds (connections between the conductors or the commutator bars, and the iron or metal portions of the armature); (*b*) a short in the commutator, caused by a piece of solder, metal, or other foreign substance getting between the commutator bars or their connections; (*c*) two wires touching each other, due to faulty insulation.

1. The machine should be started with no load, and if the fault is not a serious one, the short-circuited coil can be located by the excessive heat generated in it after a few minutes' run. Care should be taken not to run too long, or the coil will quickly burn out. In the case of a dynamo, if the fault is a serious one, the field will not excite itself. If a source of supply is at hand, the machine can be separately excited and run for a few minutes, when the fault can be traced as before. In the case of a motor, the armature may make a portion of a revolution and then stop, blowing the fuse. The coil affected will have one end under one of the brushes, so the segments should be marked under each set of brushes to facilitate the location of the fault when the armature is removed.

2. The first method usually adopted is to test for the fault under (*a*). Having two wires coupled to a lamp circuit, by placing one on the metal of the armature and the other on the commutator, the lamp should glow if the fault comes under (*a*). This can then be quickly located by unsoldering the commutator at different points until the exact places are located. To test for the fault under (*b*) or (*c*) with the lamp, all the top wires should be unsoldered in the case of a lap winding; with a wave winding $\frac{P}{2}$ usually being sufficient, where P = the number of poles. Connect the unsoldered ends together by means of a piece of bare wire, also to one end the testing wires. Now test each circuit separately, by disconnecting one at a time, and placing the other testing wire on to it. When the shorted coil is reached the lamp will glow. In the case of the wave winding, each circuit should also be tested on to the commutator, and should only glow on one of the unsoldered segments, the fault being in the soldered portion if the lamp glows on any other, of course assuming it does not glow on the other top unsoldered connections. There is one class of fault that the incandescent lamp fails to locate—viz, when a coil is short-circuited on itself. A short under (*b*) is often successfully cleared in the case of a small armature by passing a heavy current through the armature, which burns out the metal bridge. Where alternating current is available the following device can be arranged. A pole-shoe of laminated iron, shaped like a field pole, is mounted on a suitable wood stand. A few turns of rather thick wire are wound on it. The armature to be tested is brought as close to it as possible, well in the curve of the shoe. An alternating current is then passed through the coil on the shoe, and the armature slowly revolved. The operator then passes a piece of sheet iron over the part of the armature which is embraced by the coils, which have part of their windings under the testing shoe. If there be a closed circuit—that is, a short-circuit—the piece of iron is attracted to the armature. If the coils are in good order there is no attraction. This apparatus is more fully described by a correspondent in the *Electrical Engineer* of Aug. 3, 1906, whom I have to thank for the idea.

3 The author has in many cases tested an armature for a short-circuit with the following apparatus, which is generally procurable in most places. A four-volt accumulator, such as used for motorcar work, and a small ammeter reading 0 to 1 amperes, such as used for testing lamps, is all that is required. Connect a short spiral of iron wire in series with the accumulator and ammeter, so that when the circuit is complete the ammeter deflects one ampere. Now unsolder one segment of the commutator and separate the wires. By placing two wires on adjacent segments so as to complete the circuit through one of the windings, a reading will be observed on the ammeter slightly below one ampere provided the coil is not short-circuited. Each coil can thus be tested, but as the short may be of a more serious nature a larger span of the commutator may have to be taken, and a correspondingly lower reading observed. The querist will have to use his own judgment in locating the fault speedily. H. COLLINSON.

Answer to No. 1,073 (awarded 7s. 6d.).— A simple method of localising a short-circuited section is to run the machine on open circuit for about five or ten minutes and then stopping it. The faulty coil, if not burnt out, can then be located by running the fingers over the armature, by its excessive temperature over the rest of the coils, and by the charred appearance of the varnish or insulation. Short-circuits are often produced by pieces of solder which have dropped inside between adjacent commutator lugs during the process of soldering on the conductors. It is, therefore, necessary to carefully examine the commutator lugs and segments. With regard to short-circuits between adjacent coils in drum armatures, the method above described is not applicable, as the whole armature would heat equally.

The following method has been given in the *Electrical Engineer* of New York, and I have tried it with success. Attach a wrench to the pulley, so as to be able to turn the armature round by hand. Now excite the field, the coils being preferably connected in parallel, to make the effect more marked. When it is attempted to pull the armature round, it is found that it can only be done very slowly, *except at one position*. Mark the armature at points in the centre of the pole-pieces and at both ends of the armature. The explanation is that both halves of the armature oppose one another at this point, but when not at these points a continuous circuit is formed, and the resultant magnetic effect is very great. The short-circuit will be found at one of these four marked points, and experience has shown that it is nearly always on the commutator end, in the last half of the winding, where the wires pass down through the first half terminals. When a short-circuit occurs by the wirdings coming into contact with the core or frame, it can be located by disconnecting the armature coils from the commutator, and testing each separately with a small battery and bell, one end of which is permanently connected to the shaft, while the other is connected in turn to each of the armature wires.—ARMATURE.

Answer to No. 1,073 (awarded 5s.).—The following method may be found of some use: The principle consists in placing the armature in an alternating field. The circuit which contains the short will then act as the short-circuited secondary of a transformer, and if the conditions are favourable, currents will flow sufficiently heavy to clear the faulty coil, or at any rate heat it sufficiently to indicate its position. Various methods might be employed to accomplish this, depending upon the size of the faulty armature: (*a*) Assuming it is a direct-current machine, raise brushes from commutator, excite field magnets from an external source, and drive armature from another machine or its own prime mover. If necessary, over-excite or run above normal speed. (*b*) If an induction motor of same diameter is available, it would be worth while trying the following method: Replace rotor by the faulty armature, blocking it in position. Apply a gradually increasing

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alternating voltage to the stator, when the currents induced in the short-circuit by the rotating flux will burn out the faulty coil. (*c*) Other methods will suggest themselves if an alternating source of supply is available, such as putting a few turns round the armature to act as the primary of a transformer, the secondary being the assumed short-circuit.—P. H.

Answer to No. 1,073 (awarded 5s.).—(1) A short in an armature could be found by means of the arrangement shown in Fig. 1. A A and B B are two adjacent armature

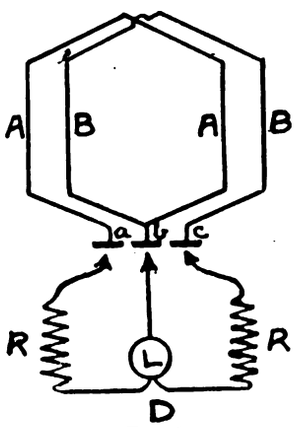

FIG. 1.

coils connected up to the segments of commutator, *a*, *b*, *c*; R R are two equal resistances, and L is a small-voltage incandescent lamp. A suitable current is made to flow in the armature, and the three terminals of the arrangement are then brought into contact with *a*, *b*, *c* as shown. When there is no fault in either of the coils the drops in voltage between *a* and *b* and *a* and D will be each equal to half the

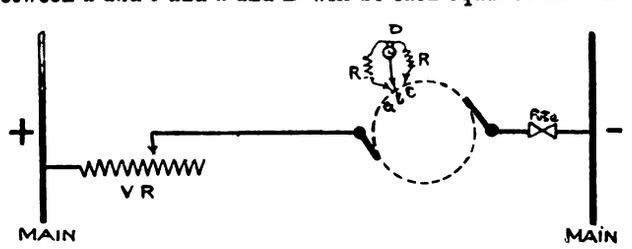

FIG. 2.

drop *a c*, and there will thus be no current through L, while a short across *b c* would produce a voltage across D *b* equal to a little less than half the drop *a c*, and the lamp would glow. A short can thus be readily detected by passing the arrangement R L R round the commutator until the lamp lights. In order to make the apparatus as effective as possible, the resistance, R, should be as large

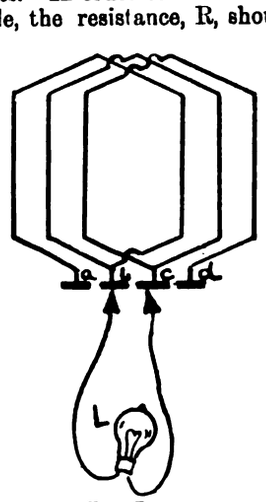

FIG. 3.

as possible with relation to the resistance of an armature coil, at the same time keeping it well under the resistance of the lamp. For a dead short it should be possible to get through the lamp about one quarter of the voltage produced by the current between the segments. The current required may be taken from the mains through a suitable variable resistance, V R, this being adjusted until L glows brightly when in position shown in Fig. 2. (2) A more simple but less sensitive method is shown in Fig. 3. In this case the current is adjusted as above until the voltage drop between the segments is sufficient to make the lamp glow brightly. A short between two segments is indicated by the failure of the lamp to light up properly when placed between them.—T. E. BRIDGE.

Answer to No. 1,073 (awarded 5s.).—If testing instruments are dispensed with, the only way in which the position of a short-circuit can be located is by having recourse to the heating effect produced by an electric current, and for this object to induce, in some way, a voltage in the armature coils which will cause a current to circulate in the short-circuited coil or coils, so that by simply running one's hand round the armature coils the position of the short-circuit can be located. This can be conveniently carried out by coupling the machine having the defective armature with a small driving motor by means of a belt, and running it at somewhere about normal speed with the fields fully excited and the armature circuit open. This will induce an E.M.F. in the armature coils, and, of consequence, a large current will circulate in the short-circuited winding, so that after the machine has been running in this way for five or ten minutes it should be quite an easy matter to pick out the defective coils after the armature has been brought to rest. It might even be possible, if the short-circuit is not a very bad one, to run the machine as a motor, the result being the same as when

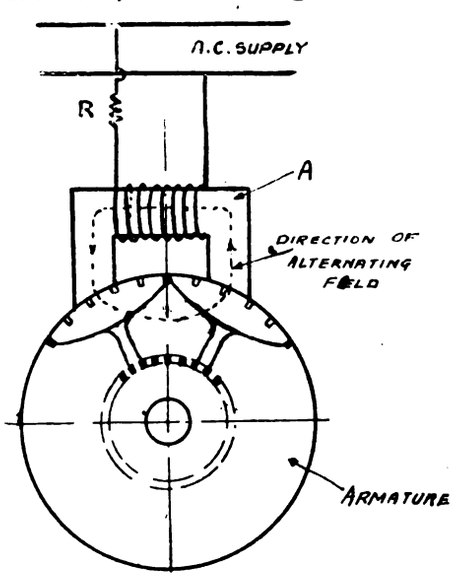

FIG. 1.

it is driven by mechanical means, as the heating effect of the current taken to run the armature would be so small as to be almost negligible, and, therefore, the excessive heating produced in the short-circuited coils would soon manifest itself.

If the armature has been removed from its bearings, the necessity of reassembling and running it in either of the ways described above can be overcome by constructing some such device as shown in Fig. 1. This piece of apparatus consists of an iron core, A, made up of a bunch of laminated punchings of the shape shown in the diagram, upon which is wound a coil of wire large enough to carry, say, five or ten amperes. The method of testing the armature with this piece of apparatus consists simply in placing it upon the periphery of the armature, as shown in the diagram, and exciting the coil with alternating current. Obviously, the magnetic circuit is such that the alternating flux will thread a number of coils for any given position of the core, A, and, therefore, an E.M.F. will be induced in the coils, and if one of these is short-circuited a current will circulate which in a very little time will heat the conductors appreciably. By moving the core, A, step by step round the whole periphery, and keeping the current on from two to three minutes for each position, the defective coils will soon be found out.—A. P. YOUNG.

[Other replies to Question No. 1,073 will be given in our next issue.—ED., *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

1,084. Is it commercially possible to have a motor-generator, transforming direct current 500 volts to three-phase alternating current 11,000 volts, wound so as to produce the alternating current at 50 or 25 cycles, so that machine can be used for supplying power or lighting mains respectively as occasion may require? State difficulties in making or running such a machine.—A. B. C.

1,085. What tools and plants are necessary to start a factory for instrument repairs (electrical)? Give details of plant and approximate costs.—RAYMOND CORREA.

1,086. What are the best kind of works at which the young electrical engineer should receive his mechanical engineering training?—M. G. TWEEDIE.

ANSWERS.

Question No. 1,073.—By what methods can a short-circuit in an armature be accurately located without the use of testing instruments?

Answer to No. 1,073 (awarded 5s.).—The exact position of a short-circuit in an armature is often rather difficult to find, even when using instruments. "A. L. R." wishes to locate the fault without using any instruments; he will by the following method be able to get at the cause of the trouble. Run the machine up for a few seconds with field excited, and with a switch in the field circuit if a generator; if a motor, the ordinary starter will do. On shutting down, one or more coils will be heated if any shorts are present. The hot coils should be marked and the connections traced down to the commutator bars. The mica segments adjacent to these commutator bars should be carefully examined to see that no copper bridges across same and that they are clear of carbon and metallic dust. The connections of the heated coil (or coils) may then be lifted out of the commutator lugs and the bars bridged over by a stiff piece of copper wire. On repeating the same experiment, if the marked coil does not heat up again the trouble will have been due to a short-circuit in the commutator; if, on the other hand, the coil still heats up, then there is an internal short in the marked armature coil.

"A. L. R." does not give much information about the short-circuits he refers to. Should the heating be above normal and more or less uniform throughout the whole of the winding, the trouble will most likely be due to carbon or metallic dust accumulating inside the commutator or on the coil connections. It is, however, impossible to locate the shorts in this case except with the aid of instruments. "A. L. R." will be well advised to have the armatures thoroughly blown out, when a good deal of his trouble will disappear.—PERCY W. DAVIS.

Question No. 1,074.—In many designs of turbo-generators fans are fixed to the rotor to produce the necessary draught for cooling. What governs the design of these fans for such high tip speed? How is the pressure, efficiency, and output affected by number of blades, depth of same, and shape?

Answer to No. 1,074 (awarded 10s.).—It is probable that in most cases where ventilating fans are fixed to the rotor of turbo-generators very little theory is brought to bear upon their design, and in fixing the general dimensions and shape the engineering sense, so to speak, is relied upon more than theoretical considerations. In the case of a centrifugal air-compressor, where we have a fan rotating at a high speed in an enclosed space, very reliable formula can be employed to predict the pressure, discharge, efficiency, etc., for given conditions; but in the case of a ventilating fan the conditions are so different as to make the formula almost unreliable, and, therefore, if theory is brought to bear upon their design the results are only approximate. If, however, the fan blades are enclosed so that the air is made to flow in and out in a definite way, then we can apply the usual formula for centrifugal air-compressor design with some degree of accuracy. The formula can be simplified to some extent by assuming that the density of the air remains constant during its passage through the fan, and this assumption is very nearly correct, as the rise of pressure will always be very small.

As a starting point for the design of such a ventilating fan we take a representative figure for the quantity of air necessary to produce good ventilation, per kilowatt loss, as being 100 cubic feet per minute. If the output of the generator in kilowatts is W, then assuming a 5 per cent. loss in the generator the quantity of air required will be

$$Q_1 = 5\ W \text{ cubic feet per minute.}$$

$$Q = \cdot 083\ W \text{ cubic feet per second.}$$

Referring to Fig. 1, which shows the end view of a typical fan, it is quite an easy matter to calculate the velocity, V_1,

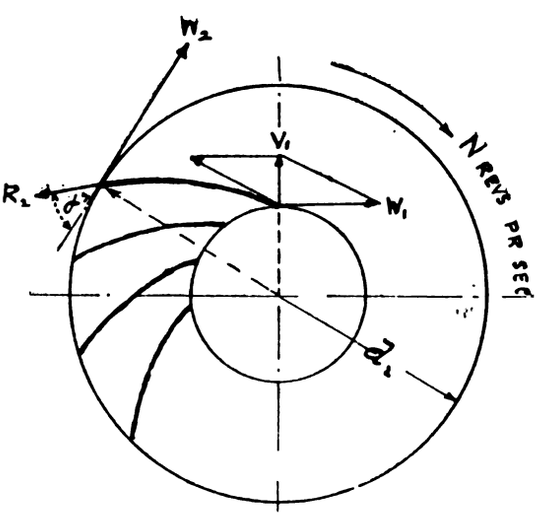

FIG. 1.

at the blade inlet from the area of the inlet passage, and the value of Q obtained as above. In the diagram the vanes are shown to bend away from the direction of motion—that is, the air has a backward discharge—and this shape of vane is found to give the most efficient results. If d_2 = blade diameter and m_2 = blade width at exit in feet, then

$$A_2 = \text{blade area at exit} = \pi\, m_2\, d_2 \text{ square feet}$$

and

$$R_2 = \frac{Q}{A_2 \sin \alpha_2}.$$

Also

$$W_2 = \pi\, d_2\, N,$$

where N = revolutions per second. From this data we can calculate the effective pressure rise from the formula,

$$P = \cdot 0000165\, \eta\, W_2^2 \left\{ 1 - \left(\frac{R_2}{W_2} \right) \cos \alpha_2 \right\} \text{lbs. per sq. in.,}$$

where η = hydraulic or compression efficiency, and can be taken to be 0·6. The value of the pressure rise given by this formula is the difference in pressure between points where the velocity is zero—that is, assuming we have a quantity of air which from a condition of rest is made to pass through the fan blades, and is then brought to rest again, then the pressure rise between the two points where the condition of rest exists is given by the above formula. Of course, these conditions do not exist absolutely, but before

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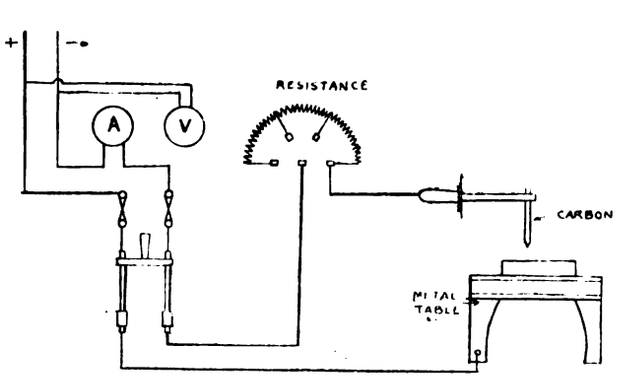
entering and after leaving the blades the velocity will certainly be small, so that the value of the pressure given by the formula will give some idea of the pressure actually produced. The theoretical power required to effect this pressure rise is given by ·195 Q P in kilowatts. Assuming a shaft efficiency of 50 per cent., this means that the actual power required to run the fan to give this discharge and pressure is, driving power = ·39 Q P, kilowatts. The pressure is, within limits of course, unaffected by the number of blades—that is, so long as sufficient are used to constrain the air to flow in a definite path so that the velocities as computed above can be relied upon. It can be readily seen by reference to the pressure formula that the pressure can be altered by varying the discharge angle α_2—that is, as this angle is increased the pressure will also increase. The construction of the air-passage through the rotor leading to the inlet of the blades should be such that the velocity in this passage is small—say not more than 20ft. or 30ft per second.

In certain designs of turbo-generators funnels are attached to the ends of the rotor in much the same way that they are attached to the deck of a ship for producing ventilation. These funnels are connected by a cylindrical passage which passes right through the rotor, the result being that air is being continually forced through this passage. These produce the same result as would a fan placed at one end of the rotor—that is, air is continually drawn through the rotor. A certain scheme of ventilation which I have seen consisted in placing the fan blades, such as shown in Fig. 1, inside the rotor ducts. This would create a pressure all along the space between rotor and stator, the result being that air would be drawn radially through the rotor and forced out partly through the stator ducts and partly along the air-gap in an axial direction. The formula given above could be applied to fans fixed in this way, and the method would seem to be very efficient.—A. P. YOUNG.

Question No. 1,075.—Which is the most efficient system of electric welding for jobbing work about a large engine works—*i.e.*, repairs to shafts, etc. ? It is to be worked during the day from a private lighting installation of about 110 volts, 400 amperes, continuous current (compound-wound dynamo).

Best Answer to No. 1,075 (awarded 10s.).—The Benardos arc welding system is the most suitable for jobbing work and repairs in an engine works provided with a continuous-current supply. For certain kinds of repairs, such as joining together broken parts of finished work, which would be ruined if heated externally to any considerable extent, the Thomson system is better, but for this single-phase alternating current is necessary. In the Benardos system the article to be repaired is placed on a metal support, to which is clamped the positive lead from the dynamo, and the negative lead is connected to the welding tool. The current thus flows from the work to the carbon,



and this tends to prevent particles of carbon from entering the weld, which would have the effect of rendering it brittle. The welding tool may consist simply of a gunmetal or brass clip for holding the carbon rod, with a wooden handle through which the negative lead is carried and connected to the carbon-holder by a screw terminal. A circular wrought-iron screen is fitted between the handle and the carbon-holder to protect the operator's hand. A series resistance with four-stop switch is used to regulate the current through the arc. This is generally of the grid type. Liquid resistances are sometimes used, but they require more attention than wire resistances. The general arrangement of the apparatus is shown in the accompanying diagram. The operator wears a canvas or asbestos mask fitted with a coloured glass window, to protect his eyes and face, and the greatest care is necessary to shield neighbouring workpeople from the glare of the arc. For this purpose canvas screens should be arranged around that part of the shop where the welding is done.

Blowholes in steel castings are repaired by first thoroughly cleaning out the hole, which may be done with the arc, and then inserting some small pieces of scrap steel. These are then melted in, and the process repeated until the hole is filled. Broken lugs and projections are repaired by making a mould of gannister or fireclay to the required shape, and building up a new piece by melting scraps of steel in the mould. Broken teeth on gear wheels are mended in the same way. To repair a crack in a plate or casting, the arc is first used to cut a V-shaped groove along the line of the crack, and this is then filled up a few inches at a time by melting in small pieces of steel. Broken shafts may be repaired by butting the pieces closely together, and burning out a V-shaped cavity between them by the arc. This cavity is then filled up by welding in new metal. The partly-repaired shaft can then be turned over and the operation repeated on the opposite side. Boilers that have become corroded can be repaired by welding on a "patch" to cover the defective part, making a sound job. For working on thin plates a special welding tool is used, in which two carbons are arranged in such a way that the arc is blown out in the form of a flame, similar to a flame arc lamp. This gives a wider distribution of heat than the single-carbon tool. The two carbons are connected to the positive and negative lead respectively, and the work is not connected in the welding circuit. The quality of carbon used is very important, as the frequent heating and cooling tend to cause it to crumble or crack in pieces. Particles of carbon then become incorporated in the weld, and produce a hard weld almost impossible to machine afterwards. With suitable hard, solid carbons a good toolable weld can be made after some little practice. The size of carbon is usually 12in. long by about 1in. in diameter.

On account of the intense heat of the arc the welding tool must be kept moving around the part to be repaired, so as to thoroughly heat the metal in the vicinity of the weld, otherwise it would cool too rapidly and produce a hard weld. It is also advisable to hammer the weld after each new layer is added, as this assists in making a satisfactory weld. For ordinary purposes a current of 200 to 300 amperes at 80 volts is sufficient, but for very large castings or forgings 500 amperes or more may in some cases be required.

This system of welding is now very largely used in steel works and foundries, and its usefulness in rendering serviceable many valuable castings and finished parts, which would otherwise have to be entirely scrapped on account of some defect, is obvious.—A. B.

Answer to No. 1,075 (awarded 5s.).—The question as to which is the most efficient method of welding will depend upon the class of work that is to be carried out. In a large engine works the repairs that have to be dealt with are of a most varied nature, both as regards magnitude and intricate design; it will, therefore, be necessary to describe each system of welding. There are three commercial systems of electrical welding suitable for an engine-repair shop—*i.e.*, the Thomson, Goldschmidt, and ordinary arc systems.

The Thomson method, which is specially suitable for welding tubes, bars, rods, etc., up to about 3in. diameter, depending upon the power available, consists of an alternating-current step-down transformer giving a secondary voltage of two or more volts with a very large current. The secondary terminals are arranged in the form of massive clamps, which grip the material to be welded; one of these clamps is usually fixed, and the other movable and attached to a lever. The two pieces of material which it is proposed to weld are placed between the clamps in connection with each other, so that when the

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current is switched on the material is instantly raised to a welding temperature due to the high current flowing. The movable clamp is now pressed towards the other clamp by a lever, which forces the weld together, thereby pressing out any inequalities in the ends of the material. For welding steel tubes together of, say, 2in. diameter, a power of about 35 kw. would be required; this value may appear excessive, but the time the current is flowing is so short that the power consumed is but a fraction of a unit. The disadvantage of this system is that the operating plant is very expensive, and unless a good deal of repetition work is likely to be required, it is very questionable whether the results would warrant the initial expenditure. The cost of a 35-kw. welding plant, exclusive of the alternator, would be about £450, and of a belt-driven single-phase alternator at 220 volts, 50 cycles, with exciter, about £130. For very heavy work, such as the welding of tramway rails, etc., a special design of transformer fitted with suitable terminal clamps is provided, so that the rails can be welded in position. The method of operation is the same as described above.

Dr. Goldschmidt's system is an alumino-thermic process for obtaining an intense local heat by means of a chemical combination between aluminium and oxygen. The special metallic mixture or welding compound which is employed is named "Thermit," and usually consists of a powdered mixture of aluminium and iron oxide. It is well known that if combustion takes place with aluminium the various metals can be separated from their combinations. In order to commence the reaction between the two metals mentioned above, a small quantity of oxide with a low melting point is provided, which can be ignited with a match. As soon as the reaction commences it proceeds automatically through the whole mass, and in about half a minute the whole reaction is complete, resulting in a temperature of about 3,000deg. C. The parts to be repaired are effectually welded together by the molten iron flowing into the joint, and a thick covering of aluminium slag appears on the surface, which can be easily chipped off. This system is largely used in welding electric tramway rails together for special heavy work in connection with shipbuilding, such as welding together broken propeller shaft brackets, stern posts, tubes, also the repair and welding of rings on shafts of 12in. diameter and upwards, welding broken bosses on main rolls for steelworks, etc. This system has the great advantage that practically no special plant is required beyond a few crucibles, rods, clamps, and other similar material recommended by the makers. It is a most valuable addition to a large repair shop, and many important weldings have been successfully carried out. The welding of two bull-headed rails together, weighing, say, 90lb. to the yard, would take about 14lb. of "Thermit," costing approximately 4d. per pound.

The arc system consists of two converging carbons carried in a suitable frame with an electromagnet to deflect the arc to the extremities of the carbons. It is chiefly used in filling up holes in iron and steel castings or for light welding. In some instances one carbon only is used, the material to be operated upon forming the other pole. For ordinary work a carbon of ⅜in. diameter is used, and takes about 300 amperes at 80 volts; the cost of the complete plant (exclusive of dynamo) of two welding tools, screens, 100ft. of carbon, switchboard, and regulating resistance would be about £110.

The Falk system of cast welding has not been mentioned, as it is hardly suitable for ordinary shop repair work.

From the above suggestions it will be concluded that the arc system should be installed, and the Goldschmidt system to be used for any heavy work. It would, of course, be an advantage if the Thomson plant could be installed, as it is quite possible that for some repairs this system would be preferable to the other previously mentioned.—K.

Answer to No. 1,075 (awarded 5s.).—For the perfect welding of shafting, rails, or rods, there is nothing to beat the Thomson process. The two pieces to be welded form the secondary circuit of a transformer, and the resistance at the point of contact raises the temperature very rapidly to welding point. Most of the large railway works are equipped with the necessary plant, which is chiefly used for the piecing together of rails. Shafting manufacturers also piece together small pieces of shafting by this process. The plant, however, which consists of a single-phase alternator, exciter, switchgear, and special transformer to transform down to a very low pressure at an enormous current, is necessarily expensive, and is not adaptable to the many repairs found necessary in the ordinary engine works.

The Bernados process, or some modification of it, is by far the best process to use for the purpose. The private lighting installation referred to just furnishes the right pressure and power for the purpose. The welding must be arranged to be done when the plant is not being used for lighting, for if both are attempted at the same time a sudden demand of 200 to 300 amperes for welding will seriously interfere with the steadiness of the lighting pressure. The ordinary Bernados process consists of a large regulating resistance, special carbon-holder attached by a heavy flexible cable to one polarity, and a shield to protect the welder's eyes and skin from the intense light and heat. The casting, broken machine, or shafting is connected to the other pole. The intense heat of the electric arc is taken advantage of to raise the metal to melting or welding point. A great deal depends on the skill and experience of the workman. A fresh hand will simply make a hopeless job of the repair.

Some examples of the use that can be made of this process will be mentioned by the writer. A defective place in some line shafting gave way just before the meal hour; this caused over 50 men to be stopped until it could be repaired. A trough lined with fireclay was fixed at the defective spot, the broken ends brought to melting point, fresh metal was added as required, and the shaft ready for work as strong as ever by the time the men came back from dinner. An important machine had two or three teeth broken on a gear wheel. Fresh metal was welded on to replace the broken teeth and the new teeth filed into shape. A large gear wheel, badly cracked through the rim, was quickly and satisfactorily welded and made sound again. A small flaw was found when turning up a connecting rod; it could not be machined out as the rod was down to size, but some fresh metal was welded in and the part finished off. For the welding up of blowholes discovered whilst machining up castings the process is invaluable. Some important points to notice in doing this work may be mentioned. All the defective material should be cut clean out, leaving nothing but sound metal to be welded. The metal should be subjected to the intense heat for as short a time as possible, as otherwise the metal may oxidise. The pieces of metal which are added to the weld should be most carefully chosen, as a great deal depends on this point. The double-carbon process is very good for smaller work. In this case the metal to be welded does not form part of the circuit at all. The tool used is simply a hand-fed arc lamp specially arranged to obtain a long flame between the carbons blown downwards on to the work. The process is used for the repair of light castings, brazing, or the welding of objects of small cross-section. The Bernados system has been used and will probably be much more extensively used for cutting purposes, such as removing unnecessary projections on castings, the trimming of sheet metal to the desired shape.

The Admiralty object to the electrical repairing of any machinery, but this is only because the processes described are capable of being abused by unscrupulous engineers. For instance, instead of making an absolutely sound weld, it is possible to just make a good surface finish and leave the interior untouched. It is because this can and has been done that electric welding has been brought rather into disrepute.—RESEARCH.

Question No. 1,076.—What are the chief difficulties met with in single-phase commutator motors for railway work?

Answer to No. 1,076 (awarded 5s.).—The difficulties experienced with single-phase commutator motors for railway work have not necessarily been consequent upon their application to traction, but have rather been due to troubles peculiar to the motor itself. Various types of single-phase commutator motors have appeared from time to time, but a consideration of the three main types, shown

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diagrammatically in Figs. 1 to 4, will be sufficient to show the nature of the troubles and the methods of overcoming them. The chief troubles are commutation and sparking. The process of commutation is continually varying as the commutation starts at different points of the current wave; the difference of the short-circuit current at the beginning and end of commutation varies between zero and nearly double the maximum of the current wave.

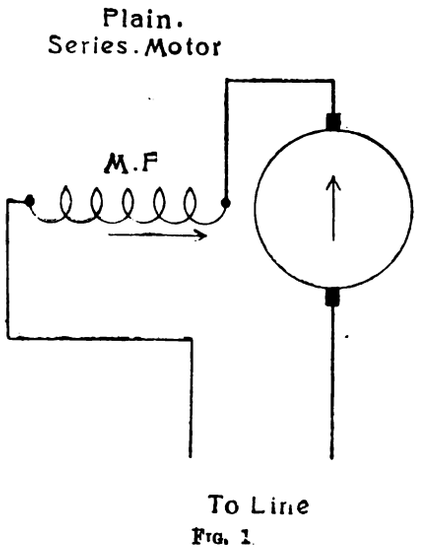

FIG. 1.

Sparking may be due to the reactance voltage, E_R, as in the case of a direct-current motor, but also to an induced voltage, E_1, in the short-circuited coil undergoing commutation and due to the transformer effect of the field. A third E.M.F., E_2, may be induced in the short-circuited coil by rotation in an outside field. The short-circuit current equals the geometrical sum of

$$\frac{E_R + E_1 + E_2}{R_1}$$

where R_1 equals the resistance of the short-circuited coil. To keep these E M F.'s down, or rather the value of the short-

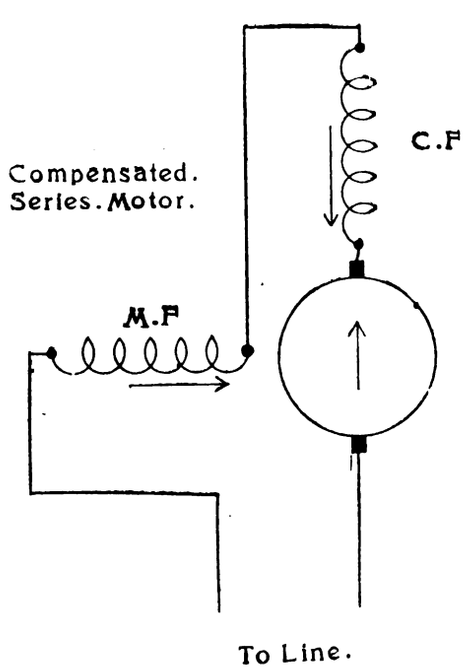

FIG. 2.

circuit current, they must be individually low, neutralise each other, or the resistance of the short-circuited coil must be high. The reactance voltage can be kept down by using a low voltage per commutator bar, short armatures, etc. The transformer effect of the field may be reduced by having as few turns per coil as possible, by inserting high resistances in the armature coils (the commutator connections often being made of some high-resistance alloy), or by making the main flux small.

FIG. 1 shows the simple series motor, or with compensating winding, C F, in Fig. 2, the arrows indicating the relative directions of the main flux, the compensating, and the cross flux. In the repulsion motor (Fig. 3) there are two extreme positions—one parallel to the axis of the stator flux, the other at right angles to it—where in the first case maximum current will be induced in the rotor but without producing torque, and in the second zero current and zero torque, since the flux due to the rotor currents

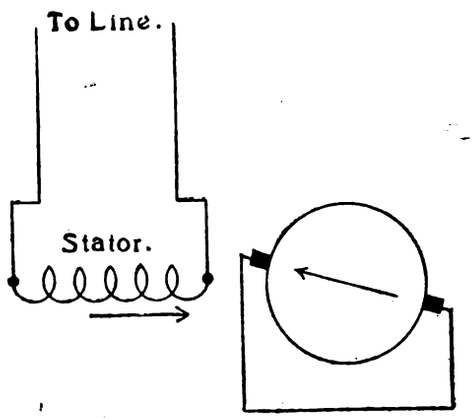

FIG. 3.

takes up a position parallel to the diameter which joins the brushes. A resultant of these two rectangular positions is found in practice (for position of maximum torque) to be some 20deg. from the axis of the stator flux, as represented by the diagram, and to which position the brushes must be moved. In Fig. 4 variation of the resultant flux angle can be effected without movement of the brushes. If the short-circuited brushes be placed parallel to the axis of the stator flux, and another set of brushes at right angles to them (for a two pole motor) fed from the variable secondary of a series transformer, then, by varying the current from the series transformer, the magnitude of the vertical component of the flux (dotted arrow) can also be varied, and thereby the angular displacement of the reluctant flux (full arrow). At or about synchronous speed the voltages E_1 and E_2 become equal and opposite, and thereby neutralise each other both in the repulsion and compensated repulsion motor. The repulsion motor differs from the series motor in possessing an elliptical

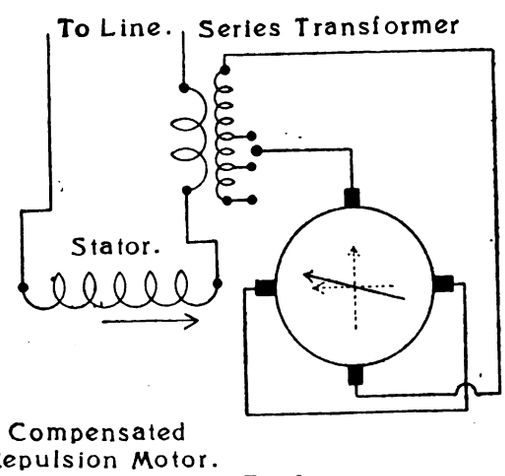

FIG. 4.

rotary field (composed of two fields) at all speeds, and the two component fields become equal and perpendicular to each other at synchronous speed, thereby forming a circular rotary field.—O. H. BRICKWELL.

[Other replies to Question No. 1,076 will be given in our next issue.—ED., *E. E.*]

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

If thou hast knowledge, let others light their candle at it

Under this heading we insert questions of a practical character relating to central-station working, tramway undertakings, construction work, and electrical finance. For each suitable question we offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any problem should be sent within ten days after the same has appeared. The replies should deal concisely with the points at issue, and should not exceed *about one thousand words in length*. Discursive answers are apt to be discarded, owing to the space they would occupy.

We would call the attention of our contributors to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper, and the source of all extracts and quotations from other authors must be acknowledged. Questions may be sent at any time.

QUESTIONS.

1,087. What are the chief items to take into consideration when estimating for the rewinding of armatures (direct current or alternating current) from 5 kw. to 1,000 kw.?—W. HINGLEY.

1,088. Please explain how an iron-cored single-phase alternator will work in synchronism with one which has no iron in core like the Mordey-Victoria alternator.—A. B. C.

ANSWERS.

Question No. 1,076.—What are the chief difficulties met with in single-phase commutator motors for railway work?

Best Answer to No. 1,076 (awarded 10s.).—The chief considerations in the design of a single-phase commutator motor for railway work are: (1) commutation, (2) power factor, (3) heating, and (4) starting torque. Of these, the first presents the greatest difficulty, and it is toward the improvement in the commutation of the single-phase motor (incidentally the improvement of the power factor also) that so much skill and invention has been displayed during the last few years.

The difficulty in obtaining good commutation in single-phase commutator motors may be briefly explained by a consideration of the voltages induced in the coils short-circuited by the brushes, which may be classed as: (1) The *reactance voltage*, due to the decrease and growth of the armature current in the short-circuited coils, similar to the reactance voltage in continuous-current motors, proportional to the armature current and speed. (2) The *transformer voltage*, induced in the short-circuited coils under the brushes by the alternating main field flux, the short-circuited coils under the brushes acting like a short-circuited secondary winding of a transformer, of which the field or stator forms the primary. It is evident that this voltage depends upon the frequency of supply and also upon the current input, but is independent of the speed, and lags 90deg behind the current and field flux. (3) The *rotation voltage*, due to the coils undergoing commutation cutting a flux which is in a direction tending to increase the short-circuit current, this flux being derived from magnetic leakage and the presence of iron in the vicinity of the commutating zone between the main pole-tips. This voltage is obviously in phase with the current, and is proportional to the speed of rotation. Its effect is, therefore, equivalent to an increase in the reactance voltage.

At starting the reactance and rotation voltages are zero, but we have present the transformer voltage, which may be calculated from

$$E_t = 4{\cdot}44\ T.M.\ \sim\ \times 10^{-2},$$

where E_t is the transformer voltage; T, the number of turns in series per commutator segment; M, the flux per pole in megalines; and $\sim$ the frequency of supply. The current generated by this voltage in the coils short-circuited by the brushes can be limited by adopting high-resistance brushes, covering not more than two commutator segments (since a wide brush will evidently give a larger short-circuit current, due to the increase of the short-circuited armature turns under the influence of the alternating flux), or by inserting resistances in the commutator connections. The latter procedure results in increased losses during starting and running, thereby increasing the temperature rise of the armature in service. The flux, M, cannot be diminished below certain limits, since it is productive of the starting torque of the motor. The starting torque, however, increases more rapidly with the current than the transformer voltage does, due to the increasing saturation of the magnetic circuit, so that by reducing the terminal voltage at starting a sufficiently high torque can be secured without unduly increasing the transformer voltage in the short-circuited coils.

When the motor is running under load all the above voltages are in operation, their resultant—*i.e.*, the "sparking voltage"—being given by

$$\sqrt{(\text{transformer voltage})^2 + (\text{reactance voltage} + \text{rotation voltage})^2}$$

The reactance voltage can be diminished by adopting a compensating winding on the stator in series with the armature, together with commutating poles.

The commutation of single-phase railway motors is practically the chief difficulty met with in their design and operation in service, and until this problem is satisfactorily solved the progress of the single-phase motor for railway work will always be more or less retarded, particularly as continuous-current traction motors with commutating poles are now being introduced for operation on fairly high voltage lines. The commutation difficulty also results in increased heating of the single-phase railway motor, due not only to sparking, but also to the means adopted for the suppression of the sparking—*e.g.*, high-resistance commutator connections—and this increased heating reduces the rated output from the motor (based upon thermal considerations), therefore necessitating a larger and heavier motor to perform the same service as a continuous-current traction motor.

It was mentioned above that the improvements relating to the commutation characteristics also effected an improvement on the power factor of the single-phase commutator motor. Considerations of power factor at once limits several important points in the design of these motors for railway work. For instance, in series motors the speed corresponding to the average load should be considerably greater than the synchronous speed (obtained from $\frac{\sim \times 120}{p}$, where $\sim$ is frequency of supply and p is the number of poles), in order to obtain a high power factor at this load, whereas, with a repulsion motor, this load should correspond to the synchronous speed of the motor. A simple expression for the power factor of the single-phase series motor has been given by Punga ("Single-Phase Commutator Motors," p. 95). Thus

$$\cos\phi\ (= \text{power factor} = \frac{1}{\sqrt{1 + \left(\frac{1}{a.b}\right)^2}},$$

where

$$a = \frac{\text{armature turns in series between brushes}}{\text{field turns per pole}},$$

and

$$b = \frac{\text{speed of rotation of armature in r.p.m.}}{\text{synchronous speed in r.p.m.}}.$$

In order to reduce the magnetising or wattless component of the current input, the magnetic saturation of the iron circuits of the motor must be kept low. A corresponding increase in the armature turns per pole is, therefore, necessary in order to obtain the requisite starting torque.

The considerations of power factor, therefore, result in a design which is not favourable from the commutation standpoint, which requires a relatively "strong" field and a "weak" armature, whereas that obtained from the above considerations is a "weak" field and a "strong" armature, and in order to obtain satisfactory commutation under such conditions compensating windings and commutating poles must be resorted to.

A further difficulty in connection with single-phase commutator motors is the low voltage of the armature, which is absolutely essential from sparking considerations in the case of the series motor. The low voltage of the armature is readily accounted for from the commutation standpoint,

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as this at once limits the number of turns per coil to the minimum value—viz, one turn per commutator segment—while the size and mechanical design of the commutator limits the number of commutator segments. With motor of 75 h.p. and over it is necessary, from considerations of sparking, to adopt a multiple-circuit winding for the armature, which, therefore, requires as many sets of brushes on the commutator as there are poles on the motor. The compensated repulsion motor requires twice as many sets of brushes as there are poles. The commutator losses and upkeep of the brushes must, therefore, be somewhat high.

We have, in the above discussion, briefly touched upon the cardinal points which present the chief difficulty in the design of the single-phase commutator motor, and, in conclusion, we would call attention to the diametrically opposed conditions required by considerations of commutation and power factor, which result in a complicated, costly, and somewhat unsatisfactory type of motor for railway work.—A. E. T.

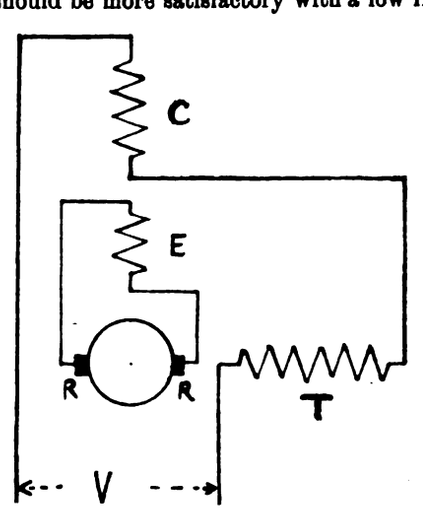
Answer to No. 1,076 (awarded 7s. 6d.).—The greatest difficulty encountered in the commutator type of alternating-current motors is that due to the unavoidable E.M.F. produced in the coil under the brush owing to the cyclic variation of the field magnetism. Consider the armature stationary, then it will be seen there is a transformer effect taking place owing to the field coils acting as primary and the armature coils under the brushes as secondary. Thus, on the armature rotating, the E.M.F. between one commutator segment and its neighbour is short-circuited, resulting in a large value for the current in this short-circuit, with consequent ill effects—viz., undue heating of coils, segments, and brushes, destructive arcing due to rupture of current. The transformer E.M.F. in the repulsion type of motor has been neutralised to a certain extent by a speed-generated E.M.F. when armature is rotating, while in other types special magnetising coils are used. One method employed to limit the short-circuit current is to introduce non-inductive resistance between the armature coil and its corresponding commutator segment, giving practically time phase between this current and transformer E.M.F. This resistance should be so chosen that the loss due to short-circuit current or that due to main current is not excessive, but reduced to a satisfactory minimum. It is due to the imperfect commutation at speeds much higher than 150 per cent. of synchronism that the repulsion motor is best adapted to slow-speed freight locomotive service.

The single-phase motor differs from the direct-current series motor in having two fields, the series or energising field and the compensating field, the latter being employed to neutralise the inductance of the armature produced by the alternating current therein. The compensating field winding may be short-circuited upon itself (inductively wound) or in series with armature windings (conductively wound). This latter is preferable when the motor is to be used both on direct current and alternating current. By such an arrangement of compensation the power factor may have an operating value from 94 per cent. upwards. The winding is distributed in the field face. In other cases the power factor is improved by making the field weak and the armature correspondingly strong, as for a certain current the field flux varies as the first power, and the reactance as the square of the field turns. Also a larger number of poles is used to improve power factor, owing to the magnetomotive force for producing the field flux being distributed throughout a large number of turns of few coils. It is seen that there is a limit to the number of poles; also in this case the machine will be larger and heavier than a direct-current series motor, and the question of ventilation will be seriously affected. The field-magnet structure must be laminated owing to the cyclic magnetisation due to the alternating current, thus increasing cost of machine. Generally, weight for weight, the single-phase alternating-current motor is twice as heavy as the direct-current motor, for it has been found that for a given capacity the alternating-current motor runs about 85lb. per horse-power and the direct-current series motor 35lb.-40lb. per motor. Owing to the fact that the single-phase motor is unsuited in itself for continuous rapid acceleration work, its efficiency of acceleration, about 72 per cent., has no considerable operative value, alternating-current experiments being used entirely upon roads calling for infrequent stops.—F. A. T.

Answer to No. 1,076 (awarded 5s.).—The chief difficulties to be met with in a single-phase traction motor of the commutator type are due to inferior commutation, which may be caused either by bad electrical design or faulty construction. The inherent troubles of single-phase traction motor design as compared with continuous-current motors have frequently been discussed in these columns. It may, however, be of advantage to indicate a few of the modern methods adopted to ensure satisfactory commutation.

Single-phase traction motors may be generally divided into two classes—*i.e.*, compensated series and compensated repulsion types. The former is represented by machines of the Westinghouse, Finzi, and Oerlikon types, and the latter by the Winter-Eichberg and Alioth-Fynn types. It must be remembered when dealing with single-phase motors that, whereas with the continuous-current motors it is only necessary to provide a compensating winding to balance a single reactance voltage, with the alternating-current motors it is required to compensate for two or three distinct voltages, each differing from one another both in magnitude and phase.

A few of the disadvantages met with in series-wound alternating-current motors are as follows: (*a*) It is absolutely necessary to employ a low frequency of supply in order that the impedance may be as low as possible; a reasonable number of turns must also be used in the stator field for the same reason. (*b*) The power factor is a maximum at no load and is somewhat inferior, irrespective of the frequency. This is due to the impedance of the stator field and armature winding, and the greater the value of the current flowing the more the current lags behind the supply pressure. (*c*) For the same reason the torque of the motor is limited at constant line pressure. (*d*) The motor should be designed to work at a pressure of about 200 volts or 250 maximum in order to avoid any trouble with the commutation. The heavy lagging currents with these motors, with the resultant armature reaction, causes a low power factor, and in order to improve this as much as possible the armature flux should be reduced to a minimum. The fact that the flux and armature reaction decreases with the frequency indicates that the motors of this class should be more satisfactory with a low frequency.



Some of the more important devices used to obtain satisfactory commutation, apart from the use of special brushes, are: (1) to provide resistance strips between the commutator segments and the armature conductors; (2) to employ two windings, each being alternatively in circuit; (3) a compensating winding of the distributed type, as originally used by Deri (this winding is placed in the stator slots in between the main poles of the motor, and compensates for the distortion of the main field due to armature reaction); (4) in order to prevent demagnetisation of the field, special slots are cut in the poles, as originally used by Lamme and Finzi.

The connections of an Alioth-Fynn motor are shown in the figure, which is typical of all repulsion motors of this class, where C is the main winding in series with the compensating winding, T, on the stator and E, the exciting

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winding, on the stator, which is connected to the rotor brushes, R. It will be noticed that the winding C is in quadrature as regards space to the compensating winding, and that the brush axis is in phase as regards space with the latter. The exciting winding, E, is, however, in phase as regards space (or practically so) with the winding, C, the two windings being actually in the same slots. It will, therefore, be seen that this winding is in quadrature as regards space to the winding T and the brush axis.

Special attention should be given to the design of the brush gear to ensure that there shall be no chattering or undue friction when subjected to excessive vibration, as usually met with in connection with traction work.—K.

Answer to No. 1,076 (awarded 5s.).—The chief drawbacks to the single-phase commutator motor for railway work may be summarised under the following heads: (1) power factor; (2) efficiency; (3) weight; (4) cost; (5) commutation; and (6) maintenance.

Power Factor.—This quantity, both in the series and repulsion types, increases with speed, but is very low under starting conditions. Hence the greater the number of stops per mile, the lower the average power factor of the system.

Efficiency.—This must of necessity be lower than for the equivalent continuous-current motor, owing to (*a*) iron losses in field due to alternating flux; (*b*) copper losses in compensation winding and resistance leads to commutator; (*c*) greater commutator friction and C^2R; (*d*) higher gear losses due to higher rotative speed. Further, the efficiency falls off within very narrow limits of load when running at constant potential. The electrical efficiency at rated load averages about 5 to 7 per cent. lower than the equivalent continuous-current motor.

Weight.—This is intimately connected with the question of efficiency. It is found that to attain the 75deg. rise in temperature in one hour (the standard basis of rating), the losses should be about 5,000 watts per ton weight. Comparing a single-phase motor with a continuous-current series motor of the same rated output, the electrical losses in the former approach double the value of those in the latter, hence either the weight must be relatively greater or the motor is not correctly rated. As a matter of fact, the single-phase motor will contain more iron—due to the necessary low saturation and laminated structure—and more copper for the compensating windings.

Cost.—This item will be seen from the last paragraph to be unfavourable to the single-phase motor. The following figures are due to Mr. A. H. Armstrong, of Schenectady: continuous-current railway motors with control equipment, £3 per rated horse-power; single-phase railway motors with control equipment, £5 per rated horse-power.

Commutation.—Sparking is admittedly the most detrimental feature, and is occasioned by the transformer E.M.F. set up in the short-circuited coil. This can only be effectually neutralised at one speed, and under starting conditions especially commutation is of necessity bad.

Maintenance.—The commutator of the railway motor probably requires more attention than any other part, hence it is that the question of maintenance is intimately connected with that of commutation. The voltage across brushes in a single-phase motor has to be kept down to half the value usual in a continuous-current motor of the same rating. This means that armature rating and length of commutator will be doubled, and there will be double the commutator surface requiring attention.

Armature coils will require more frequent replacement, due to burn-outs, from the heavy induced currents. The higher rotative speeds render the bushes and pinions liable to more rapid deterioration.—E. V. P.

Question No. 1,077.—Describe Frahm's frequency indicator. One of these indicators is in use on a 50 ~ supply, single-phase. If the frequency be increased, say, from 49, the vibrations of the reeds die away on reaching 50, increasing again at about 51. On the frequency being reduced, all the reeds respond over the above range. Give cause of this.

Answer to No. 1,077 (awarded 7s. 6d.).— The Frahm speed and frequency indicator is based on the employment of the principle of resonance, which, as is well known, is the property that elastic bodies possess of being set in vibration if they are subjected to periodic impulses, the frequency of which corresponds to the natural period of vibration of the bodies themselves. In this particular instrument the vibrating bodies consist of springs of best watch-spring steel, the dimensions for ordinary purposes being 1½in. to 2in. long, ⅛in. wide and ·01in. thick, each spring being set in a slit cut in a small rectangular shoe to which it is firmly pinned and soldered, as shown in Fig. 1. At the upper end each spring is bent over at right angles for about ⅛in., and the head thus formed is covered with white enamel to render it easily visible. In the angle which the head makes with the stem of the spring a small drop of solder is placed. Each spring is, to all practical purposes, of the same cross-section, and, therefore, the frequency of the vibrations to which any one spring will respond depends only on the length of the stem and the weight of head. By varying the weight of head by altering the mass of solder attached, the springs can be readily adjusted to

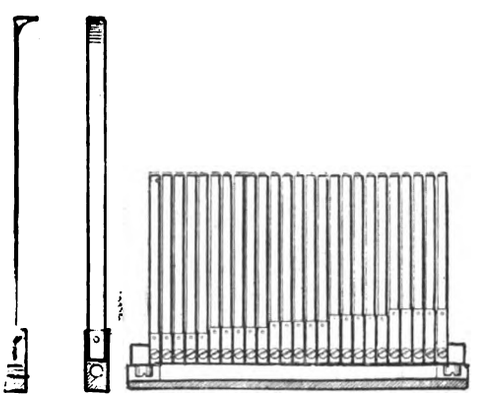

FIG. 1. FIG. 2.

correspond to the correct frequency. Thus, a spring of the dimensions given above can be adjusted to respond to any frequency between 35 and 100 cycles per second simply by altering the mass of solder fixed in the angle at the head.

Fig. 2 shows the manner in which the springs are arranged in an instrument. They are screwed to a brass rod ¼in. square, supported at each end by a steel strip screwed to supporting feet, so that the "bridge" to which the vibrating springs are attached is free to vibrate in a plane at right angles to that in which the springs themselves vibrate. A number of springs arranged in this way will be sensitive as regards any vibration communicated to the "bridge" to which they are attached, and the particular spring whose period of vibration corresponds to that of the vibration communicated will respond. By calibrating the springs so that the natural period of vibration of each differs by an equal amount from that of its adjoining

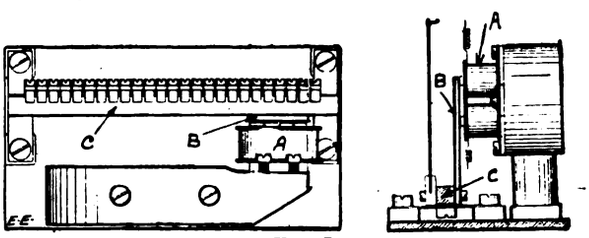

FIG. 3.

members, we possess an arrangement which can be utilised to read either speed or frequency. The speed of any machine having a rotating member can be readily determined by placing a piece of apparatus, such as described above, upon a part of the frame subjected to the slight vibration always occurring even in the most perfectly-balanced machines.

For a frequency indicator an electrical vibrator has to be added, as shown in Fig. 3. This consists of an electromagnet, A, which causes an iron armature, B, fixed to the "bridge," C, to vibrate. The coils of this electromagnet are connected in series with a resistance across the lines the frequency of which it is desired to determine. In this way the frequency of the vibrations communicated to the "bridge," C, will correspond to the frequency of the lines. Fig. 4 gives a picture of a frequency indicator with the cover removed, such as described above, and it shows the way in which the springs vibrate when the instrument is connected in circuit. Of course, the spring which most

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nearly corresponds to the applied frequency will vibrate with the maximum amplitude, but as the difference in the natural period of vibration between adjoining springs is slight, the springs immediately adjoining the responding spring will also vibrate, but with much decreased amplitude.

As to the phenomenon referred to in the latter part of the question, it would seem to indicate that the springs in the particular instrument referred to are adjusted so that the difference in the frequencies at which any two adjacent ones respond is two cycles per second. That is, supposing that a certain spring, *a*, is adjusted to respond at 49 cycles per second, the adjoining ones, *b* and *c*, would respond at 47 and 51 cycles per second respectively. On this assumption—it is pure assumption, however—we can explain the phenomenon observed, for if the frequency be adjusted to 49 ~ spring *a* would vibrate with maximum amplitude, and on increasing the frequency to 50 ~ this amplitude would decrease whilst the amplitude of spring *c* would increase, increasing and attaining its maximum amplitude when the frequency has reached 51 ~, the frequency for which it has been tuned.

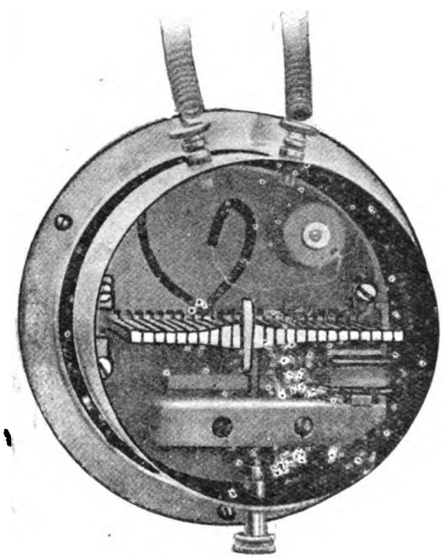

FIG. 4.

The sensitiveness of an instrument of this type simply depends on the number of springs used—that is, supposing 100 springs are used over a range of 50 cycles per second, then such an instrument would respond absolutely to differences of one-half a cycle per second. For ordinary commercial use, however, an instrument tuned to give a two-cycle per second difference between adjacent springs would give indications sufficiently accurate.

In conclusion, it must be added that the Frahm speed and frequency indicator is manufactured and supplied by W. Lucy and Co., Limited, of Oxford, and the description of this instrument substantially as given above is taken from their very lucid pamphlet describing these instruments, from which the illustrations and diagrams given above are also taken.—A. P. YOUNG.

Answer to No. 1,077 (awarded 5s.).—The principle underlying the construction of the Frahm speed or frequency indicator is based on the employment of the principle of resonance, this being the property that elastic bodies possess of being set in vibration if they are subjected to rhythmic impulses, the frequency of which corresponds with the natural period of vibration of the bodies themselves. The fundamental part of the Frahm frequency indicator consists of a spring of steel or other elastic material about 2in. long and $\frac{1}{8}$in. wide, being bent at the top and weighted by means of a small drop of solder. The number of vibrations such a spring will make depends primarily on the length of the vibrating part and the weight at the head, as it is made of a material as uniform as possible in quality and thickness. Thus, by arranging a number of such springs, each of different tuning, clamped rigidly at the base by a supporting shoe, a range of frequency proportional to the number of springs is obtained.

Fig. 1 shows such an arrangement. The comb thus formed is fixed on two end plates of springy material screwed to supporting feet, so as to permit the bridge to have a small vibrational movement at right angles to its axis. Since it is necessary to produce vibrations (corresponding with those to be measured) on the springs so arranged, an electromagnet is arranged as in Fig. 2, the

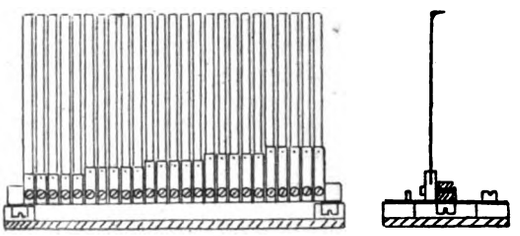

FIG. 1.

armature of which is fixed on the bridge of the comb and parallel to the springs. If, now, an alternating current is passed through the coils, the armature will be regularly attracted and repelled, so that the comb is made to vibrate in correspondence with the frequency of the current. All the springs are made to quiver slightly, and that particular spring whose natural period of

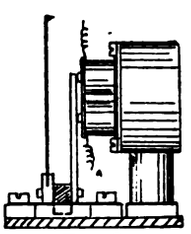

FIG. 2.

vibration is most nearly in unison with the actuating impulses will be thrown in very strong vibration, its amplitude depending on the more or less close agreement of its natural period with that of the actuating device. This is probably the reason that when changing the frequency the whole series of springs is affected, a stable condition being obtained when the frequency becomes

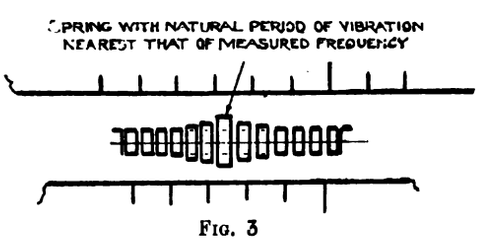

FIG. 3

constant. Should the actual number of vibrations be exactly in synchronism with the natural period of the spring, then the amplitude will reach its maximum. Under working conditions the springs appear as shown in Fig. 3, the centre one of the group having the greatest vibration indicating on the scale the frequency measured, the movement of the adjacent springs dying down gradually

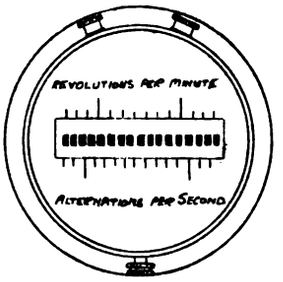

FIG. 4

as shown, hence a variation of 2 per cent. in the tuning of adjacent springs is necessary to give a clear reading. Fig. 4 shows the appearance of the instrument manufactured by Messrs. W. Lucy and Co., of Oxford.—Y.

[Other replies to Question No. 1,077 will be given in our next issue.—ED., *E. E.*]

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